SOUTH KINGS
GROUNDWATER SUSTAINABILITY AGENCY

Groundwater Sustainability Plan

Public Review Draft

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Prepared for:
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Fresno County, CA

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LIMITATION

In preparation of this Groundwater Sustainability Plan (Plan), the professional services of Provost & Pritchard Consulting Group were consistent with generally accepted engineering principles and practices in California at the time the services were performed.

Judgments leading to conclusions and recommendations were made based on the best available information but are made without a complete knowledge of subsurface geological and hydrogeological conditions. This Plan is intended to provide information from readily available published or public sources. We understand that the interpretations and recommendations are for use by the South Kings Groundwater Sustainability Agency (SKGSA) in assisting the GSA in making decisions related to potential water supplies and groundwater management activities in light of California's new and evolving Sustainable Groundwater Management Act (SGMA) regulations. Subsurface conditions or variations cannot be known, or entirely accounted for, in spite of significant study and evaluation. Future surface water and groundwater quantity, quality, and availability cannot be known. Trends have been estimated and projected based upon past historical data and events and are used for planning purposes. It should be noted that historic trends may not be indicative of future outcomes. Historic hydrology has been used to identify averages and potential extremes that may be experienced in future years; however, it will be important for the GSA to continually evaluate all the parameters that make up the agency water budget. Additionally, the rapidly changing regulatory environment surrounding the SGMA and State regulatory agencies may render any or all recommendations invalid in the future if not implemented and necessary approvals, permits, or rights obtained in a timely manner. Information contained in this GSP should not be regarded as a guarantee that only the conditions reported and discussed are present within the SKGSA or that other conditions may exist which could have a significant effect on groundwater availability.

In developing our methods, conclusions, and recommendations we have relied on information that was prepared or provided by others. We have assumed that this information is accurate and correct, unless noted. Changes in existing conditions due to time lapse, natural causes including climate change, operations in adjoining GSAs or subbasins, or future management actions taken by a GSA may deem the conclusions and recommendations inappropriate. No guarantee or warranty, expressed or implied, is made.

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Abbreviations

AF	Acre-Foot
AFAD	Acre-Feet Per Acre Per Day
AFY	Acre-Foot Per Year
bgs	Below Ground Surface
CASGEM	California Statewide Groundwater Elevation Monitoring
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
cfs	Cubic Feet Per Second
CID	Consolidated Irrigation District
CKGSA	Central Kings Groundwater Sustainability Agency
Coalition	Kings River Water Quality Coalition
CSD	Community Service District
CVP	Central Valley Project
CV-SALTS	Central Valley Salinity Alternatives for Long Term Sustainability
CWC	California Water Code
DAC	Disadvantaged Community
DBCP	1,2-Dibromo-3-chloropropane
DDW	Division of Drinking Water
Del Rey	Del Rey Community Service District
DMS	Data Management System
DQO	Data Quality Objective
DTSC	Department of Toxic Substance Control
DWR	(California) Department of Water Resources
E-Clay	Corcoran Clay
EDB	Ethylene-Dibromide
EPA	Environmental Protection Agency
ET	Evapotranspiration
FCEHD	Fresno County Environmental Health Department
FID	Fresno Irrigation District
FMFCD	Fresno Metropolitan Flood Control District
Fowler	City of Fowler
GAC	Granular Activated Carbon
GAMA	Groundwater Ambient Monitoring and Assessment
GC	Government Code

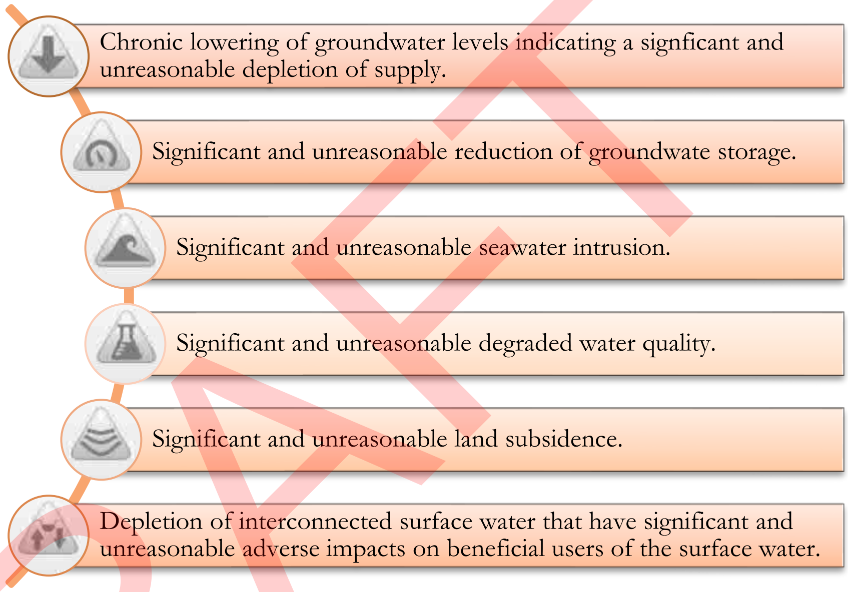
GDE	Groundwater Dependent Ecosystem
GPD/FT	Gallons Per Day Per Foot
GPS	Global Positioning System
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HCM	Hydrogeological Conceptual Model
ILRP	Irrigated Lands Regulatory Program
InSAR	Interferometric Synthetic Aperture Radar
IRWMP	Integrated Regional Water Management Plan
JPA	Joint Powers Agreement
KDSA	Kenneth D. Schmitt & Associates
Kings Subbasin	Kings Groundwater Subbasin
Kingsburg	City of Kingsburg
KRCD	Kings River Conservation District
KRI	Kings River for Irrigation
KRWA	Kings River Water Association
LSA	Lake and Streambed Alteration
M&I	Municipal & Industrial
MCL	Maximum Contaminant Level
µg/L	Micrograms Per Liter
mg/L	Milligrams Per Liter
MGD	Million-Gallon-Per-Day
MSL	Mean Sea Level
MTBE	Methyl-Tert-Butyl-Ether
NASA	National Aeronautics and Space Administration
NC Dataset Viewer	Nature Conservancy's Natural Communities Dataset Viewer
NGS	National Geodetic Survey
NRCS	Natural Resource Conservation Service
Parlier	City of Parlier
pCi/L	Picocuries/Liter
PG&E	Pacific Gas & Electric Company
Program	Kings River Fisheries Management Program
pTu	Basement Complex
Qb	Quaternary Flood-Basin Deposits
Qoao	Quaternary Older Alluvium

Qsd ... Quaternary Sand Dunes
QTc ... Quaternary and Tertiary Age Continental Deposits
Qya ... Quaternary Younger Alluvium
RWQCB ... Regional Water Quality Control Board
Sanger ... City of Sanger
SGMA ... Sustainable Groundwater Management
SJRRP ... San Joaquin River Restoration Project
SKF ... Selma-Kingsburg-Fowler
SKGSA ... South Kings Groundwater Sustainability Agency
SWRCB ... State of California Water Resources Control Board
TCP ... 1,2,3-Trichloropropane
TDS ... Total Dissolved Solids
USACE ... US Army Corps of Engineers
USBR ... United States Burau of Reclamation
USGS ... United States Geological Survey
UWMP ... Urban Water Management Plan
WHPA ... Wellhead Protection Area
WSIP ... California Water Commission's Water Storage Investment Program
WWTP ... Wastewater Treatment Plant

Executive Summary

Section 1 Introduction

On September 16, 2014, Governor Jerry Brown signed into law a three-bill legislative package, composed of AB 1739 (Dickinson), SB 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act of 2014 (SGMA), which is codified in Section 10720 et seq. of the California Water Code. This legislation created a statutory framework for groundwater management in California that can be sustained during the planning and implementation horizon without causing undesirable results in the six categories shown to the left.



The location of the South Kings GSA (SKGSA) area is more than 100 miles from the ocean, therefore seawater intrusion or use (as a supply) is not anticipated or feasible, respectively; therefore, seawater intrusion is not discussed significantly in the rest of this GSP.

SGMA requires governments and water agencies of high and medium priority basins to halt groundwater overdraft and bring groundwater basins into balanced levels of pumping and recharge. Under SGMA, these basins should reach sustainability within 20 years of implementing their sustainability plans. For critically over-drafted basins, including the Kings Subbasin, the deadline for achieving sustainability is 2040.

The SKGSA is a Joint Powers Authority (JPA) formed for the purpose of developing and implementing the Groundwater Sustainability Plan (GSP). The members include the cities of Fowler, Kingsburg, Parlier and Sanger and the Del Rey Community Services District. The SKGSA is governed by a five-member Board of Directors where the Directors are typically elected or appointed officials from the member agencies.

The sustainability goal of the Kings Basin and the SKGSA is to ensure that, by 2040, the basin is being managed in a sustainable manner to maintain a reliable water supply for current and future beneficial uses without experiencing undesirable results.

Section 2 Plan Area

The Kings Groundwater Subbasin (Kings Subbasin) is in the southern part of the San Joaquin Valley with most of the subbasin surface water being supplied from the Kings and San Joaquin Rivers. The Kings Subbasin boundary is defined in the Department of Water Resources (DWR) Bulletin 118 as DWR Subbasin No. 5-22.08.

The SKGSA boundary encompasses the city and district limits of the member agencies, on the San Joaquin Valley floor in the County of Fresno. The location of the SKGSA and the other GSAs within the Kings

Subbasin are shown in **Figure ES-1.** The SKGSA area boundaries are coterminous with the city and district boundaries but do not encompass their individual spheres of influence. There is no overlap among the seven GSA boundaries and there are no adjudicated areas in the groundwater basin.

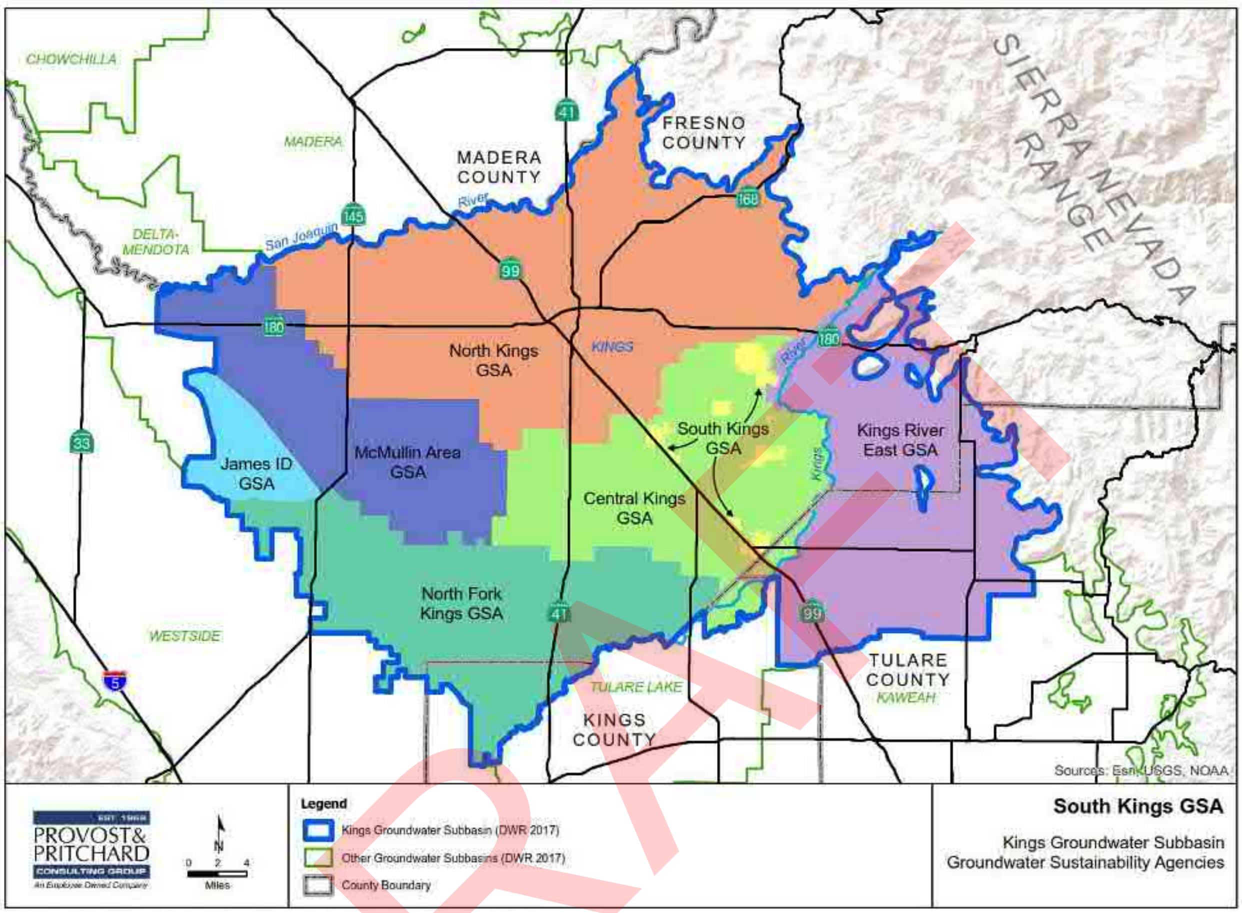


Figure ES-1: Kings Subbasin Groundwater Sustainability Agencies

Figure ES-1 also shows the five Groundwater Subbasins bordering the Kings Subbasin including the Madera Subbasin, Kaweah Subbasin, Tulare Lake Subbasin, Westside Subbasin, and Delta-Mendota Subbasin. The easterly boundary of the Kings Subbasin is the contact with the foothills—generally the 300-ft elevation-- of the Sierra Nevada mountain range.

The South Kings Groundwater Sustainability Plan has the same area as the South Kings Groundwater Sustainability Agency, as shown in **Figure ES-1**. The Plan area boundary is coterminous with the city limits of the four cities (Kingsburg, Fowler, Parlier, Sanger) and the district boundary of the Del Rey Community Service District within the eastern portion of the Kings Subbasin. Six other GSAs together with SKGSA form the boundary of the Kings Subbasin. The SKGSA Plan area is approximately 9,877 acres. The agencies within the GSP do not own surface water facilities but are instead connected, in some portions, to the surface water facilities of the Central Kings Groundwater Sustainably Agency (CKGSA), specifically Consolidated Irrigation District. The agencies do own and operate municipal or quasi-municipal community water facilities throughout their boundaries and several private wells are used in the rural and semi-rural areas throughout the GSA.

The majority of the SKGSA's acreage are utilized by residential or commercial uses, with only 1,438 acres operating in agricultural production. The five agencies rely on groundwater for their water supply and will acquire surface water supplies to recharge the underlying groundwater basin to offset their extraction impacts.

The SKGSA has drafted an agreement with the CID for firm surface water deliveries to be utilized for recharge activities; the agreement provisions for annual deliveries with a five-year rolling average of the firm water supply to account for possible dry years. Some of those activities may utilize existing or future CID facilities; however, the SKGSA agencies will be pursuing their own recharge facilities, as discussed in more detail in **Section 6**. The soils that underlie the GSA boundary generally consist of sands and gravels and are conducive to intentional recharge activities.

Section 3 Basin Setting

Hydrogeologic Conceptual Model

The purpose of a Hydrogeologic Conceptual Model (HCM) is to provide an easy to understand description of the general physical characteristics of the regional hydrology, land use, geology, geologic structure, water quality, principal aquifers, and principle aquitards in the basin setting. Once developed, an HCM is useful in providing the context to develop water budgets, monitoring networks, and identification of data gaps. An HCM is not a numerical groundwater model or a water budget model. An HCM is rather a written and graphical description of the hydrologic and hydrogeologic conditions that lay the foundation for future water budget models. In addition, this HCM supports and provides the hydrogeologic setting to support the Groundwater Conditions and Water Budget of this GSP. The narrative HCM description provided in this chapter is accompanied by graphical representations of the South Kings GSA portion of the Kings River basin that have attempted to clearly portray the geographic setting, regional geology, basin geometry, and general water quality. This HCM has been prepared utilizing published studies and resources and will be periodically updated as data gaps are addressed, and new information becomes available.

The Kings Subbasin is an alluvial basin bounded north and south by the San Joaquin and Kings Rivers, respectively. To the east, the subbasin is bounded by the Sierra Nevada foothills and . by the Delta Mendota and Westside Subbasins to the west.

As shown in **Figure ES-1**, the SKGSA area is located to the east of the center of the Kings Subbasin, which is located in the approximate center of the San Joaquin Valley. The Kings Subbasin is bounded by the foothills of the Sierra Nevada mountains on the east, which define the eastern boundary of the alluvial groundwater aquifer system, and by the San Joaquin River on the north. The major features that affect groundwater flow are the San Joaquin River and the basement complex of the Sierra Nevada Mountains (i.e., bedrock). Minimal amounts of groundwater flow into the SKGSA through fractures in bedrock.

The basement complex of the Sierra Nevada and the seepage loss along the San Joaquin River under natural conditions affect the direction of flow in the region as groundwater flows away from both features. The groundwater flows to the southwest away from the Sierra Nevada Mountains towards the axial trough of the valley. Additionally, seepage from the San Joaquin River, and the recharge ridge associated with seepage loss from the river, induce groundwater to flow away from the river to the south and southwest. Numerous groundwater depressions have also developed as aquifer usage has increased over time, which can cause the direction of groundwater flow to vary locally, but the dominant direction of groundwater flow in the region remains southwest.

Soils within the Kings Subbasin can vary significantly. In general, coarser grained soils are found along the eastern portions of the subbasin and adjacent to the San Joaquin River and Kings River, as well as areas associated with recent alluvial deposition along intermittent streams. Finer grained soils are typically found in the area of the compound fan created by intermittent streams in the east and are also found in the western areas of the Subbasin near the Fresno Slough. In general the dominant topsoil textural class in the SKGSA area is moderately coarse (**Figure ES-2**). The map was prepared using soil textural classes from the Natural Resource Conservation Service (NRCS). Patches of coarse soils that regionally trend southwest-northeast are present in much of the GSA area and represent recent alluvial deposits along the area's streams and rivers. Pockets of medium-grained to moderately fine-grained soils have been mapped in Sanger and Del Rey.

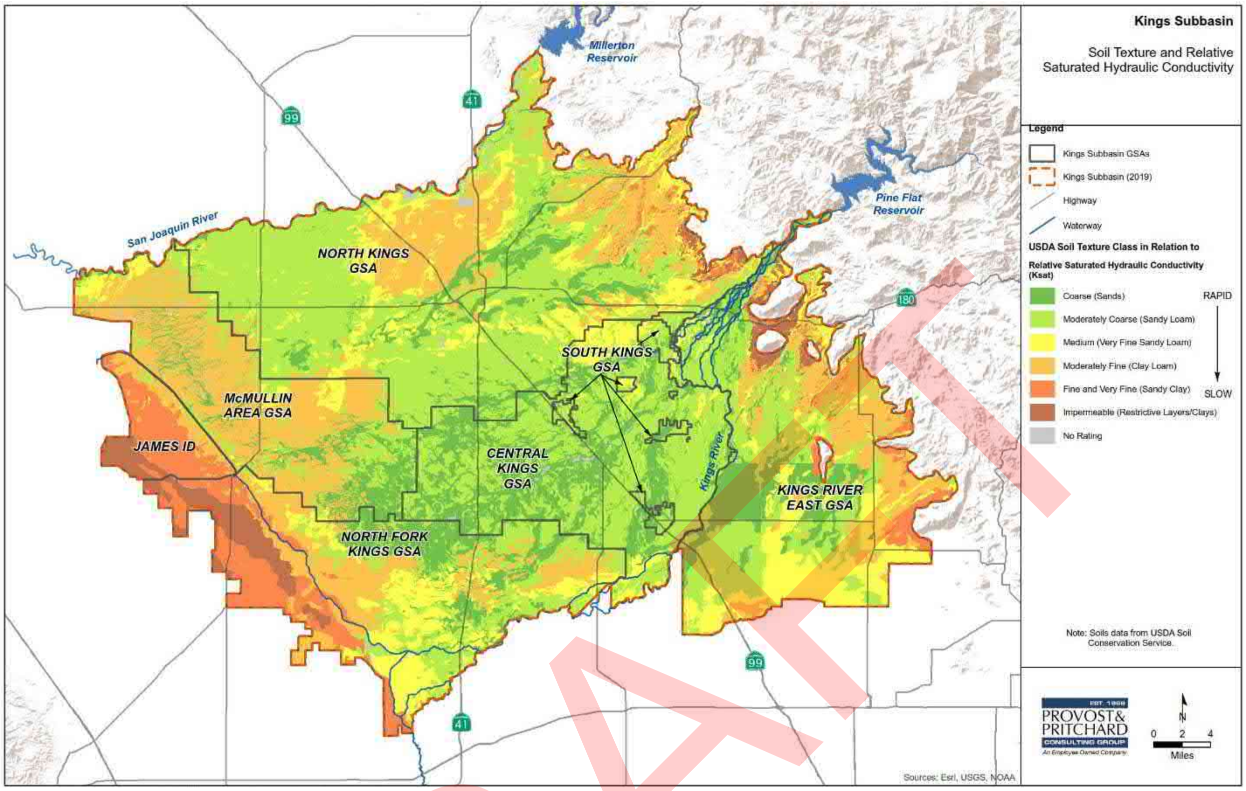


Figure ES-2: Kings Basin Soil Texture and Saturated Hydraulic Conductivity

In this figure, soil textural classes have additionally been related to Saturated Hydraulic Conductivity (Ksat or hydraulic conductivity) based on NRCS general categories. For the SKGSA area, the NRCS has generally described soils to depths of 5 to 7 feet. The hydraulic conductivity values shown on the map are expressed in general terms ranging from relatively rapid for coarse grained topsoils to relatively slow for moderately fine-grained topsoil. Duripan soil horizons (i.e., hardpan), have, for the purposes of this document, been assumed to have largely been broken up through deep tillage related to historical agricultural operations throughout the area.

Groundwater Conditions

Unconfined groundwater conditions extend across essentially the entire Kings Subbasin. Within the western portions of the subbasin, lacustrine and marsh deposits including the well-known regional clays, interbed with more coarse-grained alluvium. Historically, confined groundwater conditions existed below these regional clays, which have been identified as the A, C, and E clays. Currently, confined groundwater conditions still exist below the E and C clays. Groundwater below the A clay no longer appears to be confined. These clays are highly impermeable and restrict the vertical movement of water between more permeable beds wherever they occur. The most extensive and hydrologically important of these aquitards is the E-clay, commonly known as the Corcoran Clay, which is present beneath the approximate western third of the Kings Subbasin, where the depth to the top of the Corcoran Clay ranges from approximately 350 to 550 feet.

Figure ES-3 shows the Spring 2017 groundwater surface elevation contours and general direction of unconfined groundwater flow in the Kings Subbasin for the seasonal high condition. In general, groundwater flow is to the southwest within nearly the entire subbasin with a few notable exceptions where municipal and irrigation pumping in parts of the Kings Subbasin have influenced the direction of groundwater flow or the influence of recharge from basins and the major rivers can be seen.

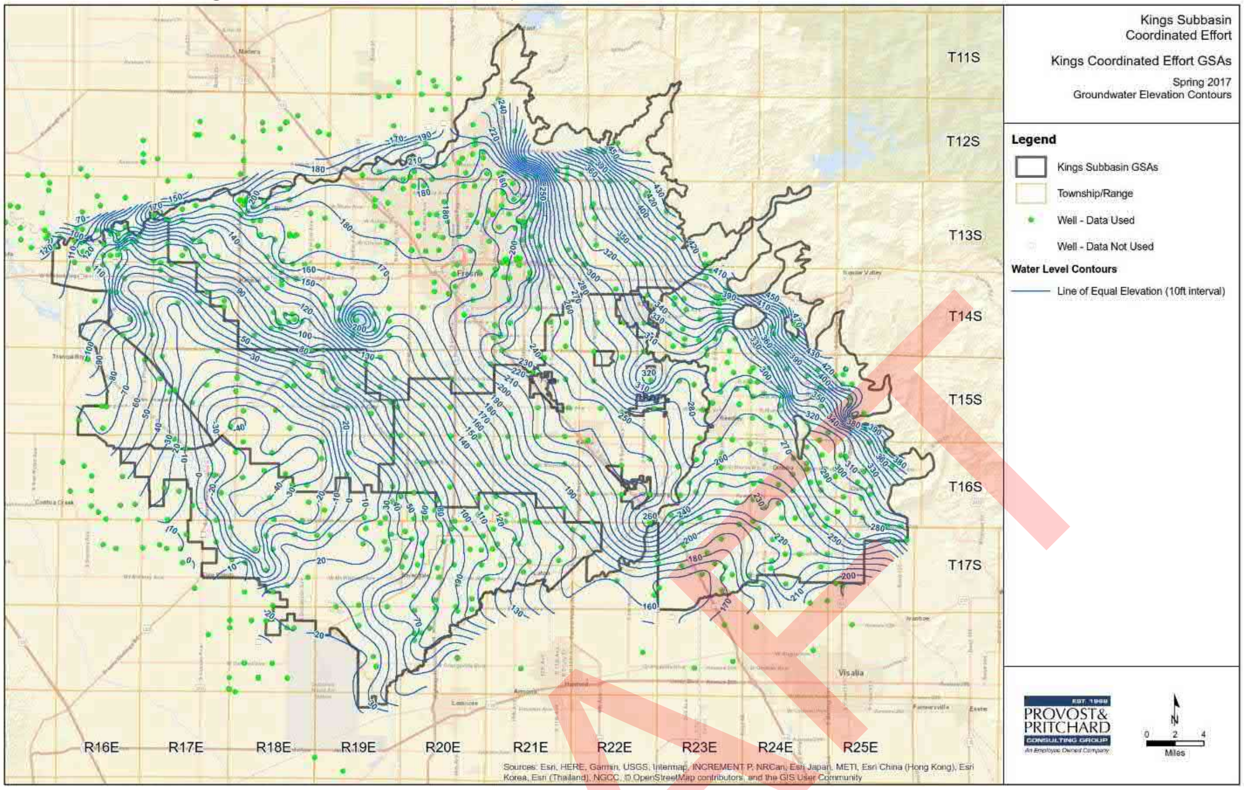


Figure ES-3: Groundwater Surface Elevation Contour Map (Spring, 2017)

In the Fresno-Clovis metropolitan area, an urban cone of depression is located north-northeast of the intersection of Highways 180 and 41 and has caused changes in the generally southwesterly groundwater flow direction as groundwater now moves toward the cone of depression under the urban area. There is also a general increase in groundwater gradient apparently associated with the finer grained deposits of the compound fan of intermittent streams south of the Kings River in the eastern portion of the Kings River East GSA.

In the west-southwest part of the subbasin, the lack of surface water supply combined with decades of agricultural pumping has influenced the natural direction of groundwater flow and created a cone of depression through the middle portion of McMullin GSA and the central portions of North Kings River GSA. The cone of depression has caused changes in the general flow direction and gradients as unconfined groundwater now moves toward the cone of depression from adjacent areas west of the Subbasin and southeast through McMullin GSA. Groundwater east of the Kings River in the Kings River East GSA flows southwesterly near the mountains and to the south-southeast near the Kings River.

Under natural flow conditions, the dominant flow direction in the Kings Subbasin was southwest, roughly perpendicular to the Sierra Nevada and towards the trough of the valley. The San Joaquin and Kings Rivers were historically locations of groundwater discharge and within about 2 to 4 miles of them groundwater flow deviated from the regional southwest direction and flowed towards them. The rivers and Fresno Slough being areas of groundwater discharge were thus gaining streams. Once pumping lowered water levels sufficiently, the San Joaquin and Kings Rivers, for the most part, became losing streams and groundwater started flowing away them.

Groundwater Levels

Depth to groundwater in the northeast side of the SKGSA is approximately 60 feet below ground and gets as low as about 75 feet below ground on the southwest side of Fowler. Higher water levels in Sanger are likely due to its proximity to the Kings River, which recharges the groundwater system through seepage.

The SKGSA used the same wells discussed in **Section 4** for groundwater level monitoring to track and report groundwater depth trends. The periods of record for these wells extend from the 1960s to 2019. One well near each city within SKGSA was chosen to represent groundwater levels for the respective areas. Long term rate of decline for each of the wells ranged from 0.15 feet per year to 0.40 feet per year, with an average rate of decline at 0.30 feet per year for SKGSA. Each of the Spring measurements for the five wells were averaged to create an average depth to water hydrograph for SKGSA, presented as **Figure ES-4**.

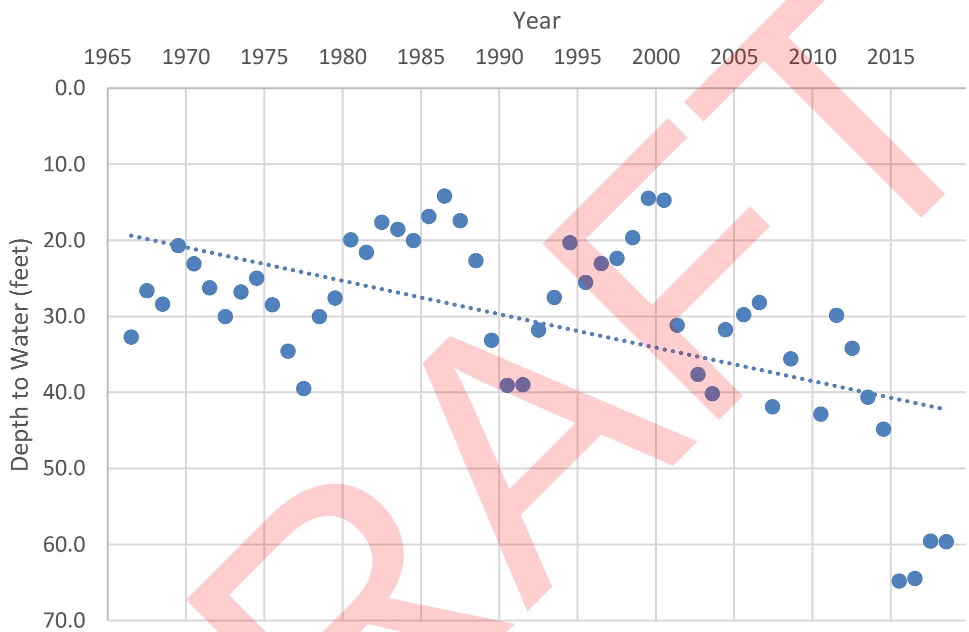


Figure ES-4: Average Depth to Water Measurements (Spring)

Groundwater Quality

Groundwater quality in SKGSA is generally suited for irrigation and domestic use, although there are a few groundwater issues for drinking water that exist. The water is generally described as being a calcium bicarbonate-type water but can also include magnesium, and sodium as the dominant cation. Typical water quality concerns throughout the basin include Nitrate, Arsenic, total dissolved solids (TDS), Dibromochloropropane (DBCP), 1,2,3-Trichloropropane (TCP), Methyl-Tert-Butyl-Ether (MTBE), and Uranium. While some of these constituents are caused by humans, several are naturally occurring.

Land Subsidence

One category of land subsidence occurs when groundwater levels decline due to excessive withdrawals of groundwater. There are two types of within this category of subsidence: elastic and inelastic. Elastic subsidence is recoverable if water levels later rise while inelastic subsidence is permanent. Although there are several causes of inelastic land subsidence, the compression of clay because of groundwater extraction from confined aquifers is the cause of the vast majority of subsidence documented in the San Joaquin Valley, west of the SKGSA. This results in compaction of fine-grained confining beds (clays) above and within the confined aquifer system as water is removed from pores between the sediment grains. Most of the permanent subsidence in the San Joaquin Valley has historically been correlated to overdraft in the confined aquifer below the Corcoran Clay. However, with increased reliance on groundwater to meet demands, land subsidence is currently occurring in areas outside of the Corcoran clay. Even though subsidence is now occurring in areas outside of the Corcoran clay, the relative amount is less than the historical subsidence in areas underlain by the Corcoran Clay.

Land subsidence was first monitored from the 1920s to 1970s when there was less access to surface water. Subsidence monitoring decreased after the 1970s when there was more access to surface water due to the canals and water storage projects built in California and less reliance on groundwater to meet demands. Monitoring land subsidence increased again in the 2000s. Data from 2013 to 2017 was used to evaluate the land subsidence in the SKGSA area. Data sources include KRCD and NASA InSAR (Interferometric Synthetic Aperture Radar) data provided by DWR. **Figure ES-5** shows NASA InSAR data provided by DWR from May 2015 to April 2017. The legend shows the change in ground surface elevation and provides the most thorough aerial extent coverage of the GSA. There is minimal subsidence shown in the SKGSA area during this period. According to NASA InSAR data, the majority of the GSA has experienced zero to one inch of subsidence over the two years.

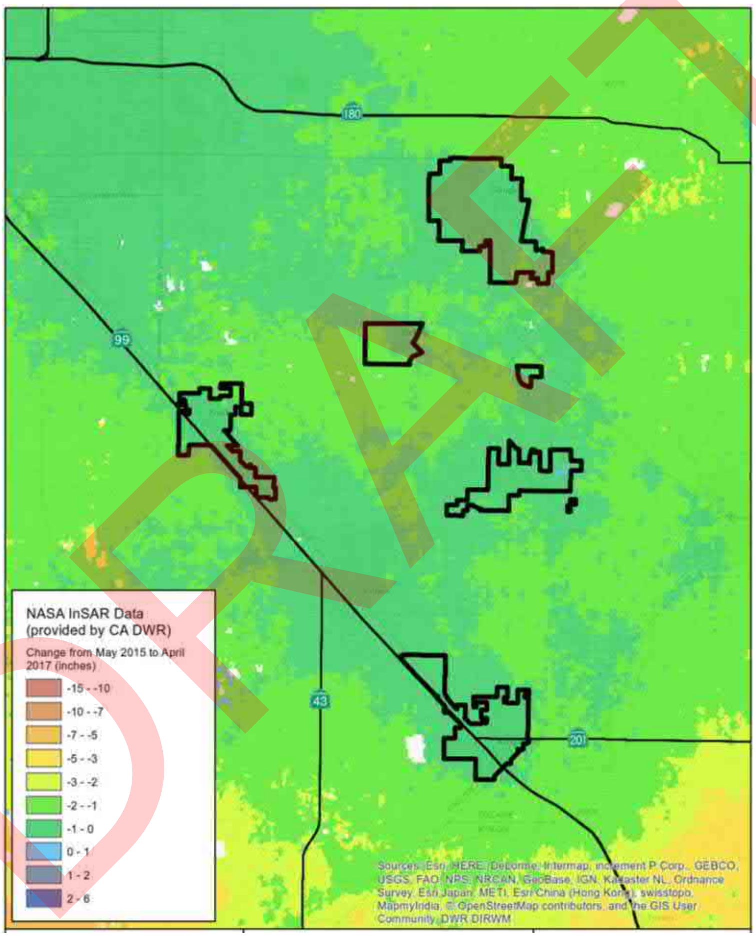


Figure ES-5: Land Subsidence for South Kings 2015 to 2017 (NASA)

Water Budget

A water budget is an accounting of all the water that flows into and out of a specified area and describes the various components of the hydrologic cycle. A water budget includes all the water supplies, demands, modes of groundwater recharge, and non-recoverable losses, making it possible to identify how much water is stored in a system and changes in groundwater storage during a given period. Aggregated water budgets have been prepared for the entire Kings Subbasin as well as detailed water budgets for the SKGSA and CKGSA combined. The water budgets for SKGSA and CKGSA were prepared in a combined manner due to the geographic positioning of the SKGSA being wholly within the CKGSA.

Water budgets were prepared for a historic period (1997-2011), current period (2016-2017) and future periods (2040 and 2070). The current water budget shows that the combined SKGSA/CKGSA is nearly, but not quite sustainable without an additional 1,100 acre-feet per year (AFY) in additional recharge; further, the combined area will require approximately 15,100 AFY by 2040 to remain sustainable. SKGSA and CKGSA determined the overdraft responsibility for each of the GSAs by estimating their Groundwater Impact, which is essentially their groundwater pumping minus any natural and artificial forms of recharge. Based on these discussions, an agreement was drafted for SKGSA to account for approximately 42 percent of their groundwater extraction in recharge projects or through purchasing water from CKGSA. The SKGSA anticipates recharging an annual average of approximately 8,000 AF, based on population projections through 2040. As the member agencies grow and water use changes, that number may change and will increase after 2040. Future water budgets beyond 2040 are based on assumption likely to require modifications as time progresses including population changes, conservation measures, boundary flows and climate change. With these and other uncertainties in the water budgets, they should be treated as approximations that will be updated as more concrete information is understood in the future.

Section 4 Sustainable Management Criteria

The SGMA defines Sustainable Groundwater Management as "*the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results*." The avoidance of undesirable results is important to the success of the GSP. Several requirements from GSP regulations have been grouped together under the heading of sustainable management criteria, including a sustainability goal, undesirable results, minimum thresholds, and measurable objectives for various indicators of groundwater conditions.

The sustainability goal of the Kings Basin and the SKGSA is to ensure that by 2040 the basin is being operated to maintain a reliable water supply for current and future beneficial uses without experiencing undesirable results. This goal will be met by balancing water demand with available water supply to stabilize declining groundwater levels without significantly and unreasonably impacting water quality, land subsidence or interconnected surface water. The goal of the Basin is to correct and end the long-term trend of a declining water table understanding that water levels will fluctuate based on the season, hydrologic cycle and changing groundwater demands within the basin and its proximity.

The conditions with the basin and this GSA will be considered sustainable when:

- The basin is continuously operated within its sustainable yield.
- The current rate of decline of the groundwater table within the basin monitoring network indicator wells has been corrected and the multi-year trend of water elevations in these wells has been stabilized.
- Groundwater levels are maintained to prevent Undesirable Results of the applicable sustainability indicators.

The seven GSAs within the Kings Basin have been coordinating within the basin for several years on how to reach and maintain sustainability within the Basin. As described in **Section 3**, the Kings Basin includes significantly varied geologic conditions, water supplies and land uses that lead to different conditions and obligations within each GSA. The basin setting describes the trend of declining groundwater levels within the basin and the SKGSA. The degree of decline varies by location based primarily on land use and available surface water supplies. The Basin setting information, including historic groundwater conditions, surface supplies, groundwater flows, land use and other information were used to establish the water budget, estimates of overdraft within each GSA and sustainable yield. The coordination efforts between the GSAs have resulted in agreed to initial quantities for each GSA to correct in order to correct current and future conditions. These quantities and each GSAs respective obligation will continue to be monitored and evaluated as additional information is gathered.

Each GSA in the Kings Basin is responsible for implementing projects and management actions required to reach sustainability and meet their initial mitigation requirements for overdraft. The measures that will be implemented to ensure the basin will be operated within the sustainable yield are identified in detail in **Section 6** of the GSP. Collectively, these projects and programs have been identified to ensure the basin reaches sustainability by 2040. The projects and programs include technical data and estimates of project benefit, and the total of these benefits within the basin meet the initial estimates for reaching sustainability within the basin.

The basin has agreed to a phased approach of increasing mitigation to achieve sustainability. The proposed mitigation schedule is shown in the table below.

Table ES-1: Overdraft Mitigation Schedule

Period	Percent of Overdraft Mitigated	Cumulative Mitigation
2020-2025	10%	10%
2025-2030	20%	30%
2030-2035	30%	60%
2035-2040	40%	100%

Groundwater Levels

The GSAs within the Kings Basin have defined the Undesirable Result for groundwater levels to be significant and unreasonable when either the water level has declined to a depth that a new productive well cannot be constructed, or when the water level has declined to a depth that water quality cannot be treated for beneficial use.

The following figure (Figure ES-6), shows a typical hydrograph of a monitoring well used to track groundwater levels in the SKGSA. The minimum thresholds established are based on implementation of incremental correction of the historic decline starting immediately and reaching stabilization by 2040. The measurable objective will include the extension of a current stabilizing trendline and the minimum threshold is a projection of the groundwater depth if another 5-year drought were to occur, based on the rate of decline of the last historic drought.

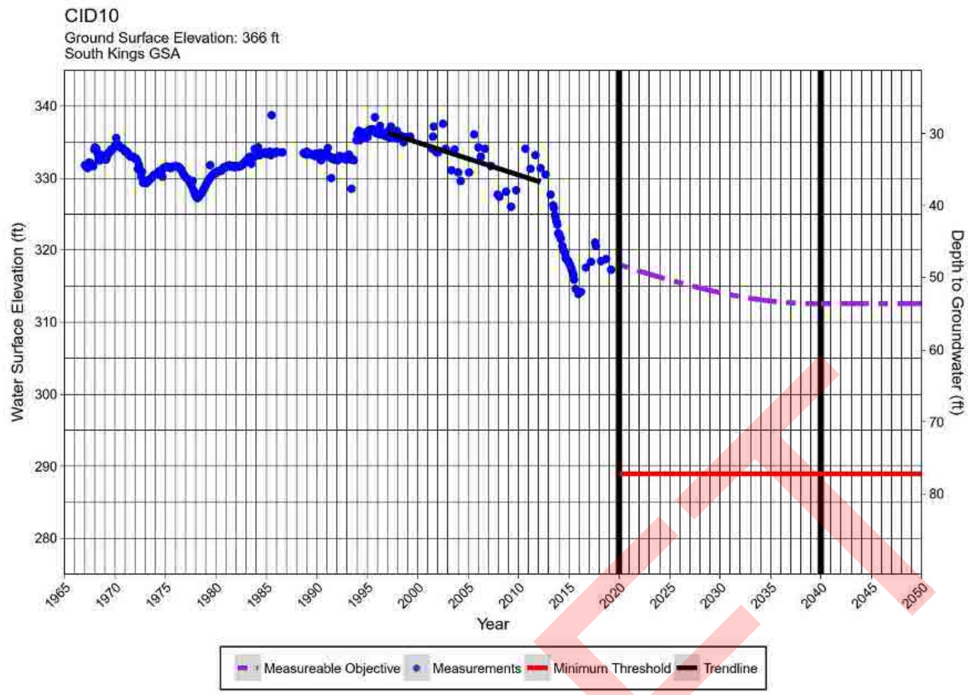


Figure ES-6: SKGSA Monitoring Well Hydrograph

Groundwater Storage

Groundwater storage is directly linked to groundwater levels, and the measurable objective and minimum threshold for groundwater levels dictate the amount of groundwater in storage. A common method was utilized to estimate change in groundwater storage for the entire subbasin and within each GSA as part of the coordination efforts within the Kings Subbasin. Storage change was estimated for the Kings Subbasin to be approximately -1.8 million acre-feet during the hydrologic average base period from spring 1997 to spring 2012, or about -122,000 AFY. Estimated storage change in the lower confined aquifer is not possible at this time due to limited or no data from confined wells in the area. Additionally, vertical leakage in the unconfined aquifer through wells and aquitards captures storage change in the confined aquifer. The goal, by 2040, is to stabilize changes in groundwater storage, prevent groundwater storage from falling below the overall storage shown in the measurable objectives, and to prevent the groundwater storage from fluctuating below the minimum thresholds.

Seawater Intrusion

As the SKGSA is more than 100 miles from the nearest seawater, seawater intrusion is not anticipated to effect the GSA and is not discussed further in this GSP.

Groundwater Quality

Groundwater monitoring and reporting by community water systems is a requirement of California Code of Regulations (CCR) Title 22. Community and other public supply wells within the SKGSA monitoring network are already being routinely monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyors under Title 22. The SKGSA will only have authority related to groundwater pumping policies, however the SKGSA will review and analyze publicly available routine groundwater monitoring data, as it becomes available, in order to monitor if groundwater pumping may be exacerbating groundwater quality concerns and where to enforce pumping restrictions should it become necessary.

Within the Kings Basin, the measurable objective shall be to maintain water quality at potable water standards, or in other words, below MCLs for the chemicals of concern. In areas where chemical concentrations are initially above MCLs, the measurable objective shall be to maintain stable or improving groundwater quality trends.

Land Subsidence

As discussed above, NASA InSAR data shows that subsidence in most of the SKGSA area was between 0 and 1 inch over a two year period. This amount of subsidence is considered very minimal and has had no visual impacts on structures or wells. Furthermore, most inelastic subsidence occurs when there is heavy pumping from below a confining layer such as the E clay; however, this layer does not extend to the SKGSA area, thus subsidence is not anticipated to be an issue. Lastly, as groundwater levels are stabilized over the implementation of this plan, the minimal subsidence is expected to do the same. Therefore, no criteria needs be established for sustainable management criteria. It is planned that there will be periodic checkups to identify if this assertion continues to be true. If trends do not behave as expected, criteria may be established in the future as needed

Interconnected Surface Water and Groundwater

Interconnected surface water has been defined in the California Code of Regulations Title 23, Division 2, Chapter 1.5, Subchapter 2 as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.

The only place that SKGSA may be close enough to affect river flows is in the south east corner of Sanger; however, most of the wells for municipal use are located closer to the center of town, away from the river. The only other surface water in the SKGSA area are a couple of Consolidated ID canals that run through the cities, but groundwater depth throughout the rest of the GSA ranges from 40 to 80 feet, indicating a lack of connection. Due to the current lack of undesirable results and the unlikely event that undesirable results will occur caused by SKGSA pumping, sustainable management criteria will not be evaluated for interconnected surface water.

Section 5 Monitoring Network

This chapter identifies the monitoring network being developed by the SKGSA that collects sufficient data to determine short-term, seasonal, and long-term trends in groundwater and related surface conditions and will yield information necessary to support the implementation of this Plan, evaluation of the effectiveness of this Plan, and decision making by the SKGSA management.

The following figure illustrates the monitoring well network for the SKGSA. The SKGSA will continue to evaluate potential new monitoring well sites, the efficacy of existing monitoring wells, and opportunities to more fully understand the regional data by reviewing nearby well data. Separate monitoring wells are identified to monitor water quality, otherwise all criteria will be evaluated utilizing the remaining wells.

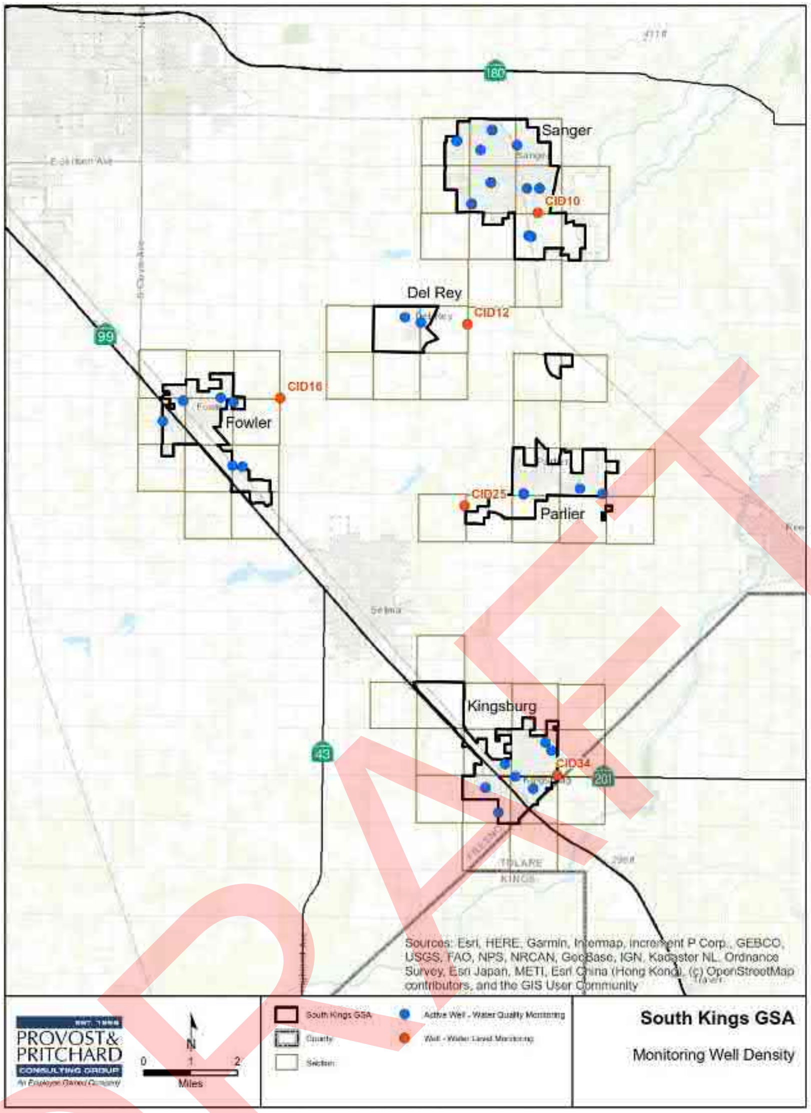


Figure ES-7: SKGSA Monitoring Wells

Chapter 6 Projects and Management Actions to Achieve Sustainability

GSAs have two primary types of tools which may be used to achieve sustainable groundwater management: potential Projects and Management Actions. The SKGSA will reach sustainability if it implements both projects and management actions to mitigate impact of groundwater extraction. The SKGSA efforts focus primarily on recharge of groundwater supplies within the GSA and reduction of groundwater demand and increase of data collection including education and outreach, regulatory policies, incentive-based programs, and enforcement actions.

The SKGSA has identified nineteen potential Projects which may be undertaken by the GSA or individual member agencies to aid in achieving sustainability. Each of the projects are a recharge basin and would allow the member agency the ability to recharge surface water supplies. The recharge basins allow for surface water to be diverted and recharged to replenish the aquifer. If the rain/snowmelt patterns change and more surface water is available outside the normal crop irrigation demand season, these proposed facilities may allow each member agency to take advantage of the timing of the surface water availability and may make more surface water available for recharge.

The SKGSA has identified nine Management Actions which may be undertaken by the GSA or individual member agencies to aid in achieving sustainability. The identified potential Management Actions discussed in Section 6 may be implemented in any order or not at all if determined unnecessary based on sustainability achievement through other methods. The Management Actions may be further refined or revised based on stakeholder input and/or updated available information and/or science. The Management Actions identified include: Education and Outreach, Wellhead Requirements, and Groundwater Pumping Restrictions.

Between the potential Projects and Management Actions, the GSA has identified at least 7,848 AFY of mitigation against groundwater extraction by 2040, which achieves the goals set forth in this GSP. This mitigation amount does not include estimates of benefits from potential Management Actions. The GSA understands the Projects and Management Actions are uncertain, may take longer to implement and may yield varying levels of benefits from those discussed in this GSP. The GSA is equipped to modify and expand, as necessary, to achieve its sustainability goals. Modifications to these Projects and Management Actions will be included in subsequent updates to the GSP.

Chapter 7 Plan Implementation

The adoption of the GSP will be the official start of the Plan Implementation. The GSA will continue its efforts to engage the public and secure the necessary funding to successfully monitor and manage groundwater resources within the Plan Area in a sustainable manner. While the GSP is being reviewed by DWR, the GSA will coordinate with various stakeholders and beneficial users to improve the monitoring network and begin the implementation of projects and management actions. The plan will be implemented under the existing authorities of both the GSA and the member agencies and, through coordinated activities, the groundwater resources of the region will now be managed.

Section 7 includes estimates of costs of implementing the GSP, including Projects and Management Actions; administration costs will be spread proportionally across the member agencies.

Successful implementation of this GSP will be an ongoing effort through 2040 and beyond. The GSA is committed to meeting their sustainability goals and will continue to modify and adjust its approach, when necessary. Those efforts will include engaging stakeholders and the public, monitoring and evaluating groundwater and environmental data pertaining to the GSP sustainability indicators, and overall basin operation and coordination with the other GSAs in the Kings Subbasin.

The GSA will include updates to changes to the GSP or policy changes in its annual report and submit to that report to DWR. Certain components of the GSP may be re-evaluated more frequently than every five years, if deemed necessary. This may occur, for example, if sustainability goals are not being met, additional data is acquired, or priorities change. Those results will be incorporated into the GSP when it is resubmitted to DWR every five years.

1 Introduction

1.1 Purpose of Groundwater Sustainability Plan

On September 16, 2014, Governor Jerry Brown signed into law a three-bill legislative package, composed of AB 1739 (Dickinson), SB 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act of 2014 (SGMA), which is codified in Section 10720 et seq. of the California Water Code. This legislation created a statutory framework for groundwater management in California that can be sustained during the planning and implementation horizon without causing undesirable results in the following six categories:

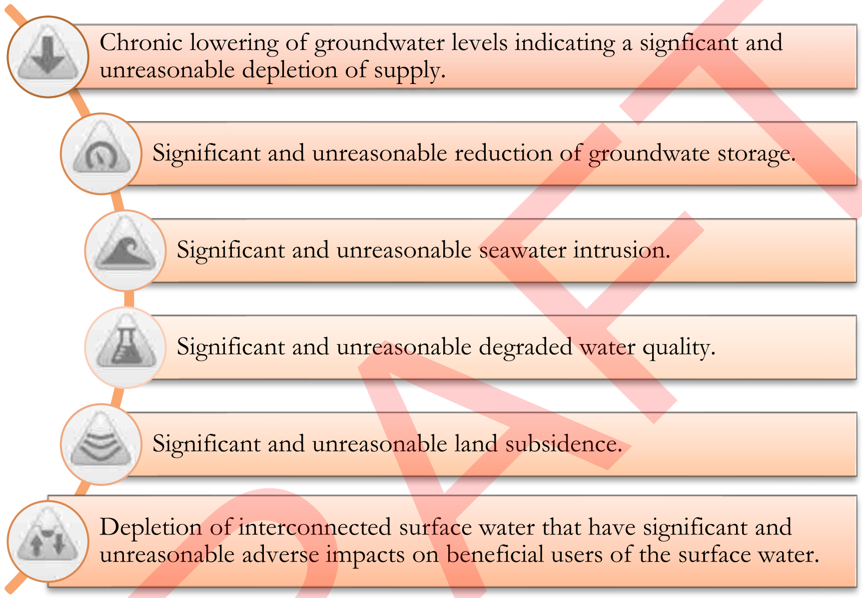


Figure 1-1: Six Categories of Undesirable Results

The location of the SKGSA area is more than 100 miles from the ocean, therefore seawater intrusion or use (as a supply) is not anticipated or feasible, respectively; therefore, seawater intrusion is not discussed significantly in the rest of this GSP.

SGMA requires governments and water agencies of high and medium priority basins to halt groundwater overdraft and bring groundwater basins into balanced levels of pumping and recharge. Under SGMA, these basins should reach sustainability within 20 years of implementing their sustainability plans. For critically over-drafted basins, including the Kings Subbasin, the deadline for achieving sustainability is 2040.

In his signing statement, Governor Brown emphasized that “groundwater management in California is best accomplished locally.” The GSAs within the Kings Subbasin are working to achieve basin-wide sustainability.

1.2 Sustainability Goal

The sustainability goal of the Kings Basin and this GSA is to ensure that by 2040 the basin is being managed in a sustainable manner to maintain a reliable water supply for current and future beneficial uses without experiencing undesirable results. A more detailed description of the Sustainability Goal for the subbasin and Sustainable Management Criteria for the subbasin and this GSA is included in **Section 4**.

The Tulare Lake Basin, including the Kings Subbasin, has been determined to be in a state of overdraft consistently since the first edition of the DWR Bulletin 118 in 1978. Since that time, the Kings Subbasin has lost subsurface storage through a combination of groundwater pumping and several years of below-normal recharge driven by drought conditions and low surface water flows. **Section 3** of this Groundwater Sustainability Plan (GSP) discusses this chronic water imbalance in more depth.

While the Kings Subbasin has lost a great deal of its stored water in recent decades, the aquifers beneath the subbasin contain more water than the total in all the reservoirs on the watersheds above the subbasin. That extensive storage volume has long obscured the effects of overdraft from year to year, providing a buffer against what would otherwise be extreme fluctuations in surface water supplies depending on the rain year. Water agencies in the subbasin must work together to maintain the viability of the aquifer so that buffer capacity is always available.

To that end, this GSP proposes measures to immediately reduce and eventually eliminate systematic overdraft within the SKGSA area. Eliminating overdraft is defined as balancing average annual groundwater withdrawals with average annual natural and artificial groundwater recharge, accounting for subsurface flows into and out of the GSA area, over a rolling range of years. The variability in surface water supplies, in contrast to the steady nature of water demands, makes it infeasible to achieve balance every year. In reality, there will be years where the GSA area gains storage, and other years where the storage balance declines, but overall the average GSA area basin storage will no longer be in decline within the GSA area once this plan becomes fully effective.

In order to accomplish this overarching goal, this plan identifies undesirable results, which are outcomes that will be realized should the plan's strategies not be effective or not be effectively implemented. Undesirable results are marked by minimum thresholds or data points which if not met mean an undesirable result has been realized. Every positive outcome defined in this GSP will take time to achieve; none of the goals can be realized in a year. Many won't be fully achieved until well into the 20-year attainment period defined in the SGMA legislation. Measurable objectives have been defined to gauge progress during the intervening years and to help assure not only that the GSA is moving toward its sustainability goals, but also that the rate of progress is as planned and sufficient to meet the overall implementation schedule.

Sustainability goals, undesirable results, minimum thresholds, and measurable objectives are all defined and discussed in detail in **Section 4** of this GSP.

1.3 Coordination Agreements

The Kings Subbasin has seven Groundwater Sustainability Agencies (GSAs), all of whom are preparing individual GSPs (see **Figure 2-1**). The seven GSAs have cooperatively worked together since 2016 to coordinate the formation of the GSAs and the required coordination elements of the GSPs. The GSAs entered into a cooperative Memorandum of Understanding for development of the GSPs and grant funding. Then the GSAs developed a Coordination Agreement in accordance with section 357.4 of the Regulations. The formalized coordination agreement will help to ensure that: (a) the GSPs have been developed utilizing the same data and methodologies; and (b) elements of the GSPs necessary to achieve the sustainability goal for the basin are based upon consistent interpretations of the basin setting. This approach has assured common assumptions and development of water budgets, monitoring network, sustainable management criteria, data management system.

1.4 Inter-basin Agreements

There are no agreements between the Kings Subbasin and its neighboring basins. Rather the GSAs that neighbor other subbasins have coordinated directly with those neighboring basins and GSAs.

1.5 Agency Information

Regulation Requirements:

§354.6(a) The name and mailing address of the Agency

South Kings Groundwater Sustainability Agency
128 S. Fifth Street
Fowler, CA 93625
Contact: Karnig Kazarian, Board Chairman

1.5.1 Organization and Management Structure of the GSA

Regulation Requirements:

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

The SKGSA was formed as a Joint Powers Authority (JPA), pursuant to the Joint Exercise of Power Act (Government Code § 6500, et seq), comprised of the cities of Fowler, Kingsburg, Parlier and Sanger and the Del Rey Community Service District. The Del Rey Community Service District was established under the Municipal Water District Act of 1911 (California Water Code (CWC) 7100). The five member agencies, either incorporated cities or districts, have the authority and responsibility to manage water supply within their respective boundaries and therefore have the authority to implement this GSP.

The SKGSA is essentially coterminous with the city limits of four cities and the district boundary of one special district: the cities of Fowler, Kingsburg, Parlier and Sanger and the Del Rey Community Service District. The SKGSA has no staff and relies upon the staff of the five communities to perform the studies and investigations, develop outreach, and provide for the planning and implementation of the plan.

The point of contact for South Kings GSA is the City Engineer of the cities of Fowler/Kingsburg. At the time of writing this Plan, the following is the current contact information:

GSA Plan Manager: David Peters
South Kings GSA
128 S. Fifth Street
Fowler, CA 93625

The following graphic illustrates the GSA organization.

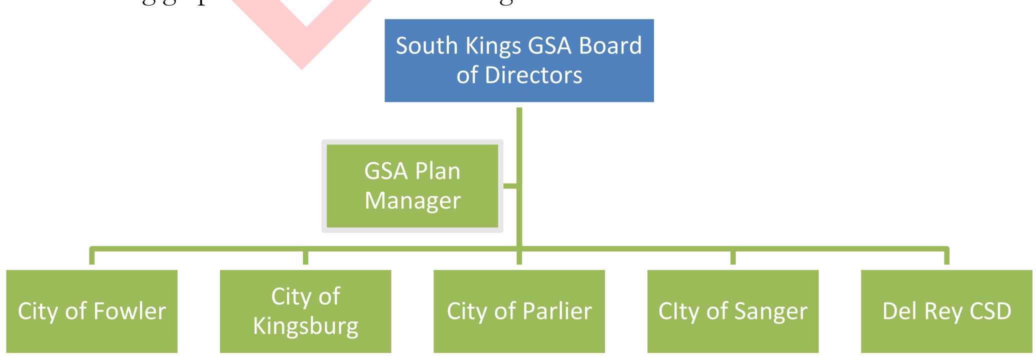


Figure 1-2: South Kings GSA Management Structure

1.5.2 Legal Authority of the GSA

Regulation Requirements:

§354.6(d) The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the plan.
§354.6(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

The South Kings GSA was established as a Groundwater Sustainability Agency (GSA) under Water Code 10720 (the Sustainable Groundwater Management Act) for the portion of the Kings Subbasin that lies within the boundaries of the Agency, which are shown on **Figure 2-1**. The legislation requires the Agency to develop and implement a GSP to achieve groundwater sustainability management within the territory of the Agency in compliance with the mandates and timelines in SGMA.

While there are a number of public and private water purveyors and agencies throughout the territory of the Agency, these entities do not have sufficient staff or resources to otherwise form a GSA, and these entities have agreed that the interests of the area are best served by having a single agency dedicated to the management of groundwater resources. Accordingly, the Agency has been deemed the exclusive local agency within the designated territory endowed with powers to comply with SGMA.

The Agency's enabling act is codified in Water Code Appendix Section 143-801. The section provides that pursuant to Chapter 8 of Part 2.74 of Division 6 of the Water Code, the Agency may impose a variety of fees as it may determine to be necessary to fund its groundwater sustainability program, including but not limited to permit fees and fees on groundwater extraction and other regulated activities.

Additionally, the member agencies are local public agencies, each with either express or implied authority to manage groundwater resources. The cities of Fowler and Kingsburg were both incorporated in 1908, while Parlier and Sanger were incorporated in 1921 and 1911, respectively and the Del Rey CSD was established in 1963.

Historically, cities have had the authority to regulate groundwater pursuant to their police power as reserved in Article XI, Section 7 of the California Constitution and as further provided by Government Code (GC) Section 37100. AB 3030, codified at CWC Section 10750, et seq., authorized local agencies, including cities, to develop groundwater management plans, a concept tied to the police power and the subject of 1994's Baldwin v. County of Tehama, in which the 3rd District Court of Appeal upheld the ability of a county (or city) to manage groundwater. Although certain statutory components of AB 3030 were amended with the enactment of SGMA, it still contains provisions related to groundwater management by local agencies.

Del Rey CSD is statutorily authorized by its enabling act (the Community Services District Law; GC Section 61000, et seq.) to exercise powers related to groundwater management. GC Section 61100, Subdivision (a) states that a CSD may "supply water for any beneficial use, in the same manner as a municipal water district…". The Municipal Water District Law of 1911, commencing at CWC Section 71000, enumerates multiple powers and activities related to groundwater resource management. Further, pursuant to GC Section 61060 the CSD may "adopt…and enforce rules and regulations for the administration, operation, and use and maintenance of the facilities and services listed in Part 3 (commencing with Section 61100)."

The costs associated with implementation of the GSP are discussed in **Section 7**.

1.6 GSP Organization and Preparation Checklist

All of the GSPs within the King Subbasin utilize the same GSP outline structure and format. The GSP is organized in accordance with the Emergency Regulations in a format similar to the outline provide by DWR.

- **Executive Summary** provides a summary of what will be included in the GSP.
- **Section 1** describes the Introduction, including purpose of the GSP, sustainability goal, agency information, and GSP organization.
- **Section 2** describes the Plan area, including geographic setting; existing water resources planning and programs; relationship of the GSP to other general plan documents within the Agency boundary and additional GSP components.
- **Section 3** describes the Basin setting. It includes a detailed discussion of the hydrogeologic conceptual model used to prepare the GSP, current and historical groundwater conditions, a discussion of the area groundwater budget, and a description of the special management areas created within the overall boundary.
- **Section 4** sets forth the Agency's adopted sustainability goals, addresses the mandated Undesirable Results, defines Minimum Thresholds for each Undesirable Result and sets Measurable Objectives for both intermediate plan years (Interim Milestones) and for the Plan's complete implementation.
- **Section 5** describes the network of monitoring wells and other facilities adopted by the Agency to measure Plan outcomes and assesses the need for improvements to the network in order to provide fully representative data. Monitoring protocols and data analysis techniques are also addressed.
- **Section 6** lists and describes each project and management action that will be evaluated and may be adopted by the Agency in pursuit of sustainability. The section includes such project details as Measurable Objectives, required permits, anticipated benefits, project capital and operations/maintenance costs, project schedule, and required ongoing management operations, along with management actions that may be implemented.
- **Section 7** describes the Plan implementation process, including estimated costs, sources of funding, an overall preliminary schedule through full implementation, description of the required data management system, methodology for annual reporting, and how progress evaluations will be made over time.
- **Section 8** summarizes the references and sources used to prepare and document this Plan.

Table 1-1: Preparation Checklist for GSP Submittal

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 3. Technical and Reporting Standards				
352.2		Monitoring Protocols	• Monitoring protocols adopted by the GSA for data collection and management • Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin	Section 5.2 Section 5.1.4
Article 5. Plan Contents, Subarticle 1. Administrative Information				
354.4		General Information	• Executive Summary • List of references and technical studies	Section ES Section 8
354.6		Agency Information	• GSA mailing address • Organization and management structure • Contact information of Plan Manager • Legal authority of GSA • Estimate of implementation costs	Section 1.5
354.8(a)	10727.2(a)(4)	Map(s)	• Area covered by GSP (**Figure 2-1**) • Adjudicated areas, other agencies within the basin, and areas covered by an Alternative (**Figure 2-1**) • Jurisdictional boundaries of federal or State land • Existing land use designations (**Figure 2-3**) • Density of wells per square mile (**Figure 2-4**)	Section 2.0 Section 2.0 N/A—Section 2.0 Section 2.1 Section 2.1
354.8(b)		Description of the Plan Area	• Summary of jurisdictional areas and other features	Section 2.1

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 1. Administrative Information (Continued)				
354.8(c) 354.8(d) 354.8(e)	10727.2(g)	Water Resource Monitoring and Management Programs	• Description of water resources monitoring and management programs • Description of how the monitoring networks of those plans will be incorporated into the GSP • Description of how those plans may limit operational flexibility in the basin • Description of conjunctive use programs	Section 2.2 Section 2.2.1 Section 2.2.2 Section 2.2.3
354.8(f)	10727.2(g)	Land Use Elements or Topic Categories of Applicable General Plans	• Summary of general plans and other land use plans • Description of how implementation of the GSP may change water demands or affect achievement of sustainability and how the GSP addresses those effects • Description of how implementation of the GSP may affect the water supply assumptions of relevant land use plans • Summary of the process for permitting new or replacement wells in the basin • Information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management	Section 2.3 (2.3.1) Section 2.3.2 Section 2.3.3 Section 2.3.4 Section 2.3.5

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 1. Administrative Information (Continued)				
354.8(g)	10727.4	Additional GSP Contents	**Description of Actions related to:** • Control of saline water intrusion • Wellhead protection • Migration of contaminated groundwater • Well abandonment and well destruction program • Replenishment of groundwater extractions • Conjunctive use and underground storage • Well construction policies • Addressing groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects • Efficient water management practices • Relationships with State and federal regulatory agencies • Review of land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity • Impacts on groundwater dependent ecosystems	Section 2.4 Section 2.4.1 Section 2.4.2 Section 2.4.3 Section 2.4.4 Section 2.4.5 Section 2.2.3 Section 2.4.6 Sections 2.2.1 and 2.2.2 Section 2.4.8 Section 2.4.9 Section 2.3.3 Section 2.4.10
354.10		Notice and Communication	• Description of beneficial uses and users • List of public meetings • GSP comments and responses • Decision-making process • Public engagement • Encouraging active involvement • Informing the public on GSP implementation progress	Section 2.5.1 Section 2.6.1 Appendix B Section 2.6 Section 2.5.4 Section 2.6 Section 7.5
Article 5. Plan Contents, Subarticle 2. Basin Setting				
354.14		Hydrogeologic Conceptual Model	• Description of the Hydrogeologic Conceptual Model • Two scaled cross-sections (Figures 3-13 and 3-14) • Map(s) of physical characteristics: topographic information, surficial geology, soil characteristics, surface water bodies, source and point of delivery for imported water supplies	Section 3.1 Section 3.1.7 Section 3.1.5 (Figures 3-5 through 3-8, and 3-20)

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 2. Basin Setting (Continued)				
354.14(c)(4)	10727.2(a)(5)	Map of Recharge Areas	• Map delineating existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas	Section 3.1.12 (Figure 3-21)
	10727.2(d)(4)	Recharge Areas	• Description of how recharge areas identified in the plan substantially contribute to the replenishment of the basin	Section 3.1.12
354.16	10727.2(a)(1) 10727.2(a)(2)	Current and Historical Groundwater Conditions	• Groundwater elevation data • Estimate of groundwater storage • Seawater intrusion conditions • Groundwater quality issues • Land subsidence conditions • Identification of interconnected surface water systems • Identification of groundwater-dependent ecosystems	Section 3.2 (3.2.1) Section 3.2.3 Section 3.2.4 Section 3.2.5 Section 3.2.6 Section 3.2.7 Section 3.2.8
354.18	10727.2(a)(3)	Water Budget Information	• Description of inflows, outflows, and change in storage • Quantification of overdraft • Estimate of sustainable yield • Quantification of current, historical, and projected water budgets	Section 3.3 (3.3.3) Section 3.3.4 Section 3.3.4 Section 3.3.5
	10727.2(d)(5)	Surface Water Supply	• Description of surface water supply used or available for use for groundwater recharge or in-lieu use **(Figure ES-2)**	Section 3.1.10
354.20		Management Areas	• Reason for creation of each management area • Minimum thresholds and measurable objectives for each management area • Level of monitoring and analysis • Explanation of how management of management areas will not cause undesirable results outside the management area • Description of management areas	Section 3.3.6

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria				
354.24		Sustainability Goal	• Description of the sustainability goal	Sections 4.1.1, 4.2.1, and 4.4.1
354.26		Undesirable Results	• Description of undesirable results • Cause of groundwater conditions that would lead to undesirable results • Criteria used to define undesirable results for each sustainability indicator • Potential effects of undesirable results on beneficial uses and users of groundwater	Sections 4.1.2, 4.2.2, and 4.4.2
354.28	10727.2(d)(1) 10727.2(d)(2)	Minimum Thresholds	• Description of each minimum threshold and how they were established for each sustainability indicator • Relationship for each sustainability indicator • Description of how selection of the minimum threshold may affect beneficial uses and users of groundwater • Standards related to sustainability indicators • How each minimum threshold will be quantitatively measured	Sections 4.1.3, 4.2.3, and 4.4.3
354.30	10727.2(b)(1) 10727.2(b)(2) 10727.2(d)(1) 10727.2(d)(2)	Measurable Objectives	• Description of establishment of the measurable objectives for each sustainability indicator • Description of how a reasonable margin of safety was established for each measurable objective • Description of a reasonable path to achieve and maintain the sustainability goal, including a description of interim milestones	Sections 4.1.4, 4.2.4, and 4.4.4

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 4. Monitoring Networks				
354.34	10727.2(d)(1) 10727.2(d)(2) 10727.2(e) 10727.2(f)	Monitoring Networks	• Description of monitoring network • Description of monitoring network objectives • Description of how the monitoring network is designed to: demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features; estimate the change in annual groundwater in storage; monitor seawater intrusion; determine groundwater quality trends; identify the rate and extent of land subsidence; and calculate depletions of surface water caused by groundwater extractions • Description of how the monitoring network provides adequate coverage of Sustainability Indicators • Density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends • Scientific rational (or reason) for site selection • Consistency with data and reporting standards • Corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone • Location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used • Description of technical standards, data collection methods, and other procedures or protocols to ensure comparable data and methodologies	Section 5.1 Sections 5.1.1 through 5.1.7 Section 5.1.4 Section 5.1.5 Section 5.1.6.1 Section 5.1.6.2 Section 5.1.6.3 Section 5.1.7 (Figure 5-3) Section 5.2

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 4. Monitoring Networks (Continued)				
354.36		Representative Monitoring	• Description of representative sites • Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators • Adequate evidence demonstrating site reflects general conditions in the area	Section 5.3
354.38		Assessment and Improvement of Monitoring Network	• Review and evaluation of the monitoring network • Identification and description of data gaps • Description of steps to fill data gaps • Description of monitoring frequency and density of sites	Section 5.4 (5.4.1) Section 5.4.2 Section 5.4.3 Section 5.4.4
354.44		Projects and Management Actions	• Description of projects and management actions that will help achieve the basin's sustainability goal • Measurable objective that is expected to benefit from each project and management action • Circumstances for implementation • Public noticing • Permitting and regulatory process • Timetable for initiation and completion, and the accrual of expected benefits • Expected benefits and how they will be evaluated • How the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included. • Legal authority required • Estimated costs and plans to meet those costs • Management of groundwater extractions and recharge	Section 6 (6.2.1) Section 6.2.2 Section 6.2.6 Section 6.1 Section 6.2.8 Section 6.2.7 Section 6.2.3 Section 6.1 Section 6.2.9 Section 6.2.5 Section 6.2.4
354.44(b)(2)	10727.2(d)(3)		• Overdraft mitigation projects and management actions	Section 7

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 8. Interagency Agreements				
357.4	10727.6	Coordination Agreements - Shall be submitted to the Department together with the GSPs for the basin and, if approved, shall become part of the GSP for each participating Agency.	**Coordination Agreements shall describe the following:** • A point of contact • Responsibilities of each Agency • Procedures for the timely exchange of information between Agencies • Procedures for resolving conflicts between Agencies • How the Agencies have used the same data and methodologies to coordinate GSPs • How the GSPs implemented together satisfy the requirements of SGMA • Process for submitting all Plans, Plan amendments, supporting information, all monitoring data and other pertinent information, along with annual reports and periodic evaluations • A coordinated data management system for the basin • Coordination agreements shall identify adjudicated areas within the basin, and any local agencies that have adopted an Alternative that has been accepted by the Department	Section 1.3

2 Plan Area

Regulation Requirements:

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

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

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

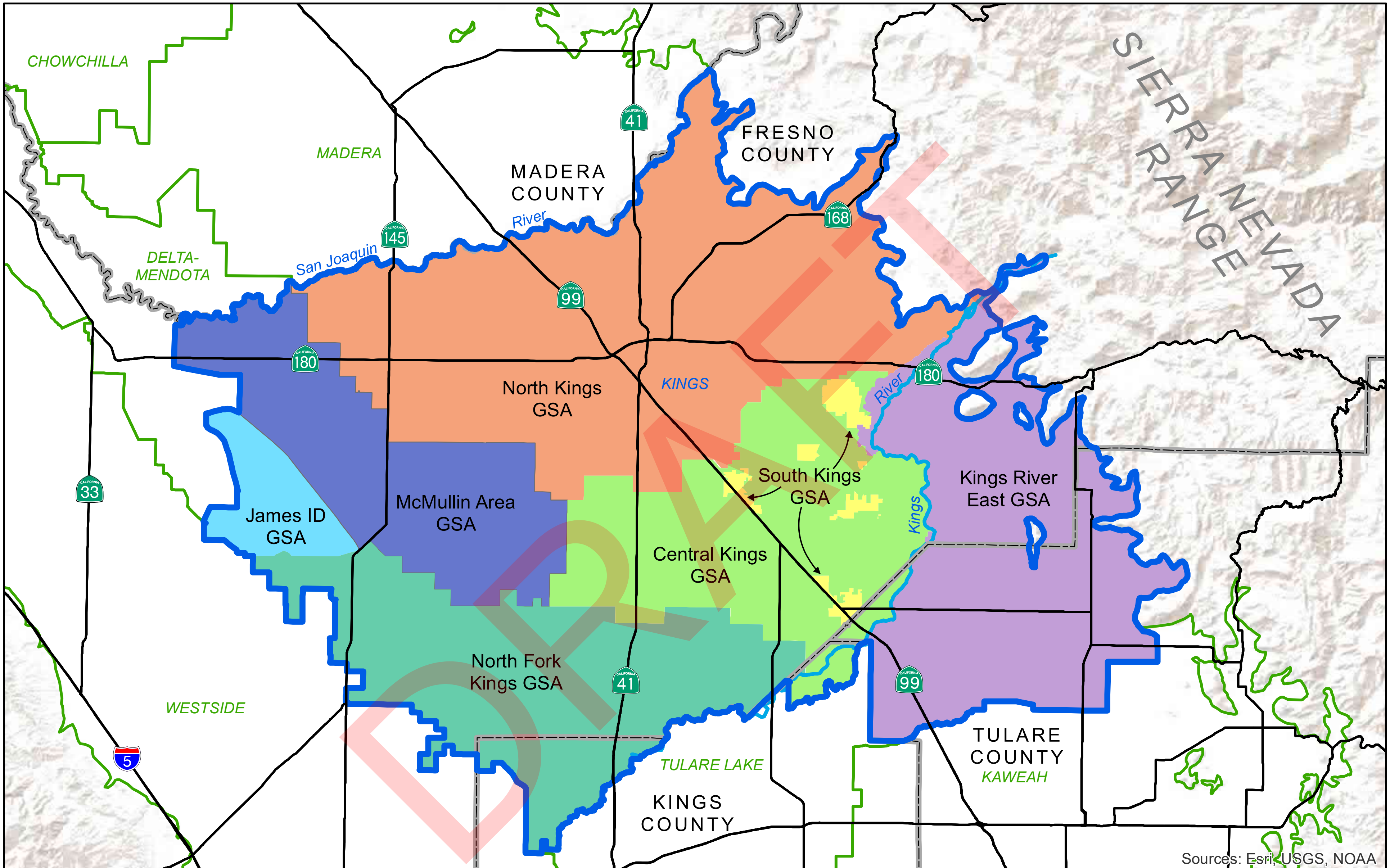
The Kings Groundwater Subbasin (Kings Subbasin) is in the southern part of the San Joaquin Valley with most of the subbasin surface water being supplied from the Kings and San Joaquin Rivers. The Kings Subbasin boundary is defined in the Department of Water Resources (DWR) Bulletin 118 as DWR Subbasin No. 5-22.08. The SKGSA is comprised of five, member agencies, the cities of Fowler, Kingsburg, Parlier and Sanger and the Del Rey Community Service District.

The SKGSA boundary encompasses the city and district limits of the member agencies, total an area of 9,877 acres on the San Joaquin Valley floor in the County of Fresno. The location of the SKGSA and the other GSAs within the Kings Subbasin are shown in **Figure 2-1**. The SKGSA area boundaries are coterminous with the city and district boundaries but do not encompass their individual spheres of influence. There is no overlap among the seven GSA boundaries and there are no adjudicated areas in the groundwater basin.

Figure 2-1 also shows the five Groundwater Subbasins bordering the Kings Subbasin including the Madera Subbasin, Kaweah Subbasin, Tulare Lake Subbasin, Westside Subbasin, and Delta-Mendota Subbasin. The easterly boundary of the Kings Subbasin is the contact with the foothills—generally the 300-ft elevation-- of the Sierra Nevada mountain range.

No federal, state, or tribal lands are within the SKGSA area; however, some federal and state buildings are within the Plan Area.

The most recent land use data, 2014 Statewide Crop Mapping (Land IQ, 2014), was used as the current and comprehensive data set in the basin. However, the 2014 data set did not include some non-irrigated agricultural land-use types typical of the historic DWR land use surveys. Due to this, the entire Kings Basin had several areas missing land use information. To fill those data gaps, the next most recent DWR land use survey was used: 2009 for Fresno County. **Table 2-1** shows the acreages of area for each land use classification with largest land use being Urban/Residential at 72%. The remaining 28% includes various agricultural uses, such as citrus and vineyards, and industrial.



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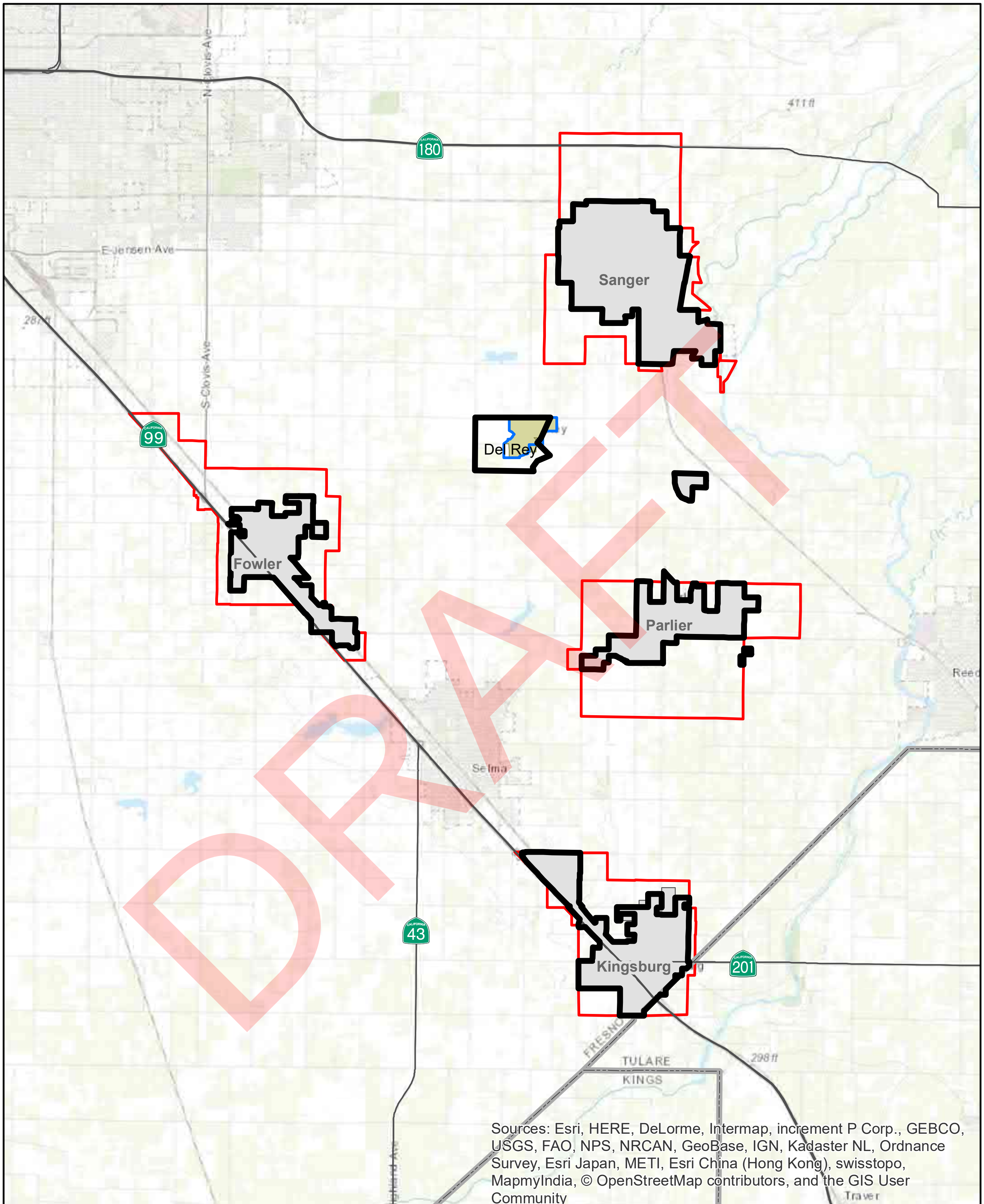
- Kings Groundwater Subbasin (DWR 2017)
- Other Groundwater Subbasins (DWR 2017)
- County Boundary

South Kings GSA

Kings Groundwater Subbasin
Groundwater Sustainability Agencies

Figure 2-1



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- South Kings GSA
- County
- City Limits
- City SOI
- Del Rey CSD
- Del Rey CSD SOI

South Kings GSA

Plan Participants

Figure 2-2

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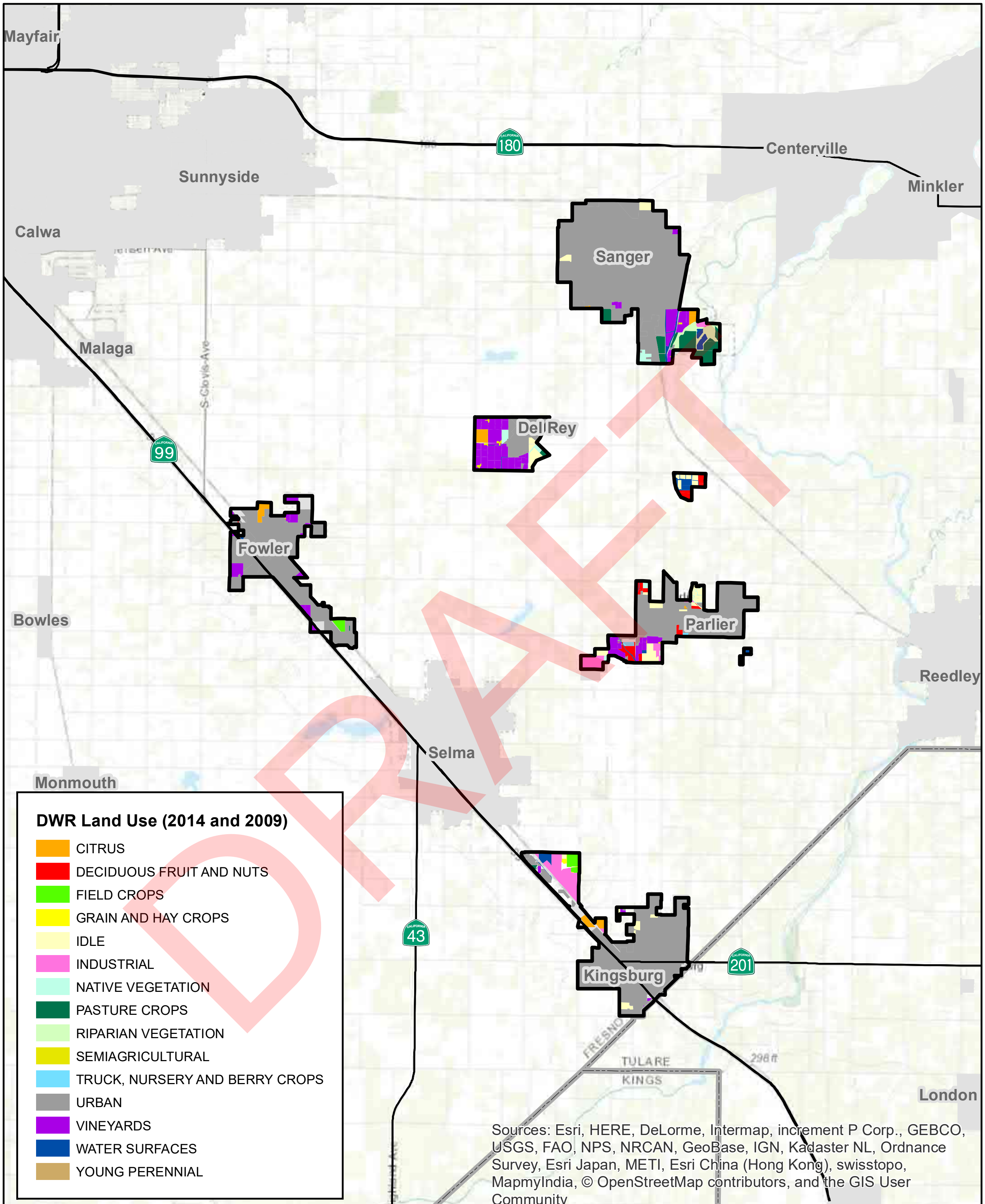

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South Kings GSA

County

City/Place

South Kings GSA

Land Use Classifications

Figure 2-3

Table 2-1: Land Use in South Kings GSA

Land Use Classification	Dely Rey CSD	Fowler	Kingsburg	Parlier	Sanger
Citrus	38.4	35.5	36.5	1.4	28.9
Deciduous Fruit and Nuts	---	1.1	6.6	83.2	42.9
Field Crops	---	25.6	40.1	---	---
Grain and Hay Crops	---	---	8.3	0.4	---
Idle	48.8	1.7	55.1	139.4	81.2
Industrial	---	0.2	160.7	92.9	15.9
Native Vegetation	30.2	0.1		23.7	28.0
Not Labelled	27.4	97.4	194.1	20.6	2.6
Pasture Crops	8.6	0.8	4.8	---	237.7
Riparian Vegetation	---	---	---	---	95.8
Semi-agricultural	10.6	3.8	0.8	3.2	2.3
Truck, Nursery and Berry Crops	---	0.4	0.4	12.8	---
Urban Uses [1]	254.4	1,289.8	1,687.1	1,032.1	2,896.3
Vineyards	369.0	143.5	24.1	115.8	150.2
Water Surfaces	7.0	4.6	29.2	25.3	97.9
Total (acres)	**794**	**1,604**	**2,248**	**1,551**	**3,679**

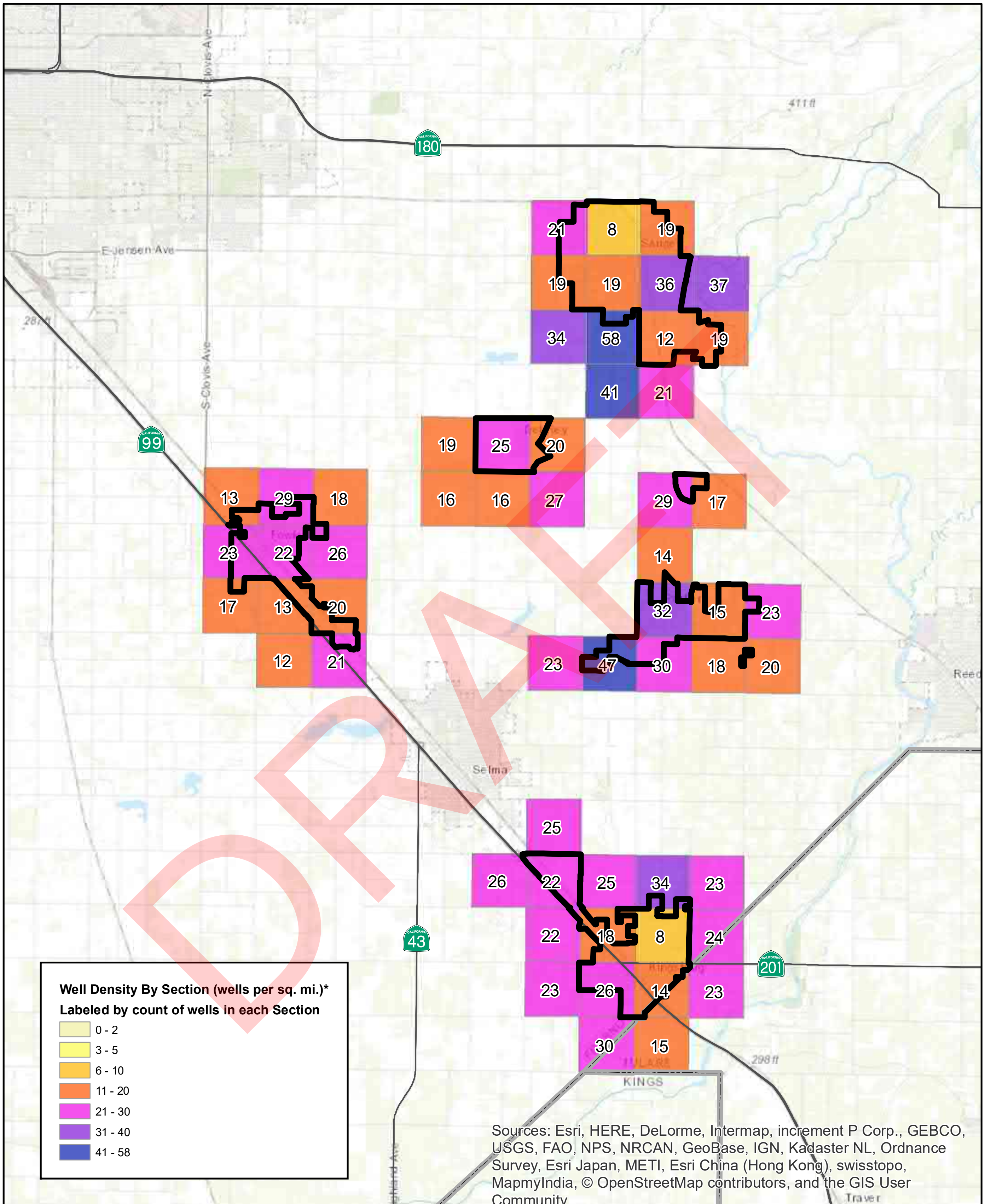
Notes:
[1] Urban uses include commercial, residential, urban and urban landscape.

Water use type and water source for each Plan participant are shown in **Table 2-2**. The primary water use designations for the cities are residential, commercial, and industrial. The Plan participants do not have access to surface water and rely entirely on groundwater for deliveries to their customers.

Table 2-2: Water Uses and Water Sources

Agency	Water Use Type	Water Source
City of Fowler	Residential, Commercial, and Industrial	Groundwater
City of Kingsburg	Residential, Commercial, and Industrial	Groundwater
City of Parlier	Residential, Commercial, and Industrial	Groundwater
City of Sanger	Residential, Commercial, and Industrial	Groundwater
Del Rey Community Service District	Residential, Commercial, and Industrial	Groundwater

Figure 2-4 illustrates the well density in the GSA area. There are an estimated 1,300 active wells in and adjacent to the SKGSA area. The map is based on best available data including known well locations for each water agency and private well locations provided by Fresno County. The map excludes monitoring wells and test wells. The private wells were mapped by assuming that all wells constructed since 1975 remain active, unless a County permit authorizes their destruction. If a well was destroyed without issuance of a County permit, then it will show up on the map as still active. Fresno County did not have information readily available to sort the wells based on domestic or irrigation use. The map does not necessarily show where pumping is concentrated since there is no differentiation between the different well uses.



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South Kings GSA

County

South Kings GSA

Well Density By Section

Figure 2-4

2.1 Summary of Jurisdictional Areas and Other Features

Regulation Requirements:

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

Groundwater Basin Boundaries

The Kings Subbasin is a large groundwater subbasin located within the southern part of the San Joaquin Valley Basin in the Central Valley of California. The Kings Subbasin boundary is defined in the DWR Bulletin 118 and is DWR Basin No. 5-22.08 and covers an area of 1,530 square miles (979,200 acres). DWR estimated in 1961 that the groundwater storage for the entire Kings Subbasin is about 93 million acre-feet (AF) to a depth of more than 1,000 feet (DWR, 2006).

The SKGSA jurisdiction area lies within the Kings Subbasin, within Fresno County, as shown in **Figure 2-1**.

Groundwater Sustainability Plan Area

The South Kings Groundwater Sustainability Plan has the same area as the South Kings Groundwater Sustainability Agency, as identified in **Figure 2-1**. The Plan area boundary is coterminous with the city limits of the four cities (Kingsburg, Fowler, Parlier, Sanger) and the district boundary of the Del Rey Community Service District within the eastern portion of the Kings Subbasin. Six other GSAs together with SKGSA form the boundary of the Kings Subbasin. The Plan area is approximately 9,877 acres. The agencies within the GSP do not own surface water facilities but are instead connected, in some portions, to the surface water facilities of the Central Kings Groundwater Sustainably Agency, specifically Consolidated Irrigation District. The agencies do own and operate municipal or quasi-municipal community water facilities throughout their boundaries and several private wells are used in the rural and semi-rural areas throughout the GSA. The wells in the GSP boundary, both municipal and private, are shown on **Figure 2-4**.

The majority of the SKGSA's acreage are utilized by residential or commercial uses, with only 1,438 acres operating in agricultural production. The five agencies rely on groundwater for their water supply and will acquire surface water supplies to recharge the underlying groundwater basin to offset their extraction impacts.

City of Fowler

The City of Fowler (Fowler), incorporated in 1908 (Fresno COG, 2019), lies southeast of the City of Fresno, in Fresno County at an elevation of approximately 308 feet above sea level. Encompassing about 2.5 square miles (1,604 acres), Fowler is home to approximately 6,200 residents (ACS, 2013-2017). The city operates its own water supply and distribution system, supplying water to its customers from groundwater sources, solely, through 1,784 metered water service connections. The city delivered approximately 1698 acre-feet (AF) in 2015, at the height of a drought period, and 1869 AF in 2017. The city sends its wastewater to a special district, the Selma-Kingsburg-Fowler Sanitation District (SKF), that is jointly operated by the cities of Selma, Kingsburg and Fowler. The deliveries of wastewater in 2015 and 2017, respectively, were 692 (41% of the total water deliveries) and 689 (37 % of the total water deliveries).

City of Kingsburg

The City of Kingsburg (Kingsburg), incorporated in 1908 (Fresno COG, 2019), lies southeast of the City of Fresno, at the southern border of Fresno County at an elevation of approximately 302 feet above sea level. Kingsburg encompasses about 3.6 square miles (2,248 acres) and is home to nearly 12,000 residents (ACS, 2013-2017). The city operates its own water supply and distribution system, supplying water to its customers from groundwater sources, solely, through 3,549 metered water service connections. The city delivered approximately 2,627 AF in 2015 and 2,621 AF in 2017. The city also sends its wastewater to SKF. The deliveries of wastewater in 2015 and 2017, respectively, were 1,345 (51% of the total water deliveries) and 1,311 (50% of the total water deliveries).

City of Parlier

The City of Parlier (Parlier), incorporated in 1921 (Fresno COG, 2019), lies southeast of the City of Fresno, in Fresno County at an elevation of approximately 344 feet above sea level. Parlier encompasses about 2.3 square miles (1,551 acres) and is home to over 15,000 residents (ACS, 2013-2017). The city operates its own water supply and distribution system, supplying water to its customers from groundwater sources, solely, through 2,505 metered water service connections. The city delivered approximately 1,801 AF in 2015 and 1,944 AF in 2017. The city treats its own wastewater through a 2 million-gallon-per-day (MGD) wastewater treatment plant (WWTP). The plant operates by percolating the treated effluent in nearby ponding basins. The deliveries of wastewater in 2015 and 2017, respectively, were 1,134 (63% of the total water deliveries) and 1,225 (61% of the total water deliveries).

City of Sanger

The City of Sanger (Sanger), incorporated in 1911 (Fresno COG, 2019), lies east of the City of Fresno, in Fresno County at an elevation of approximately 371 feet above sea level. Sanger encompasses about 5.8 square miles (3,679 acres) and is home to nearly 25,000 residents (ACS, 2013-2017). The city operates its own water supply and distribution system, supplying water to its customers from groundwater sources, solely, through 6,210 metered water service connections. The city delivered approximately 5,177 AF in 2015 and 5,188 AF in 2017. The city treats its own wastewater through a dual WWTP, treating domestic and industrial waste streams separately. The capacity of the domestic plant is 3 MGD, while the capacity of the industrial plant is 1.3 MGD. The Domestic WWTP operates by percolating the treated effluent in nearby ponding basins, while the Industrial WWTP ponds are lined and the effluent is agronomically applied to the adjacent farmlands. The combined deliveries of wastewater in 2015 and 2017, respectively, were 2,528 (41% of the total water deliveries) and 2,314 (45% of the total water deliveries).

Del Rey Community Service District

The Del Rey Community Service District (Del Rey), established in 1963 under the Municipal Water District Act of 1911 (California Water Code 7100) (LAFCo, 2007), lies southeast of the City of Fresno, in Fresno County at an elevation of approximately 344 feet above sea level. The boundary shown in the GSA for the Del Rey CSD encompasses about 1.2 square miles (794 acres); however, the service area of the CSD encompasses approximately 300 acres. Del Rey is home to nearly 1,500 residents (ACS, 2013-2017). The district operates its own water supply and distribution system, supplying water to its customers from groundwater sources, solely, through 328 primarily unmetered water service connections. The district delivered approximately 656 acre-feet (AF) in 2015 and 714 AF in 2017. The wastewater within the district is treated through one of three processes: The Del Rey CSD domestic WWTP, the Del Rey CSD industrial WWTP or a privately-owned industrial WWTP. The plants operate by percolating the treated effluent in nearby ponding basins. The combined total deliveries of wastewater in 2015 and 2017, respectively, were 491 (75% of the total water deliveries) and 425 (60% of the total water deliveries).

2.2 Water Resources Monitoring and Management Programs

2.2.1 Monitoring and Management Programs

Regulation Requirements:

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

Groundwater Level Monitoring

The cities and district within the GSA do not have dedicated monitoring wells; however, they do have municipal production wells and some have monitoring wells at their WWTPs, where water depth can be verified and tracked and is done so on a periodic frequency. To comply with SGMA, the agencies will expand their monitoring networks through use of existing or installation of dedicated monitoring wells and implementation of consistent water level recordation in those and existing production wells. For the purposes of documenting historical groundwater levels, nearby monitoring wells in the CID network will be utilized.

The Kings River Conservation District (KRCD) also monitors groundwater levels in a few additional wells near to the GSA. KRCD collects data from agencies of the surrounding GSAs to develop regional groundwater contour maps that cover the entire Kings Groundwater Subbasin. Since 2003, KRCD has published an annual groundwater report that includes regional groundwater contours and maps showing annual change in groundwater levels. KRCD's groundwater level monitoring program may cease when a SGMA approved groundwater monitoring program is developed and implemented by the GSAs in the Kings Subbasin.

Groundwater Extraction Monitoring

All water agencies in the GSA meter their groundwater extraction and record the pumping volume. There are private wells within the GSA not metered, therefore, the related volume pumped is unknown. In these cases, the volume pumped must be estimated based on typical demands, such as per capita water uses, or crop water demands per acre. This results in groundwater extraction estimates with varying levels of accuracy. Potential future groundwater metering policies are discussed in **Section 5** and **Section 6**.

Groundwater Quality Monitoring

Groundwater quality is monitored at mandated frequencies per Title 22 drinking water requirements and reported to the State Water Resources Control Board (SWRCB), Division of Drinking Water (DDW). The requirements are based on the size of the community, past sampling results and specific constituent concerns. Water quality data is available for all agencies in the GSA. The only consistently found constituents within the communities are 1,2,3-trichloropropane (1,2,3-TCP) and dibromochloropropane (DBCP).

Land Surface Subsidence Monitoring

While some local agencies in the San Joaquin Valley monitor for land subsidence, the majority rely on monitoring performed by regional water agencies or the State and Federal government. Lands within the plan area have been observed for land subsidence for many years. A Global Positioning System (GPS) control network has been established throughout the plan area. This control network can be utilized to survey existing benchmarks to monitor subsidence. Currently, the United States Bureau of Reclamation (USBR or Reclamation) in conjunction with DWR, USGS and USACE obtain subsidence data twice yearly in December and July and publish maps of the results as part of the San Joaquin River Restoration Project (SJRRP). The subsidence areas shown in these maps cover the majority of the SKGSA area. USGS, NASA, and KRCD also measure subsidence in the Central Valley. USGS and NASA have maps on their websites that show the subsidence for a defined time period. KRCD has a 7-mile grid that monitors new and existing benchmarks for land subsidence.

Surface Water Monitoring

Surface water in the area is monitored by numerous agencies. Kings River Water Association (KRWA) monitors surface water in the Kings River and its watershed including snowpack, reservoir stage, reservoir inflow and outflow, Kings River flows, and Kings River diversions.

Irrigated Lands Regulatory Program

The Irrigated Lands Regulatory Program (ILRP) was initiated in 2003 to address pollutant discharges to surface water and groundwater from commercially irrigated lands. The primary purpose of the ILRP is to address key pollutants of concern including salinity, nitrates, and pesticides introduced through runoff or infiltration of irrigation water and stormwater. Surface water and groundwater quality have been monitored for several years. The program is administered by the Central Valley Regional Water Quality Control Board (RWQCB).

Under the ILRP rules, growers may form "third party" coalitions to assist with required monitoring, reporting, and education requirements for irrigated agriculture. The Kings River Water Quality Coalition (Coalition) was established in 2009 as a Joint Powers Agency to pool resources and combine regional efforts to comply with the regulatory requirements of the ILRP. All of the properties within the Plan fall within the boundary served by the Coalition. Growers also have the option to complete regulatory requirements independently of the Coalition, but this is not recommended due to the high cost and complexity of performing required studies. Therefore, most growers have opted to join the Coalition. Additional information on the Coalition is located on their website at http://www.kingsriverwqc.org/. The Coalition area and supplemental areas cover the Plan area. Regional information on surface and groundwater quality is available from the Coalition.

GSP Monitoring and Management Plans

The individual agencies located within the Plan area will be responsible for collecting data for any monitoring or management plan for which they are already collecting data. As needed, the agencies will report the water quality and water supply data to the GSA. The monitoring program is described later in this GSP.

Impacts to Operational Flexibility

Regulation Requirements:

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

Several existing water management constraints impact operational flexibility and water operations. These programs are illustrated in **Figure 2-5** below, followed by a description of each program and possible measures to adapt to them.

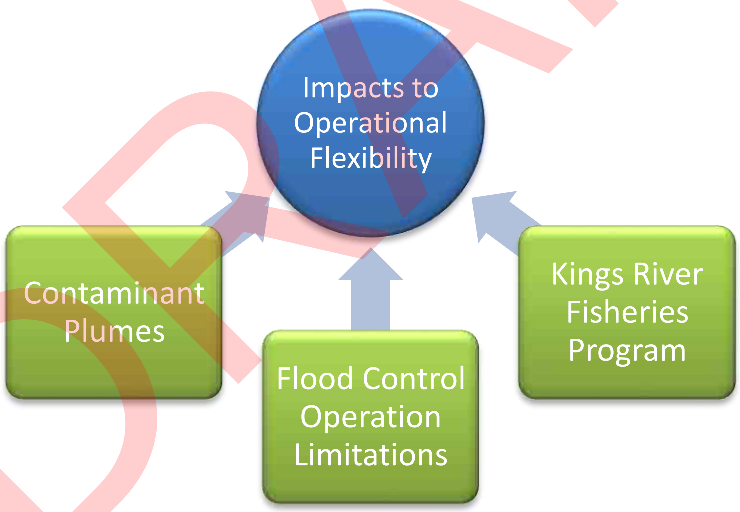


Figure 2-5: Impacts to Operational Flexibility

Contaminant Plumes

Contaminant plumes can certainly impact operational flexibility and water operations, but groundwater within the Plan area is generally of good quality. The GSA has an in-depth accounting of the water quality issues within the boundary. In general, water quality is regulated by the State Water Resources Control Board under the drinking water program for municipal uses. Further from 2005 to 2006, the USGS performed their Groundwater Ambient Monitoring and Assessment (GAMA) program which undertook investigation to characterize the groundwater condition in the Southeast San Joaquin Valley (Burton, Beltiz, & Shelton, 2012). Groundwater quality is further discussed in **Section 3**.

Issues that could constrain groundwater recharge efforts:

- New wells cannot be installed because they may capture contaminated water or cause a plume to migrate.
- Some existing wells cannot be used and are either abandoned or placed on standby.
- Groundwater recharge basins cannot be constructed because they may cause a plume to migrate.
- Wellhead treatment is required at some wells increasing the cost to produce water. These wells are often put on stand-by and only used to help meet peak demands.

Flood Control Operational Limitations

The SKGSA agencies have varying levels of storm facilities to capture stormwater; however, they generally do not have sufficient storm facilities to capture all stormwater runoff, and when rainfall events occur, portions of the stormwater are discharged into the CID canal system for conveyance away from the communities. The storm facilities the agencies own and operate typically rely on gravity collection and percolation or discharge into CID canals.

Kings River Fisheries Program

A partnership has been forged between Kings River Conservation District, the KRWA, and the California Department of Fish and Wildlife to create the Kings River Fisheries Management Program (Program). The Program includes numerous measures to benefit the Kings River fisheries, including year-round flows, improved temperature control, and additional monitoring. However, this comes at the expense of some operational flexibility for Kings River water users. The Kings River provides most of the surface water used by the surrounding GSAs and will impact the SKGSA members, as they become reliant on surface water to balance their groundwater extraction.

As part of the Program, several requirements are placed on Pine Flat Reservoir and Kings River operations. These include maintaining a minimum 100,000-acre-foot Pine Flat Reservoir temperature control pool (10% of the reservoir's capacity) and year-round minimum fish flow releases below Pine Flat Dam.

As part of the agreement, CID alternates with neighboring Fresno Irrigation District in taking the responsibility for the fish flows below the dam. These flows must reach Fresno Weir before a portion can be diverted. This requirement limits operational flexibility by restricting where and when CID can divert their water. In addition, during dry years, the KRWA member agencies struggle to maintain the temperature control pool and minimum fish flows. As a result, they often collaborate by sharing reservoir storage space to meet the fishery requirements.

The local agencies have already adjusted operations to adapt to the Fisheries Program. In the future, additional recharge and banking facilities could help them to further adapt by providing a place to store Kings River waters when supply exceeds irrigation demands.

2.2.2 Conjunctive Use Programs

Regulation Requirements:

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

Conjunctive use is the coordinated and planned management of both surface and groundwater resources in order to maximize their efficient use. Conjunctive use is utilized to improve water supply reliability and environmental conditions, reduce groundwater overdraft and land subsidence, and protect water quality.

Conjunctive use can include using surface water when it is available and relying on groundwater when surface water supplies run out in the late summer or are limited during droughts. Conjunctive use also includes cyclic storage where surplus surface waters are recharged during wet years and groundwater is pumped during dry periods. Conjunctive use should also include a robust monitoring program to help prevent negative impacts and verify the quantity of water in storage. For the GSAs that have surface water in the Kings Basin, they recharge surface water to offset the groundwater pumping. They also deliver surface water to growers who buy the water to use instead of using groundwater to irrigate the crops.

The SKGSA has drafted an agreement with the CID for firm surface water deliveries to be utilized for recharge activities; the agreement provisions for annual deliveries with a five-year rolling average of the firm water supply to account for possible dry years. Some of those activities may utilize existing or future CID facilities; however, the SKGSA agencies will be pursuing their own recharge facilities, as discussed in more detail in **Section 6**. The soils that underlie the GSA boundary generally consist of sands and gravels and are conducive to intentional recharge activities.

2.3 Relation to General Plans

2.3.1 Summary of General Plans and Other Land Use Plans

Regulation Requirements:

§354.8(f) A plain language description of the land use elements or topic categories of applicable general plans that include the following:
1) A summary of general plans and other land use plans governing the basin.

California Government Code (§65350-65362) requires that each county and city in the state develop and adopt a general plan. The General Plan consists of a statement of development policies and includes diagrams and text setting forth objectives, principles, standards, and plan proposals. It is a comprehensive long-term plan for the physical development of the county or city. In this sense, it is a "blueprint" for development.

The General Plan must contain eight (8) state-mandated elements defined by the State as: land use, housing, circulation, conservation, noise, safety, open space, and environmental justice. It may also contain any other voluntary elements that the legislative body of the county or city wishes to adopt. The General Plan may be adopted in any form deemed appropriate or convenient by the legislative body of the county or city, including the combining of elements. The following agencies within the GSA have general plans:

- Fresno County – 2000 General Plan
- Fowler, City of – 1976 General Plan (update in process)
- Kingsburg, City of – 1992 General Plan
- Parlier, City of – 2010 General Plan Update
- Sanger, City of – 2003 General Plan (update in process)

2.3.2 Impact of GSP on Water Demands

Regulation Requirements:

§354.8(f) (2) A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects.

All noted general plans in the Plan area were adopted prior to the development of the GSA and this GSP. Consequently, these general plans have not considered the potential implications or impacts of this GSP's implementation on urban water demands or supplies within these jurisdictions.

The cities' general plans make assumptions for urban development and those assumptions are further carried forth and addressed in the Urban Water Management Plans (UWMPs) for the cities of Fowler, Kingsburg and

Sanger. This GSP uses the same land use and population assumptions identified in the general plans for forecasting the anticipated water budget, described later in this GSP.

The GSA will maintain growth projections stated in their individual planning documents (where available) or based on past growth trends. The water demands associated with those growth projections and water demand projects are based on the 2020 per capita conservation targets stated in the UWMPs (where applicable) in compliance with Senate Bill x7-7 or current 10-year average per capita demands. If the State adopts new conservation targets for urban water usage, the water demand projections will be adjusted. These projections are used later in this GSP to determine the amount of groundwater remediation necessary. If either (a) the quantity of water needed for remediation is not available or (b) the GSA member agencies are unable to execute the projects described in Section 6 to achieve remediation, the member agencies will determine what additional conservation measures are necessary for implementation to reduce water demands to achieve sustainability.

2.3.3 Impact of GSP on Land Use Plan Assumptions

Regulation Requirements:

§354.8(f) (3) A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.

As mentioned earlier, there are five General Plans with the Plan area. The General Plan sections that apply to water supply are summarized below. As noted, all of these plans were developed prior to the development of the GSP.

Fresno County 2000 General Plan

The Public Facilities and Services section of the Fresno County General Plan discusses general public facilities and services; funding; water supply and delivery; wastewater collection, treatment, and disposal; storm drainage and flood control; and numerous other services. The goal of the water supply and delivery section is to ensure the availability of an adequate and safe water supply for domestic and agricultural consumption. The relevant policies are listed below:

- Policy PF-C.1 – The County shall engage in efforts and support the efforts of others to retain existing water supplies within Fresno County.
- Policy PF-C.3 – To reduce demand on the county's groundwater resources, the County shall encourage the use of surface water to the maximum extent feasible.
- Policy PF-C.4 – The County shall support efforts to expand the groundwater and/or surface water storage that benefits Fresno County.
- Policy PF-C.12 – The County shall approve new development only if an adequate sustainable water supply to serve such development is demonstrated.
- Policy PF-C.13 – In those areas identified as having severe groundwater level declines or limited groundwater availability, the County shall limit development to uses that do not have high water usage or that can be served by a surface water supply.
- Policy PF-C.16 – If the cumulative effects of more intensive land use proposals are detrimental to the water supplies of surrounding areas, the County shall require approval of the project to be dependent upon adequate mitigation. The County shall require that costs of mitigating such adverse impacts to water supplies be borne proportionally by all parties to the proposal.
- Policy PF-C.17 – The County shall, prior to consideration of any discretionary projected related to land use, require a water supply evaluation be conducted. The evaluation shall include the following:
    - A determination that the water supply is adequate to meet the highest demand that could be permitted on the lands in question. If surface water is proposed, it must come from a reliable source and the supply must be made "firm" by water banking or other suitable arrangement. If groundwater is proposed, a hydrogeologic investigation may be required to confirm the

availability of water in amounts necessary to meet project demand. If the lands in question lie in an area of limited groundwater, a hydrogeologic investigation shall be required.
    - A determination of the impact that use of the proposed water supply will have on other water users in Fresno County. If use of surface water is proposed, its use must not have a significant negative impact on agriculture or other water users within Fresno County. If use of groundwater is proposed, a hydrogeologic investigation may be required. If the lands in question lie in an area of limited groundwater, a hydrogeologic investigation shall be required. Should the investigation determine that significant pumping-related physical impacts will extend beyond the boundary of the property in question, those impacts shall be mitigated.
    - A determination that the proposed water supply is sustainable or that there is an acceptable plan to achieve sustainability. The plan must be structured such that it is economically, environmentally, and technically feasible. In addition, its implementation must occur prior to long-term and/or irreversible physical impacts, or significant economic hardship, to surrounding water users.
- Policy PF-C.20 – The County shall not permit new private water wells within areas served by a public water system.
- Policy PF-C.22 – The County shall promote the use of surface water for agricultural use to reduce groundwater table reductions.
- Policy PF-C.24 - The County shall encourage the transfer of unused or surplus agricultural water to urban uses within Fresno County.
- Policy PF-C.25 The County shall require that all new development within the County use water conservation technologies, methods, and practices as established by the County.
- Policy PF-C.26- The County shall encourage the use of reclaimed water where economically, environmentally, and technically feasible.
- Policy PF-C.27 The County shall adopt, and recommend to all cities that they also adopt, the most cost-effective urban best water conservation management practices circulated and updated by the California Urban Water Agencies, California Department of Water Resources, or other appropriate agencies.

City of Fowler General Plan (Updated 2004)

Land Use, Section 4 of the Fowler General Plan, discusses the land use, zoning, open space, and public and institutional land use. The relevant policies include:

- Open Space for Managed Resource Production, Policy 4 – Expand programs to recharge the groundwater supply.
- Open Space for Managed Resource Production, Policy 5 – Water Conservation programs shall be continued and enhanced.
- Goal 2-3, Policy 2 – Within one year of General Plan adoption, update master plans for sewer, water and drainage improvements showing existing facilities and proposed improvements.
- Goal 5-6, Policy 2 – Encourage the use of drought-tolerant native plants and the use of recycled water for roadway landscaping.

City of Kingsburg

Part V, Resource Management Element, of the Kingsburg General Plan, discusses the policies that will guide the city's management of their resources. The relevant goals and policies include:

- Open Space for Health, Welfare, and Well-Being, Policy 1 – The City should continue to improve the quality of its drinking water through appropriate improvements to the domestic water system.
- Open Space for Health, Welfare, and Well-Being, Policy 3 – The City should adopt standards which require industrial process analysis before the fact of site and building permit approval to assure compliance with State water and air quality standards. Standards should provide for periodic

monitoring of industrial processes which could have an adverse impact on water or air quality, including impacts that could result from a break-down in equipment designed to control emissions or the pre-treatment of industrial liquid waste.

City of Parlier (Amended 2010)

Land Use, Chapter 4 of the City of Parlier General Plan, discusses population growth, land demand, sphere of influence, development, open space, residential, commercial, public and institutional land use, managed land use and agricultural resources. The relevant policies include:

- Open Space for Managed Resource Production, Policy B.1 – Protect areas of natural groundwater recharge from land uses and disposal methods which would degrade water quality.
- Open Space for Managed Resource Production, Policy B.2 – Expand programs to recharge the groundwater supply.
- Open Space for Managed Resource Production, Policy B.4 – Water conservation methods shall be continued.

City of Sanger, 2003 General Plan

Conservation, Section 7 of the Sanger General Plan, discusses hydrology and water quality, wastewater and storm drainage, natural water bodies, geology and soils, vegetation and wildlife, and cultural resources. The goal of hydrology and water quality is to manage the City's water resources to provide for urban uses while protecting the environment. The relevant policies are listed below:

- Policy 1 (page 7.8) - Protect and preserve water resources in order to provide sufficient quantities of water that meet State quality standards to serve the domestic water demand for build-out of the General Plan.
- Policy 2 (page 7.9) - Protect and preserve watershed and recharge areas, including those critical for the replenishment of domestic water supplies.

2.3.4 Permitting New or Replacement Wells

Regulation Requirements:

§354.8(f) (4) A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.

Well permitting is governed by the cities and Fresno County (for Del Rey CSD). The County of Fresno does not allow installation of new wells within areas where a public water system exists, which applies to the entire Plan area. The following Fresno County policy applies to new or replacement wells.

- **County of Fresno**
    - Policy PF-C.20 The County shall not permit new private water wells within areas served by a public water system.

2.3.5 Land Use Plans Outside the Basin

Regulation Requirements:

§354.8(f) (5) To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.

There are not relevant land use plans outside the SKGSA that would affect the ability of the GSA to achieve sustainable groundwater management.

2.4 Additional GSP Components

Regulation Requirements:

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

2.4.1 Saline Water Intrusion

Saline (or brackish) water intrusion is the induced migration of saline water into a freshwater aquifer system. Saline water intrusion is typically observed in coastal aquifers where over pumping of the freshwater aquifer causes saltwater from the ocean to encroach inland, contaminating the freshwater aquifer. The distance of the GSP area from the Pacific Ocean negates the possibility of saltwater intrusion from the ocean into the freshwater aquifer.

However, groundwater with naturally occurring elevated concentrations of salts exist at depth in the local aquifers. The base of freshwater, or the depth at which elevated specific conductance is encountered, has been characterized as the boundary where the concentration of specific conductance is over 3,000 µS/cm (Page, 1973). The base of freshwater varies throughout the GSP area and is discussed in detail in **Section 3.1**. As wells are drilled deeper, pumping can cause upcoming (i.e., upward vertical migration) of saline water thus increasing salinity in the freshwater aquifer.

In addition, the Participants strive to prevent the importation of saline surface waters that could ultimately degrade the groundwater. If alternative water sources are available for importation, the Participants will consider not only the cost but also the quality, including salinity, of the water. The Participants will monitor water quality in a manner that provides management information about salinity in the area.

2.4.2 Wellhead Protection

A Wellhead Protection Area (WHPA) is defined by the Safe Drinking Water Act Amendment of 1986 as "the surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield." The WHPA may also be the recharge area that provides the water to a well or wellfield. Unlike surface watersheds that can be easily determined from topography, WHPAs can vary in size and shape depending on subsurface geologic conditions, the direction of groundwater flow, pumping rates, and aquifer characteristics.

The Federal Wellhead Protection Program was established by Section 1428 of the Safe Drinking Water Act Amendments of 1986. The purpose of the program is to protect groundwater sources of public drinking water supplies from contamination, thereby eliminating the need for costly treatment to meet drinking water standards. The program is based on the concept that the development and application of land use controls, usually applied at the local level, and other preventative measures can protect groundwater.

Under the Act, States are required to develop an EPA-approved Wellhead Protection Program. To date, California has no state-mandated program but instead relies on local agencies to plan and implement programs. Wellhead Protection Programs are not regulatory in nature, nor do they address specific sources. They are designed to focus on the management of the resource rather than control a limited set of activities or contaminant sources.

Contaminants from the surface can enter an improperly designed or constructed well along the outside edge of the well casing or directly through openings in the wellhead. A well is the direct supply source to the customer, and such contaminants entering the well could then be pumped out and discharged directly into the distribution system. Therefore, essential to any wellhead protection program are proper well design, construction, and site grading to prevent intrusion of contaminants into the well from surface sources.

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

Municipal and agricultural wells constructed by the member agencies are designed and constructed in accordance with DWR Bulletin 74-81 and 74-90 (DWR, 1981; DWR, 1991). Also, a permit is needed from the County to construct a new well. In addition, the member agencies encourage landowners to follow the same standard for privately owned wells. DWR Bulletins 74-81 and 74-90 (DWR, 1981; DWR, 1991) provide specifications pertaining to wellhead protection, including:

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

2.4.3 Migration of Contaminated Groundwater

Groundwater contamination can be human induced or caused by naturally occurring processes and chemicals. Sources of groundwater contamination can include irrigation, dairies, pesticide applications, septic tanks, industrial sources, stormwater runoff, and disposal sites. Contamination can also spread through improperly constructed wells that provide a connection between two aquifers or improperly abandoned/destroyed wells that provide a direct conduit of contaminants to aquifers. Groundwater within the Plan area is generally of excellent quality; however, several of the agencies in the GSA have experienced exceedances of the Maximum Contaminant Level (MCL) for 1,2,3-TCP and DBCP. Both constituents are mitigable through wellhead treatment. The city of Sanger operates wells with granular activated carbon (GAC) wellhead treatment for DBCP. It is anticipated the member agencies may require wellhead treatment for 1,2,3-TCP in the future.

The cities and district are required to sample their production wells on a monthly, quarterly, annual or multi-annual basis, depending on their particular monitoring schedule, as prescribed by the SWRCB. This data is available through the SWRCB, upon request.

Additionally, several State of California online databases provide information and data on known groundwater contamination, planned and current corrective actions, investigations into groundwater contamination, and groundwater quality from select water supply and monitoring wells. These databases are discussed below:

California Water Resources Control Board

The State of California Water Resources Control Board (SWRCB) maintains an online database that identifies known contamination cleanup sites, known leaky underground storage tanks, and permitted underground storage tanks. The online database contains records of investigation and actions related to site cleanup activities at http://geotracker.waterboards.ca.gov.

The Department of Toxic Substance Control

The State of California Department of Toxic Substances Control (DTSC) provides an online database with access to detailed information on permitted hazardous waste sites, corrective action facilities, as well as existing site cleanup information. Information available through the online database includes investigation, cleanup, permitting, and/or corrective actions that are planned, being conducted, or have been completed under DTSC's oversight. The online database can be accessed at http://www.envirostor.dtsc.ca.gov.

Groundwater Ambient Monitoring and Assessment Program

The State Water Resources Control Board Groundwater Ambient Monitoring and Assessment (GAMA) program collects data by testing untreated raw water for naturally occurring and man-made chemicals and compiles all of the data into a publicly accessible online database. The online database can be accessed at http://geotracker.waterboards.ca.gov/gama/.

2.4.4 Well Abandonment/Well Destruction Program

Well abandonment generally includes properly capping and locking a well that has not been used in over a year. Well destruction includes completely filling in a well in accordance with standard procedures.

Proper well destruction and abandonment are necessary to protect groundwater resources and public safety. Improperly abandoned or destroyed wells can provide a conduit for surface or near surface contaminants to reach the groundwater. In addition, undesired mixing of water with different chemical qualities from different strata can occur in improperly destroyed wells.

The administration of a well construction, abandonment, and destruction program has been delegated to the Counties by the State legislature. Fresno County requires that wells be abandoned according to State standards documented in DWR Bulletins 74-81 and 74-90 (DWR, 1981; DWR, 1991). Due to staff and funding limitations, enforcement of the well abandonment policies is limited.

The member agencies have and will continue to properly destroy any of their wells that are no longer used and will enforce proper well destruction procedures for private wells. In addition, the member agencies will encourage landowners and developers to convert unusable wells to monitor wells, rather than destroy them, so that they can become a part of the region's groundwater monitoring program.

2.4.5 Replenishment of Groundwater Extractions

Replenishment of groundwater is an important technique in management of a groundwater supply to mitigate groundwater overdraft. Groundwater replenishment occurs naturally through rainfall, rainfall runoff, and stream/river seepage and through intentional means, including deep percolation of crop and landscape irrigation, wastewater effluent percolation, and intentional recharge. The primary local water sources for groundwater replenishment include precipitation, the Kings River, and various local streams.

As noted, there is significant groundwater recharge activity within the GSA. For more information, refer to Conjunctive Use Programs **Section 2.2.2**. Refer to **Section 3.3** for discussions on how groundwater recharge is accounted for and tracked.

2.4.6 Well Construction Policies

Proper well construction is important to ensure reliability, longevity, and protection of groundwater resources from contamination. All of the member agencies follow state standards (DWR Bulletin 74-81 and 74-90) when constructing municipal and agricultural wells (DWR, 1981; DWR, 1991). Fresno County has adopted a well construction permitting program consistent with State Well Standards to help assure proper construction of private wells. The County maintains records of all wells drilled in the Plan area. The County restricts the construction of new wells in areas that are served by a community water system; this applies to all area covered by this Plan.

The cities do not allow construction of private wells in their boundaries, except under very limited circumstances. The purpose of these regulations is to keep the water system under central control by the subject city.

State well standards address annular seals, surface features, well development, water quality testing and various other topics. Refer to DWR Bulletins 74-81 and 74-90 for more details (DWR, 1981; DWR, 1991). Well construction policies intended to ensure proper wellhead protection are discussed in **Section 2.4.2**.

This section has discussed the current policies for well construction; when future policies are developed, they will be added to the GSP.

2.4.7 Groundwater Projects

All of the member agencies share responsibility for development and operation of recharge, storage, conservation, water recycling, and extraction projects. The member agencies in general develop their own projects to help meet their water demands and will develop additional future projects to meet sustainability. Developing more groundwater recharge and banking projects is considered key to stabilizing groundwater levels. **Section 6** provides descriptions, estimated costs, and estimated yield for numerous proposed projects. The role of the South Kings GSA is to promote cooperation and sharing of information and ideas between the agencies.

The GSA will also support measures to identify funding and implement regional projects that help the region achieve groundwater sustainability. This can include recharge projects that take advantage of local areas conducive to recharge and areas where recharge provides the most benefit to the GSA. This can reduce the burden for certain agencies from having to recharge within their boundaries if they do not have suitable land or soils.

2.4.8 Efficient Water Management Practices

Water conservation has been and will continue to be an important tool in local water management, as well as a key strategy in achieving sustainable groundwater management. All of the member agencies engage in some form of water conservation including water use restrictions, water metering, education, tiered rates, etc. These water conservation programs were tested during the 2014-2015 drought, which included State mandated urban water restrictions for the first time. Details of water conservation programs can be found in various documents, including Urban Water Management Plans for Fowler, Kingsburg, and Sanger, which include a multi-stage water shortage contingency plans to help conserve water in droughts. Efficient water management practices will include maximizing the beneficial uses of water along with recycled water use as it can replace potable water use in some instances. Future efforts will include an increased focus on elevating awareness on groundwater overdraft and land subsidence and explaining the requirements of SGMA. Some or all of these conservation efforts will be necessary to achieve groundwater sustainability.

2.4.9 Relationships with State and Federal Agencies

From a regulatory standpoint, the plan members have numerous relationships with State and Federal agencies related to water supply, water quality, and water management. Those relationships that are common to all water agencies, such as regulation of municipal water by the California Division of Drinking Water, are not discussed here. Relationships unique to the region are briefly summarized below.

<u>Kings River Water.</u> The Kings River provides the majority of the surface water used in the area. Kings River water is impounded by Pine Flat Dam, which is owned and operated by the US Army Corps of Engineers. The water rights permits were obtained from the SWRCB, although allocation and management of water is largely handled by the Kings River Water Association. The member agencies do not have surface water rights currently; however, that may change in the future, at which point the member agencies will work with the USACE and SWRCB to oversee and manage those supplies.

Many of the member agencies receive grants from various agencies for water related projects. Grants are obtained from the DWR, SWRCB, USBR, and others. The member agencies work closely with these State and Federal agencies to track grant programs and administer and implement grant contracts.

2.4.10 Land Use Planning

The member agencies that are cities have direct land use planning authority while the Del Rey CSD, being located with Fresno County, does not. However, all of the member agencies have an interest in land use planning policies and how it will impact their continued development and water supplies. **Figure 2-3** is a map showing land use in the GSA area, including areas that are developed for urban and agricultural use.

Land use policies are documented in various reports, such as General Plans, Specific Plans, and plans for proposed developments. Updating some of these plans is a multi-year process and not all could be fully updated concurrently with the GSP development. These plans are expected to be modified gradually over time to be consistent with the goals and objectives of this GSP. The Del Rey CSD relies on County policies.

2.4.11 Impacts on Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDEs) are defined under SGMA as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)). The Kings Subbasin coordinated effort conducted a GDE evaluation based on depth to water and proximity to surface water bodies within the subbasin. See **Section 3.2** for additional information on methodology and figures depicting the possible GDEs in the Kings Subbasin.

2.5 Notice and Communication

2.5.1 Description of Beneficial Uses and Users

Regulation Requirements:

§354.10 Each plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:
a) A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.

Beneficial users within the SKGSA area were identified during development of the GSA's Communication & Engagement Plan (C&E) (available online at www.southkingsgsa.com/resources.html), and are described below:

- **Agricultural Users/Food Processors** – Most of the GSA's area is developed urban area. The city limit areas are represented by the representatives of each member agency. There are some food processors and wineries within the GSA boundary.
- **Domestic Well Users** – Domestic well owners will have the opportunity to seek representation as an interested party on a committee of the GSA or through public participation.
- **Municipal/Community Well Operators** – Four incorporated cities (Fowler, Kingsburg, Sanger and Parlier) and Del Rey CSD are the municipal/community well operators within the GSA's boundary.
- **Local Land Use Planning Agencies** – County of Fresno, City of Sanger, City of Parlier, City of Kingsburg and City of Fowler are represented on the GSA Board or through the GSA's Memorandum of Understanding (MOU).

- **Disadvantaged Communities** – Portions of the area within the GSA's boundary are DACs and are within the urban areas of the communities and are therefore represented through membership in the JPA. DACs within the SKGSA boundary include: City of Fowler, City of Kingsburg (portion of the city), City of Parlier, City of Sanger, and Del Rey Community Services District.
- **Entities monitoring and reporting groundwater elevations in all or part of a groundwater basin** – The Kings River Conservation District (KRCD) is the California Statewide Groundwater Monitoring Program (CASGEM) monitoring entity for the Kings Subbasin. The KRCD compiles groundwater measurement data from local agencies and inputs the collected data to CASGEM.

2.5.1.1 Nature of Consultation with the Stakeholders

2.5.1.1.1 Municipalities/DACs

Communication efforts with municipalities cover the majority of the beneficial users of groundwater categories that apply to the SKGSA: domestic well users, municipal/community well operators, disadvantaged communities, and local land use planning agencies. Essential information communicated to the residents of the municipalities/DACs within the SKGSA included an explanation of SGMA, education on water conservation and water usage within the GSA, and soliciting feedback from community members on water quantity challenges their communities may face. In addition, representatives for all five of the municipalities are represented on the GSA board. Any feedback received from these stakeholders was reviewed and evaluated by the GSA's technical team and Board of Directors, and taken into consideration during the GSP development phase.

2.5.1.1.2 Agriculture/Wineries & Food Processing

The SKGSA primarily covers an urban and rural residential area, but the primary industry near the SKGSA is agriculture. Fresno County is a home to multiple food processors, particularly wineries and packing house facilities within the SKGSA boundary. Sun-Maid Growers of California, one of the top raisin producers, is headquartered in Kingsburg, California, and is the top employer for that City alone. Other food processing/wineries, packing, and industrial facilities within the SKGSA are identified in the C&E Plan. Because of their reliance on and usage of groundwater supplies to operate their facilities, food processors, wineries and industrial companies were included in the groundwater sustainability management public participation efforts within the SKGSA boundary. Any feedback received from these stakeholders was reviewed and evaluated by the GSA's technical team and Board of Directors, and taken into consideration during the GSP development phase.

2.6 Public Engagement/Public Outreach Plan

Regulation Requirements:

§354.10 Each plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:
b) A list of public meetings at which the Plan was discussed or considered by the Agency.
c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.
d)(2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.
d)(3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of population within the basin.
d)(4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

As the SKGSA GSA was formed and as the GSP has been prepared, the active involvement of diverse, social, cultural and economic elements of the population with the GSA boundary was encouraged and practiced by the GSA Board of Directors and its technical team. In addition to this GSP, the SKGSA developed the Communication & Engagement (C&E) Plan as a roadmap for the stakeholder engagement part of the GSP process. This C&E Plan provides an overview of the SKGSA, its stakeholders, and decision-making process;

identifies opportunities for public engagement and discussion of how public input and responses are/will be used; describes how the SKGSA continues to encourage the active involvement of the beneficial users of groundwater within the GSA boundary; and the methods the GSA used to inform the public stakeholders about the progress of GSP development and public review phases. These same methods will be used during the implementation and reporting phase. The latest version of the C&E Plan can be found on the SKGSA's website at www.southkingsgsa.com/resources.html.

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

- Education of stakeholders about the purpose, requirements and phases of SGMA, and about the SKGSA and its decision-making process
- Identify and document primary concerns/challenges of beneficial groundwater users to be considered during the GSP preparation and public review process, and establish consistent responses for a unified message
- Promote communication between stakeholders and the SKGSA Board, and encourage/solicit public comments throughout all SGMA phases
- Establish the methods of communication between the SKGSA Board of Directors and technical team and the stakeholders (maintenance of Interested Parties List, direct communication, district correspondence, email blasts with newsletters and other pertinent GSA/GSP information, and one-on-one and public outreach meetings, etc.)

2.6.1 Overview of GSA Stakeholder Involvement During SGMA Phases

2.6.1.1 Phase 1: GSA Formation and Coordination

To form the South Kings GSA, representatives from the cities of Fowler, Kingsburg, Parlier, Sanger and Selma met on a semi-regular basis in 2016 and early 2017 to develop the recommended GSA formation governance structure. A Joint Powers Agreement (JPA) was developed and executed, and the GSA conducted its first board meeting in May 2017. Public notices were published on May 15 and May 22, 2017 in the Fresno Bee to notify residents of the May 25, 2017 public hearing.

In June 2017, the City of Selma decided to withdraw from the SKGSA JPA. On June 14, 2017, a Memorandum of Understanding (MOU) was put into place between the SKGSA and Del Rey Community Services District regarding their participation in the GSA and GSP development and implementation.

Stakeholder input was utilized during the GSA formation phase, as beneficial users and stakeholders with interests in groundwater usage within the SKGSA's boundary were notified via public meeting notices. The List of Interested Parties was established during Phase 1.

Each of the five member agencies hold a seat on the GSA's Board of Directors. Throughout the SGMA phases, the SKGSA's Board of Directors and technical team has been responsible for collecting and organizing data, engaging and retaining experts and consultants, and soliciting feedback from beneficial users of groundwater and interested parties within the GSA boundary. Engagement with the SKGSA stakeholders will continue throughout the implementation and reporting phase.

2.6.1.2 Phase 2: GSP Preparation and Submission

Phase 2: GSP Preparation and Submission spanned from 2018 through the end of 2019. With the goal of having the draft GSP in mid-2019, 2018 was primarily be the technical development of the plan, working with stakeholders for feedback and input. This phase also consisted of creating the C&E Plan to outline communication efforts for the GSP development, public review and implementation phases. During 2018, the focus was interaction with stakeholders to educate and inform stakeholders about SGMA and the GSP process, while also soliciting feedback and input from these groups to mitigate the negative impacts to beneficial users of groundwater as much as possible.

Following the process of the public review phase, the SKGSA adopted the GSP on ____________________.

2.6.1.3 Phase 3: GSP Review

During the second half of 2019, Phase 3: GSP Review was the primary focus of communication and engagement efforts. The draft GSP was presented to the Board on _____________, and the 90-day public comment period began, concluding with a public hearing held on ____________________. Notice for the public hearing was published on ____________________ in the Fresno Bee.

During the public review phase, the GSP draft was posted on the SKGSA's website for stakeholders to conveniently download and review. Outreach meetings were held during this phase at locations throughout the GSA boundary. These meetings focused on an overview of the GSP content, while giving stakeholders a public forum to provide their feedback and comments.

Once the public review period was completed, public comments were taken into consideration and incorporated into the final version of the SKGSA's GSP before submitting to the DWR by the January 31, 2020 deadline. Following submittal, stakeholders will be given a second 60-day comment period through the DWR's SGMA portal at http://sgma.water.ca.gov/portal/. Comments will be posted to the DWR's website prior to the state agency's evaluation, assessment and approval.

2.6.1.4 Phase 4: Implementation and Reporting

Phase 4: Implementation and Reporting will begin once the GSP is submitted in January 2020. Even while the DWR is reviewing the GSP, implementation must proceed at the GSA-level. During the implementation phase, communication and engagement efforts will be shifted to educational and informational awareness of the requirements and processes of reaching groundwater sustainability. Active involvement of all stakeholders will be encouraged during this phase.

2.6.1.5 Public Meetings and Outreach Efforts

A list of public meetings held by the SKGSA where the GSP was discussed or considered by the agency is included in **Table 2-3**.

Table 2-3: Public Meetings and Workshops

Meeting Date		Public Meetings/Workshops
2017	5/25/17	Board Meeting, Fowler
	6/14/17	Board Meeting, Kingsburg
	6/27/17	Board Meeting, Fowler
	6/30/17	Board Meeting, Fowler
	8/9/17	Board Meeting, Parlier
	9/18/17	Board Meeting, Sanger
	11/13/17	Board Meeting, Fowler
	12/4/17	Board Meeting, Kingsburg
2018	1/10/18	Board Meeting, Parlier
	2/12/18	Board Meeting, Sanger
	6/4/18	Board Meeting, Del Rey CSD
	7/11/18	Board Meeting, Parlier

Meeting Date		Public Meetings/Workshops
	10/10/18	Board Meeting, Fowler
	12/12/18	Board Meeting, Kingsburg
2019	4/10/19	Board Meeting, Parlier
	6/5/19	Board Meeting, Sanger
	7/12/19	
	8/xx/19	
	9/xx/19	
	10/xx/19	
	11/xx/19	
	12/xx/19	
2020	1/xx/20	

2.6.2 Decision-Making Process

Regulation Requirements:

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

South Kings GSA was formed by a Joint Powers Agreement (JPA) (Refer to **Appendix A**). The decision-making structure of the South Kings GSA is delivered through a hierarchical structure where subcommittees, committees and executive staff advise, and request direction from, the Board of Directors on important topics and issues. **Figure 2-6** provides the decision-making structure of South Kings GSA.

Figure 2-6: South Kings GSA Management Structure

The governing body of the JPA consists of a five-member Board of Directors that includes Members as identified in the JPA. Directors shall be elected officials who have been appointed to serve on the GSA's Board of Directors by their respective boards, councils or commissions. All decisions require a majority vote of the present and voting Board of Directors with the following exceptions:

Table 2-4: SKGSA Decision-Making Process

Key Authority	Threshold
Adoption of or amendments to the GSP	Unanimous vote of all Directors
Annual operating budget	Four Affirmative votes by Directors
Imposition of any fee, charge or rate	Unanimous vote of all Directors
Imposition of any cost sharing contribution on Members	Unanimous vote of all Directors

Key Authority	Threshold
Bylaws	Four Affirmative votes by Directors
Removal of a Member from the GSA	Four Affirmative votes by Directors
To incur debts, liabilities, or obligations on behalf of the Authority	Four Affirmative votes by Directors
Amendment of the Agreement	Unanimous votes of all Directors
Authorization to obligate the Authority to participate in litigation or other legal proceedings	Four Affirmative votes by Directors

2.6.3 Comments Received

Comments received by the SKGSA during the public review phase and a summary of agency responses is included as **Appendix B** .

3 Basin Setting

3.1 Hydrogeologic Conceptual Model

Regulation Requirements:

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

3.1.1 Introduction

Regulation Requirements:

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

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

An HCM is not a numerical groundwater model or a water budget model. An HCM is rather a written and graphical description of the hydrologic and hydrogeologic conditions that lay the foundation for future water budget models. In addition, this HCM supports and provides the hydrogeologic setting to support the Groundwater Conditions, **Section 3.2**, and Water Budget, **Section 3.3**, of this GSP.

This HCM has been written by adhering to the requirements set forth in the California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5, Subarticle 2 (§354.14). Several topics are touched on in the HCM, including groundwater quality, groundwater flow, and groundwater budget which are discussed in greater detail in Groundwater Conditions (**Section 3.2**) and Water Budget (**Section 3.3**).

The narrative HCM description provided in this section is accompanied by graphical representations of the South Kings GSA portion of the Kings River basin that have attempted to clearly portray the geographic setting, regional geology, basin geometry, and general water quality. This HCM has been prepared utilizing published studies and resources and will be periodically updated as data gaps are addressed, and new information becomes available.

3.1.2 Lateral Basin Boundaries

Regulation Requirements:

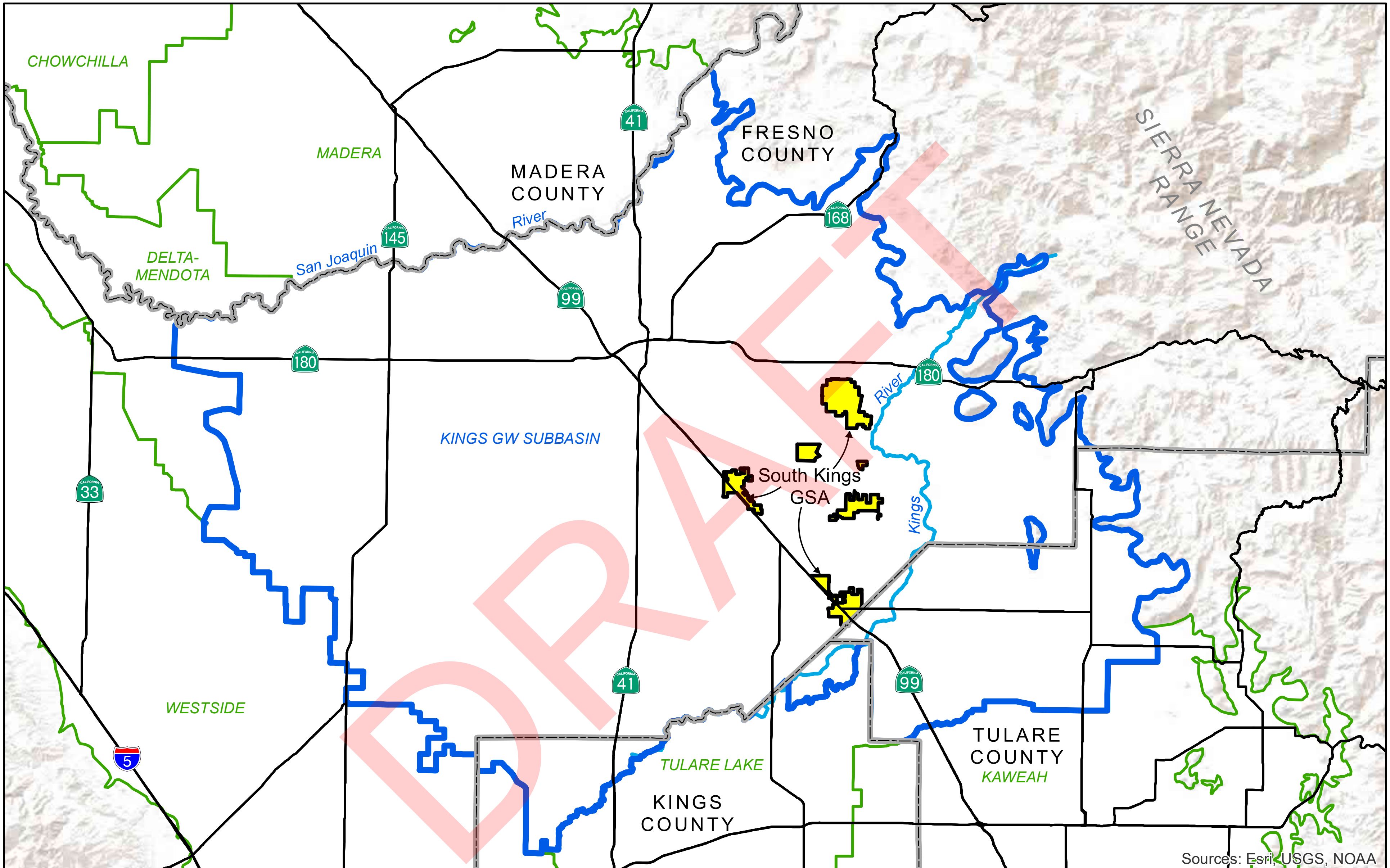
§354.14(b)(2) The hydrogeologic conceptual model shall be summarized in a written description that includes lateral basin boundaries, including major geologic features that significantly affect groundwater flow.

To the east, the Kings Subbasin is bounded by the Sierra Nevada foothills. To the west the subbasin is bounded by the Delta Mendota and Westside Subbasins. Starting in the southwest corner the Kings Subbasin shares a common border for a mile with the Westside Subbasin, then runs easterly along the northern boundary of the South Fork Kings GSA, the south fork of the Kings River, the southern boundary of Laguna Irrigation District, the northern boundary of the Kings County Water District, the southern boundaries of the Consolidated and Alta Irrigation Districts, and the western boundary of Stone Corral Irrigation District. To the north it is bounded by the San Joaquin River and the northwest corner of the subbasin is formed by the intersection of the east line of the Farmers Water District with the San Joaquin River (DWR, 2006). A more detailed description for the GSA is included below.

As shown in **Figure 2-1**, the SKGSA area is located to the east of the center of the Kings Subbasin, which is located in the approximate center of the San Joaquin Valley. The Kings Subbasin is bounded by the foothills of the Sierra Nevada mountains on the east, which define the eastern boundary of the alluvial groundwater aquifer system, and by the San Joaquin River on the north. The major features that affect groundwater flow are the San Joaquin River and the basement complex of the Sierra Nevada Mountains (i.e., bedrock). Minimal amounts of groundwater flow into the SKGSA through fractures in bedrock.

The basement complex of the Sierra Nevada and the seepage loss along the San Joaquin River under natural conditions affect the direction of flow in the region as groundwater flows away from both features. As groundwater flows from areas of high hydraulic head to areas of low head, the groundwater map presented in this section has been referenced to elevation to show groundwater flow direction. As seen in **Figure 3-2**, groundwater flows to the southwest away from the Sierra Nevada Mountains towards the axial trough of the valley. Additionally, seepage from the San Joaquin River, and the recharge ridge associated with seepage loss from the river, induce groundwater to flow away from the river to the south and southwest. As shown on **Figure 3-2**, mounding of groundwater occurs around the Fresno-Clovis Regional Wastewater Reclamation Facility. Numerous groundwater depressions have also developed as aquifer usage has increased over time, which can cause the direction of groundwater flow to vary locally, but the dominant direction of groundwater flow in the region remains southwest.

SKGSA boundaries are determined by the political boundaries of the cities that comprise it (Fowler, Del Rey, Sanger, Parlier, and Kingsburg). It is encompassed entirely by the Central Kings GSA (CKGSA), which is bounded by five of the seven GSAs in the subbasin.



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Legend

- South Kings Groundwater Sustainability Agency
- County Boundary
- Kings Groundwater Subbasin (DWR 2017)
- Other Groundwater Subbasins (DWR 2017)

South Kings GSA

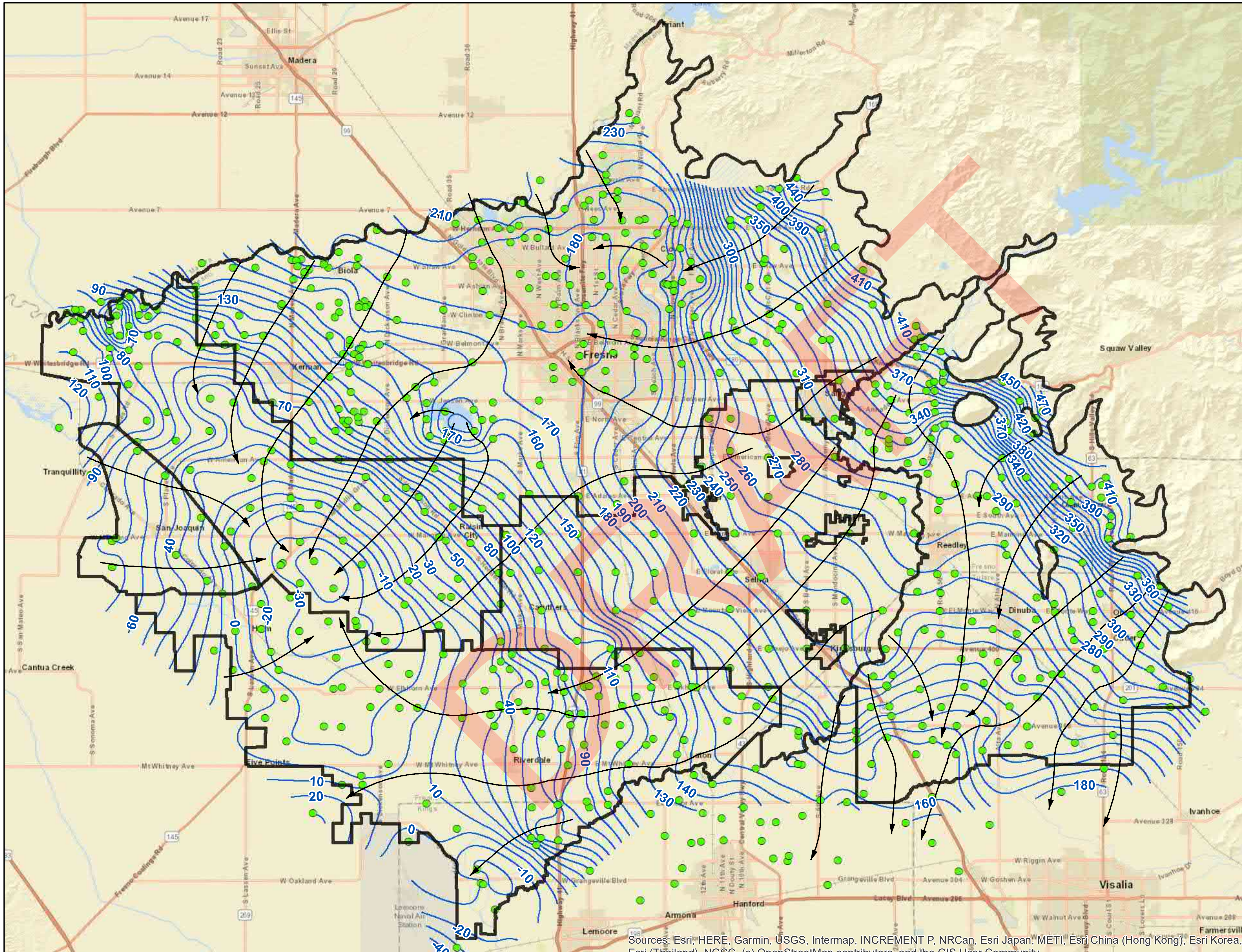
Lateral Basin Boundaries

Figure 3-1

Kings Subbasin
Coordinated Effort

Spring 2016 - Water Level Elevations
(feet above mean sea level)

Figure 3-2



Legend

Kings Coordinated Effort GSAs

Well Used in Analysis

General Groundwater Flow Direction

Water Level Contours

Line of Equal Elevation (10ft interval)

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3.1.3 Regional Geologic and Structural Setting

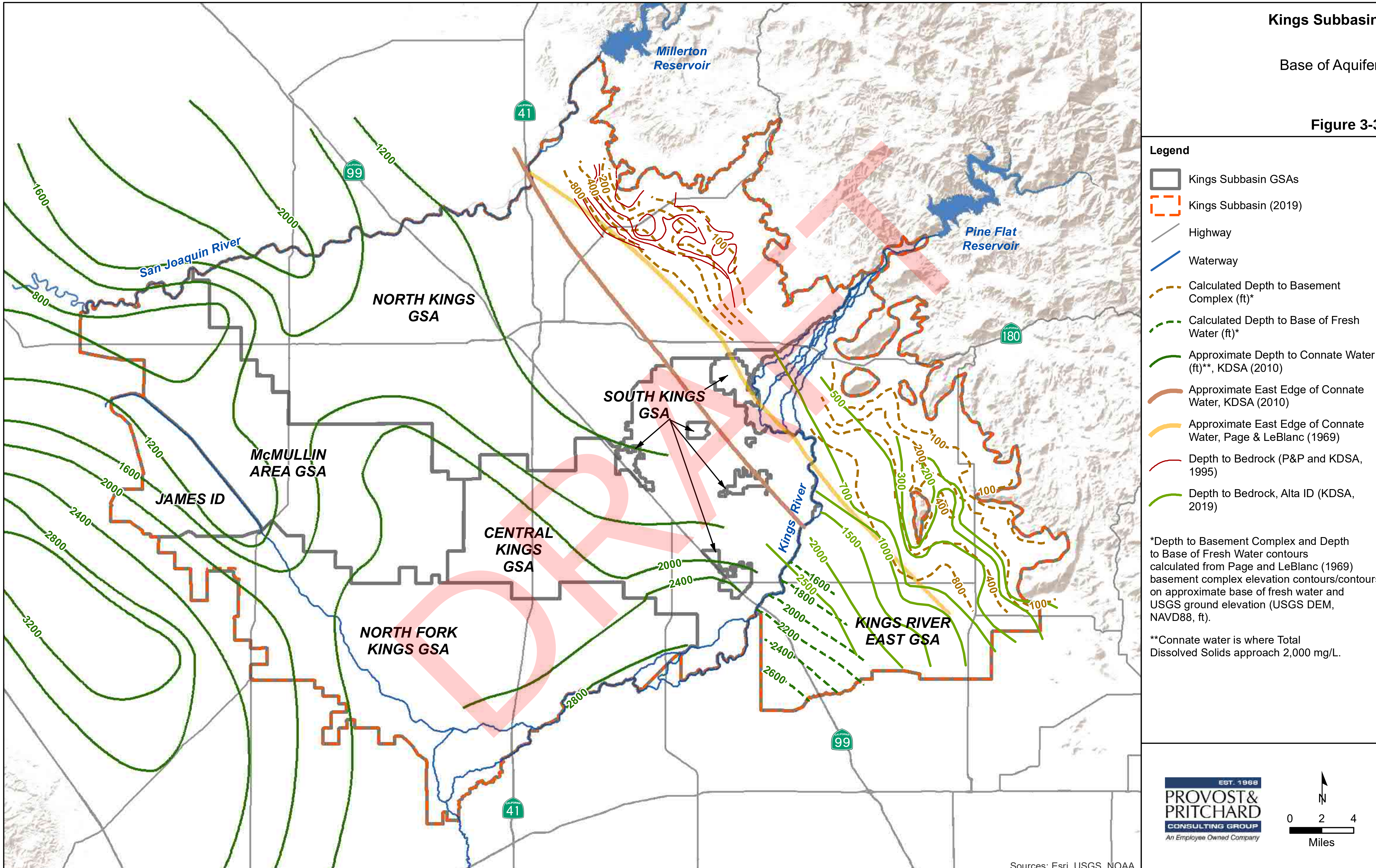
Regulation Requirements:

§354.14(b)(1) The hydrogeologic conceptual model shall be summarized in a written description that includes the regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.
§354.14(b)(3) The hydrogeologic conceptual model shall be summarized in a written description that includes the definable bottom of the basin.

The Kings Subbasin is centrally located within the San Joaquin Valley, which represents the southern portion of the Great Central Valley of California. The San Joaquin Valley is a structural trough up to 200 miles long and 70 miles wide. It is filled with up to 32,000 feet of marine and continental sediments deposited during periodic inundation by the Pacific Ocean and by erosion of the surrounding mountains, respectively. Continental deposits shed from the surrounding mountains form an alluvial wedge that thickens from the valley edges toward the axis of the structural trough. This depositional axis is slightly west of the series of rivers, lakes, sloughs, and marshes, which mark the current and historic axis of surface drainage in the San Joaquin Valley (DWR, 2006).

In the east, the geologic structure of the Kings Subbasin can be divided into two categories, a basement complex (i.e., bedrock) and overlying sedimentary rocks and deposits (Page and LeBlanc, 1969). Despite being faulted and jointed, the regional structure of the basement complex is formed from the western slope of the southwest tilted Sierra Nevada (Smith, 1964). For the purposes of this HCM, the basement complex is the definable bottom of the Kings Subbasin. The definable bottom of the basin is the base of the aquifer on the east side of the basin east of the interface between the depth to bedrock and further west and southwest is defined by the depth to connate water (**Figure 3-3**). East of the approximate edge of connate water or where freshwater extends to bedrock, the base of the aquifer is the same as the base of the basin. West of the interface between connate water and bedrock, the depth to bedrock is deeper than the base of freshwater or depth to connate water, i.e., deeper than the base of the aquifer, Some of the sedimentary deposits overlaying the basement complex have also been folded and/or faulted, but the overriding structure of the sedimentary deposits are homoclinal (i.e., sedimentary deposits that dip uniformly in one direction). The dip of the homoclines is controlled by the back slope of the Sierra Nevada and the age of the deposits (i.e., older sediments are more steeply dipping than younger sediments). Similarly, to the west, the general orientation of sediments originating from the Coast Ranges is dipping east toward the valley trough. A more detailed description of the GSA is included below.

As described by Page and LeBlanc (1969), the geologic structure of the Fresno area (near the vicinity of the SKGSA cities) can be divided into two basic categories: a basement complex (i.e., bedrock) and overlying sedimentary rocks and deposits. Despite being faulted and jointed, the regional structure of the basement complex is formed from the western slope of the southwest tilted Sierra Nevadas (Smith, 1964). Some of the sedimentary deposits overlaying the basement complex have also been folded and/or faulted, but the overriding structure of the sedimentary deposits are homoclinal (i.e., sedimentary deposits that dip uniformly in one direction). The dip of the homocline is controlled by the back slope of the Sierra Nevada and the age of the deposits (i.e., older sediments are more steeply dipping than younger sediments). The buried basement complex just northeast of the SKGSA area is inferred to be faulted; however, the inferred fault does not have any demonstrated effect on groundwater movement (Page, 1975). The basement complex that crops out along the eastern border of the basin does not provide appreciable amounts of groundwater to the San Joaquin Valley (Page & LeBlanc, Geology, Hydrology, and Water Quality in the Fresno Area, California, 1969). For the purposes of this HCM, the basement complex is the definable bottom of the basin for the SKGSA area.



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Much of the regional structural setting described above can be seen in an isometric block diagram (not to scale) of the Central Valley, presented herein as **Figure 3-4** with the SKGSA highlighted. The Sierra Nevada Mountain Range and its foothills are located east of the basin, and erosion of these mountains and hills have formed alluvial deposits that slope generally southwest to west toward the axis of the San Joaquin Valley.

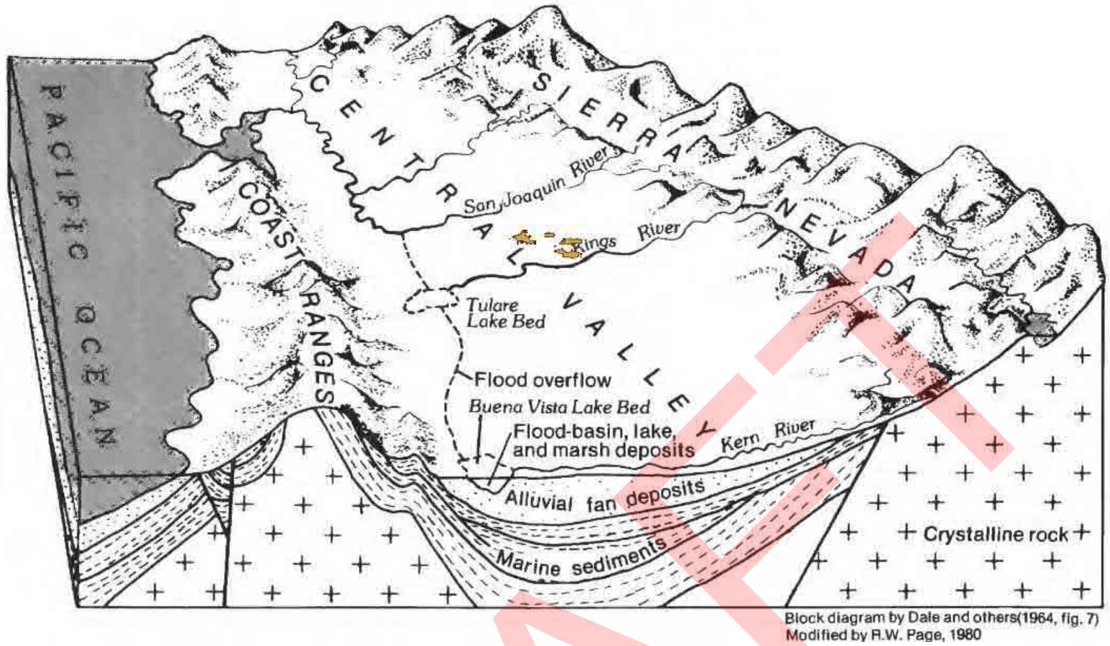


Figure 3-4: Isometric Block Diagram of the Fresno Area with South Kings GSA Highlighted

3.1.4 Topographic Information

Regulation Requirements:

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

The geomorphology of the Kings Subbasin is dominated by a series of overlapping alluvial fans originating from the Sierra Nevada foothills and the San Joaquin and Kings Rivers. A relatively large area of sand dune deposits is located within the eastern central middle of the basin. Surface elevations in the subbasin range from approximately 700 feet above mean sea level (msl) in the east to as low as approximately 160 feet in the west. Relatively steep slopes exist in the areas adjacent to the Sierra Nevada foothills, however the overall topography of the subbasin slopes gently to the southwest. Additional description of this GSA is included below.

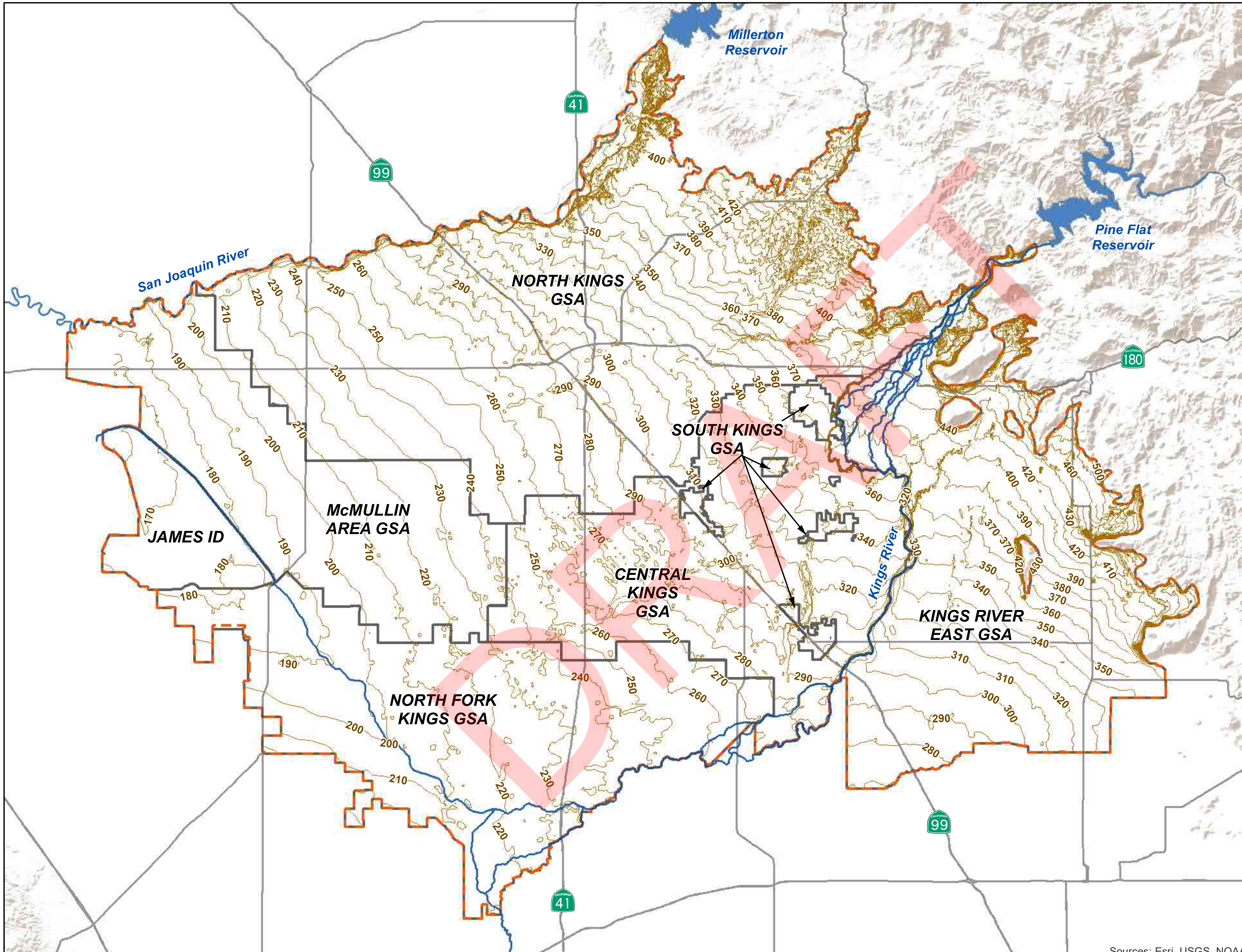
Geomorphic features of the SKGSA area and surrounding areas were mapped by Page and LeBlanc (1969). As shown in **Figure 3-7**, the landscape of the SKGSA area is dominated by overlapping alluvial fans of the Kings and San Joaquin Rivers and the compound alluvial fans of the intermittent streams between the two major rivers. In general terms, alluvial fans are fan or cone-shaped deposits of sediment built by streams. Alluvial fans are narrower at the head than at the toe and slope with decreasing gradient from head to toe. The SKGSA area is bounded to the east by the foothills and mountains of the Sierra Nevada which provide the source of the sediment for the alluvial fan deposits.

A topographic map of the SKGSA area is presented below as **Figure 3-5**. Within the Kings Subbasin, the landscape generally slopes gently to the southwest with the highest points near the eastern edges of the Sierra Nevada foothills and the lowest elevations in the western parts of the subbasin, near the axis of the valley. For the SKGSA, elevations are as high as approximately 380 feet above mean sea level (msl) near Sanger and slope gently to approximately 300 feet above msl near Fowler and Kingsburg.

Kings Subbasin

Topography

Figure 3-5



Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Waterway
- USGS Ground Elevation (USGS DEM, NAVD88, ft)

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3.1.5 Surficial Geology

Regulation Requirements:

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

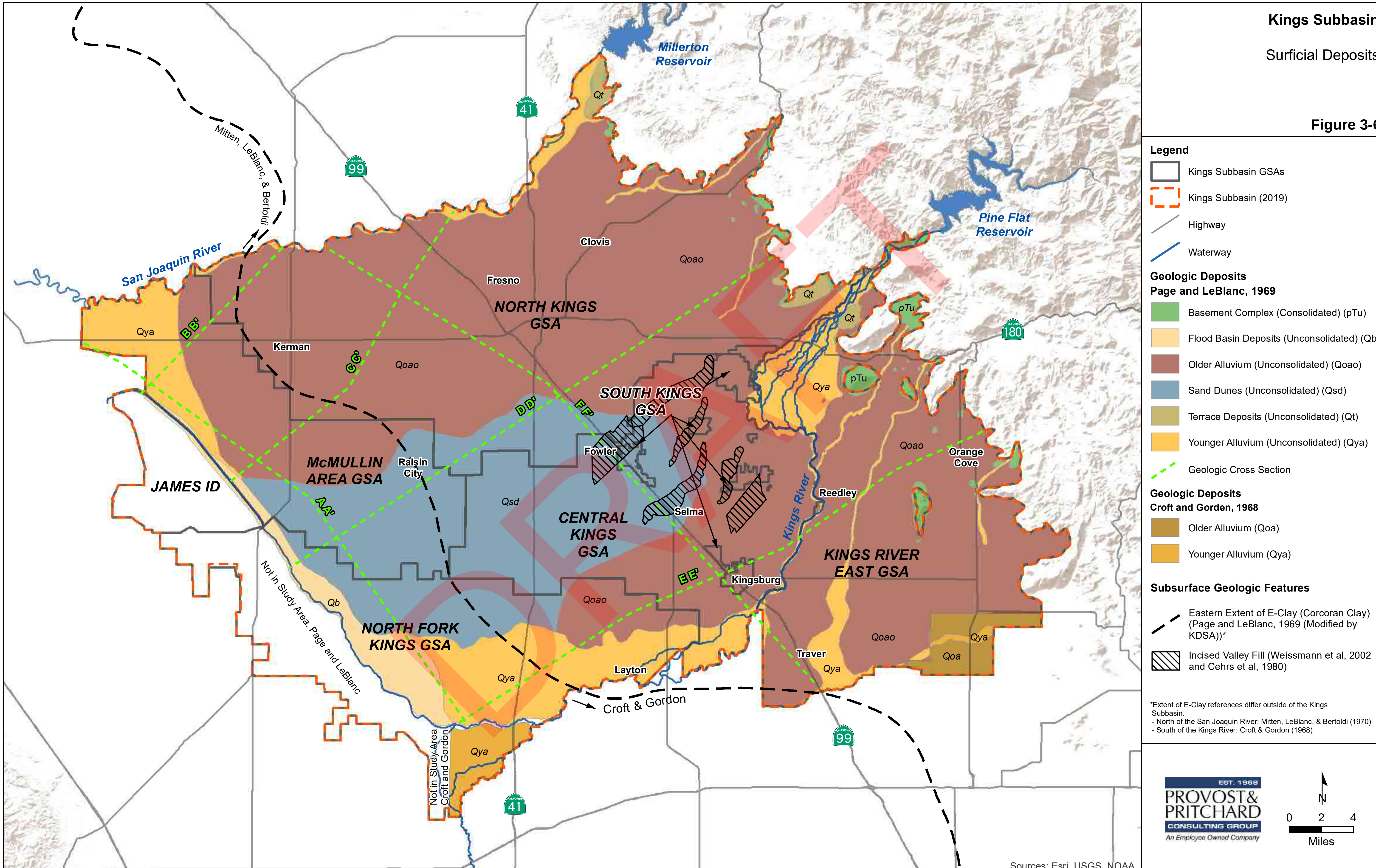
Surficial geologic materials in the Kings Subbasin consist of consolidated rocks and unconsolidated deposits. The consolidated rocks are comprised of a pre-Tertiary age basement complex, and marine and continental sedimentary rocks of Cretaceous (145 to 66 million years ago) and Tertiary age (66 to 2.6 million years ago). The basement complex comprises a large portion of the Sierra Nevada and other regional mountain ranges that is composed of a mass of plutonic and metamorphic rocks commonly referred to as the Sierra Nevada batholith. The basement complex surface slopes gently to the southwest from the foothills to beneath the valley floor. The unconsolidated deposits are of both Tertiary and Quaternary age (2.6 million years ago to the present) and are generally comprised of alluvial material from the nearby foothills.

Quaternary age (2.6 million years ago to the present) deposits dominate the Kings Subbasin surface. These deposits have been categorized by Page and LeBlanc (1969) as Quaternary Older Alluvium (Qoao), Quaternary Younger Alluvium (Qya), and Quaternary Sand Dunes (Qsd). Qoao deposits are the most prominent and cover most of the subbasin. A large swath of Qsd is located in the south-central portion of the subbasin and Qya can generally be found along the banks and alluvial fans of rivers and intermittent streams. Quaternary Flood-basin deposits (Qb) are found along the western boundary of the subbasin between the San Joaquin and the Kings Rivers. Several relatively small outcroppings of basement complex (pTu) are located along the subbasin western edge. **Figure 3-6** is a map depicting surficial deposits in Kings Subbasin. More detailed descriptions of this GSA are included below.

Surficial geology of the SKGSA consists of unconsolidated Quaternary age (2.6 million years ago to the present) deposits. As shown on **Figure 3-7**, within SKGSA, surface materials have been categorized by Page and LeBlanc (1969) as Quaternary Older Alluvium (Qoa), Quaternary Younger Alluvium (Qya), and Quaternary Sand Dunes (Qsd).

Geomorphic features and surficial geology of SKGSA and surrounding areas were mapped by Page and LeBlanc (1969). As shown in **Figure 3-7**, the landscape of the eastern four SKGSA cities is characterized by the High Alluvial Fan of the Kings River while sand dune deposits are present where Fowler is located. In general terms, alluvial fans are fan or cone-shaped deposits of sediment built by streams. Alluvial fans are narrower at the head than at the toe and slope with decreasing gradient from head to toe.

Cross-section locations are shown on **Figure 3-7**. Cross-sections are described later in **Section 3.1.7**.



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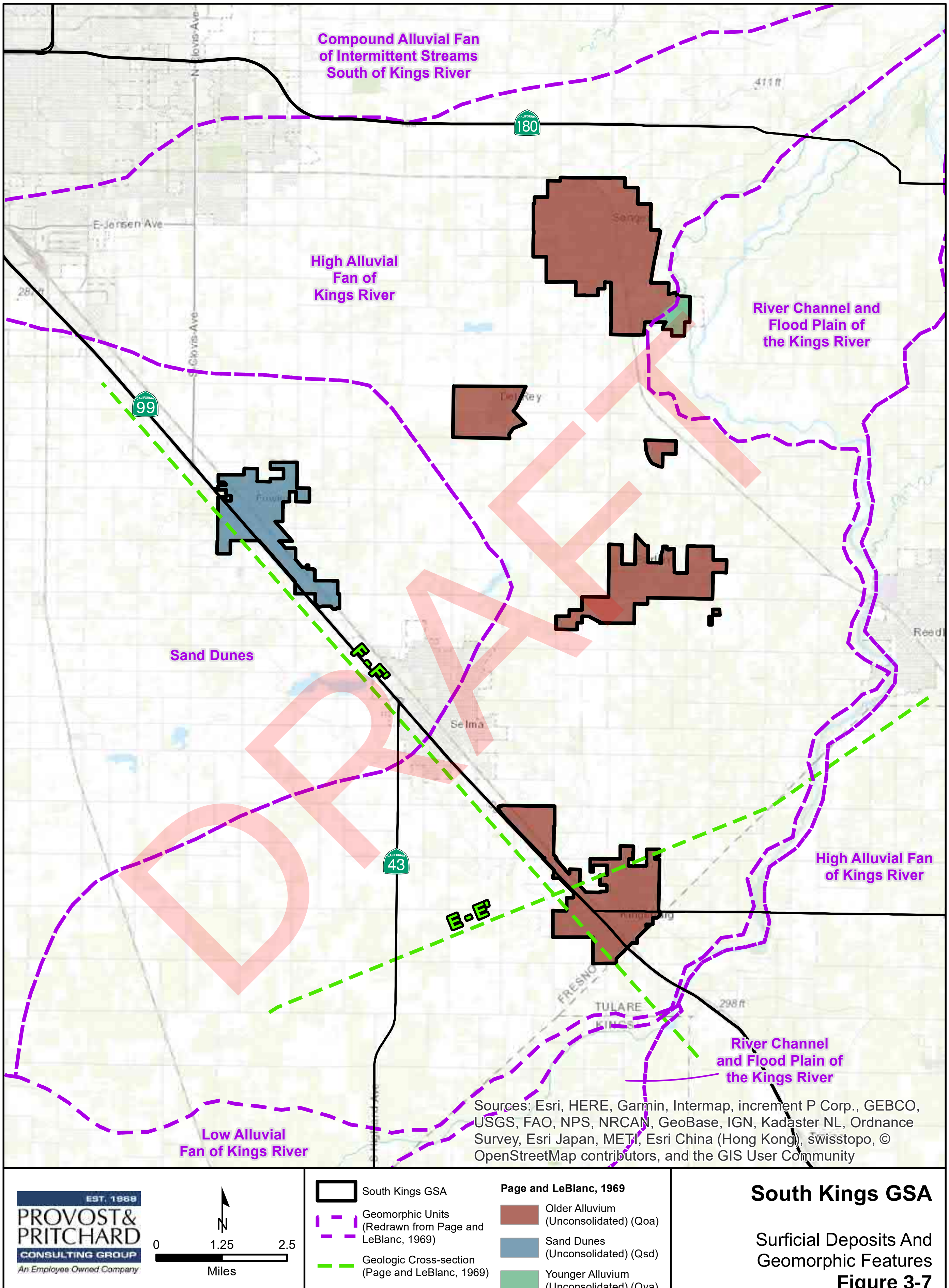

South Kings GSA

Surficial Deposits And Geomorphic Features

Figure 3-7

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3.1.6 Soil Characteristics

Regulation Requirements:

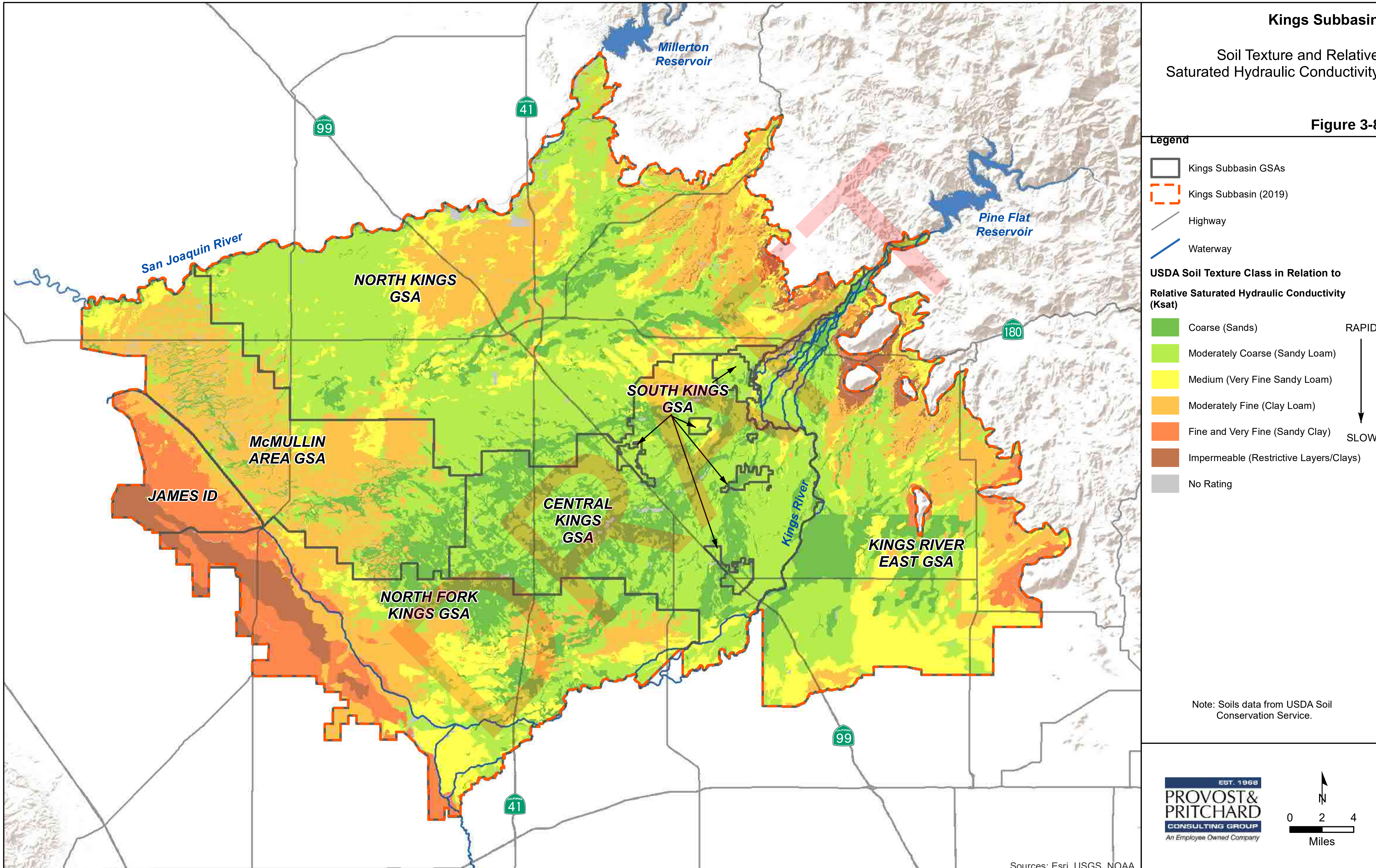
§354.14(d)(3) Physical characteristics of the basin shall be represented on one or more maps that depict soil characteristics as described by the appropriate Natural Resource Conservation Service soil survey or other applicable studies.

Soils within the Kings Subbasin can vary significantly. In general, coarser grained soils are found along the eastern portions of the subbasin and adjacent to the San Joaquin River and Kings River, as well as areas associated with recent alluvial deposition along intermittent streams. Finer grained soils are typically found in the area of the compound fan created by intermittent streams in the east and are also found in the western areas of the Subbasin near the Fresno Slough. Soil maps and a more detailed description of this GSA are included below.

In general the dominant topsoil textural class in the SKGSA area is moderately coarse (**Figure 3-8**). The map was prepared using soil textural classes from the Natural Resource Conservation Service (NRCS). Patches of coarse soils that regionally trend southwest-northeast are present in much of the GSA area and represent recent alluvial deposits along the area's streams and rivers. Pockets of medium-grained to moderately fine-grained soils have been mapped in Sanger and Del Rey.

In this figure, soil textural classes have additionally been related to Saturated Hydraulic Conductivity (Ksat or hydraulic conductivity) based on NRCS general categories. For the SKGSA area, the NRCS has generally described soils to depths of 5 to 7 feet. The hydraulic conductivity values shown on the map are expressed in general terms ranging from relatively rapid for coarse grained topsoils to relatively slow for moderately fine-grained topsoil. Duripan soil horizons (i.e., hardpan), have, for the purposes of this document, been assumed to have largely been broken up through deep tillage related to historical agricultural operations throughout the area and are therefore not shown on **Figure 3-5**.

Figure 3-8 may be useful for initial screening tool for potential recharge and groundwater banking sites, but site-specific assessments, on-site drilling investigations, and/or pilot studies should be conducted before projects are pursued.



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3.1.7 Cross-Sections

Regulation Requirements:

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

Conceptualized cross sections of the Kings Subbasin from the northwest to southeast and from the southwest to northeast (perpendicular) to the basin axis are presented below in **Figure 3-9** through **Figure 3-14**. The major stratigraphic and structural features such as the confining A-Clay, C-Clay, and E-clay (lacustrine deposits) that exist in the western portion of the subbasin are clearly identified. Likewise, the structural basement complex can be seen sloping to the southwest away from the foothills to beneath the valley floor, while the valley floor itself is primarily composed of alluvial deposits. Additional description and cross sections for the GSA are included below.

Portions of Page and LeBlanc (1969) cross sections cut through small pieces of SKGSA and area are presented as **Figure 3-13** and **Figure 3-14**. Cross section locations are shown on the Surficial Geology Map (**Figure 3-7**). They include one cross section parallel to and one cross section perpendicular to the structural trough of the San Joaquin Valley.

As shown on the regional cross section F-F', the Quaternary Older Alluvium (Qoao) is inferred to exist from the surface to depths ranging from approximately 600 to 900 feet below ground surface (bgs) and is inferred to be shallower in the northwestern and southeastern parts of the area. These soils overlie older Quaternary and Tertiary age continental deposits (QTc), which extend to depths of at least 2,800 feet bgs. The Quaternary Sand Dune deposits (Qsd) located in the south-central portion of the area are inferred to extend to a depth of approximately 50 feet bgs. Similarly, cross section E-E', the Quaternary Older Alluvium (Qoao) is inferred to exist from the surface to depths ranging from approximately 700 feet bgs in the southeast near the Kings River to approximately 1,000 feet bgs in the northwest portions of the area. These soils overlie older Quaternary and Tertiary age continental deposits (QTc), which extend to depths of at least 3,300 feet. On cross-sections E-E', a shallow band of Quaternary Younger Alluvium (Qya) is located at relatively shallow depths immediately adjacent to the Kings River channel in the northeast.

Page and LeBlanc (1969) indicated in general terms that the deposits of Quaternary age yield more than 90 percent of groundwater pumped from wells with the older alluvium material (Qoao) being the most important aquifer in the area. While the Qoao is still the most important portion of the aquifer, it is recognized that there are now a larger number of deeper wells pumping more water from below the Qoao than in the 1960s.

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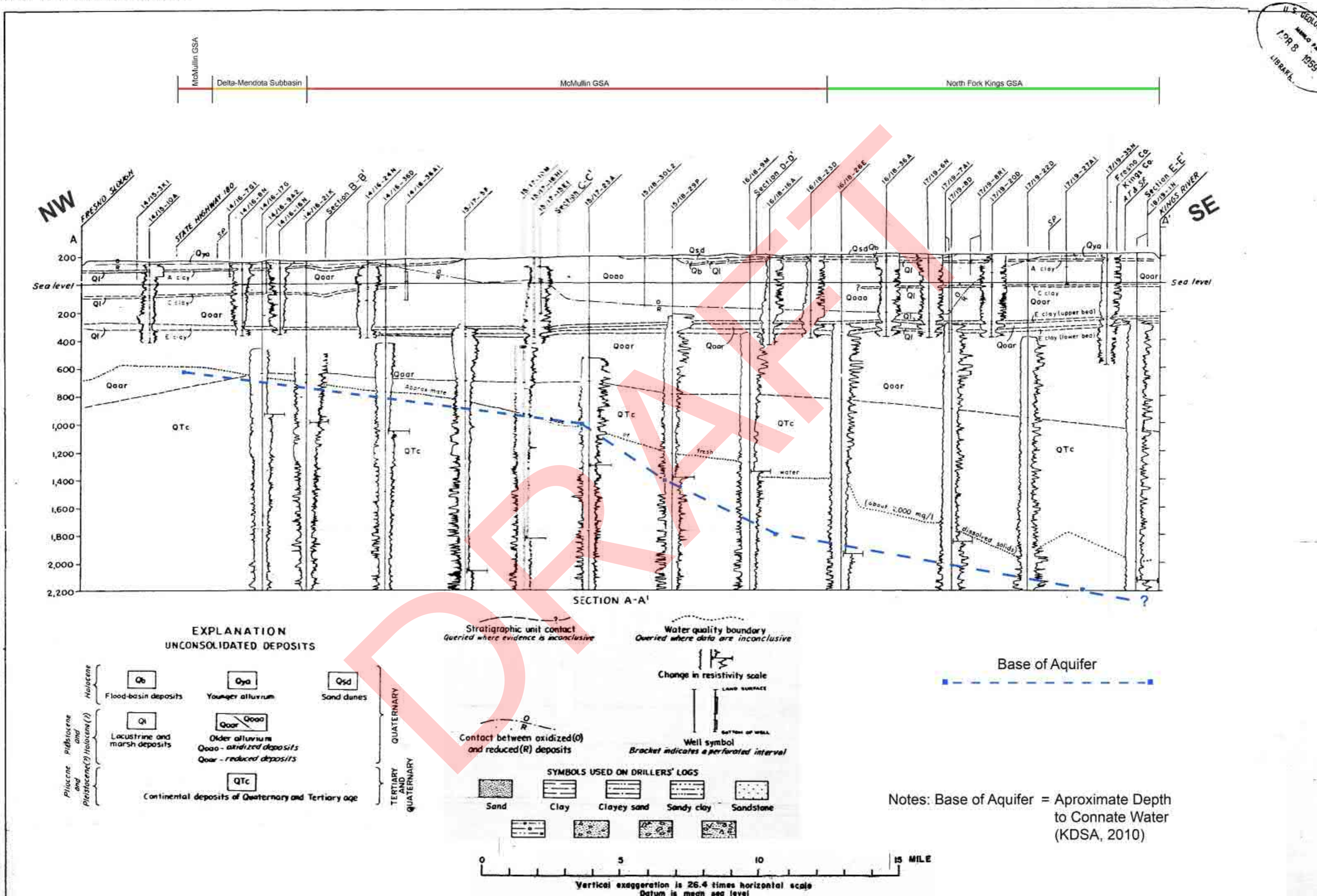


FIGURE 10.-GEOLOGIC CROSS SECTION A-A'. FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-9

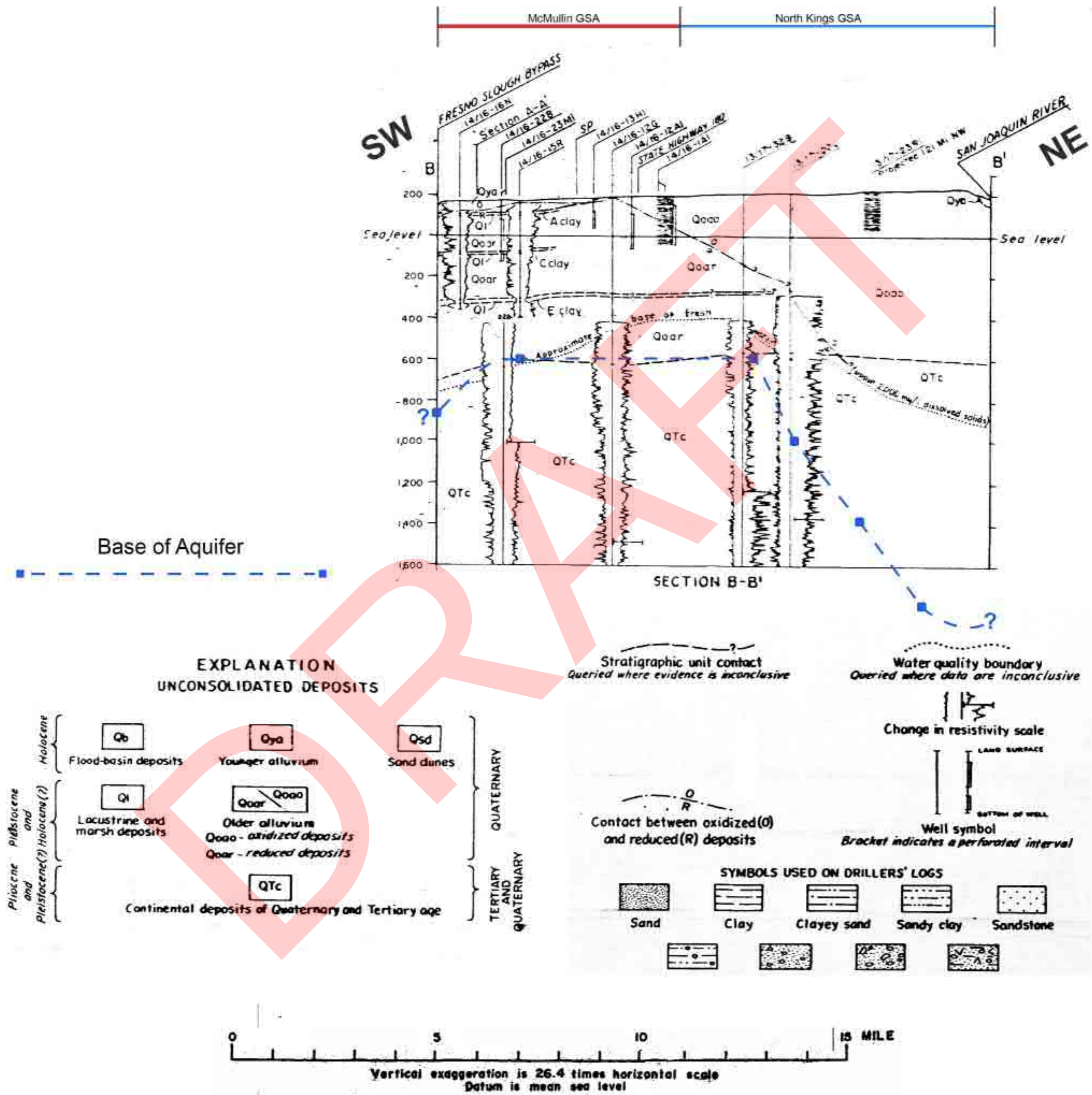


FIGURE 10.-GEOLOGIC CROSS SECTION B-B'. FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-10

U. S. GEOLOGICAL SURVEY

Prepared in cooperation with CALIFORNIA DEPARTMENT OF WATER RESOURCES

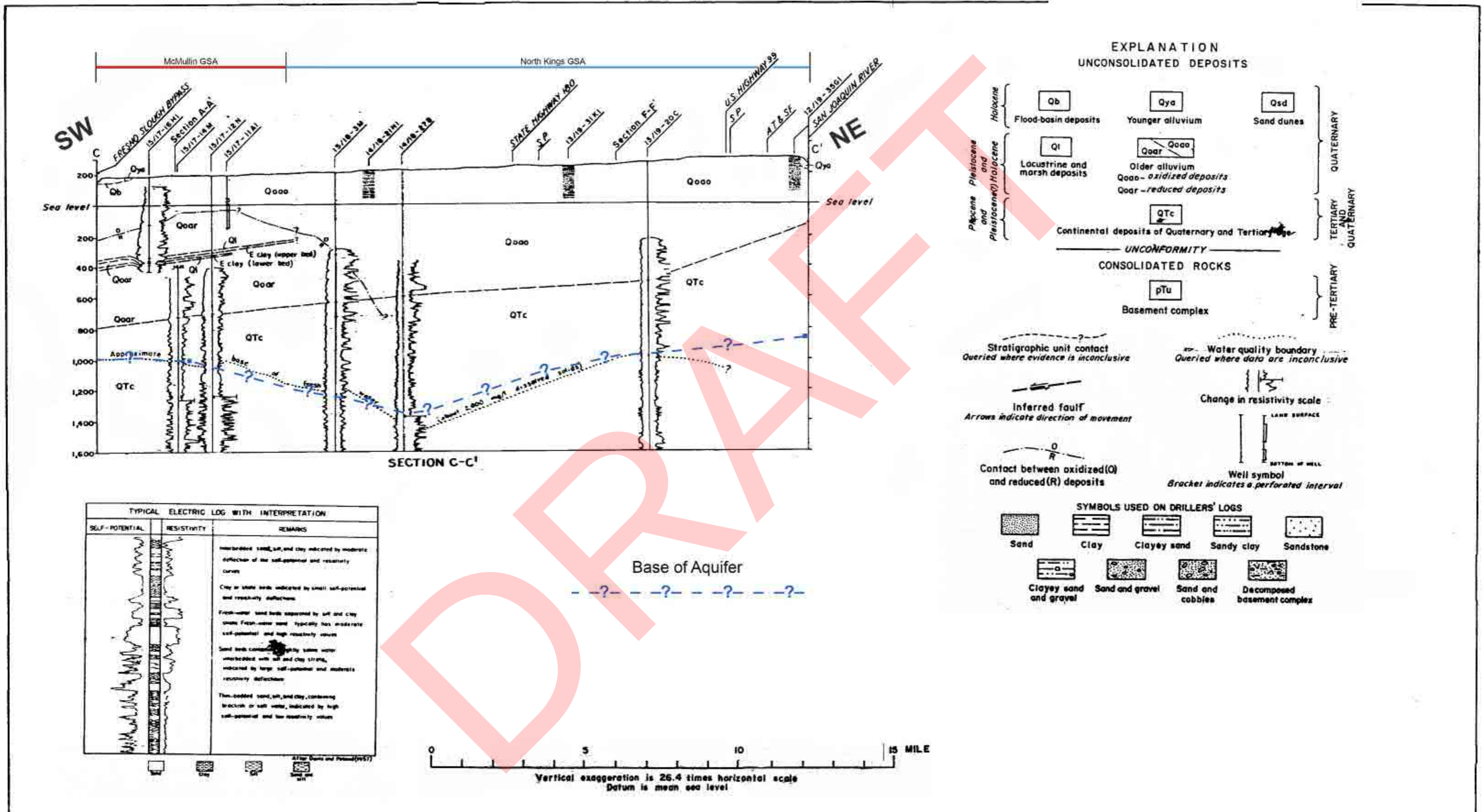


FIGURE 8 GEOLOGIC CROSS SECTIONS C-C'. FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-11

U. S. GEOLOGICAL SURVEY Prepared in cooperation with CALIFORNIA DEPARTMENT OF WATER RESOURCES

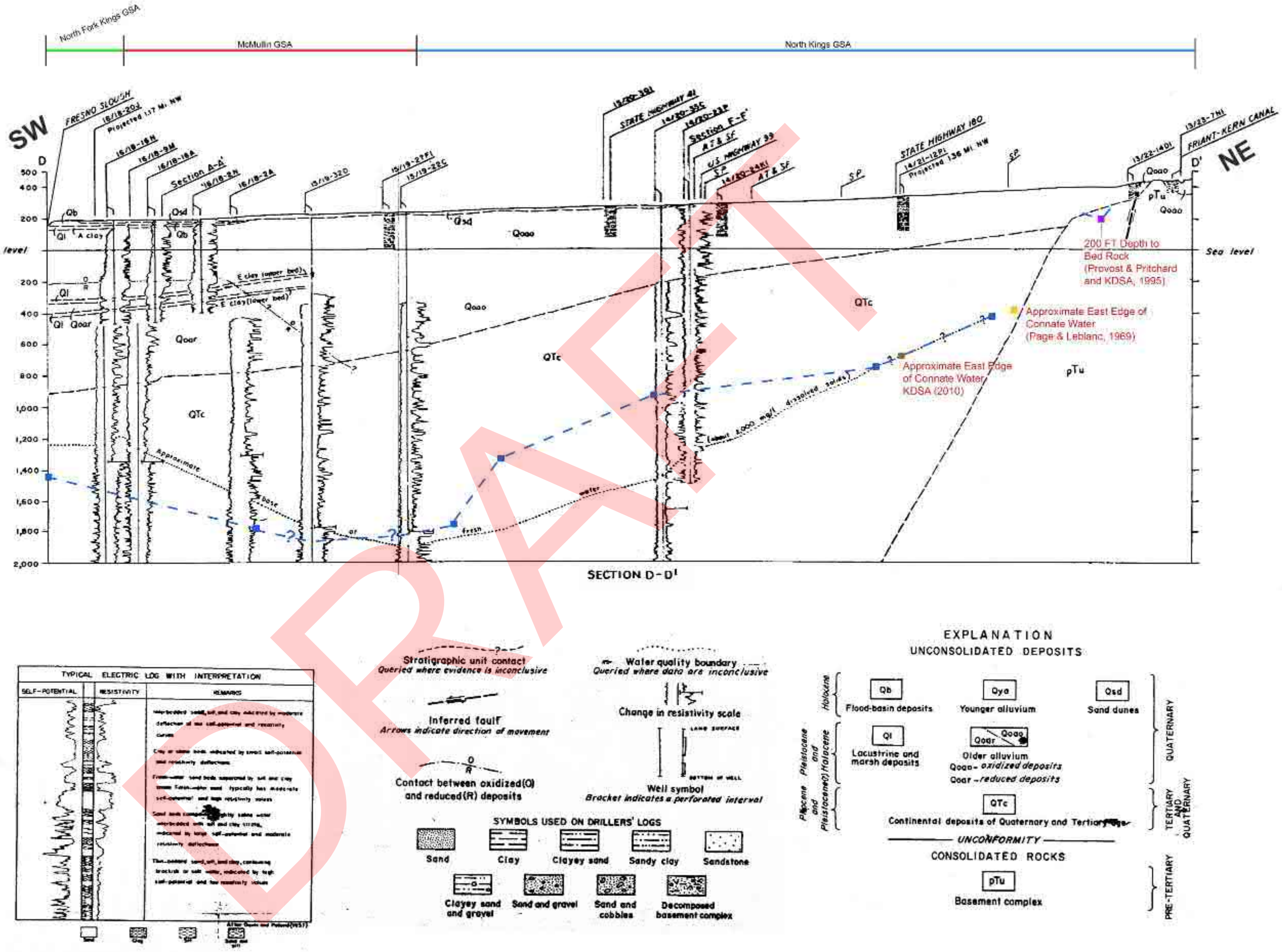


FIGURE 8 GEOLOGIC CROSS SECTION D-D'. FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

0 5 10 15 MILE

Vertical exaggeration is 26.4 times horizontal scale
Datum is mean sea level

Figure 3-12

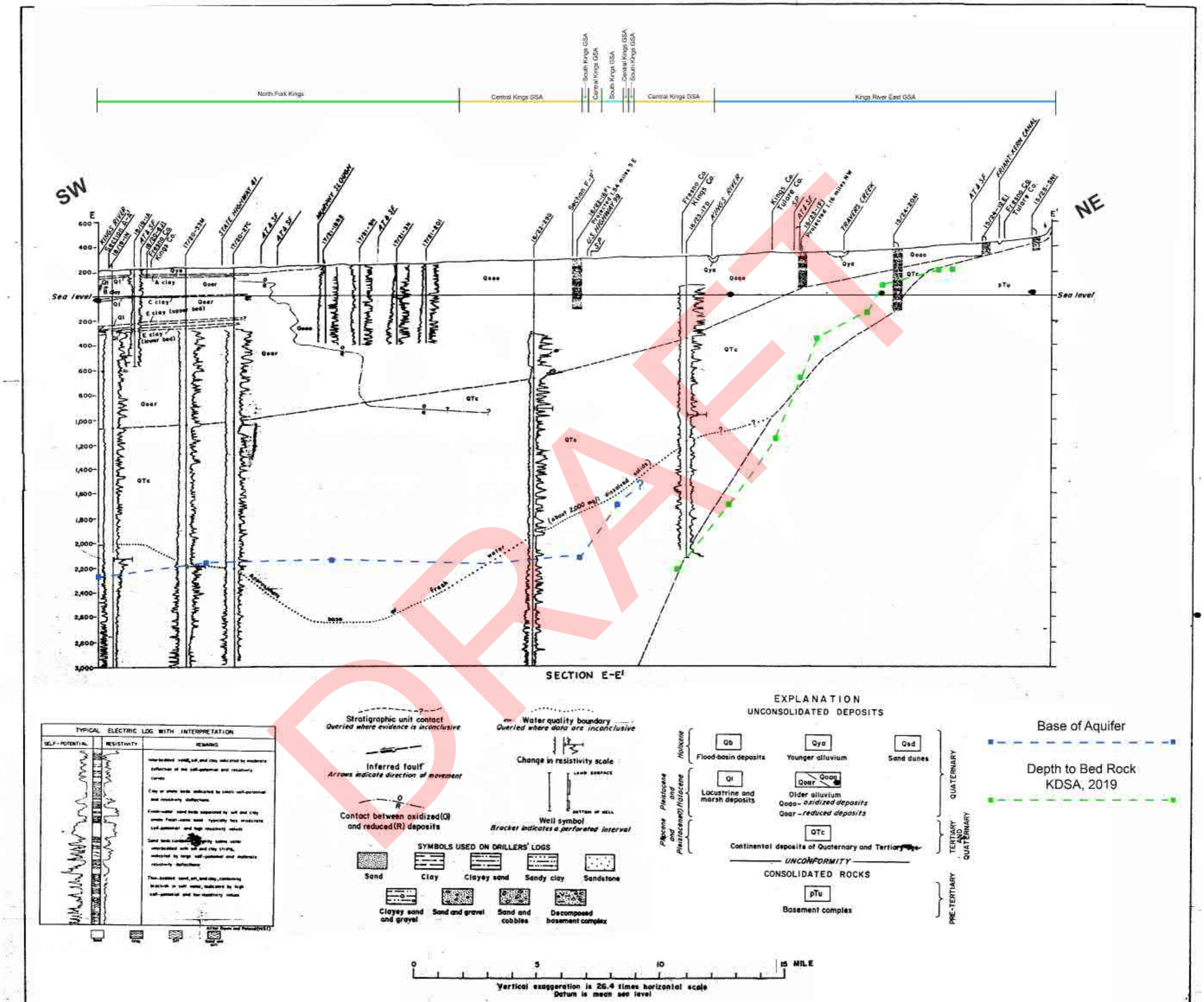


FIGURE 8 GEOLOGIC CROSS SECTION E-E'. FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-13

U. S. GEOLOGICAL SURVEY

Prepared in cooperation with CALIFORNIA DEPARTMENT OF WATER RESOURCES

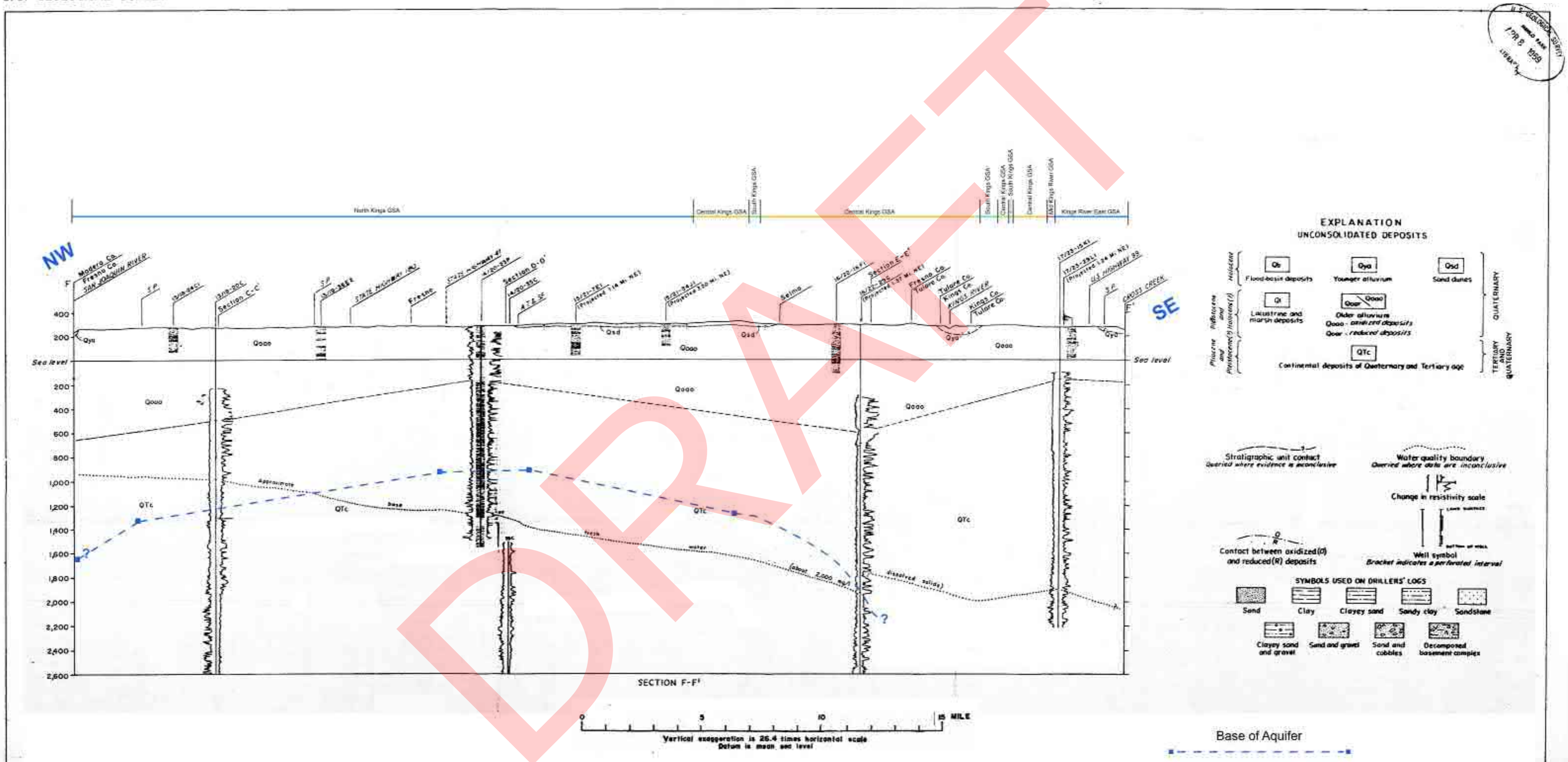


FIGURE 10.-GEOLOGIC CROSS SECTION F-F', FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-14

3.1.8 Aquifer System

Regulation Requirements:

§354.14(b)(4) The hydrogeologic conceptual model shall be summarized in a written description that includes the principal aquifers and aquitards.
§354.14(b)(4)(c) Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.

The Kings Basin groundwater aquifer system consists of unconsolidated continental deposits. These deposits are an older series of Tertiary (66 to 2.6 million years ago) and Quaternary (2.6 million years ago to the present) age sediments overlain by a younger series of deposits of Quaternary age. The Quaternary age deposits are divided into older alluvium, lacustrine (lake) and marsh deposits, younger alluvium, and flood-basin deposits (Page & LeBlanc, 1969). Lacustrine and marsh deposits, known as E-Clay or Corcoran Clay, tend to lie in western portions of the subbasin and contain the major aquitards in the area that separate the unconfined aquifer system above and from confined aquifer system below, as shown on Geologic Cross Sections above.

The older alluvium, which is the most important aquifer in the area, consists mostly of interbedded layers of silts, silty/sandy clays, clay lenses, clayey and silty sands, sands, gravels, cobbles, and boulders (Page and LeBlanc, 1969). The younger alluvium is a sedimentary deposit of fluvial arkosic beds that overlies the older alluvium and is interbedded with the flood-basin deposits. Its lithology is similar to the underlying older alluvium. Beneath river channels, the younger alluvium is highly permeable (Page & LeBlanc, 1969).

Regional aquitard units of fine-grained lacustrine and marsh deposits known as the E-clay (Corcoran Clay), A-clay, and C-clay, have been identified in the Kings Subbasin but do not extend as far east as the SKGSA (Page & LeBlanc, Geology, Hydrology, and Water Quality in the Fresno Area, California, 1969).

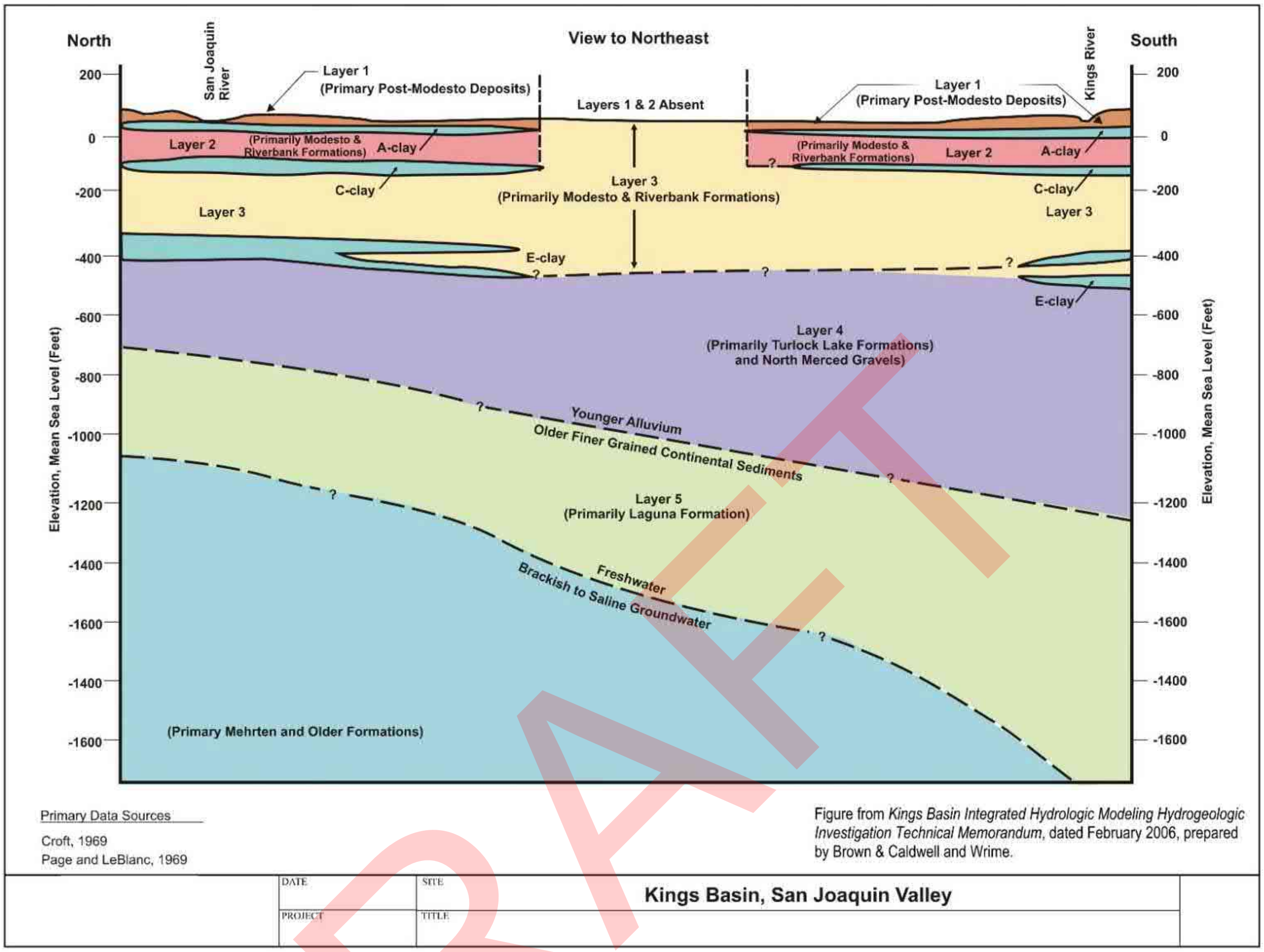


Figure 3-15: Kings Groundwater Subbasin Conceptual Cross-Section – Northwest-Southwest

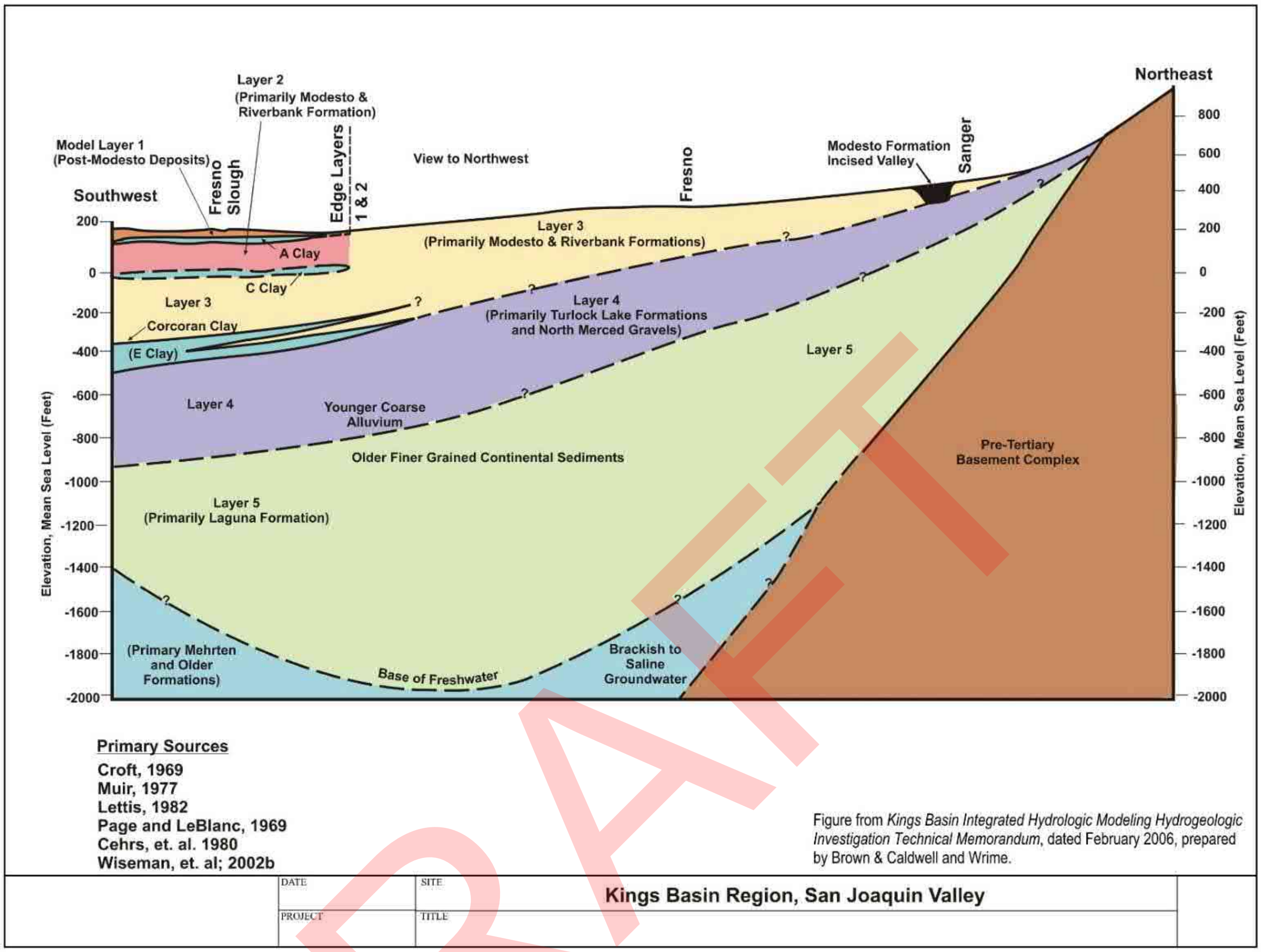
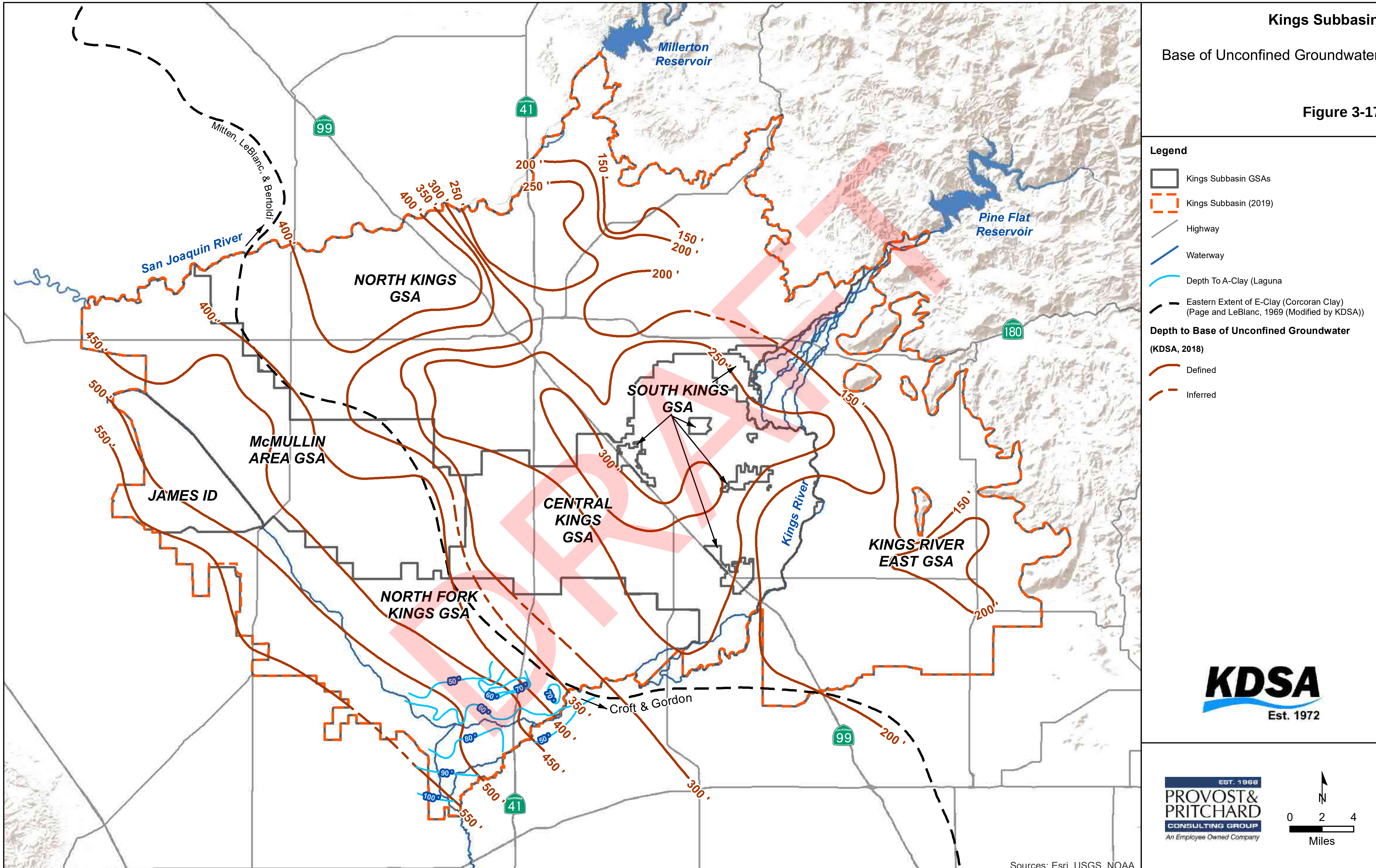


Figure 3-16: Kings Groundwater Subbasin Conceptual Cross-Section – Southwest-Northeast



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3.1.8.1 Aquifer Characteristics and Properties

Regulation Requirements:

§354.14(b)(4)(b) Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.

In general terms, the aquifer system in the Kings Subbasin extends vertically to the basement complex along the eastern margins of the subbasin and to the base of freshwater (connate water) in the other areas. For the purposes of this HCM, freshwater is defined as groundwater with total dissolved solids (TDS) content of 2,000 milligrams per liter (mg/l). Laterally, the aquifer system essentially underlies the entire subbasin. Specific yields, in the subbasin range from 0.2 percent to 36 percent (DWR, 2006). Within the central valley, hydraulic conductivity values have been estimated to range between approximately 0.00053 feet per day (ft/day) for clays to 110 ft/day for sand and gravel aquifer materials (Williamson, Prudic, & Swain, 1989). More detailed discussion of the vertical extent, aquifer characteristics, specific yield of deposits, and hydraulic conductivity and transmissivity of this GSA are discussed below.

The lateral extent of the aquifer system within the SKGSA area is described in **Section 3.1.2**.

<u>Vertical Extent</u>

For many decades, areas east of the E-clay were considered to have one unconfined aquifer. Through a series of studies including subsurface geologic cross sections, test holes and geologic logs, Kenneth D. Schmitt & Associates (KDSA) has developed an enhanced concept of the aquifer system located east of the E-clay. Based on geologic logs, electric logs, differences in water quality, and differences in hydraulic head in test holes that KDSA has worked on over the years; KDSA has proposed a two-aquifer system east of the E-clay form most of the Kings Subbasin and in other parts of the San Joaquin Valley. This two-aquifers system is comprised of a shallow unconfined aquifer and a deeper confined aquifer formed by relatively non-continuous, but locally significant clay layers. A KDSA technical memorandum with further details on the two-aquifer system and the subsurface geologic cross sections from the various studies in the Fresno-Clovis area is included as Error! Reference source not found.to this document. As shown on **Figure 3-17**, KDSA has mapped the base of the unconfined aquifer in the area of SKGSA at depths ranging from approximately 220 feet to 300 feet.

The confined aquifer system lies below the confined aquifer. For the purposes of this GSP, the base of the confined aquifer is defined as the level at which groundwater contains total dissolved solids (TDS) content of 2,000 milligrams per liter (mg/L) or greater. The two cross-sections show the approximate base of freshwater chiefly located below the Qoao bottom and within the QTc.

<u>Aquifer Characteristics</u>

Aquifer characteristics of importance to SKGSA are mainly transmissivity, hydraulic conductivity, and storativity. Hydraulic conductivity is the rate at which water can move through a permeable medium, and the transmissivity is the amount of water that can be transmitted horizontally by the full saturated thickness of the aquifer under a hydraulic gradient of 1. These two properties are related in that transmissivity is the hydraulic conductivity multiplied by saturated aquifer thickness. Storativity relates to how much space is available in the aquifer system for storage of groundwater. More specifically, storativity is the volume of water that a permeable unit will absorb or expel from storage per unit surface area per unit change in head (Meinzer, 1931). In unconfined aquifers, the storativity is approximately equal to the specific yield. Therefore, as most of the published sources consulted for this HCM provide information on specific yield, this portion of the report discusses specific yield as a close approximation of storativity. Specific yields in the area are closely related to geomorphic units, and in the Older Alluvium, fine grained materials predominate near the foothills and near the boundary between the high fans of the rivers where specific yields are lower. Course grained materials predominate near the heads of the fans where specific yields can be as high as 18 percent (Page & LeBlanc, Geology, Hydrology, and Water Quality in the Fresno Area, California, 1969).

Specific Yield of the Deposits

Specific yield is defined as the ratio of the volume of water a rock or soil sample will yield by gravity drainage to the volume of rock or soil (Meinzer, 1931). In general, specific yield data derived from subsurface material textures are considered to be the most accurate obtainable values. As part of the Kings Basin Coordination Efforts, KDSA conducted a review of available published sources of specific yield data (KDSA, 2018a). Initial sources of specific yield values used in the evaluation included Davis et al. (1959), Page and LeBlanc (1969), and Williamson et al. (Williamson, Prudic, & Swain, 1989).

Within SKGSA, additional evaluation of specific yield values was performed by KDSA, as the values from Williamson et al. (Williamson, Prudic, & Swain, 1989) were estimated over the entire saturated thickness of the aquifer, down to depths of several thousand feet (i.e., below the E-Clay, west of the SKGSA). As documented by Page and Leblanc (1969), Quaternary and Tertiary age deep continental deposits are more finely grained than the overlying Quaternary age deposits. The deeper fine-grained deposits have lower specific yield; therefore, the overall specific yield based on the entire saturated thickness of the aquifer is lower than specific yield values in the unconfined aquifer.

The additional KDSA evaluation for the SKGSA area was based on electric logs, geologic logs, and DWR Well Completion Reports. The data were used to develop several subsurface geologic cross sections in the area. On the subsurface cross sections, three types of deposits — sand or coarser materials, clay or silt, and intermediate type materials, such as sandy clay — were shown. These deposit types were assigned specific yield values of 20 percent, 3 percent, and 8 percent, respectively. Specific yield was estimated from the Spring 2005 water table to the top of the Corcoran Clay.

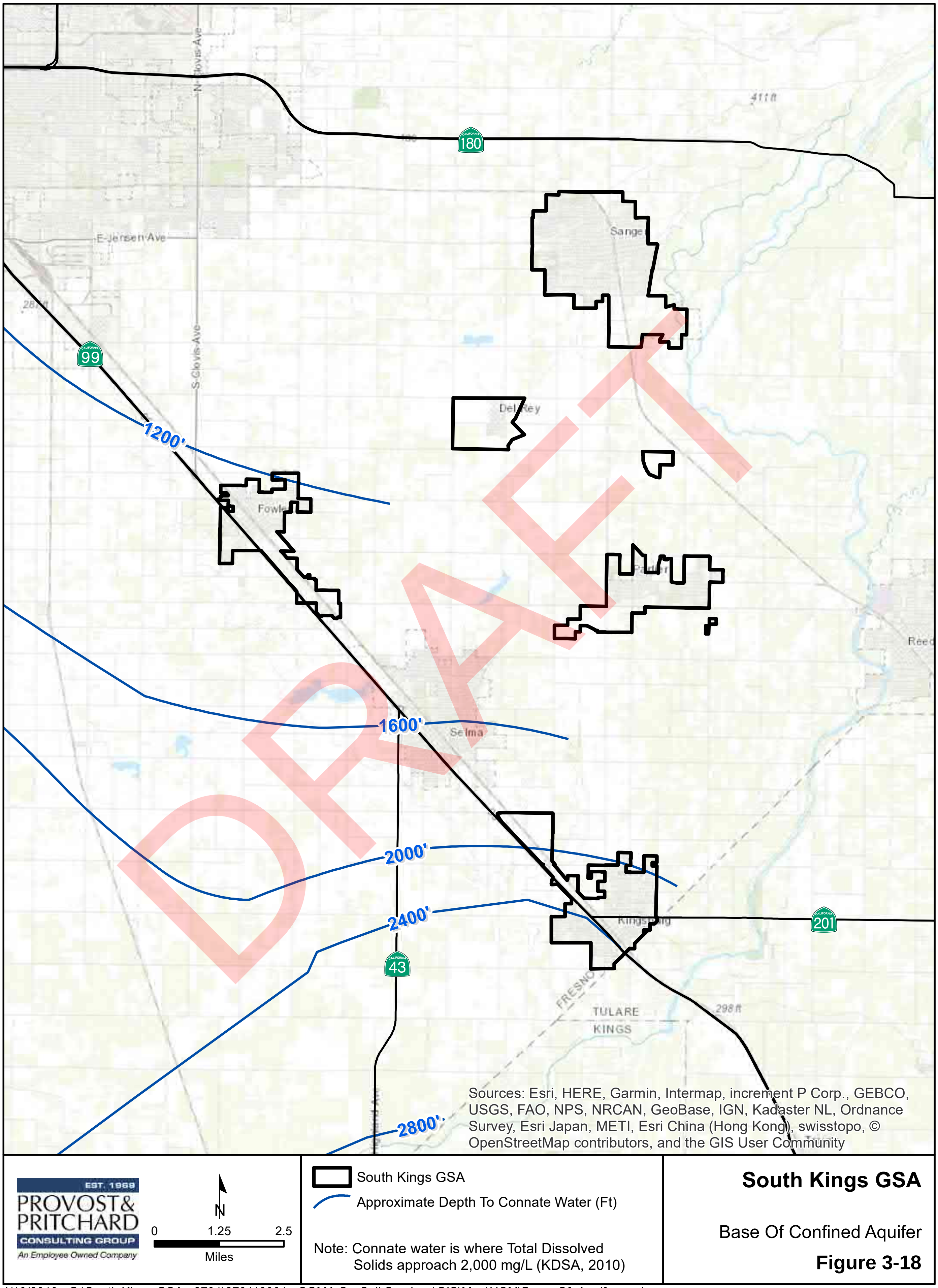
Based on the review of published data and the additional evaluation for the SKGSA area, KDSA compiled a map showing the recommended specific yield values for use in calculating changes in storage. This map is presented in **Figure 3-19**, recommending specific yield values for SKGSA ranging from 10.4% to 17.8%.

Hydraulic Conductivity and Transmissivity

The hydraulic conductivity of a saturated, porous medium is the volume of water it will transmit in a unit time, through a cross-section of unit area, under a hydraulic gradient of a unit change in head, through a unit length of flow (Lohman, 1972). In USGS Professional Paper 1401-D, Williamson et al. (1989) compiled hydraulic conductivity values estimated from more than 7,400 drillers' logs in the San Joaquin Valley and from power company pump-efficiency tests. Within the unconfined aquifer beneath the SKGSA, estimates of hydraulic conductivity range from a high of approximately 15.8 feet/day (ft/d) to a low of approximately 7.5 ft/d.

Transmissivity is the property of an aquifer that determines the ability of the aquifer to transmit groundwater flow laterally. It can be calculated by multiplying the thickness of the water producing strata by the hydraulic conductivity of the same strata. Typically, transmissivity values can readily be determined from the results of aquifer tests; however, when such information is not available, they can also be estimated from well specific capacity values. A conversion between specific capacity and transmissivity was developed by Thomasson et al. (1960) by which an estimate of transmissivity could be made by multiplying the specific capacity of a well by 1,500 for an unconfined aquifer or by 2,000 for a confined aquifer.

As part of the Kings Basin Coordination Efforts, KDSA compiled transmissivity values estimated from specific capacity compiled by Davis et al. (1964). The resulting transmissivity values were then refined where KDSA had aquifer test results and then used these to estimate groundwater flows at SKGSA boundaries with other GSAs within the Kings Basin (KDSA, 2018b). Based on the KDSA evaluation, estimates of transmissivity along the internal GSA borders in the Kings Subbasin range for 2012 from a low of 73,000 gallons per day per foot (gpd/ft) in the northwest and southwest to a high of 120,000 gpd/ft in the east along portions of the Kings River.



South Kings GSA

Base Of Confined Aquifer

Figure 3-18

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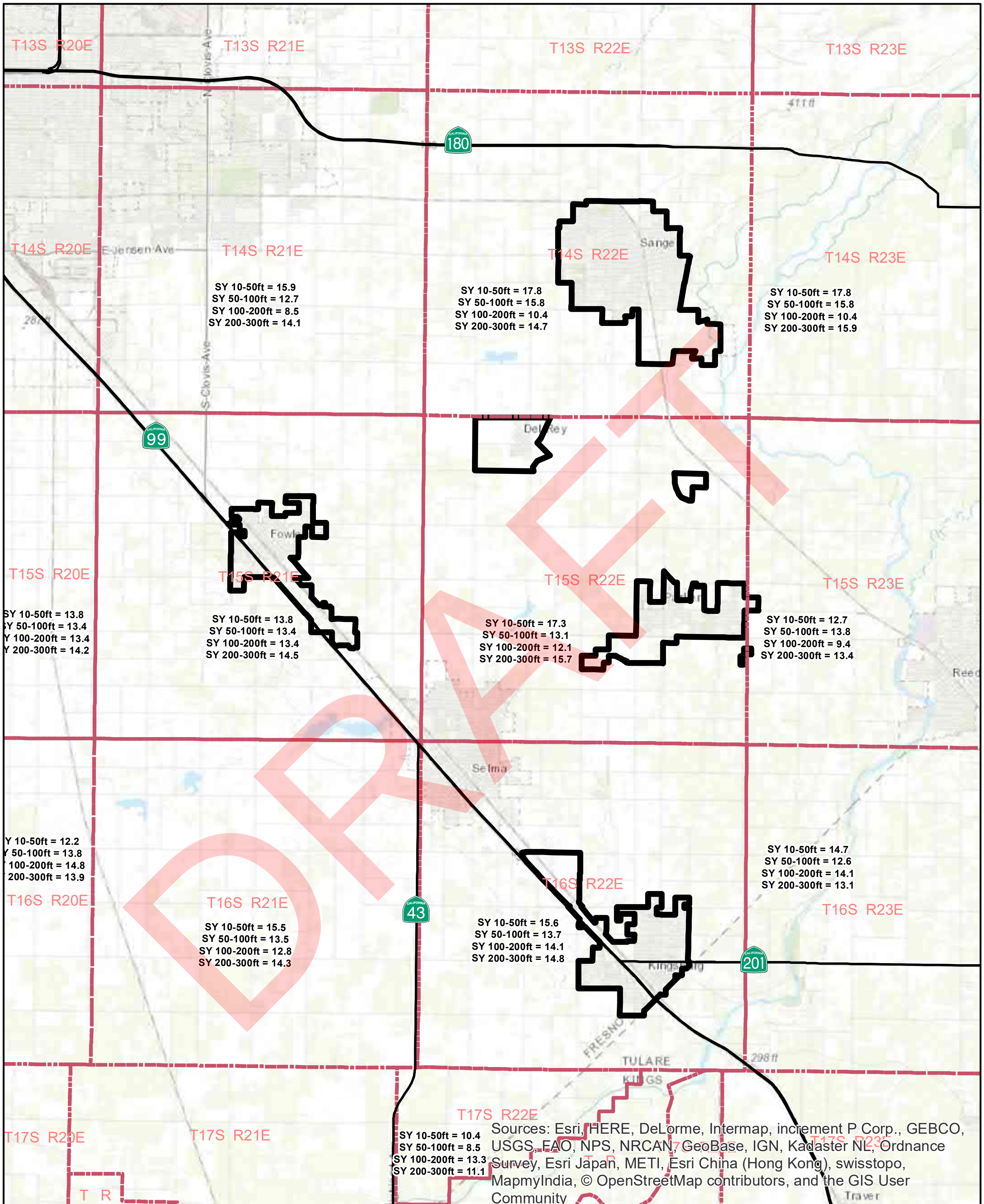

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South Kings GSA

South Kings GSA

Recommended Specific Yields

Figure 3-19

3.1.8.2 Aquifer Uses

Regulation Requirements:

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

Groundwater is pumped extensively for agricultural use within the Kings Subbasin, as it is in the San Joaquin Valley as a whole. Domestic and municipal use of groundwater is also significant within the subbasin. Domestics wells, in large part, draw water from the shallower aquifer zones. Historically agricultural wells drew water primarily from the unconfined portions of the aquifer although newer agricultural wells are often deeper and can draw water from multiple aquifer zones. Newer municipal wells are often sealed across shallow contaminated water and often tap the deeper confined portion of the aquifer. In addition, some municipal wells only draw water from a specific zone(s) of a given aquifer, usually below the base of the unconfined groundwater, in efforts to meet MCLs without the need for treatment. More detailed information for the GSA is presented below.

The aquifer in the SKGSA is used for primarily for municipal purposes with minor industrial, commercial, and agricultural use. Groundwater pumping for the municipal areas (each of the city wells) is measured. Groundwater pumping for agriculture is not measured and the pumping varies based crop type; however, there are not many irrigated acres within the boundaries of SKGSA. The estimated volume of pumping as well as other water inflows and outflows are described in the Water Budget section later in this section.

3.1.8.3 Geologic Formations

Regulation Requirements:

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

In the Selma-Kingsburg-Fowler (SKF) area the surficial geology (**Section 3.1.5**), soils (**Section 3.1.6**), and the subsurface geology (**Section 3.1.7**) have been grouped into the following formations: Post-Modesto Formation, Modesto Formation, Riverbank Formation, and Turlock Lake Formation and are discussed by Cehrs et al (1980). The Post-Modesto and Modesto Formation are the youngest mapped formations. These sediments form a 10 to 30 feet thick veneer of materials composed primarily of granitic and metamorphic alluvium. The Riverbank Formation, stratigraphically below the Modesto Formation, is between 15 to 30 feet thick and is similar to the Modesto Formation in mineralogy. The Riverbank Formation contains an extensive iron-silica hardpan horizon present at the surface and in the subsurface. This hardpan horizon is the first aquitard in the SKGSA and as such is an important consideration for recharge. The Turlock Lake Formation is stratigraphically below the Riverbank Formation. This formation includes extensive and hydraulically important subsurface deposits throughout the San Joaquin Valley. This formation extends to the trough of the valley where it interfingers with the E-clay (Corcoran Clay). According to Page (Page, 1986), the E-clay found south and west of the SKGSA area belongs to the Tulare Formation on the west side of the valley, but to the south, it is likely part of the Turlock Lake Formation.

3.1.9 General Groundwater Quality

Regulation Requirements:

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

The discussion presented below is intended to present a generalized view of groundwater quality in this GSA.

According to DWR Bulletin 118 (2006), groundwater in the Kings Subbasin is predominantly of sodium-bicarbonate type. The major cations are calcium, magnesium, and sodium. A typical range of groundwater quality in the basin is 200 to 700 mg/L. Department of Health Services data indicates an average TDS of 240 mg/L from 414 samples from Title 22 water supply wells. These samples ranged from 40 to 570 mg/L.

Groundwater quality of the SKGSA is discussed in general terms below. Further detailed groundwater quality discussions are included in the Groundwater Conditions Section of the SKGSA GSP (**Section 3.2.5**). Groundwater quality is generally very good for agriculture and good in most areas for municipal use. However, there are water quality issues in some areas of the SKGSA. The primary constituents of concern include nitrate, DBCP, TCP, and salinity.

DBCP, a soil fumigant nematicide, and nitrates can be found in groundwater along the eastern side of the subbasin. Shallow brackish groundwater can be found along the western portion of the subbasin. Elevated concentrations of fluoride, boron, and sodium have been identified in localized areas of the subbasin. Nitrate (as nitrogen) is also an important constituent of concern in the area with concentrations exceeding the maximum contaminant level (MCL) of 10 mg/L in a few domestic and municipal wells in the subbasin. Data from KDSA, also show that nitrate concentrations are higher in the unconfined aquifer and decrease below the confining beds.

More in-depth discussions of groundwater quality issues related specifically to South Kings GSA and the locations of known groundwater contamination sites and plumes are presented in **Section 3.2.5**.

3.1.10 Surface Water Features

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

The most significant surface water features within the Kings Subbasin are the San Joaquin River and Kings River. More detailed information on the surface water features within the GSA is discussed below.

There are no major surface water features that run through any of the cities within SKGSA. There are a several CID canals that run through or very near the member agencies, which will become significant to the management of the GSA as a means to deliver surface water for recharge purposes from CID which has surface water rights on the Kings River, shown on **Figure 3-20**. An agreement for the purchase of water has been drafted; however, another agreement would be needed to use existing conveyance facilities, if necessary.

3.1.11 Source and Point of Delivery of Imported Water

Regulation Requirements:

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

The primary source of surface water occurs from diversions from the Kings River. Additional sources of surface water occur from diversions from the San Joaquin River via the Friant-Kern Canal, Mendota Pool, and from intermittent streams. More detailed information on the surface water features within the GSA is discussed below.

SKGSA does not import surface water for use, rather they rely solely on groundwater. If SKGSA were to directly pursue surface water importing, the likely source would be the Kings River which runs east of Parlier and Sanger and southeast of Kingsburg. The Kings River is regulated by the Pine Flat storage reservoir located less than 20 miles northeast of Sanger.

3.1.12 Recharge and Discharge Areas

Regulation Requirements:

§354.14(d)(4) Physical characteristics of the basin shall be represented on one or more maps that depict delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.

The San Joaquin River, the Kings River, and numerous intermittent streams provide the most significant recharge in the Kings Subbasin. Numerous agencies engage in some form of recharge in the basin, which can range from seepage from unlined canals, reservoirs, stormwater basins, wastewater effluent ponds and recharge basins. More detailed information on recharge areas within the GSA is discussed below.

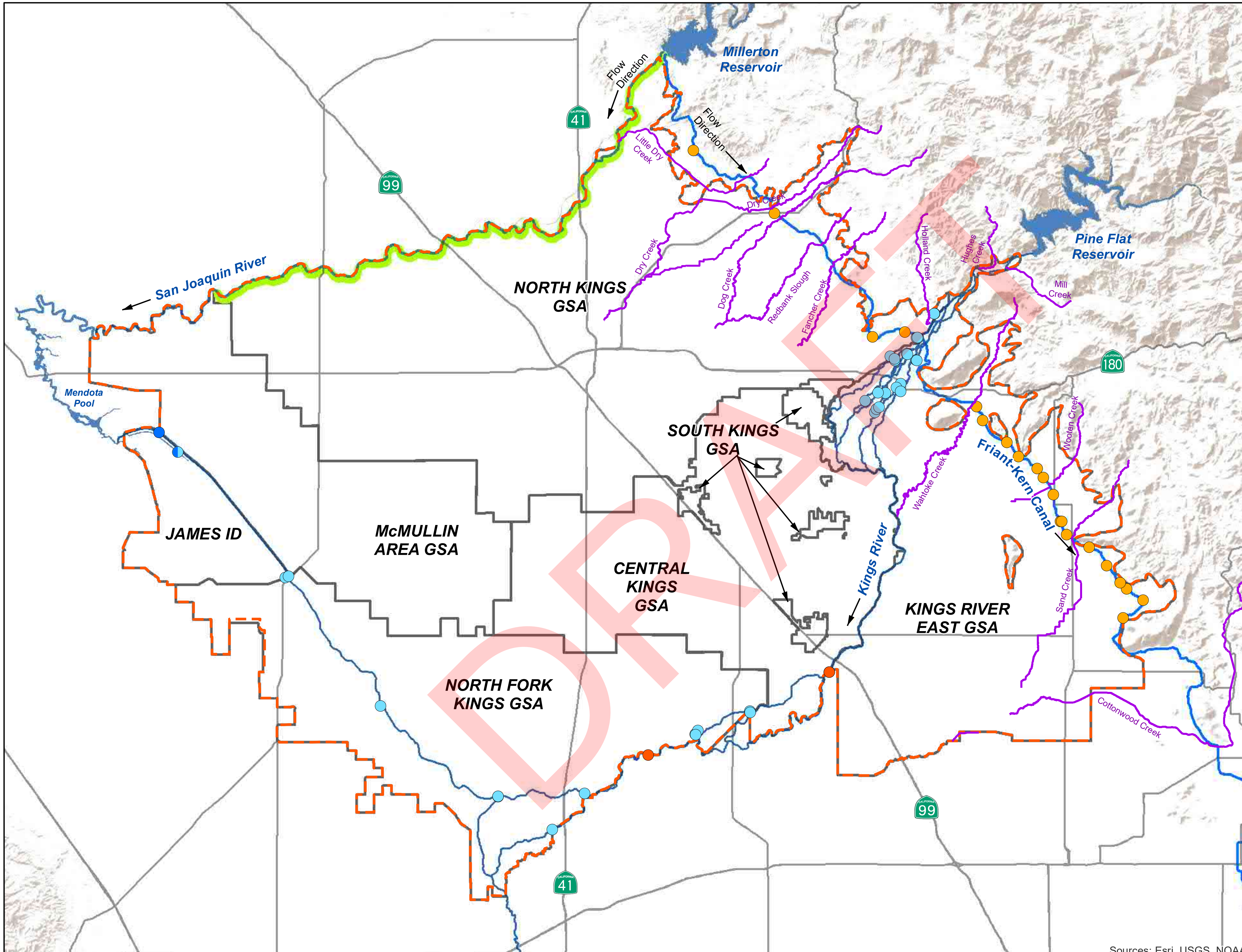
South Kings GSA does not have any dedicated recharge basins for diverting surface water. However, the cities of Del Rey, Parlier, and Sanger each have their own wastewater treatment facilities that percolate the effluent to recharge the groundwater system. Kingsburg and Fowler send their wastewater to a combined treatment facility with Selma. The effluent from this plant is also stored in ponds for recharging groundwater storage. Furthermore, SKGSA has approximately 31 acres of stormwater basins that may also act as dedicated recharge facilities in the future, as shown in **Figure 3-21**.

3.1.13 Identification of Data Gaps

Regulation Requirements:

§354.14(b)(5) Identification of data gaps and uncertainty within the hydrogeologic conceptual model.

Data gaps are discussed in detail in **Section 5**.



Kings Subbasin

Surface Water Features Significant to the Management of the Kings Subbasin Source and Point of Delivery for Imported Water Supplies

Figure 3-20

Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Intermittent Stream
- Riparian Water Right Holders
- Weir (Divert Out of Subbasin)

Diversion Into Kings Subbasin

- From Friant-Kern Canal
- From Mendota Pool (CVP)
- From Kings River

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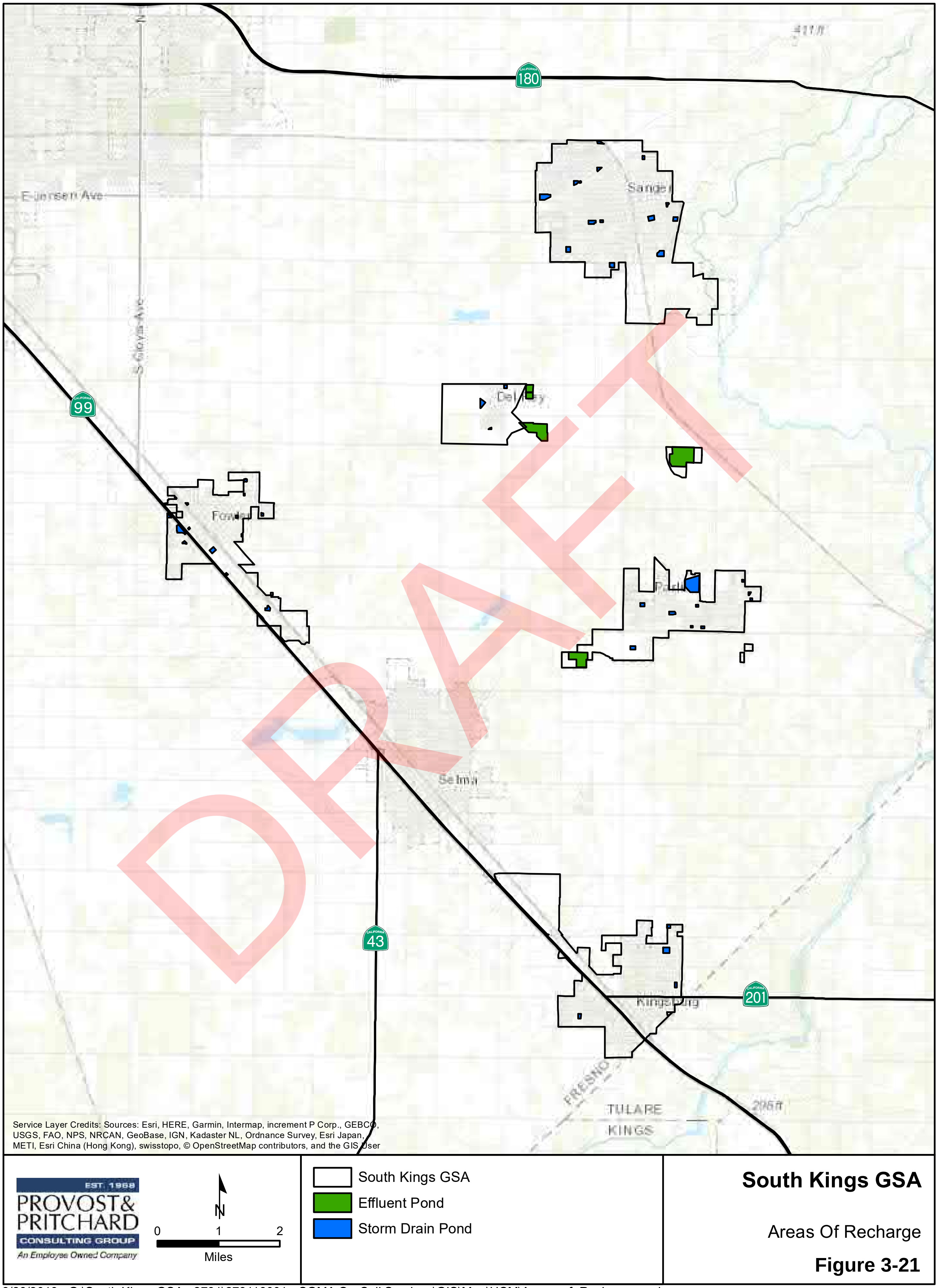


South Kings GSA

Areas Of Recharge

Figure 3-21

3.2 Current and Historical Groundwater Conditions

Regulation Requirements:

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

General current and historical groundwater level trends and flow direction for the Kings Subbasin are discussed in this Section below. More in depth discussions of groundwater conditions within the GSA, including groundwater levels, storage, and quality; land subsidence, surface water/groundwater interconnections, and groundwater dependent ecosystems, are discussed in the subsequent Subsections.

Unconfined groundwater conditions extend across essentially the entire Kings Subbasin. A map depicting the depth to the base of unconfined groundwater is shown in **Figure 3-3**. Within the western portions of the subbasin, lacustrine and marsh deposits including the well-known regional clays) interbed with more coarse-grained alluvium. Historically, confined groundwater conditions existed below these regional clays, which have been identified as the A, C, and E clays (Croft, 1972). Currently, confined groundwater conditions still exist below the E and C clays. Groundwater below the A clay no longer appears to be confined. These clays are highly impermeable and restrict the vertical movement of water between more permeable beds wherever they occur. The most extensive and hydrologically important of these aquitards is the E-clay, commonly known as the Corcoran Clay. As shown in **Figure 3-3**, the Corcoran Clay is present beneath the approximate western third of the Kings Subbasin, where the depth to the top of the Corcoran Clay ranges from approximately 350 to 550 feet.

This section includes a description of the current and historical groundwater conditions within SKGSA. The data presented in this section includes the best available historical and the most recent available information to describe the sustainability indicators in SKGSA. The sustainability indicators described herein include groundwater levels, groundwater storage, groundwater quality, land subsidence, surface water and groundwater interconnections, and groundwater dependent ecosystems.

This section provides actual monitoring data collected by various agencies. Refer to **Section 5** for descriptions of the monitoring programs used to collect the data. **Section 3.1** provides background information on the hydrogeologic setting, aquifers, soils, and stratigraphy that relate to this section.

3.2.1 Groundwater Level Data

Regulation Requirements:

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

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

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

Figure 3-22 shows the current (Spring 2017) groundwater surface elevation contours and general direction of unconfined groundwater flow in the Kings Subbasin for the seasonal high condition. In general, groundwater flow is to the southwest within nearly the entire subbasin with a few notable exceptions where municipal and irrigation pumping in parts of the Kings Subbasin have influenced the direction of groundwater flow or the influence of recharge from basins and the major rivers can be seen. **Figure 3-23** shows the current (Fall 2017) groundwater elevation contours. The overall direction of groundwater flow in Fall 2017 is similar to the Spring 2017 groundwater flow directions. In a typical or near normal water year the fall groundwater elevation contours would represent the seasonal low point in the hydrologic cycle, however the 2016/2017 water year, at 241% of normal, was a significantly wetter year than normal and, in general, groundwater levels rose in South

Kings GSA, Central Kings GSA, Kings River East GSA, the western and northeast portions of North Kings GSA. Groundwater levels also rose in portions of North Fork Kings GSA near the Kings River and along the border with Westside Subbasin. The northern and southern portion of James ID GSA also had increases in water levels. Groundwater levels generally fell in McMullin GSA but did rise near the border with James GSA and in area near the intersection of T15S R18E, T15S R19E, 1T6S R18E, and T16S19E.

Several areas show the results of groundwater recharge occurring in 2017. The FID Waldron and Boswell banking facilities show more pronounced groundwater mounds, as well there is a groundwater ridge evident on the Fall 2017 groundwater elevation contour map in Central Kings GSA in an area with favorable geology for recharge and numerous recharge sites that trend southwest through the central portions of that GSA. It is estimated Central Kings GSA recharged on the order of 150,000 to 200,000 AF that year. The Fall 2017 map highlights the importance of surface water supplies in Kings Subbasin. The general increase in groundwater levels in parts of the Subbasin from spring to fall of 2017 show how conjunctive use of groundwater and surface water in years when surface water supplies are plentiful can be managed to positively affect groundwater levels. This also indicates that recharge projects of various types, including reduced pumping in years with plentiful surface water supplies, are likely to be successful and will be significant to the Subbasin reaching sustainability.

The discussion that follows uses the Spring 2017 groundwater elevation map (**Figure 3-22**). In the Fresno-Clovis metropolitan area, an urban cone of depression is located north-northeast of the intersection of Highways 180 and 41 and has caused changes in the generally southwesterly groundwater flow direction as groundwater now moves toward the cone of depression under the urban area. In the area between southwest Fresno and the Fresno-Clovis Regional Waste-Water Treatment Facility, there is little change in groundwater elevation. In the northeast portion of the Fresno-Clovis urban area, roughly between Highway 168 and Shepherd Avenue and southwest of Big Dry Creek reservoir, groundwater gradient steepens appreciably due to deepening groundwater levels in the greater Fresno area and due to the poorer water bearing properties of subsurface materials in this area associated with the finer-grained deposits in the interfan area between the Kings and San Joaquin Rivers. There is also a general increase in groundwater gradient apparently associated with the finer grained deposits of the compound fan of intermittent streams south of the Kings River in the eastern portion of the Kings River East GSA.

In the west-southwest part of the subbasin, the lack of surface water supply combined with decades of agricultural pumping has influenced the natural direction of groundwater flow and created a cone of depression southwest of Raisin City. The cone of depression extends southeast through the middle portion of McMullin GSA and the central portions of North Kings River GSA. The cone of depression has caused changes in the general flow direction and gradients as unconfined groundwater now moves toward the cone of depression from adjacent areas west of the Subbasin and southeast through McMullin GSA. Groundwater east of the Kings River in the Kings River East GSA flows southwesterly near the mountains and to the south-southeast near the Kings River.

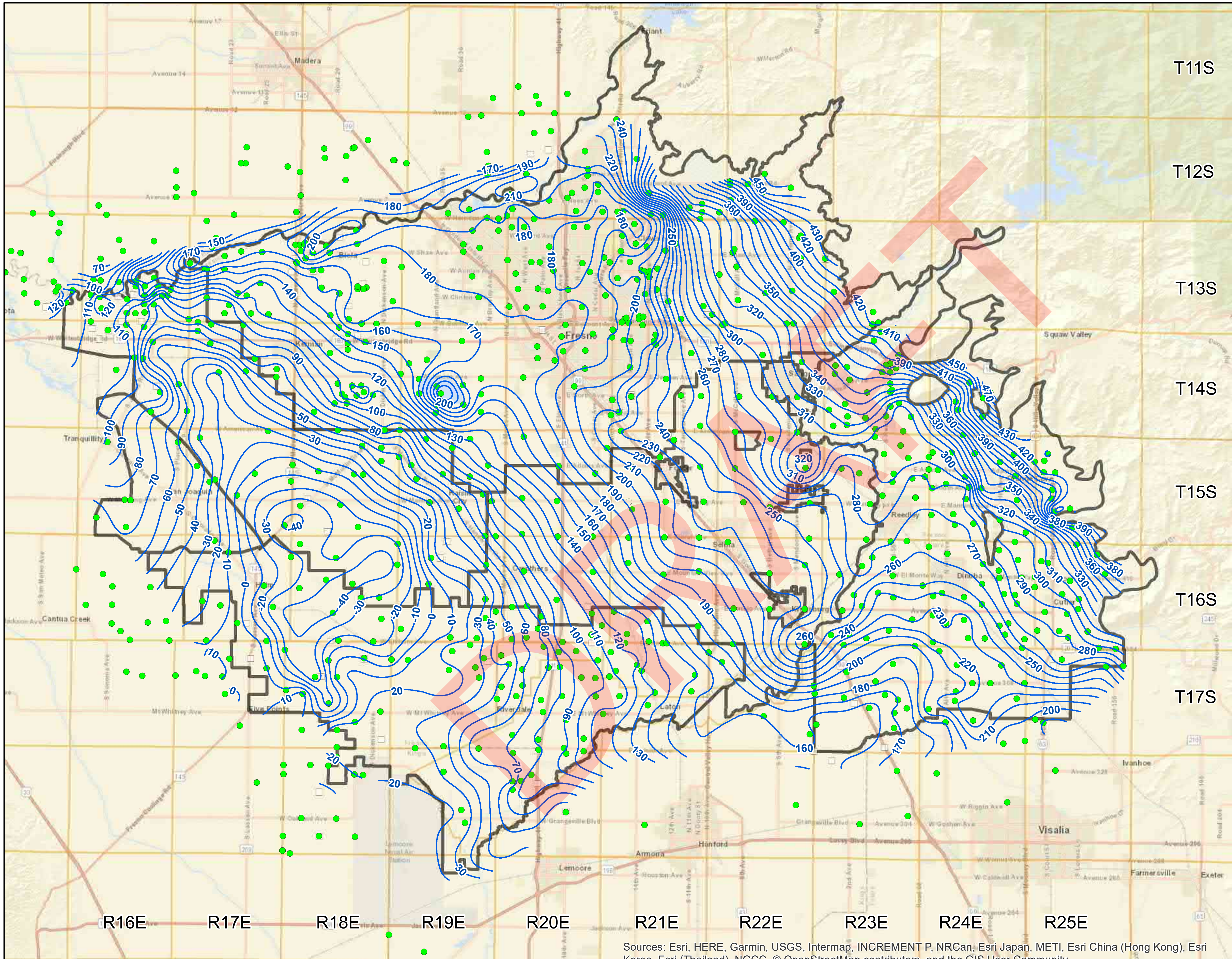
Under natural flow conditions, the dominant flow direction in the Kings Subbasin was southwest, roughly perpendicular to the Sierra Nevada and towards the trough of the valley. The San Joaquin and Kings Rivers were historically locations of groundwater discharge and within about 2 to 4 miles of them groundwater flow deviated from the regional southwest direction and flowed towards them. The rivers and Fresno Slough being areas of groundwater discharge were thus gaining streams. Once pumping lowered water levels sufficiently, the San Joaquin and Kings Rivers, for the most part, became losing streams and groundwater started flowing away them. Today groundwater forms ridges beneath both rivers which indicates both rivers are predominantly losing steams (**Figure 3-3**).

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2017
Groundwater Elevation Contours

Figure 3-22



Legend

Kings Subbasin GSAs

Township/Range

Well - Data Used

Well - Data Not Used

Water Level Contours

Line of Equal Elevation (10ft interval)

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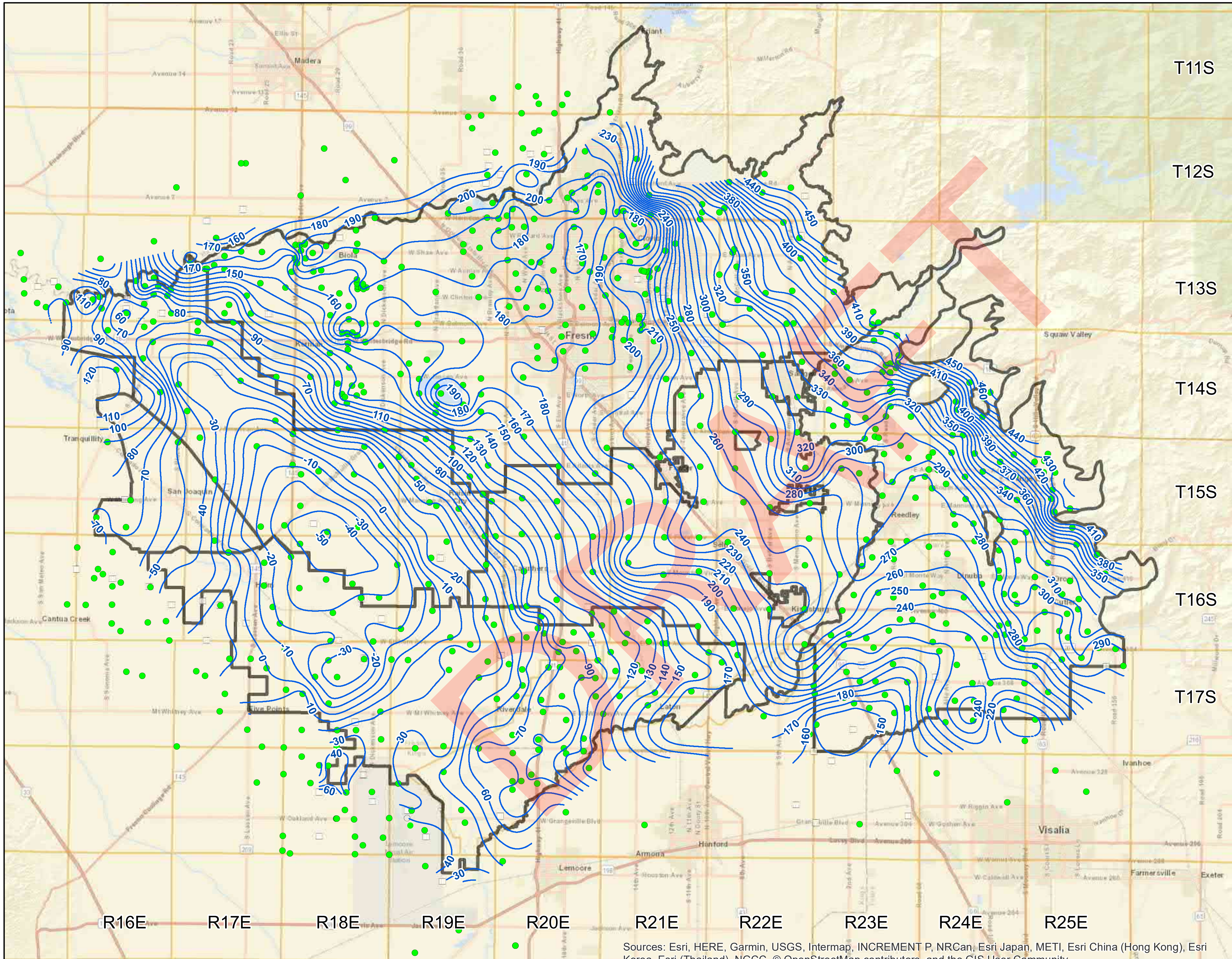
6/26/2019 : G:\Kings River East GSA-2664\266417001-Kings Basin SGMA Coordination\GIS\Map\Wells\WSE\11x17\Contours\spr17_wse_all_11x17.mxd



Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Fall 2017
Groundwater Elevation Contours

Figure 3-23

Legend

- Kings Subbasin GSAs
- Township/Range
- Well - Data Used
- Well - Data Not Used

Water Level Contours

- Line of Equal Elevation (10ft interval)

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Current groundwater depth data was gathered from local agencies and DWR to prepare contour maps for the Kings Subbasin. Figure 3-22 displays depth to water contours for SKGSA from Spring of 2017. Depth to groundwater in the northeast side of the GSA is approximately 60 feet below ground and gets as low as about 75 feet below ground on the southwest side of Fowler. Higher water levels in Sanger are likely due to its proximity to the Kings River, which recharges the groundwater system through seepage.

The SKGSA used the same wells discussed in Section 4 for groundwater level monitoring to track and report groundwater depth trends. The periods of record for these wells extend from the 1960s to 2019. One well near each city within SKGSA was chosen to represent groundwater levels for the respective areas. Long term rate of decline for each of the wells ranged from 0.15 feet per year to 0.40 feet per year, with an average rate of decline at 0.30 feet per year for SKGSA. Each of the Spring measurements for the five wells were averaged to create an average depth to water hydrograph for SKGSA, presented as Figure 3-24.

Water levels in the area have dropped from approximately 33 feet below ground surface in 1967 to about 60 feet below ground surface in 2019. Over the years there have been large swings in water table levels, which is likely due in response to hydrologically wet and dry periods. Hydrologically dry periods mean less surface water for natural and dedicated recharge as well as causing increased reliance on groundwater resources. Therefore, groundwater levels may fall more drastically during drought periods.

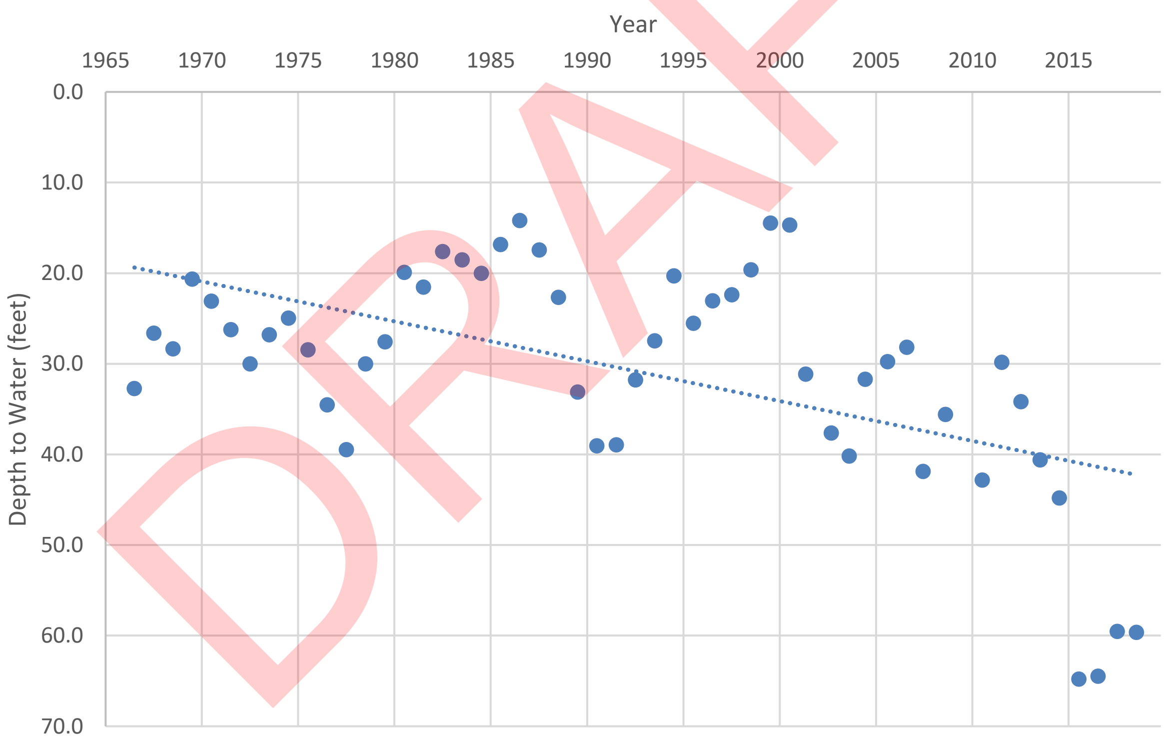


Figure 3-24: Average Depth to Water Measurements (Spring)

Historical Groundwater Conditions
Groundwater flow patterns in the upper (unconfined) and in lower confined aquifers (i.e., below the Corcoran Clay) under natural flow conditions in the western area of the Kings Subbasin differed before extensive development of groundwater resources in the valley. Groundwater recharge to the area occurs primarily from run-off from the Coast Ranges to the west and from San Joaquin river seepage and groundwater percolation. Prior to development, groundwater flowed from areas of recharge along the flanks of the valley, from both the

east and west, towards the axis of the valley where it recharged both the unconfined and confined portions of the aquifer. Groundwater from both sources flowed under the Corcoran Clay to the valley trough where mixing, circulation, and upward movement through the Corcoran Clay occurred at very slow rates (**Figure 3-25, Inset B**). As a result, the potentiometric surface of the confined groundwater was higher than the land surface in the valley trough area and flowing artesian well conditions existed within the trough area (Bull & Miller, R.E., 1975). The upward welling of groundwater and discharge at land surface supported extensive wetlands in the Fresno Slough area of the Kings Subbasin. A map depicting areas of flowing artesian wells within the San Joaquin in 1906 from Mendenhall et. al. (1916) is included as **Figure 3-26.**

Large-scale agricultural pumping in the San Joaquin Valley has resulted in a change to the flow pattern, as well as an overall lowering of groundwater levels, of the confined groundwater below the Corcoran Clay, as well as changed flow patterns in the aquifer above the Corcoran Clay (**Figure 3-25, Inset C**). As shown on **Figure 3-25, Inset C,** from 1906 to 1966, the mixing point of the two distinct water sources (Sierran and Coast Ranges) in the confined aquifer moved west, indicating confined flow to areas west of the Kings Subbasin, and the confined groundwater potentiometric surface became lower than the valley land surface (Bull and Miller, 1975). Currently, there are no known springs, seeps, or flowing wells within the Kings Subbasin.

The potentiometric surface of unconfined groundwater having been lowered considerably due to large-scale agricultural pumping, which, among other things, led to the San Joaquin and Kings Rivers transitioning over most of their reaches in the Kings Subbasin from predominantly gaining streams to predominantly losing streams. **Figure 3-25, Insets B and C** illustrate this changed flow pattern near the San Joaquin River.

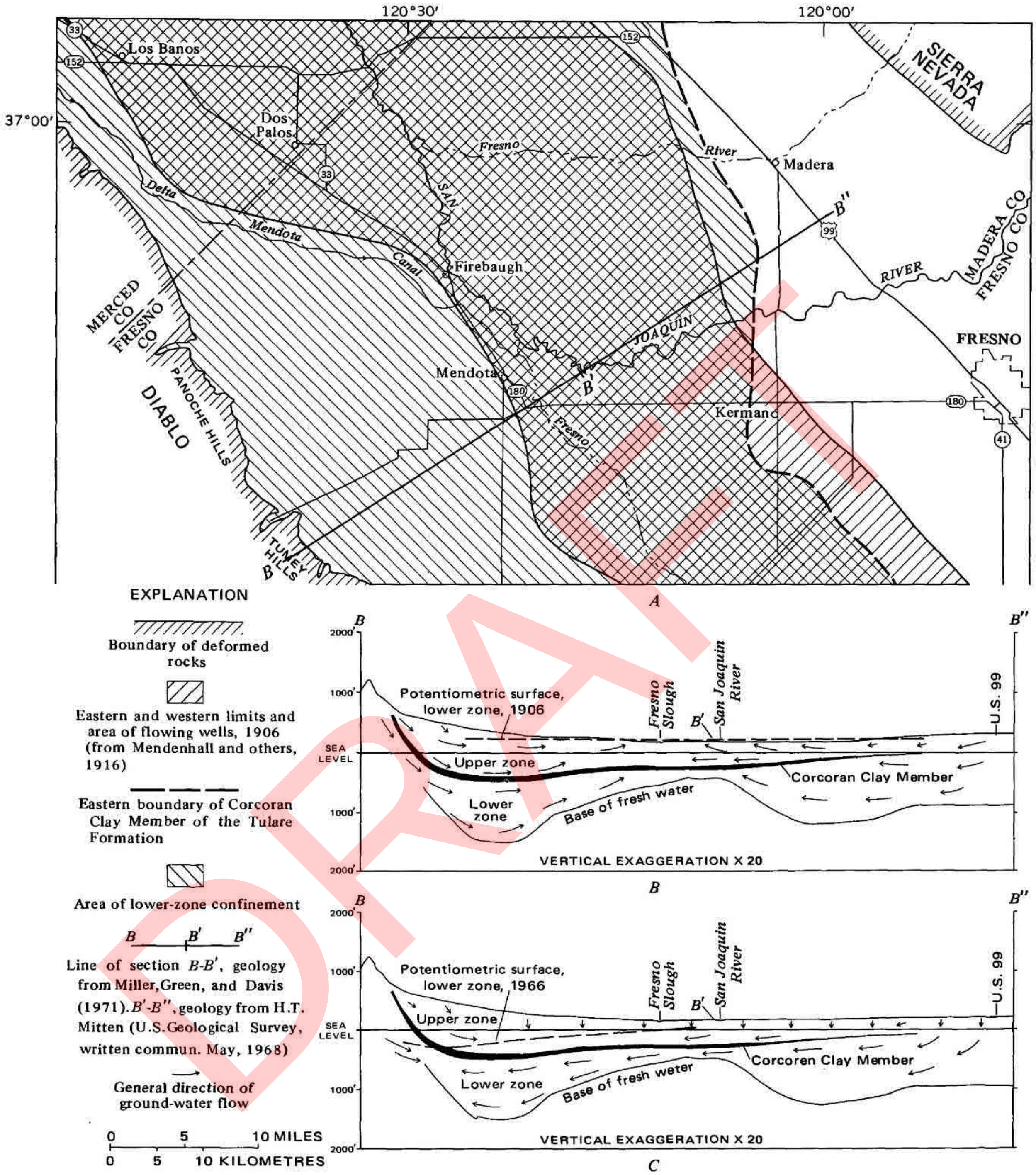


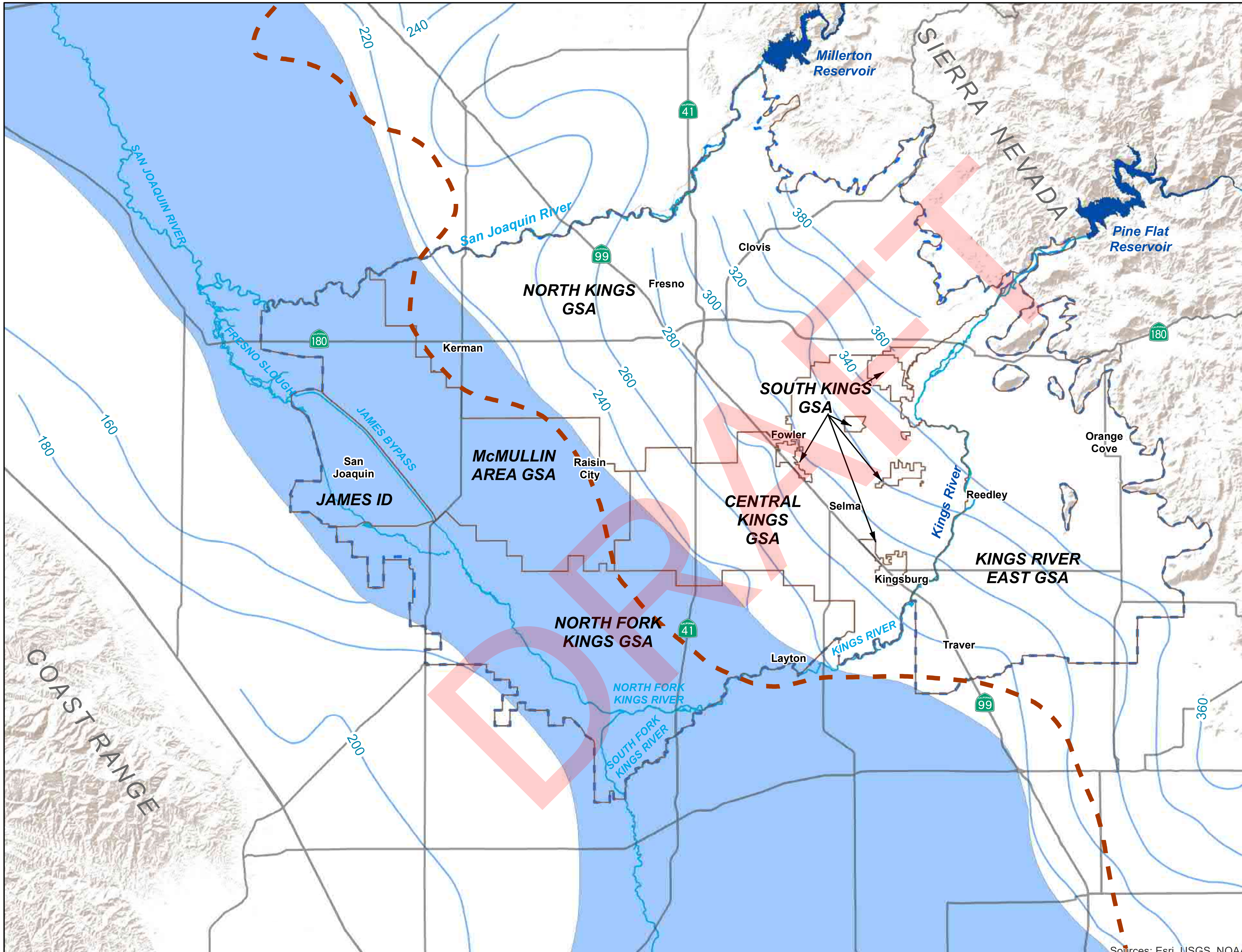
Figure 20 from Bull and Miller, 1975.

Figure 3-25: Kings Subbasin Changes to Groundwater Flow Patterns

South Kings GSA

Areas of Flowing Wells in 1906

Figure 3-26



- Kings Subbasin (DWR, Modified 2018)
- Kings Subbasin GSAs
- *Areas of Flowing Wells
- *Contours of the Water Table (in feet above sea level)
- E-Clay Eastern Extent (From Page and LeBlanc 1969, Modified by KDSA)

*Data digitized from a georeferenced image of USGS WSP 398 Plate 1

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Vertical Gradients

As discussed above, historically vertical gradients in the unconfined and confined portions of the aquifer had an upward component of vertical flow near the trough of the valley where the potentiometric surface of confined groundwater was very similar, i.e., slightly higher, than the unconfined or water table aquifer. Large scale development of groundwater resources caused a change to this historic condition. As well, since development thousands of wells perforated in aquifers above and below the Corcoran clay have increased the hydraulic connection between these aquifers and substantially increased equivalent vertical hydraulic conductivity of the aquifer system (Faunt, 2009). The dramatic lowering of hydraulic heads in the confined parts of the aquifer has resulted in a large net downward movement of water through bore holes. This vertical flow occurs in both pumped and un-pumped wells and increases during the growing season (Faunt, 2009). Most data available, with a few exceptions, to evaluate the vertical gradient is hydraulic head. These sources of data provide some indication of head differences between the lower aquifer and unconfined aquifer zones. At this time, there is insufficient data to prepare confined groundwater maps for the Kings Subbasin.

Currently, readily available information for differences in hydraulic head between confined groundwater and unconfined groundwater in the Kings Subbasin indicates hydraulic head in confined groundwater is usually less than hydraulic head in unconfined groundwater. Information on hydraulic head differences are available for the Fresno Irrigation District groundwater banking facilities, four relatively new wells installed near the border between North Fork Kings GSA and the Westside Subbasin, the regional wastewater treatment facility, and from three As-built diagrams of nested wells installed by the City of Fresno near city wells. This discussion mainly focuses on hydraulic head differences between unconfined and confined groundwater. The difference in hydraulic head between unconfined and confined groundwater is one component of estimating vertical gradients and the other is the thickness of the intervening aquitard or the difference in elevation between perforated intervals in a well tapping confined strata and a shallow well tapping unconfined strata. A positive vertical gradient value represents downward flow; thus, the unconfined aquifer is potentially recharging the confined aquifer, primarily the current condition. Negative vertical gradients represent an upward flow, indicating that the confined aquifer is potentially discharging to the overlying unconfined aquifer, the historical condition.

Page and LeBlanc (1969) calculated vertical gradients in two locations west of the McMullin GSA in 14S15E25H and 13S15E35E. The differences in water levels (hydraulic head) at that time were 70 to 90 feet and 70 to 110 feet, and the calculated vertical gradients ranged from 0.12 to 0.22. This indicates at the time vertical gradients were positive and unconfined groundwater water was potentially recharging the confined aquifer (a change from the historical conditions).

Upper and Lower aquifer zone groundwater elevation maps prepared for the City of Fresno, Metropolitan Water Resources Plan Update, 2007 provide some general information on vertical heads differences, on a regional scale, in spring 2006 for the Fresno area (KDSA, 2006). In general, head differences between the upper and lower aquifer zones were greatest in the east and north parts of the metropolitan area. At that time, head differences appear to be mostly positive except for the central portions of the metropolitan area, where both maps have closed 190 ft elevation contours, the head differences between confined and unconfined groundwater appear minimal. Near the San Joaquin River head differences were about 5 feet, in the south part of the study area head differences were from about 0 to 10 feet, at the regional wastewater treatment facility head differences were about 10 feet. The greatest head differences between unconfined and confined groundwater occurred east of the Fresno Air Terminal where it was as much as 50 feet. In north Fresno, in the Fort Washington area, head differences were about 30 to 35 feet. In June 1995, KDSA indicates water levels across a confining bed which underlies the regional wastewater treatment facility were about 11 feet, and that at time there was not much water being pumped from deeper groundwater below a depth of about 450 feet. As-built diagrams for nested monitoring wells at City of Fresno well sites No. 362, No. 359 and No. 318, have one-time data available for when the monitoring wells were built. This information indicates head differences were 7.7 feet near Maple and Perrin Avenues, and 40 near Belmont and Armstrong Avenues, and 45.7 feet near California and Temperance Avenues.

Data on vertical gradients, again mainly head differences between unconfined and confined groundwater, is available at the FID Boswell and Waldron Water Banks. Data from a leaky aquifer test in late September/early October 2017, from a shallow and a deep monitor well at the FID-Empire banking facility indicates the difference in static water levels between a shallow monitor wells and a deeper monitor well was about 9 feet. The area is underlain by a 55 feet thick aquitard, and the estimated vertical gradient was about 0.16, which is in the range estimated by Page and LeBlanc (1969). Data from the Waldron facility between shallow monitor wells and deeper monitor or recovery wells indicates that vertical head differences vary from about 5 to 8 feet under static conditions and can be as high as about 40 feet when the recovery wells are pumping. At the Empire site vertical head differences are typically between about 3 to 8 feet, and when the recovery wells pump the head difference can be as high as 55 feet. At the Lambrecht facility vertical head differences are greater and can vary from about 8 to 30 feet under static conditions and are about 50 feet when the recovery wells are pumping. At the Boswell site vertical head differences under static conditions can be from about 8 feet to as much as 40 feet and appear to be about 80 feet when the Recovery well is pumping. These data also show that vertical gradients tend to be less during the winter and early spring and increase during the summer months presumably due to increased groundwater pumpage.

Water levels are available from four nested monitor wells installed near the boundary between the North Fork Kings GSA and the Westside Subbasin under a DWR DAC grant. These wells have casings perforated above and below the Corcoran clay. Water elevation differences between unconfined and confined groundwater at the sites collected from May 31 to June 1, 2018, after the wells were developed, varied from about 25 to 70 feet. The greatest difference was in FC-1 near Yuba and Kamm Avenues and the least amount of head differential was in FC-3 near Golden Rod and Mt. Whitney Avenues.

In general, these data discussed above indicate that vertical gradients vary considerably in the Subbasin. Vertical gradients can vary through time, as water levels change relatively quickly in confined groundwater due to pumpage compared to water level changes in unconfined groundwater. Vertical gradient information will continue to be developed as additional information becomes available for well construction, as well as for specific projects were vertical gradient information is needed.

Groundwater in the SKGSA area mostly occurs in an unconfined aquifer. Water levels in an unconfined aquifer system coincide with the top of the zone of saturation, where hydrostatic pressure is equal to atmospheric pressure. Seasonal water level variations in such systems are typically subdued. Groundwater is generally unconfined within the alluvial fan deposits (older and younger alluvium), while in the deeper continental deposits it is unconfined to semiconfined with the degree of confinement generally increasing with depth.

3.2.2 Groundwater Movement

Generally, in the greater SKGSA area, groundwater movement is to the southwest, as shown in **Figure 3-22**. Surface water coming from the foothills recharges the aquifer in the east and as it flows through natural channels, surface water seeps into the ground. A network of KRCD wells along with others were used to create groundwater elevation contours for Spring 2017. **Figure 3-22** shows a current map of water surface elevation contours. The change in water surface elevation is a steep slope from northeast to southwest. This is due in part to the slope of the land, but also due to heavy pumping in the central portion of the valley where no surface water is available for irrigation or recharge. Water surface elevation in the northeast corner of Sanger is around 330 feet above mean sea level while the water table sits at about 220 feet above mean sea level in the southwest part of Fowler and Kingsburg.

3.2.3 Estimate of Groundwater Storage

Regulation Requirements:

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

A common method was utilized to estimate change in groundwater storage for the entire subbasin and within each GSA as part of the coordination efforts within the Kings Subbasin. The common method requires knowledge of the specific yield over subareas of the aquifer to calculate storage change. Specific yield is the volume of water extracted from an aquifer per unit surface area per unit decline in water table and is usually expressed as a percentage. A Technical Memorandum (TM-2) (KDSA, 2018a), identified the basis for assumptions of specific yield values utilized throughout the basin including the SKGSA area. Specific yields for each subarea (predominantly by Township) were identified (see Figure 3-10) for varying depths of 0-50 feet, 50-100 feet, 100-200 feet and 200-300 feet below ground surface. USGS Water Supply Paper No.1469 (Davis, 1959) was the primary source for SKGSA, but others were also used for smaller areas in other parts of the Kings Subbasin. **Appendix C** includes the evaluation of specific yield values (KDSA, 2018a) for the entire Kings Groundwater Subbasin (TM-2) using the aforementioned sources.

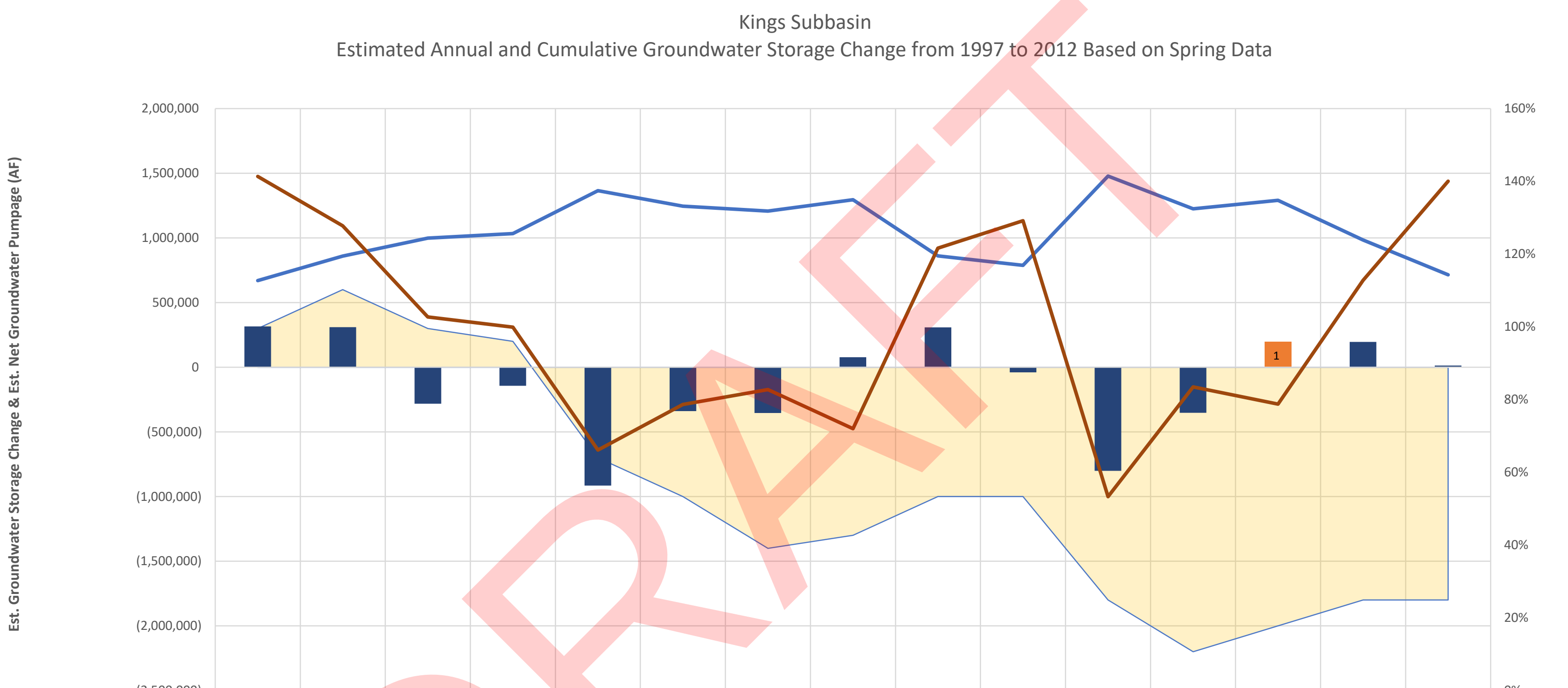
Once specific yield values have been determined, the coordination effort process for calculating storage change includes the following steps:

1. Determine the base of the unconfined groundwater (TM-1).
2. Calculate average depth to groundwater for each subarea based on the well data collected.
3. Multiply the thickness of saturated alluvium within each depth zone by the specific yield for that depth zone (TM-2) and by the area of that subarea within the Plan area.
4. Sum the total storage capacity for all subarea.
5. Then compare the storage from one year to the next, the difference equals the storage change.

As described in **Section 3.2.3**, storage change was estimated for the Kings Subbasin in Technical Memorandum 4 to be approximately -1.8 MAF during the hydrologic average base period from spring 1997 to spring 2012, or about -122,000 AF/yr. Estimates of year to year storage change (annual storage change), cumulative change in storage, percent of normal water year and estimated groundwater use between the springs of years in the hydrologic base period, based on data, are shown on **Figure 3-27**, below, for the Kings Subbasin. The methods for estimating storage change are detailed in Technical Memorandum 4 (P&P, 2018b)(Error! Reference source not found.).

The overall trend in storage change, based on groundwater elevation contours generated from water level data, from year to year generally tracks with the preceding water year type. For example, storage change is positive in 1998, 1999, 2006, 2011, and 2012 which follow above normal water years. The years 2000 to 2004 are years of near normal to below normal water years, and storage change was negative. It is interesting to note that 2001 was a 100 percent water year and the storage change in that year of 135,565 AF is reasonably close to the long-term storage change estimated for the hydrologic base period years. A similar trend also exists between change in storage and estimated groundwater use. Positive storage change is estimated in 1998, 1999, 2006, 2011 and 2012 which are years of relatively lower estimated groundwater use. Decreases in storage are also linked to increased groundwater use as illustrated by the years 2002 and 2008 which are both years when the previous year's estimated groundwater use were greater than normal. There are inconsistencies in some of the groundwater elevation contours for the years in the base period due to several factors including a general lack of well construction data in the basin, historical data being collected at different times by different agencies and possibly from different wells, lack of data in some areas in some years, and potentially inconsistencies in measurement point elevations. Groundwater elevation contours were not constructed for spring 2010 due a lack of data in Central Kings GSA, therefore storage change for 2010 was averaged between 2009 and 2011. It is likely that the storage change from 2009-2010 was negative as it follows an 83 percent water year. The groundwater contour maps used in this evaluation will continue to be refined, especially as additional well construction data is collected, and annual and cumulative estimates of storage change will be adjusted.

Figure 3-27



Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Cumulative Change in Storage, AF	300,000	600,000	300,000	200,000	(700,000)	(1,000,000)	(1,400,000)	(1,300,000)	(1,000,000)	(1,000,000)	(1,800,000)	(2,200,000)	(2,000,000)	(1,800,000)	(1,800,000)
2- Annual GW Storage Change, AF	315,000	310,000	(283,000)	(143,000)	(915,000)	(340,000)	(354,000)	78,000	309,000	(40,000)	(802,000)	(352,000)	195,000	195,000	13,000
3- Preceding WY Est. Net GW Use, AF	670,000	860,000	998,000	1,034,000	1,365,000	1,245,000	1,207,000	1,295,000	861,000	788,000	1,478,000	1,225,000	1,291,000	983,000	715,000
3- Preceding WY % of Normal	141%	128%	103%	100%	66%	79%	83%	72%	122%	129%	53%	83%	79%	113%	140%

Year

Notes:

1 - Storage change for 2010 is average between storage change from 2009 to 2011. Groundwater Elevation contours not prepared for Spring 2010 due to a lack of data in Central Kings GSA.

2 - Annual storage change is from spring of the preceding year to spring of year shown, for example storage change shown under 1 998 is storage change from spring 1997 to spring 1998.

3- Preceding WY ends Sept. 1 of the previous year, for example the 1996/1997 Water Year ends on Sept. 1, 1997 and is shown underthe 1998 column on this graph.

3.2.4 Seawater Intrusion

Regulation Requirements:

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

Seawater intrusion occurs when heavy pumping from the groundwater aquifer induces the flow of salty water from the ocean into the groundwater system. SKGSA is located over 120 miles from the coast, therefore, is not at risk of seawater intrusion. However, there is water with a high total dissolved solids (TDS) content that exists deep in the ground and is considered the base of the fresh water boundary (see **Section 3.1.8**). If water levels get too low, an upward cone of brackish water may occur.

3.2.5 Groundwater Quality Issues

Regulation Requirements:

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

Groundwater quality in SKGSA is generally suited for irrigation and domestic use, although there are a few groundwater issues for drinking water that exist. The water is generally described as being a calcium bicarbonate-type water but can also include magnesium, and sodium as the dominant cation. Typical water quality concerns throughout the basin include Nitrate, Arsenic, total dissolved solids (TDS), Dibromochloropropane (DBCP), 1,2,3-Trichloropropane (TCP), Methyl-Tert-Butyl-Ether (MTBE), and Uranium. While some of these constituents are caused by humans, several are naturally occurring.

The following is a list of the water quality concerns in the basin. General information has been acquired from the Kings Basin IRWMP (KBWA, 2018). Some of these are significant concerns while others are minor or geographically limited (**Figure 3-28** through **Figure 3-33** depict areas of occurrence for these constituents).

Arsenic. Arsenic occurs in natural deposits but can also enter the groundwater aquifer from agricultural or industrial practices. Arsenic in groundwater in the SKGSA is generally found at greater depths where reduced deposits are present. The MCL is 10 μg/L (approximates ppb) and recent results show that 387 samples of the 1470 total samples, or about 26 percent of samples exceeded the MCL (KBWA, 2018).

Dibromo-Chloropropane (DBCP). DBCP was used as a fumigant to kill nematodes in soil before planting and was widely used in California until 1977. The MCL is 0.2 μg/L (approximates 200 ppt). DBCP was used in vineyards and deciduous orchards where sandy soils were present. Higher DBCP levels are generally found in the shallow aquifer, above 200 feet.

Hexavalent Chromium (Cr6). Hexavalent chromium [Cr(VI)] is one of the valence states (+6) of the element chromium. Although chromium is naturally occurring, Cr(VI) can also be produced by industrial processes. Inhalation and ingestion of Cr(VI) is known to cause cancer. Workplace exposures occur mainly during welding and other types of "hot work" on stainless steel and other metals that contain chromium; use of pigments, spray paints and coatings; operating chrome plating baths. In 1977, California established an MCL for total chromium as 50 μg/L, under which Cr(VI) has been regulated. The US EPA adopted the same standard for total chromium but in 1991 raised the federal MCL to 100 μg/L. California did not follow the US EPA's change and maintained 50 μg/L as the standard. Efforts to set a specific Cr(VI) MCL for drinking water in California resulted in an established MCL of 10 μg/L, effective July 1, 2014. On May 31, 2017, the MCL was invalidated by the superior Court of Sacramento County stating that the SWRCB did not adequately document why the MCL was economically feasible. The court also ordered the SWRCB to adopt a new MCL for Cr(VI). The compound has not been found in the groundwater supply for the member agencies of the SKGSA.

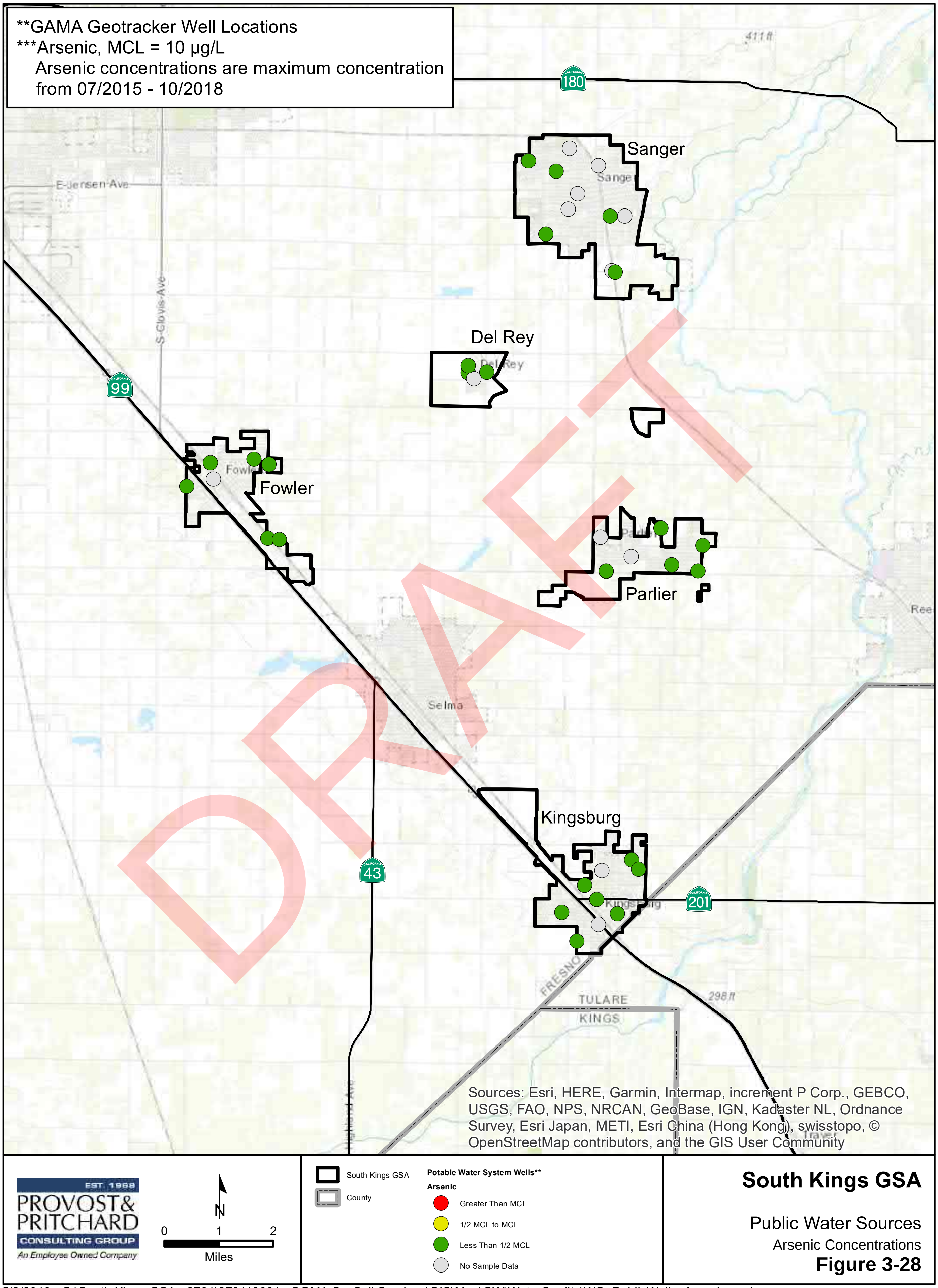
Methyl Tert-Butyl Ether (MTBE). MTBE is a flammable liquid that has been used as an additive for unleaded gasoline since the 1980s but is now banned or limited in several states (banned in California). MTBE is also used in small amounts as a laboratory solvent and for some medical applications. The primary MCL is 13 µg/L for health concerns and 5 µg/L for taste and odor concerns. MTBE is found in numerous areas, but it is typically isolated in areas around current and closed gasoline stations and generally presents few impacts to municipal wells.

Nitrate (NO_3). Nitrate is commonly found in groundwater because of application of nitrogen fertilizers in irrigated agricultural and landscaped areas. Seepage occurs from feedlots/dairies, wastewater and food processing waste ponds, winery waste, sewage effluent, and leachate from septic system drain fields, which contaminants the groundwater aquifer. The Maximum Contaminant Level (MCL) for nitrate (NO_3) is 45 mg/L, and 10 mg/L for nitrate as nitrogen (NO_3-N).

Nitrate is an important constituent of concern in the area. Concentrations exceeding the MCL of 10 mg/L for Nitrate as Nitrogen have been detected in shallow domestic wells throughout the subbasin. Sampling from 2016-17 has shown that 676 samples exceeded the MCL out of 6268 total samples, accounting for approximately 11 percent (KBWA, 2018); however, no wells sampled in SKGSA had concentrations that exceeded the MCL for Nitrate.

1,2,3-Trichloropropane (TCP). TCP is used industrially (paint and varnish remover as a cleaning and degreasing agent) and chemically (solvent and intermediate for pesticides). California has adopted its own drinking water standard of 5 parts per trillion (ppt) which went into effect starting January 1, 2018. TCP has been detected in shallow groundwater in rural areas, along Highway 99. The city of Parlier testing showed values of not detectable to 93 ppt.

Uranium. Uranium occurs naturally in groundwater in parts of the GSA. Uranium is derived from Sierra Nevada granitic rock and will preferentially adhere to clays. There is potential for radon gas, formed by the decay of uranium, to pool in unventilated basements. Uranium is used in nuclear technology, as a colorant in uranium glass, for tinting in early photography, in the leather and wood industries for stains and dyes, and in the silk and wood industries. The MCL is 30 µg/L or 20 picocuries/liter (pCi/L). Uranium generally is not a concern in SKGSA.



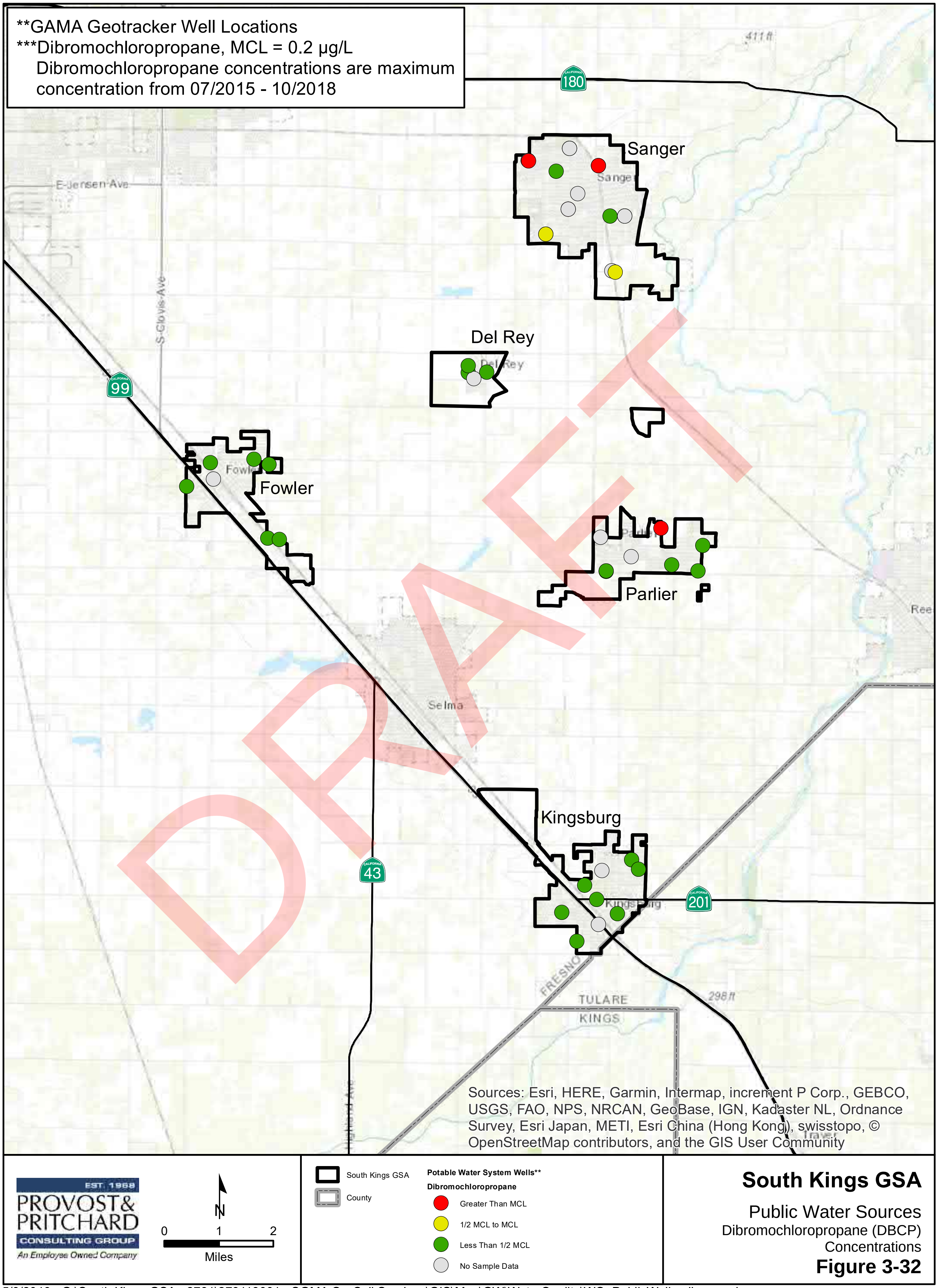
South Kings GSA

Public Water Sources

Arsenic Concentrations

Figure 3-28

5/3/2019 : G:\South Kings GSA - 2731\273118001 - SGMA On-Call Services\GIS\Map\GW\WaterQuality\WQ_PublicWells_Arsenic.mxd



South Kings GSA

Public Water Sources

Dibromochloropropane (DBCP) Concentrations

Figure 3-32

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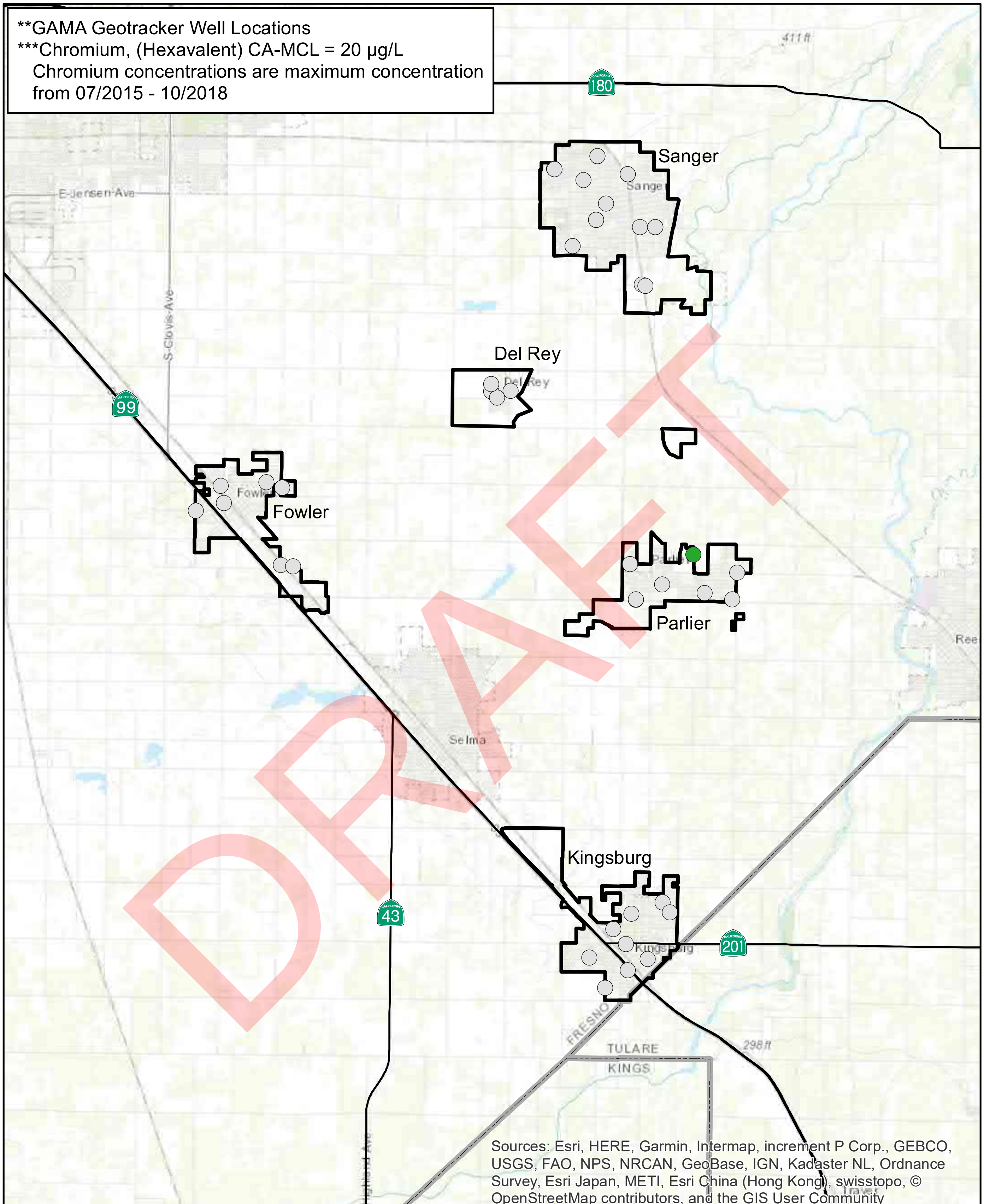

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0 1 2
Miles

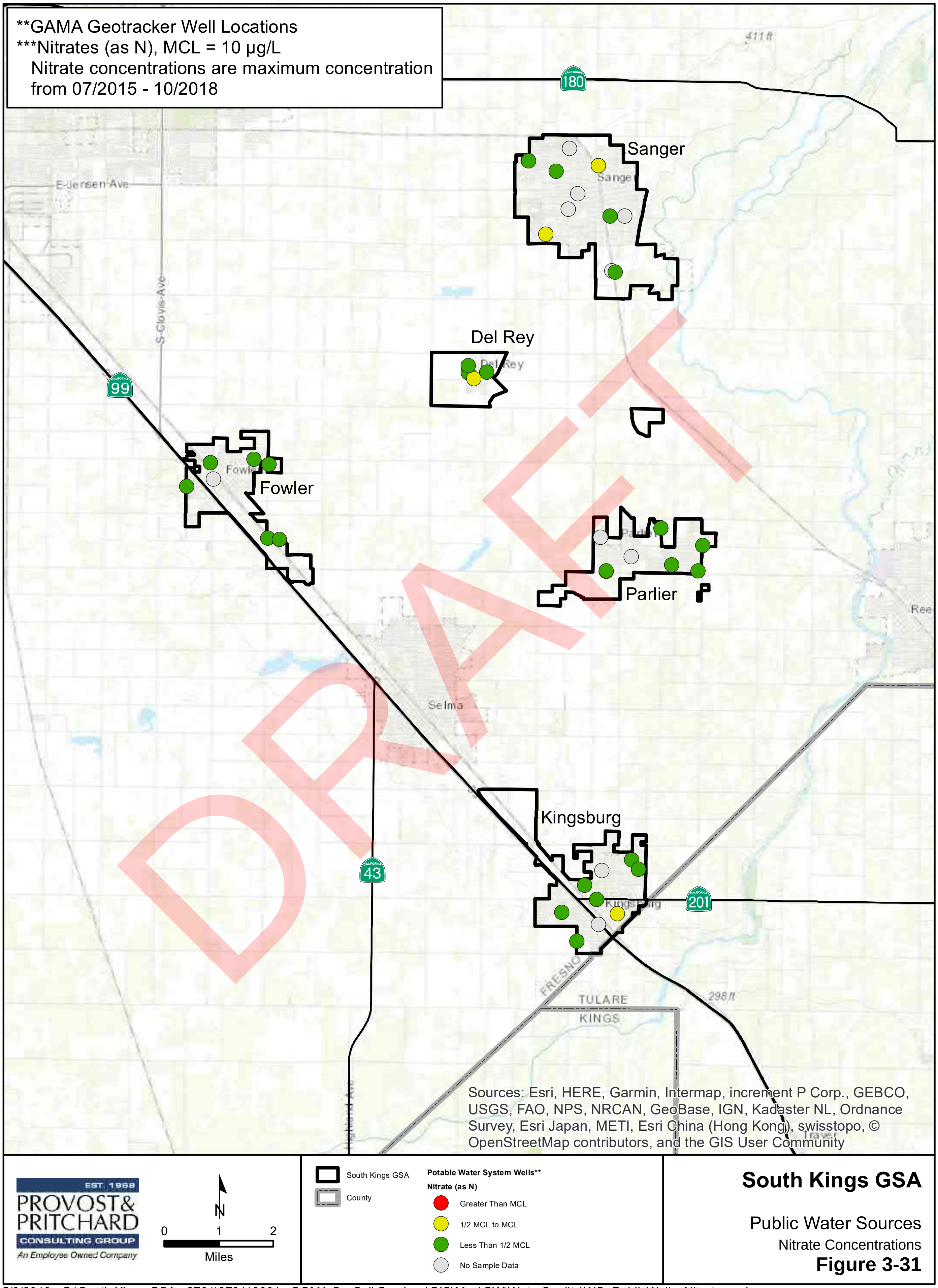
South Kings GSA
County

Potable Water System Wells**
Chromium
- Greater Than MCL
- 1/2 MCL to MCL
- Less Than 1/2 MCL
- No Sample Data

South Kings GSA

Public Water Sources
Chromium Concentrations
Figure 3-30

7/8/2019 : G:\South Kings GSA - 2731\273118001 - SGMA On-Call Services\GIS\Map\GW\WaterQuality\WQ_PublicWells_Chromium.mxd



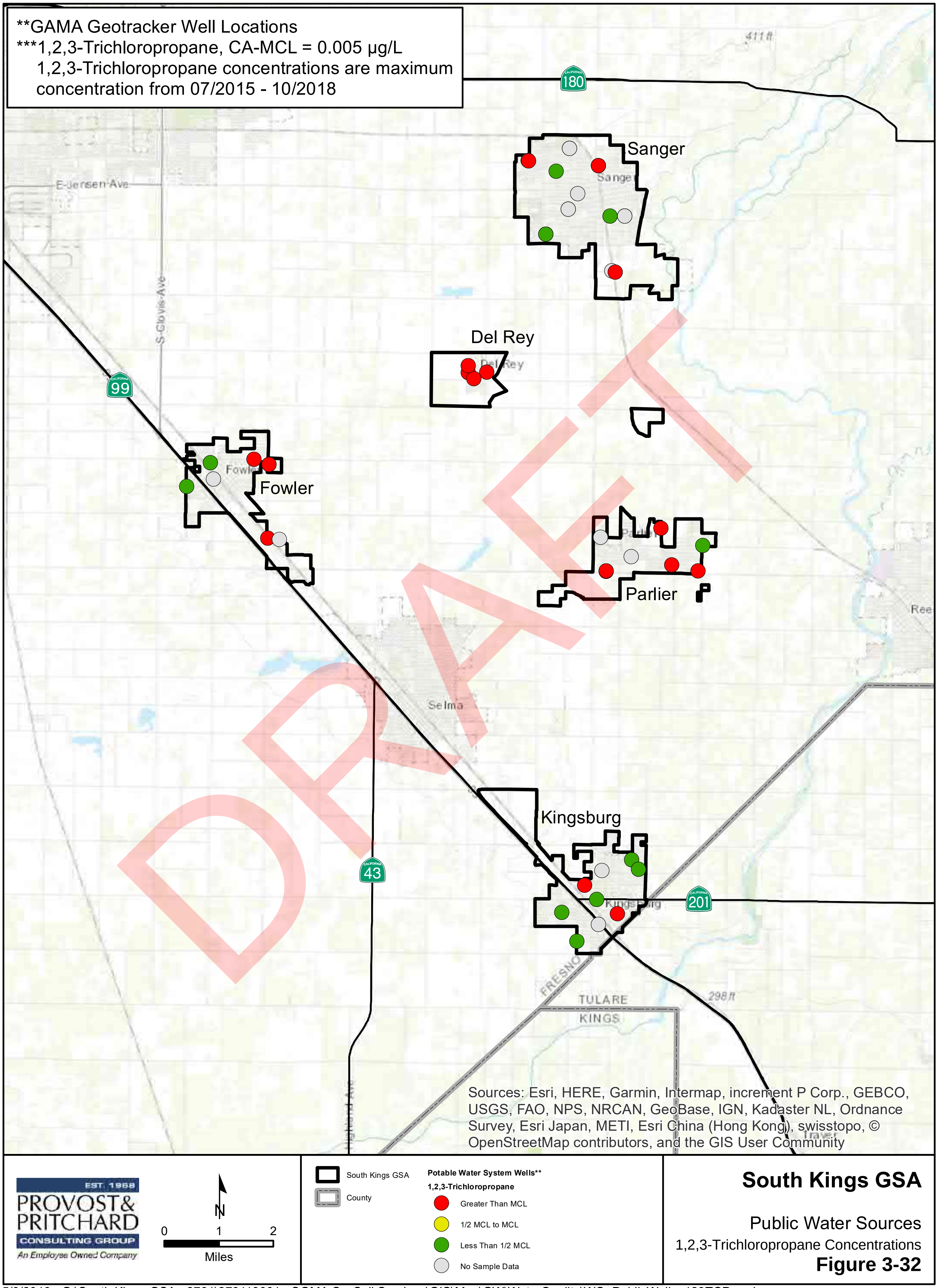
South Kings GSA

Public Water Sources

Nitrate Concentrations

Figure 3-31

5/3/2019 : G:\South Kings GSA - 2731\273118001 - SGMA On-Call Services\GIS\Map\GW\WaterQuality\WQ_PublicWells_Nitrate.mxd

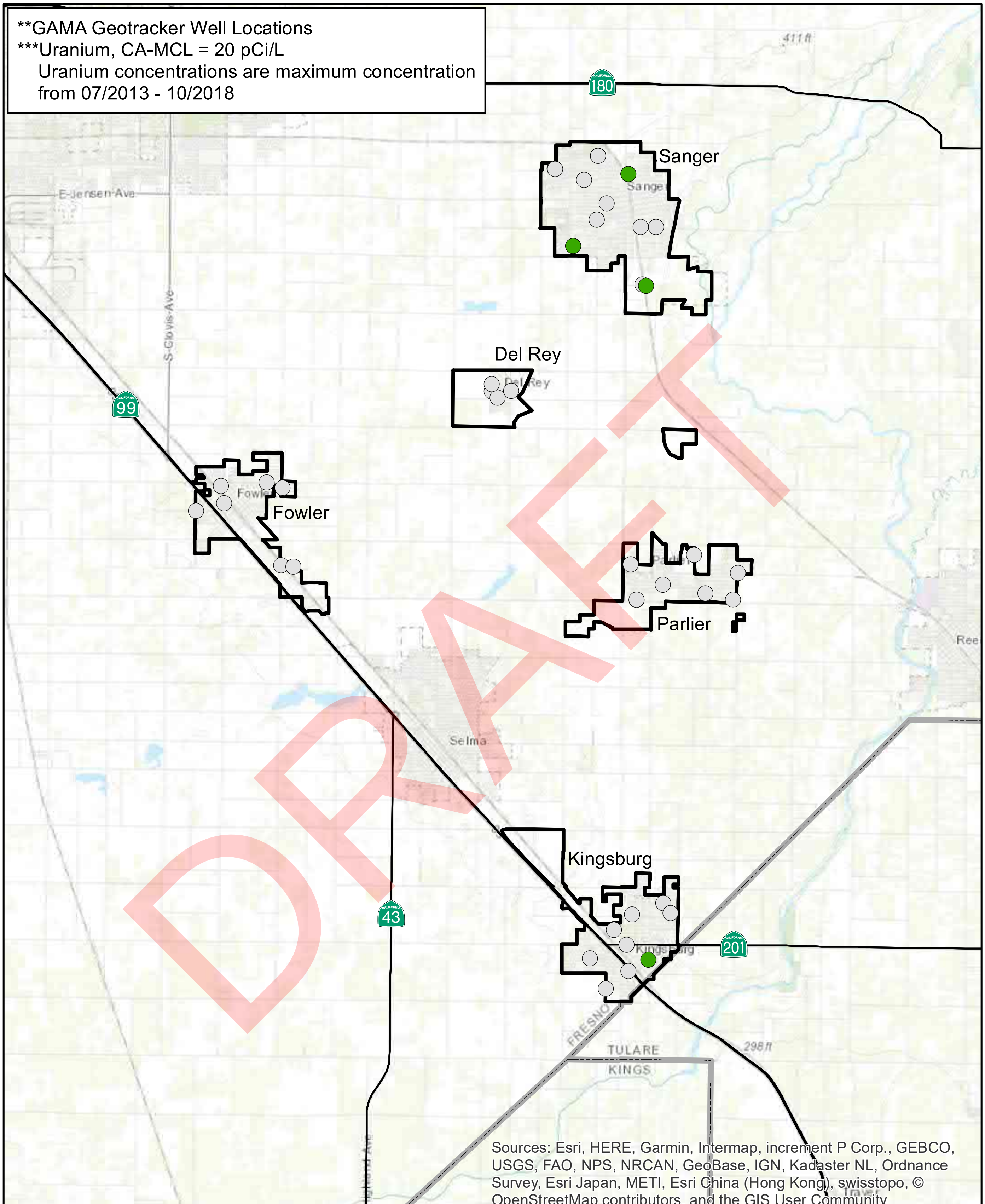


South Kings GSA

Public Water Sources

1,2,3-Trichloropropane Concentrations

Figure 3-32



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0 1 2 Miles

South Kings GSA

County

Potable Water System Wells**

Uranium

- Greater Than MCL
- 1/2 MCL to MCL
- Less Than 1/2 MCL
- No Sample Data

South Kings GSA

Public Water Sources

Uranium Concentrations

Figure 3-33

3.2.6 Land Subsidence Conditions

Regulation Requirements:

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

Five types of subsidence have been found in California and the San Joaquin Valley, including: oxidation of peat deposits in the river/delta areas, deep subsidence resulting from falling groundwater levels caused by overdraft, shallow subsidence caused by hydro-compaction of collapsible soil layers, tectonic subsidence resulting from earthquakes and ground deformation, and subsidence caused by fluid withdrawal from oil and gas fields. The main form of subsidence in the SKGSA area is deep subsidence from declining groundwater levels. Excessive groundwater pumping can contribute to deep subsidence across a broad area, resulting in aquifer compaction, loss of storage capacity, and adverse effects to surface features, such as bridges, canals, flood control systems, and water supply pipelines that rely on gravity flow.

Land subsidence occurs when groundwater levels decline due to excessive withdrawals of groundwater. There are two types of subsidence: elastic and inelastic as shown in **Figure 3-34**. Elastic subsidence is recoverable if water levels later rise while inelastic subsidence is permanent. Elastic subsidence generally occurs in the unconfined portions of the aquifer where the materials compact. Elastic subsidence can rebound if groundwater levels are restored.

Although there are several causes of inelastic land subsidence, the compression of clay because of groundwater extraction from confined aquifers is the cause of the vast majority of subsidence documented in the San Joaquin Valley, west of the SKGSA. This results in compaction of fine-grained confining beds (clays) above and within the confined aquifer system as water is removed from pores between the sediment grains. Once water is squeezed out of the compressible clay, the clay compacts, resulting in the lowering of the overlying land surface. The compressed clays, in which the clay particles have been re-arranged, can no longer re-absorb water, thus the subsidence in these areas cannot be reversed. This process is known as aquifer system compaction. Most of the permanent subsidence in the San Joaquin Valley has historically been correlated to overdraft in the confined aquifer below the Corcoran Clay. However, with increased reliance on groundwater to meet demands, land subsidence is currently occurring in areas outside of the Corcoran clay. Even though subsidence is now occurring in areas outside of the Corcoran clay, the relative amount is less than the historical subsidence in areas underlain by the Corcoran Clay.

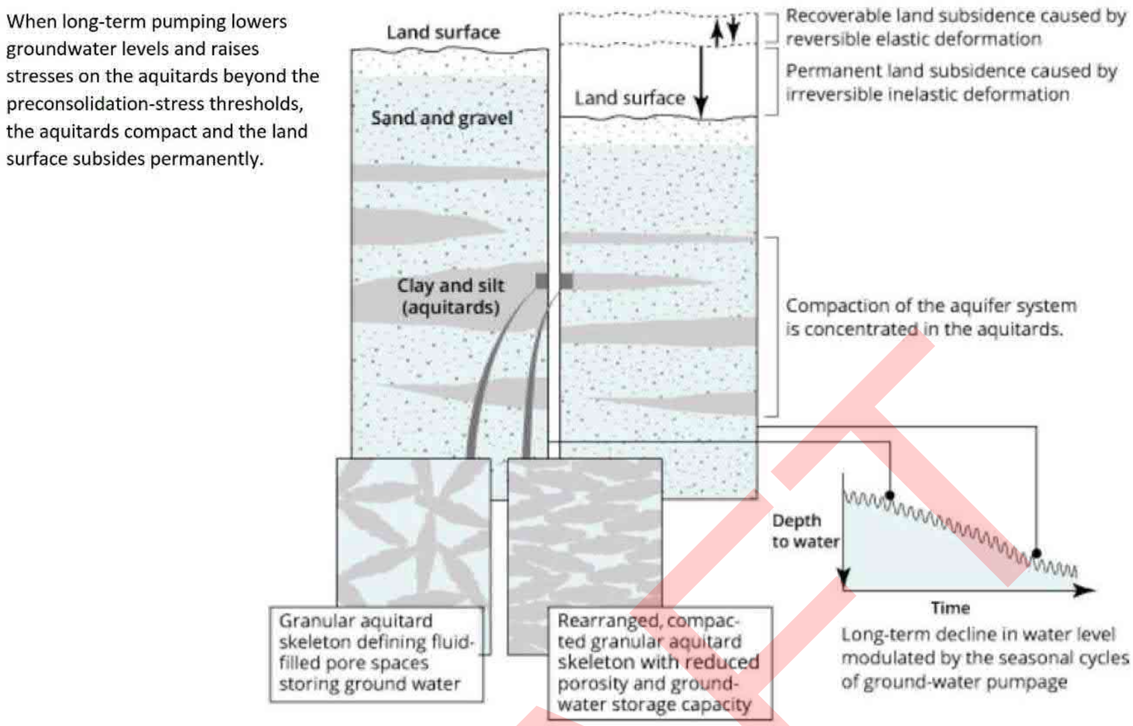


Figure 3-34: Aquifer Compaction due to Groundwater Pumping (USGS)
(Source: https://ca.water.usgs.gov/land_subsidence/california-subsidence-cause-effect.html))

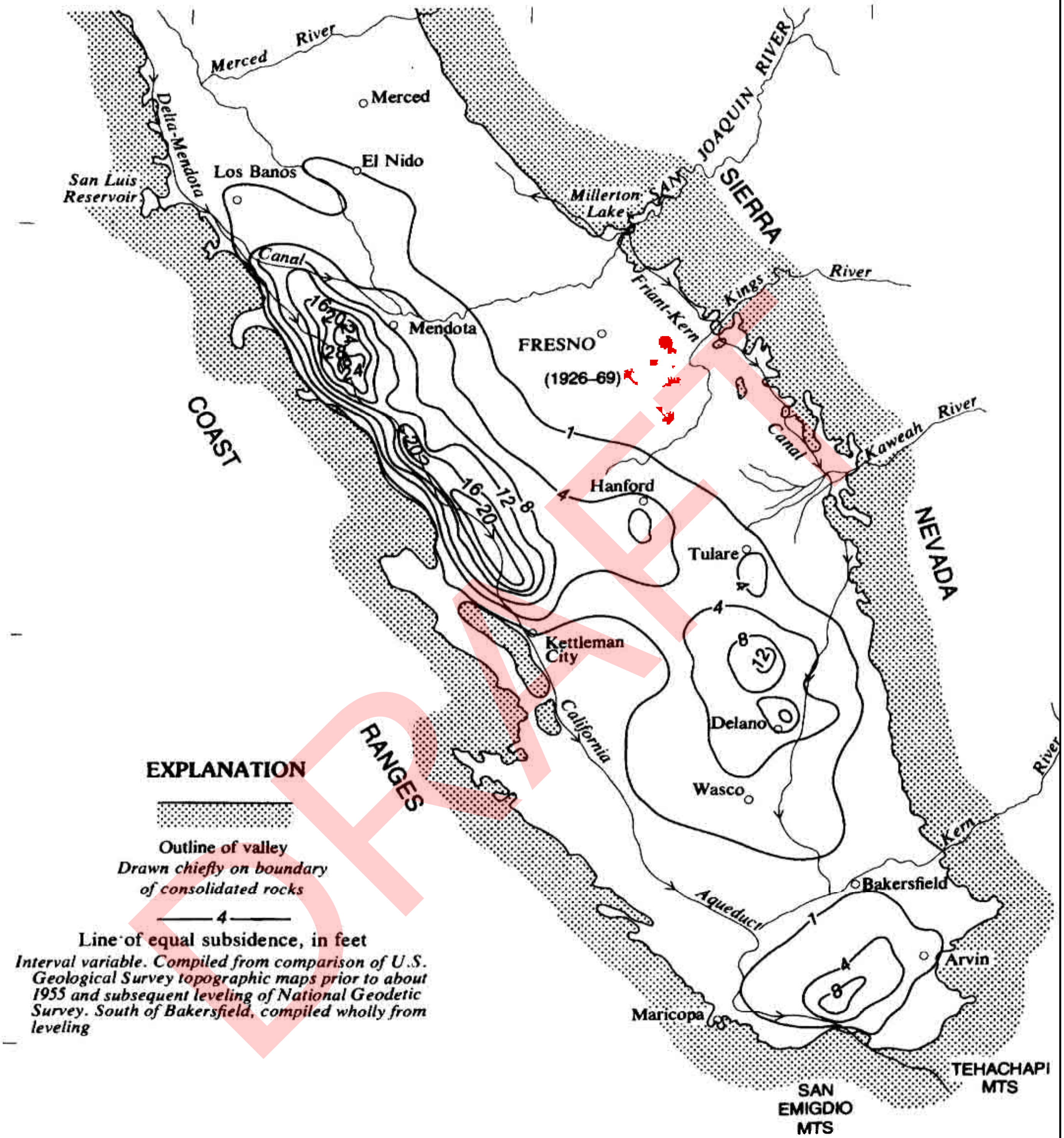
3.2.6.1 Review of Existing Data

As previously mentioned, land subsidence in the area has historically been monitored by regional water agencies and state or federal agencies for various purposes. Available land subsidence data was reviewed to assist in determining what information is available and in establishing a monitoring network. Most significant subsidence in the San Joaquin Valley has occurred on the west side over the axial trough of the valley and minimal subsidence has been recorded in SKGSA.

Those more western areas prone to subsidence and the attendant dominant soil textures, clay mineralogy, and other geologic and geochemical properties were intensely studied by the USGS in a series of Professional Papers in the 1960s, 1970s, and 1980s. The areas prone to subsidence were underlain by deposits where the clayey deposits were dominated by the clay mineral montmorillonite (Meade, 1967). Meade in written communication with R. J. Janda reports that kaolinite and halloysite are the predominant clay mineral constituents of the soils and alluvium of the upper San Joaquin basin in the Sierra. This indicates that, while there is confined groundwater and fine-grained deposits over much of the eastern valley region, the clay mineral assemblage in the fine-grained deposits for the most part do not appear to contain enough of montmorillonite to be as susceptible to subsidence as those areas west of the SKGSA.

3.2.6.2 Subsidence Monitoring Results

Land subsidence was first monitored from the 1920s to 1970s when there was less access to surface water. **Figure 3-35** (Ireland, Roland, & Riley, 1984) shows most subsidence occurring on the west side of the San Joaquin Valley. This figure also shows subsidence in the SKGSA area was less than one foot from 1926 to 1970. Subsidence monitoring decreased after the 1970s when there was more access to surface water due to the canals and water storage projects built in California and less reliance on groundwater to meet demands.



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Miles

Legend

South Kings GSA

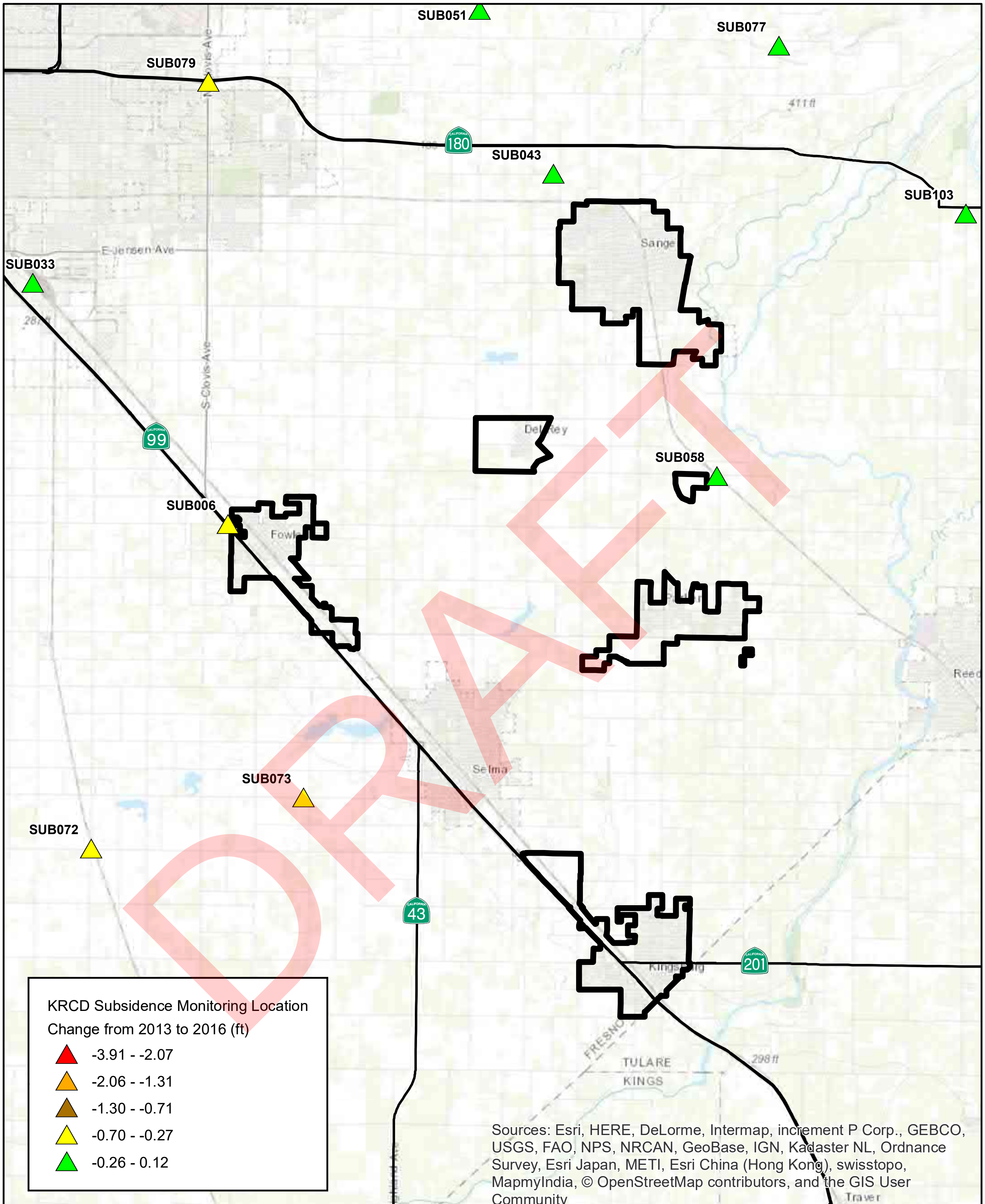
Source: USGS PP 437-I, 1984, Land Subsidence in the San Joaquin Valley, California, as of 1980

South Kings GSA

Land Subsidence from 1926 to 1970

Figure 3-35

Monitoring land subsidence increased again in the 2000s due to drought conditions, environmental regulations that resulted in lower surface water allocations, and increased local demand on groundwater. Furthermore, collapsed wells and subsidence impacts to canals were becoming more prevalent throughout the San Joaquin Valley. Data from 2013 to 2017 was used to evaluate the land subsidence in the SKGSA area. Data sources include KRCD and NASA InSAR (Interferometric Synthetic Aperture Radar) data provided by DWR. **Figure 3-36** shows the KRCD land subsidence monitoring locations and results from 2013 to 2016. KRCD estimated subsidence through surveying of permanent benchmarks. There are a handful of monitoring locations around the SKGSA area that display a range of subsidence from -0.12 to -0.7 feet over the three-year period. The locations on the higher side of the range are located towards the west. **Figure 3-37** shows NASA InSAR data provided by DWR from May 2015 to April 2017. The legend shows the change in ground surface elevation and provides the most thorough aerial extent coverage of the GSA. There is minimal subsidence shown in the SKGSA area during this period. According to NASA InSAR data, the majority of the GSA has experienced zero to one inch of subsidence over the two years.



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Miles

Legend

South Kings GSA

South Kings GSA
Land Subsidence
Kings River
Conservation District
Figure 3-36

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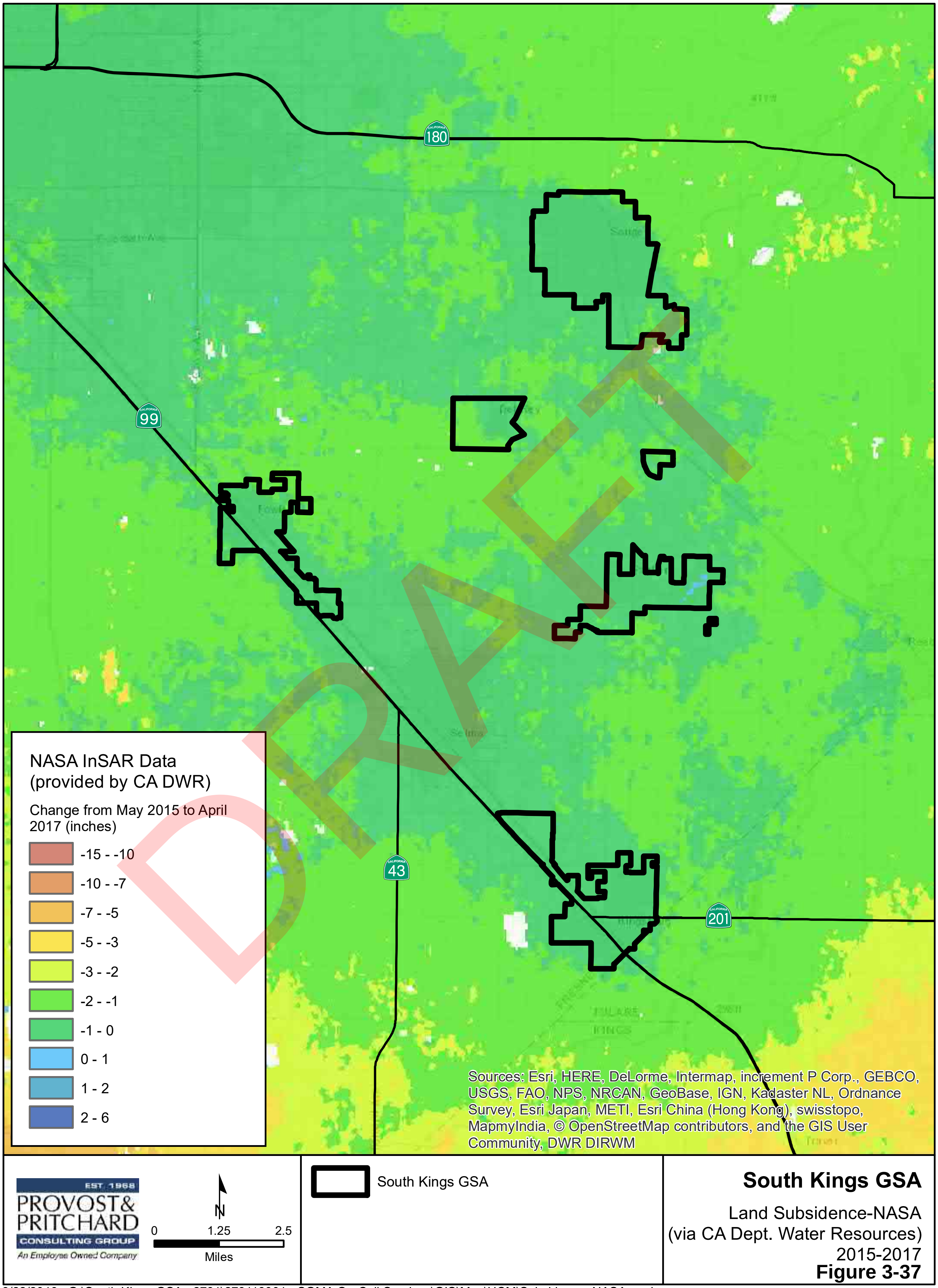

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South Kings GSA

Land Subsidence-NASA
(via CA Dept. Water Resources)
2015-2017

Figure 3-37

3/22/2019 : G:\South Kings GSA - 2731\273118001 - SGMA On-Call Services\GIS\Map\HCM\Subsidence_NASA.mxd

3.2.7 Surface Water and Groundwater Interconnections

Regulation Requirements:

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

Interconnected surface water has been defined in the California Code of Regulations Title 23, Division 2, Chapter 1.5, Subchapter 2 as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. The major surface waters in the Kings Basin include the Kings River and the San Joaquin River. Both rivers are interconnected over discrete stretches, however due to existing river management programs, the river stretches that meet the definition of interconnected surface water are not likely to become depleted

SGMA Regulations are concerned with the volume or rate of surface water depletion caused by groundwater pumping in basins where surface water and groundwater are interconnected. The purpose of this section is to identify any known areas within the SKGSA where groundwater pumping has caused surface water depletion. At this time there is no evidence that active wells along the river are causing increased seepage loss or impacts to downstream beneficial uses.

The term "disconnected" can be misunderstood for several reasons including that minimal literature is available on the topic (Brunner, Cook, & Simmons, 2011). In a disconnected system, a river loses water to the groundwater flow regime through an unsaturated region in the soil. The surface water body and the groundwater are disconnected only in the sense that changes in groundwater elevation do not affect the infiltration rate of the surface water (Brunner, Cook, & Simmons, 2011). **Figure 3-38** displays an example of what a connected versus disconnected system may look like.

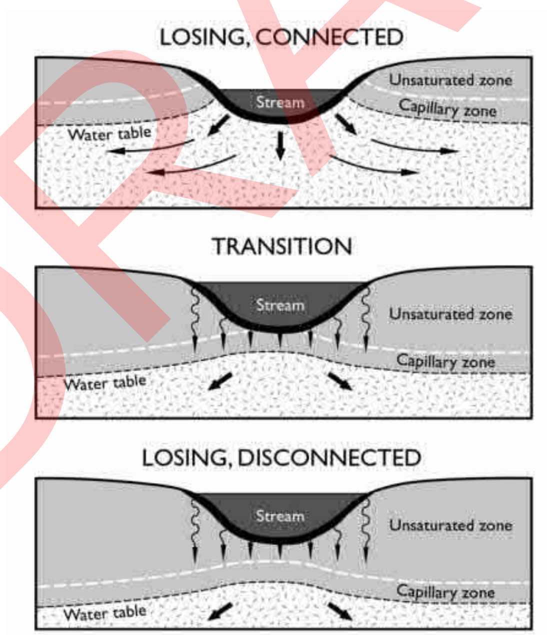


Figure 3-38: Connected versus Disconnected Groundwater and Surface Water Systems

Present Day Conditions

A limited number of studies have evaluated groundwater and surface water interaction within the San Joaquin Valley. Present day regional groundwater elevations are significantly lower than the Kings River channel and tributary channel elevations. The head differential between stream water elevations and the underlying groundwater elevations induces seepage losses from the stream reaches (losing stream). The significant decrease in groundwater elevations has now led to most reaches of the Kings River being losing reaches.

3.2.7.1 Interconnected Surface Water Systems

Information to evaluate the presence of interconnected surface water systems in the northern GSAs in a few locations along the San Joaquin River is available through the USBR's SJR Restoration Project, a US. Geological Survey groundwater flow model documentation report (Traum, Phillips, Bennet, Zamora, & Metzger, 2014), and Friant Water Users Authority and Natural Resources Defense Council (McBain & Trush, Inc. (Eds.), 2002). Additional information, of a regional nature, including the Kings River, is available from the USGS's Central Valley Hydrologic Model (Faunt, 2009) and USGS Open File Report 85-401 as part of the Regional Aquifer System Analysis (Mullen & Nady, 1985). The model reports and regional studies indicates a lack of continuous connection between surface water and groundwater in the CKGSA. The location specific data from the SJRRP indicate that there may be connection at some locations. Limited data is available from the DWR from shallow wells on interconnected surface water systems along the Kings River where it borders the North Kings GSA boundary.

Regional Reports

As mentioned, the regional reports (Faunt, 2009; Mullen & Nady, 1985) appear to show that groundwater and surface water are not interconnected along the San Joaquin River. However, these reports do not explicitly discuss interconnected surface water systems. Instead these reports provide maps that show areas of gaining or losing streams. Along the Kings River, the regional maps provided show that as of 2009, the Kings River in the CKGSA is clearly a losing stream from about five miles south of Sanger (i.e., surface water seeps into groundwater). Upstream and past Sanger, the model indicates a gaining stream based on average conditions from 1961 to 1977. Neither of these locations are adjacent to the SKGSA plan area.

3.2.7.2 Kings River

The draft HCM and Groundwater Conditions for the East Kings River East GSP (KDSA, Draft Hydrogeological Conceptual Model and Groundwater Conditions for East Kings Subbasin GSP, 2017) contains descriptions of interconnected groundwater along the Kings River upstream of Reedley. The Kenneth D. Schmidt and Associates draft report findings were based on groundwater elevation data from shallow monitor wells at existing or proposed gravel processing facilities and the wastewater facilities for Sanger and Reedley. The results of the monitoring indicate that shallow groundwater flows in the same direction as the river and is interconnected with stream flow in the reach between Highway 180 and Reedley. KDSA further indicates that along the reach of the Kings River upstream of the Reedley narrows, the groundwater is indicated to be in direct hydraulic communication with streamflow in the Kings River. This finding is supported by several hydrographs from wells monitored by DWR in the area downstream of where the Friant-Kern Canal crosses the Kings River. In this area the Kings River is a multiple channel system and numerous canals have their headworks in this area. Overall, depths to water reported from the DWR monitored wells varies from about 6 to 10 feet. Well 367433N1194466W001, which is next to one of the river channels, had several reported depths to water of just over one foot. Without having surveyed channel bed elevations, it is difficult to know for sure, but the shallow depths to water appear to indicate that the surface water system in this area is connected to groundwater. The points of potential interconnection are not proximal to the SKGSA areas.

3.2.8 Groundwater Dependent Ecosystems

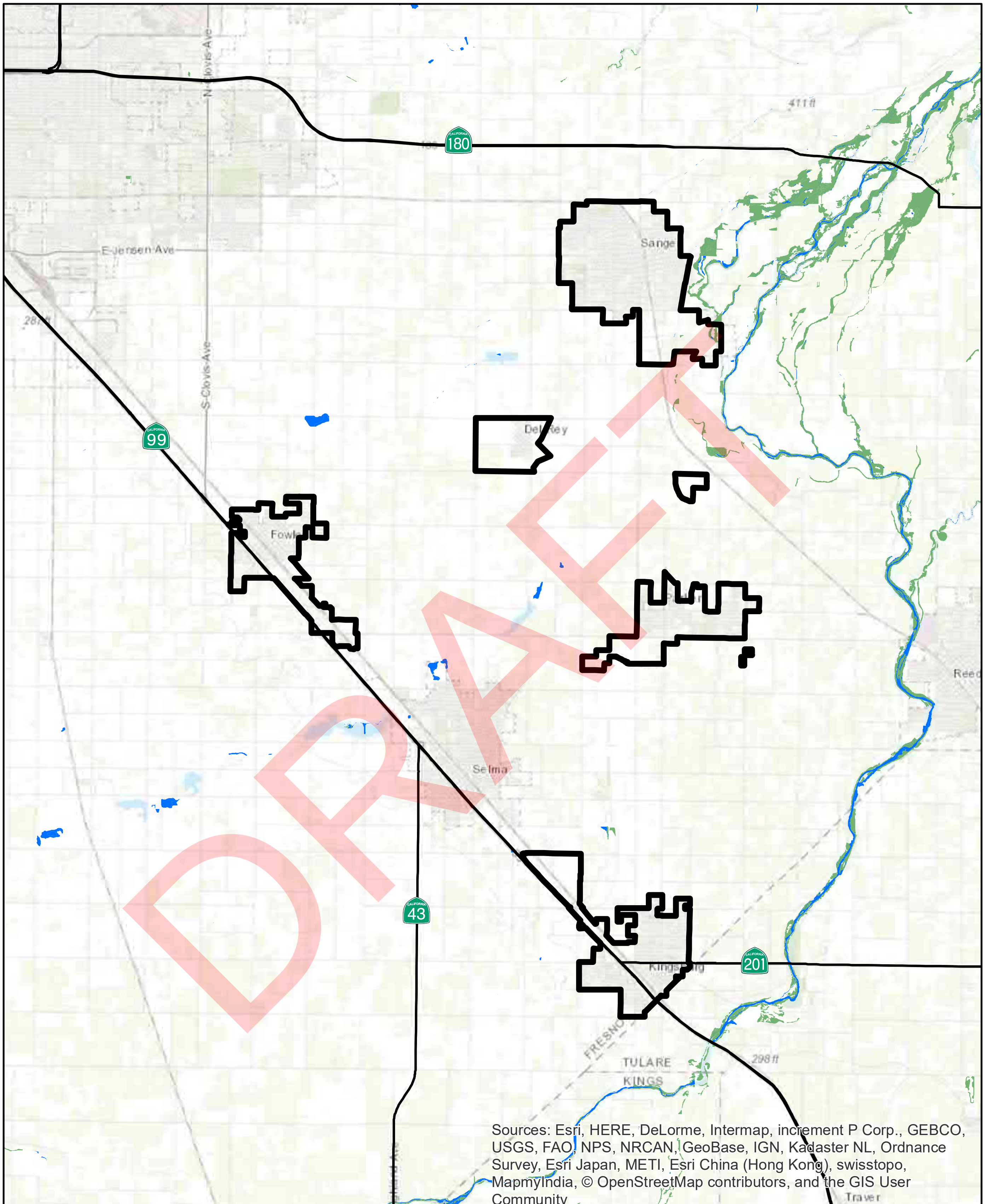
Regulation Requirements:

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

Groundwater Dependent Ecosystems (GDEs) are defined under SGMA as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)). While GDEs are not one of the six groundwater conditions that can lead to undesirable results, they can be related to sustainable management criteria identified in **Section 4**. The Nature Conservancy's Natural Communities Dataset Viewer (NC Dataset Viewer) Vegetative GDE map and Wetland GDE map with basin-wide marked revisions are provided below as **Figure 3-39**. Recognizing that much of the Kings Subbasin has a depth to groundwater greater than the deepest vegetative GDE rooting depth of thirty feet, many of the GDEs identified in the NC Dataset Viewer were mischaracterized.

Spring 2017 depth to groundwater contours and NC Dataset Viewer GDEs were overlaid to identify GDEs in areas with depth to groundwater greater than 30 feet. GDEs meeting this criterion were categorized as "Rejected GDE" and depicted in **Figure 3-39**. Areas closer to the foothills require more depth to groundwater data to sufficiently validate the presence of GDEs; therefore, they are categorized as "Possible GDEs" for the 2020 GSP. The Kings Subbasin also categorized GDEs within 100-ft of the Kings River and the San Joaquin River as "Possible GDEs" (Wegner, 1999).

The Kings Subbasin will continue to evaluate the rejected and possible GDEs and their relationship to the groundwater conditions through monitoring efforts identified in **Section 5** regarding groundwater level and interconnected surface water monitoring. If appropriate, revisions will be made in the future updates of the GSP.



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South Kings GSA
Vegetation (Nature Conservancy iGDE)
Wetlands (Nature Conservancy iGDE)

South Kings GSA

Wetlands And Vegetation

Figure 3-39

3/22/2019 : G:\South Kings GSA - 2731\273118001 - SGMA On-Call Services\GIS\Map\HCM\Wetlands_Vegetation.mxd

3.3 Water Budget Information

3.3.1 Introduction

Regulation Requirements:

§354.18
a) Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.

A water budget is an accounting of all the water that flows into and out of a specified area and describes the various components of the hydrologic cycle. A water budget includes all the water supplies, demands, modes of groundwater recharge, and non-recoverable losses, making it possible to identify how much water is stored in a system and changes in groundwater storage during a given period. Aggregated water budgets have been prepared for the entire Kings Subbasin as well as detailed water budgets for the SKGSA and CKGSA combined. The water budgets for SKGSA and CKGSA were prepared in a combined manner due to the geographic positioning of the SKGSA being wholly within the CKGSA. A schematic diagram of a water budget indicating the primary inflows and outflows and impacts on the groundwater system is shown in Figure 3-40 below:

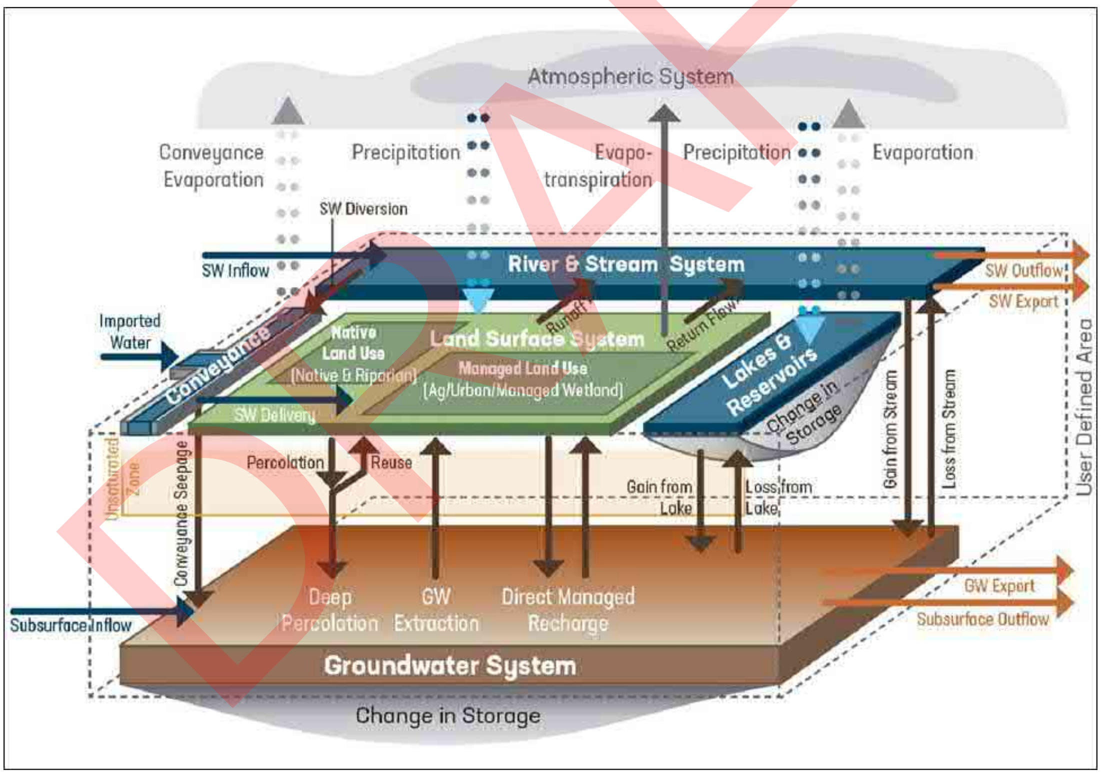


Figure 3-40: Water Budget Schematic

<u>Purpose of Water Budget</u>

Water budgets quantify the components of water supply, water use, and change in groundwater storage. The water budgets can be used as tools in numerous aspects of groundwater sustainability management including:

- Determining sustainable yield
- Identifying overdraft
- Identifying beneficial groundwater uses
- Identifying data uncertainties and monitoring needs
- Quantifying the effects of proposed projects and management actions
- Supporting development of sustainable management criteria

<u>Water Budget Methodology</u>

The Kings Subbasin GSAs have regularly coordinated and used consistent approaches to water budget development. The methods used in developing the water budgets are described generally below and may vary depending on what kind of water budget (historical, current or projected) is being discussed.

The historical, current and projected water budgets have been developed directly from measured and estimated data. A numerical model has not been used for development of the water budgets due to documented deficiencies with currently available groundwater models, including an existing numerical model of the Kings Subbasin, limited data availability for model development purposes, and limited time available for refinement, calibration and validation of a model. An analytical water budget (spreadsheet) approach has been used, which has the advantage of clearly showing the origin of data used for the water budget, as opposed to extracting disaggregated data from a numerical groundwater model that does not explicitly identify the data source or computation method. Overall, the GSAs in the Kings Subbasin mutually agreed that an analytical water budget would be a more practical and useful tool, and therefore offer greater value in managing groundwater. Ongoing use of an analytical water budget will be reviewed during the first five years of GSP implementation, and a decision will be made on the capability, data adequacy and usefulness of revising the existing Kings groundwater model for future GSP activities. The data developed as part of the analytical water budget will be used if the existing Kings groundwater model is updated in the future.

<u>Water Budget Requirements</u>

The coordinated water budgets quantify the following information in conformance with §354.18 (b) of the GSP requirements:

(1) Total surface water entering or leaving the subbasin
(2) Inflows to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.
(3) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.
(4) The change in the annual volume of groundwater in storage between seasonal high conditions.
(5) Identification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.
(6) The water year type associated with the annual supply, demand, and change in groundwater stored
(7) An estimate of sustainable yield for the basin.

<u>Water Budget Periods</u>

Water budgets were performed for historical, current and future periods, as shown in the following figure and described below:

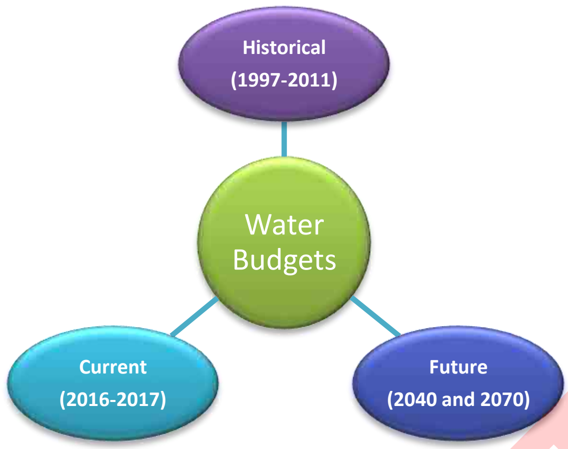


Figure 3-41: Water Budgets Evaluated

Historical. A historical water budget was prepared covering Water Years 1996/97-2010/11 (1997-2011). This historical period was selected by the Kings Subbasin based on average surface water diversion amounts during the period compared to long-term records, since average surface water deliveries would equate to average groundwater pumping. This period had surface water diversions very similar to the last 50 years. While a more recent historical period would have been ideal, unfortunately extreme drought conditions between 2012 and 2016 would have made this impractical.

Current. A current water budget was prepared to represent recent conditions. This water budget includes water demands from 2016 to 2017, and long-term average supplies.

Future. Future water budgets were prepared for 2040, which is the year when the GSA must reach sustainability, and 2070, which represents a 50-year planning horizon. These water budgets include estimated changes in demands and impacts from climate change.

In addition, water budgets were prepared for dry, normal and wet years (except for the 2070 water budget which was only prepared for a normal year).

3.3.2 Best Available Information

GSP regulations stipulate the need to use the *best available information* and the *best available science* to quantify the water budget for the basin. Best available information is common terminology that is not defined under SGMA or the GSP Regulations. Best available science, as defined in the GSP Regulations, refers to the use of sufficient and credible information and data, that is specific to the decision being made and the time frame available for making that decision, which is also consistent with scientific and engineering professional standards of practice. It is understood that initial steps to compile and quantify water budget components may be constrained by GSP timelines, limited data and limited funding, and may consequently need to rely on the best available information that is obtainable at the time the GSP is developed. The best available data for the water budget was often incomplete, had to be estimated, or was based on assumptions. The confidence intervals for each parameter vary from 5% to as high as 50%. As a result, the water budget presented herein is merely an approximation of the hydrologic system in the GSA.

3.3.3 Description of Groundwater Model

Regulation Requirements:

§354.18

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

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

A water budget is crucial to sustainable groundwater management by quantifying the historic and current overdraft, in turn having a goal to set demand mitigation and supply augmentation objectives. Historical water budgets were developed on a GSA basis for the Kings Subbasin, then rolled together to obtain a Subbasin water budget. The historical water budget does not include an annual accounting of conditions, rather average annual values over the study period (1997-2011) were identified and incorporated into an average-annual historical water budget. As described subsequently, the historical water budget has been used as the basis for the current-level and projected water budgets, with appropriate adjustments to the historical water budget as documented in **Sections 3.3.5** and **3.3.6**.

<u>Hydrologically Average Period</u>

The historical water budget for the Kings Subbasin was developed for a base period of water-year 1997 through 2011 (October 1996 to September 2011. This hydrologic period was selected since it is a relatively long period during which "…*water supply conditions approximate average conditions*" as specified in DWR Groundwater Regulations at §354.18 (b) (5). The analysis of average conditions was based on Kings River surface water diversion amounts being approximately the same as the long-term average. Kings River surface water diversions were used since they are the largest source of water supplies to the Kings Subbasin, constituting nearly 90% of surface water used and more than 60% of the total water supply. Surface water diversions were used to select the hydrologic base period rather than Kings River runoff because they are more representative of average groundwater pumping conditions, since runoff water can be regulated in Pine Flat Reservoir from one year to the next.

The Kings Subbasin operates in a classical conjunctive use manner where groundwater pumping each year is used to supplement the surface water supply. Average Kings River surface water diversions to the Kings Subbasin since the construction of Pine Flat Dam (1955-2018) were 1,088,932 AFY. Average diversions during the selected 1997-2011 historical analysis period were 1,081,700 AFY, which is 99.3-percent of the long-term average. Kings River diversions during the 50-year period from 1968-2017 averaged 1,083,901 AFY, which is also very similar.

A more recent historical analysis period was sought out, but due to the large number of exceptionally dry years between 2007 and 2015, any historical period including all of those years would have required an extended historical period going back to the 1980s to approximate average hydrologic conditions, and hence average groundwater pumping conditions. Such an extended historical period would have included periods with more questionable data and represented an older period that is not representative of more recent land use changes and water management practices. Due to these identified deficiencies, the 1997-2011 period was selected for the historical water budget even though it does not include more recent years.

<u>Water Year Types</u>

Water budgets were developed for dry, normal and wet year water types. These water-year types were developed according to a water year classification based on water supply diversion information in the Kings Subbasin. The water year on the Kings River is October through September. The water year types were developed due to the absence of DWR-developed water year types for the Kings River watershed and other watersheds in the Tulare Basin, and to account for actual surface water diversions rather than runoff.

The water year types were defined based on percentage of average Kings River diversions to the Kings Subbasin for a 50-year hydrologic period from 1968-2017, as shown in **Table 3-2**. Year types were selected for Dry, Normal and Wet conditions based on the historical diversions. A summary of how the water year types were decided is shown in **Table 3-1** below.

Table 3-1: Water Year Types

Water Year Type	Percent Historical Diversions
Dry	<75%
Normal	75% - 125%
Wet	>125%

A comparison of the Kings year type classifications was made to the DWR San Joaquin Valley water year hydrologic classification index. DWR classifies year types as critical, dry, below normal, above normal, and wet based on the San Joaquin Valley runoff hydrology. The Kings year type and the SJV Index year type generally match up very well with the exception of a few years which were considered dry by DWR standards based on runoff but were considered normal based on Kings diversions. This is due to the operation of Pine Flat Reservoir and the ability to store water for the following year.

Table 3-2: Kings River Year Types based on Diversions into Kings Subbasin

Water Year	Pre-Project Piedra	% Water Year PPP	Headgate Diversions	% Average Diversions	Kings Year Type	DWR SJV Index	Water Year	Pre-Project Piedra	% Water Year PPP	Headgate Diversions	% Average Diversions	Kings Year Type	DWR SJV Index
1955	1,120,800	66.3%	803,079	73.7%	dry	*D*	**1987**	779,051	46.0%	830,511	76.3%	**normal**	*C*
1956	2,603,500	154.1%	1,691,879	155.4%	wet	*W*	**1988**	827,211	48.9%	620,703	57.0%	**dry**	*C*
1957	1,251,400	74.1%	952,292	87.5%	normal	*BN*	**1989**	905,624	53.6%	746,970	68.6%	**dry**	*C*
1958	2,533,200	149.9%	1,523,837	139.9%	wet	*W*	**1990**	662,989	40.5%	488,305	44.8%	**dry**	*C*
1959	818,000	48.4%	732,405	67.3%	dry	*D*	**1991**	1,075,608	63.7%	791,489	72.7%	**dry**	*C*
1960	719,400	42.6%	577,568	53.0%	dry	*C*	**1992**	705,247	41.7%	579,956	53.3%	**dry**	*C*
1961	571,800	33.8%	460,148	42.3%	dry	*C*	**1993**	2,553,114	151.1%	1,511,627	138.8%	**wet**	*W*
1962	1,879,300	111.2%	1,312,010	120.5%	normal	*BN*	**1994**	861,045	51.0%	845,093	77.6%	**normal**	*C*
1963	1,906,900	112.8%	1,328,459	122.0%	normal	*AN*	**1995**	3,460,047	204.8%	1,516,205	139.2%	**wet**	*W*
1964	882,100	52.2%	774,685	71.1%	dry	*D*	**1996**	2,095,921	124.0%	1,678,550	154.1%	**wet**	*W*
1965	1,986,200	117.5%	1,451,438	133.3%	wet	*W*	**1997**	2,652,070	156.9%	1,538,836	141.3%	**wet**	*W*
1966	1,219,100	72.1%	1,010,957	92.8%	normal	*BN*	**1998**	3,104,062	183.7%	1,390,921	127.7%	**wet**	*W*
1967	3,332,800	197.2%	1,774,026	162.9%	wet	*W*	**1999**	1,261,024	74.6%	1,118,240	102.7%	**normal**	*AN*
1968	843,204	49.9%	948,479	87.1%	**normal**	*D*	**2000**	1,534,654	90.8%	1,087,483	99.9%	**normal**	*AN*
1969	4,386,300	259.6%	1,700,665	156.2%	**wet**	*W*	**2001**	1,010,201	59.8%	720,077	66.1%	**dry**	*D*
1970	1,330,595	78.7%	1,332,285	122.3%	**normal**	*AN*	**2002**	1,141,149	67.5%	856,072	78.6%	**normal**	*D*
1971	1,174,952	69.5%	1,003,329	92.1%	**normal**	*BN*	**2003**	1,426,170	84.4%	901,133	82.8%	**normal**	*BN*
1972	859,583	50.8%	708,266	65.0%	**dry**	*D*	**2004**	1,050,714	62.2%	783,628	72.0%	**dry**	*D*
1973	2,135,442	126.4%	1,551,605	142.5%	**wet**	*AN*	**2005**	2,531,327	149.8%	1,324,132	121.6%	**normal**	*W*
1974	2,095,945	124.0%	1,522,343	139.8%	**wet**	*W*	**2006**	2,948,677	174.5%	1,406,012	129.1%	**wet**	*W*
1975	1,583,365	93.7%	1,205,401	110.7%	**normal**	*W*	**2007**	679,047	40.2%	580,345	53.3%	**dry**	*C*
1976	540,664	32.0%	418,674	38.4%	**dry**	*C*	**2008**	1,216,651	72.0%	908,837	83.5%	**normal**	*C*
1977	395,994	23.4%	331,187	30.4%	**dry**	*C*	**2009**	1,348,201	79.8%	857,132	78.7%	**normal**	*BN*
1978	3,453,853	204.4%	1,585,949	145.6%	**wet**	*W*	**2010**	2,062,001	122.0%	1,227,931	112.8%	**normal**	*AN*
1979	1,729,846	102.4%	1,643,166	150.9%	**wet**	*AN*	**2011**	3,319,830	196.5%	1,524,717	140.0%	**wet**	*W*
1980	3,046,952	180.3%	1,721,195	158.1%	**wet**	*W*	**2012**	825,683	48.9%	828,979	76.1%	**normal**	*D*
1981	1,040,415	61.6%	1,030,737	94.7%	**normal**	*D*	**2013**	691,301	40.9%	429,208	39.4%	**dry**	*C*
1982	3,111,011	184.1%	1,513,954	139.0%	**wet**	*W*	**2014**	536,924	31.8%	391,587	36.0%	**dry**	*C*
1983	4,476,391	264.9%	1,573,586	144.5%	**wet**	*W*	**2015**	360,979	21.4%	215,058	19.7%	**dry**	*C*
1984	1,971,145	116.7%	1,533,875	140.9%	**wet**	*AN*	**2016**	1,253,961	74.2%	811,025	74.5%	**dry**	*D*
1985	1,252,501	74.1%	1,074,064	98.6%	**normal**	*D*	**2017**	4,096,148	242.4%	1,725,612	158.5%	**wet**	*W*
1986	3,262,497	193.1%	1,559,911	143.3%	**wet**	*W*	2018	1,274,520	75.4%	1,080,371	99.2%	normal	*BN*

Notes: 1) Kings River diversion accounting was on a calendar year basis for the years 1955 through 1964 (9 mo). Accounting began on a waer year basis (Oct-Sep) in the 1964/65 year.

2) Kings Year Type classifications: Dry = <75% of average Kings Subbasin diversions; Normal = >75% and <125% of average; Wet = >125% of average Kings Subbasin diversions.

3) DWR SJV Index = CDEC Water Year Hydrologic Classification Indices for San Joaquin Valley. C = Critical; D = Dry; BN = Below Normal; AN = Above Normal; W = Wet.

4) 50-year hydrologic period (WY 1967/68 - 2016/17) shown in **bold**.

3.3.4 Surface Water Entering and Leaving

Regulation Requirements:

§354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:
1) Total surface water entering and leaving a basin by water source type.

Surface Water

For Irrigation

Kings River delivery data were acquired from KRWA Watermaster Reports for headgate diversions to each member unit. San Joaquin River (Friant) delivery data were acquired directly from the local agencies or USBR reports. In the case of SKGSA, there are no surface water diversions into the GSA. SKGSA does not have any rights to surface water diversions and has not historically purchased surface water from neighboring agencies.

Riparian water use in the subbasin was estimated by assuming that all potential agricultural riparian lands with identified pumps that abut the Kings River diverted surface water to meet their crop demands when water was available in that reach of the river. Average annual demands were assumed to be 3 acre-feet per acre and were divided into monthly values. Similarly, along the San Joaquin River, most lands designated as having Holding Contracts with the USBR were assumed to divert 3 acre-feet per acre per year. Holding Contract lands within the City of Fresno were assumed to have no diversions, since they are generally fully developed for urban use or on City water supplies. In reality, the acreage of riparian and Holding Contract lands are unknown since they are not reported, so this value may be modified in the future. SKGSA does not have any riparian land and was therefore not included in this calculation.

For Municipal & Industrial (M&I)

Urban surface water delivery data were collected directly from local agencies. SKGSA does not have any surface water treatment plants and, while it has no plans to use surface water for municipal and industrial use in the future at this time, that may change and the agencies continue to consider all possibilities for water supply.

For Recharge

Surface water use for intentional recharge is based on measured deliveries to recharge basins. When recharge basins were not metered, the deliveries were estimated by the local agency using their own criteria and assumptions. SKGSA has not historically brought surface water into the area for intentional recharge.

Precipitation

Monthly precipitation data was collected from the NOAA Regional Climate Center's Applied Climate Information System for stations throughout the Kings Subbasin for the 20-year, 1996-2016 period. Annual precipitation contours were generated using the station coordinates and their respective annual precipitation. Using the contours, weighted average precipitation values were identified for each GSA within the Kings Subbasin for each year within the 20-year period. More specifically, SKGSA has an average annual precipitation of 11.6 inches over the hydrologic base period of 1997-2011.

Spill Inflows

This represents spills of surface water into an irrigation or water district, and therefore is a source of water. Data is based on measured spills, or estimates provided by the district. If the spills were unknown, and believed to be small, they were assumed to be zero.

3.3.5 Inflows to Groundwater System

Regulation Requirements:

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

Quantities of water entering the groundwater body in the Kings Subbasin as forms of recharge, are described and quantified in this section using the procedures described below.

Groundwater Inflows
Unconfined groundwater flows were estimated for the historical period based on measured groundwater levels and transmissivities using Darcy's Law. For lateral groundwater flows, the equation used is:

$$Q = TIL$$

where: Q = groundwater flow in gallons per day (gpd)
T = transmissivity in gallons per day/foot (gpd per foot)
I = hydraulic gradient (feet per mile)
L = width of flow (miles).

Transmissivity is a factor indicating the ability of the aquifer to transmit groundwater flow laterally. It is equal to the thickness of water-producing strata multiplied by the hydraulic conductivity of these strata. Transmissivity is best determined from the results of aquifer tests but is also commonly obtained from published data when available or estimated from specific capacity (pumping rate divided by drawdown) values when aquifer tests are not available. Both the hydraulic gradient, or water-level slope, and the width of flow are best determined from detailed (i.e., 10-foot or less contour interval) water-level elevation maps.

In estimating groundwater flow the following simplifying assumptions were made:

- Spring water levels represent the most static water level conditions and are the best levels for estimating estimate groundwater flows,
- The aquifer is relatively homogenous and isotropic

In the Kings Basin, unconfined groundwater flows were estimated at all of the GSA boundaries (with the exception of South Kings GSA, which was considered part of the Central Kings GSA for groundwater flow purposes). The analysis divided the GSA borders into flow segments. Average flow direction and gradients for each segment were determined from groundwater contour maps developed for the Kings Subbasin (P&P Technical Memorandum #4) (P&P, 2018b) Transmissivities were estimated from available aquifer tests when available. In areas with sparse aquifer tests, specific capacities from USGS reports were used. A more complete description of the calculations is presented in P&P Technical Memorandum #5 (P&P, 2018c) It has been estimated that there is only approximately 400 AF of groundwater inflow to Central and South Kings GSAs on an average annual basis.

Deep Percolation
<u>Irrigation</u>
Deep percolation was calculated by assuming that the amount of water applied above and beyond the evapotranspiration rate (due to irrigation inefficiencies) infiltrates past the root zone and into the groundwater system. As a result, the quantity of deep percolation of irrigation water is computed as a function of irrigation efficiency. For example, in SKGSA, the irrigation efficiency is estimated to be 84%, then deep percolation of irrigation water would be 100% – 84% = 16% of the applied water.

<u>Precipitation</u>
Deep percolation of precipitation was estimated based on the following empirical formula:

$$D = 0.64xP - 6.2$$

where: DP = Deep percolation (inches)

P = Annual precipitation (inches)
Source: (Williamson, Prudic, & Swain, 1989)

This empirical equation was developed for the San Joaquin Valley (Williamson, Prudic, & Swain, 1989) by estimating soil moisture budgets over a 50-year period. Note, that if annual precipitation is less than 9.69 inches, then deep percolation will not occur. The equation above was used to calculate the volume of recharge due to precipitation on an annual basis for each year over the hydrologic period from 1997-2011 and the values were averaged together to obtain deep percolation on an average annual basis.

This equation was only used in rural (agricultural, rangeland and rural residential areas) areas. Deep percolation of precipitation in urban areas is covered in Urban Stormwater Recharge.

<u>M&I</u>

Deep percolation of M&I water includes two components: 1) Indoor water usage sent to treatment plants and septic systems; and 2) Outdoor landscape water that percolates past the root zone.

When sewer flows are known the volume percolated is equal to the plant deliveries minus percolation pond evaporation. If some effluent is directly diverted for other purposes, such as irrigation of non-edible crops, that volume is subtracted. For rural populations, it is also assumed that 100 percent of indoor water use is percolated into the groundwater through septic systems and leach fields. Indoor water usage is assumed to be 35% of rural water demands based on experience with other San Joaquin Valley communities.

It is assumed that all outdoor water use is used for landscape irrigation. All water applied in excess of landscape irrigation demands is assumed to percolate past the root zone and eventually reach the water table. Landscape irrigation efficiency is assumed to be 75%, therefore, 25% of outdoor water usage is assumed to percolate.

The cities of SKGSA all send their wastewater to a treatment plant of sorts that has its own recharge ponds. It is assumed that all flow into the plant is sent to the ponds for recharge. Wastewater treatment data was obtained from each of the cities; therefore, the volume of indoor and outdoor use is known.

Seepage

<u>Channels and Pipelines</u>

Channel seepage can be acquired using one of three methods:

1. Results of local seepage tests and seepage losses
2. Difference between diversions and water deliveries. This is only possible when headgate diversions and grower deliveries are accurately metered. Channel evaporation and spills also need to be subtracted.
3. Typical seepage rates for different soil types (see discussion below)

Kings River Water District (KRWD, 1991) estimated seepage rates for different hydrologic soil groups in Alta Irrigation District. Since these were developed for general soil groups, rather than locally specific soil types, it is assumed they are applicable in other areas of the Kings Basin. These seepage rates are shown in **Table 3-3** below.

Table 3-3: Estimated Seepage Rates for Hydrologic Soil Groups

Hydrologic Soil Group	Estimated Infiltration Rates (feet/day)
A	1.0
A'	0.7
B	0.7
B'	0.5
C	0.5
C'	0.3
D	0.05

Pipeline seepage is based on data provided by local agencies, or standard values estimated using the AWWA Water Audit Loss Tool.

SKGSA does not have a surface water distribution system and losses associated with the distribution of groundwater for municipal purposes are considered negligible.

<u>Reservoirs</u>
Reservoirs seepage was based on the seepage rates for general hydrologic soils groups described above under Seepage of Channels & Pipelines. Annual seepage was calculated as the seepage rate multiplied by the period of time the reservoir is typically filled with water. There are no designated storage reservoirs in SKGSA.

Stormwater Recharge
Fresno Metropolitan Flood Control District (FMFCD) operates stormwater ponds that capture runoff from urban areas in the North Kings GSA. Using a simplified model, FMFCD estimated that 17,600 AF/year of stormwater recharged annually from 2007-2017. This includes the Fresno-Clovis urban areas served by stormwater basins (approximately 97,000 acres) and ignores the rural areas in the FMFCD service area. In personal communication with the FMFCD Program Manager (Jarrod Takemoto, December 2018), it was estimated that 20% on top of this volume was recovered from stormwater basins and sent to Fresno Irrigation District (FID) canals.

Since the period of record differed from the hydrologic base period, it was adjusted based on Kings River water deliveries. The period of 2007-2017 represented 79% of long-term deliveries, while the hydrologic base period represented nearly 100%. As a result, the stormwater seepage was adjusted to 17,600 AF / 79% = 22,000 AF/year. Based on local rainfall records over the Fresno-Clovis urban areas, it was assumed that about 20% of the local rainfall of 10.7 inches per year (2007 to 2017 average for Fresno State CIMIS Station) percolated through stormwater basins, and 4% was delivered to FID canals. It is assumed that deep percolation of precipitation in landscape and bare soils areas is negligible in urban areas.

Robust urban stormwater recharge values were not available for any other cities in the Kings Basin. Therefore, lacking any better data and based on the discussion above, it is assumed that 20% of rainfall percolates to the groundwater in urban areas.

Local Stream and River Recharge
Stream seepage occurs from three sources: Local Foothill Streams, San Joaquin River and the Kings River.

<u>Local Foothill Streams</u>
There are a number of local streams that drain small foothill watersheds into the Kings subbasin; however, this is mostly in the North Kings GSA and Kings River East GSA and not accounted for in the South Kings GSA water budget.

<u>Kings River</u>
The Kings River is the main source of surface water that runs through the Kings Subbasin. Kings River seepage benefits each of the seven GSAs to a varying degree. KRWA Annual Watermaster Reports documents river losses along designated river reaches on a monthly basis. These comprise all river losses, including seepage, evaporation and riparian diversions. Riparian diversions were estimated as described under Surface Water for Irrigation with an estimated acreage in each GSA. Evaporation was based on the river width, a local reference evapotranspiration rate, and a riparian evapotranspiration constant (0.8). Losses were estimated for each GSA based on the distance the river traverses the GSA. It was assumed that seepage was equal on each side of the river.

Seepage was from the Kings River was accounted for in the Central Kings GSA portion of the water budget for the area, as the SKGSA does not directly front on the Kings River.

3.3.6 Outflows from Groundwater System

Regulation Requirements:

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

The primary outflow from the groundwater body is groundwater pumping, which was estimated for agricultural and M&I purposes as described below.

Groundwater Pumping for Irrigation
Unmetered groundwater pumping is estimated based on crop evapotranspiration and other water budget variables. In groundwater only areas, the groundwater pumping is simply the crop evapotranspiration demand less effective precipitation, divided by an average irrigation efficiency.

When available, irrigation efficiencies were collected from local agency staff or Agricultural Water Management Plans. When no specific data was available, they were estimated based on the general crop types (USBR, 2018). Field crops are assumed to use flood/furrow irrigation and have an efficiency of 70%. Trees and vines are assumed to use drip or micro-spray and have an irrigation efficiency of 85% (Harder, 2017; Davids Engineering, 2018, January).

In areas with surface water and groundwater, the groundwater pumping must be back calculated using numerous water budget variables. In a simple situation, groundwater pumping = crop applied water demands – surface water deliveries. However, surface water deliveries to growers differ from headgate surface water diversions due to system losses and deliveries made for intentional recharge. In these situations, irrigation groundwater pumping is estimated using the following formula:

$$Private\ Irrigation\ Pumping = Crop\ Applied\ Water\ Demands - Surface\ Water\ Deliveries\ to\ Growers$$

where:

$$Surface\ Water\ Deliveries\ to\ Growers = Headgate\ Diversions - System\ Losses - Intentional\ Recharge$$

and

$$System\ Losses = Channel\ Evaporation + Channel\ Seepage + Reservoir\ Evporation + Reservoir\ Seepage + Operational\ Spills$$

As a result, private irrigation pumping can be calculated with the following formula:

$$Private\ Irrigation\ Pumping = \frac{Crop\ Evapotranspiration\ Less\ Effective\ Precipitation}{Irrigation\ Efficiency} - Headgate\ Diversions + Channel\ Evaporation$$
$$+ Channel\ Seepage + Reservoir\ Evaporation + Reservoir\ Seepage$$
$$+ Operational\ Spills + Intentional\ Recharge$$

SKGSA does not have much agricultural land within its boundaries, thus the demand on groundwater for irrigation purposes is low and is accounted for within the pumping records.

Groundwater Pumping for M&I
M&I groundwater pumping by municipal water suppliers was collected directly from the local urban agencies who are responsible for tracking and reporting on a monthly and annual basis, respectively.

Groundwater Outflows
Groundwater outflows were calculated in the same way as inflows. On an average annual basis, it is estimated that Central and South Kings GSAs have approximately 35,400 AF of outflows.

3.3.6.1 Outflows from Basin

Evapotranspiration of Applied Irrigation Water
This variable, also called crop water demands, represents crop evapotranspiration minus effective precipitation. For the historical period, this variable was estimated using DWR Land Use data by County (Fresno – 1994, 2000 and 2009; Kings – 1996 and 2003; Tulare 1999 and 2007) and annual crop evapotranspiration rates from the Department of Water Resources (DWR, 2018b). The land use data for the water budget period was interpolated each year using the DWR data. Land use was assumed to remain constant prior to the first county data and after the last county data and was linearly interpolated between available years of county land use data. The DWR annual crop evapotranspiration rates were available on-line for 20 crops for the years 1998 through 2010. 2011 annual crop evapotranspiration rates were obtained directly from DWR and 1997 was taken to be equivalent to the average of the period 1998 through 2011.

The total crop evapotranspiration rates were generally computed as the product of the interpolated crop acreage for each crop times the annual crop evapotranspiration. The totals by crop were then aggregated to totals for each GSA. In addition to this normal computation, there was an adjustment for the acreage of newly planted orchards, which would not have the same rates as mature orchards. The adjustment for newly planted orchards assumes a four-year annual increase in evapotranspiration, going from 25% of the normal annual evapotranspiration rate in the first year to 100% of the normal rate in year four. In addition to the adjustment for newly planted acreage as represented in the crop acreage data, there was also an assumption that orchards would be replaced on a twenty-year basis which resulted in an additional 6.25% reduction to crop evapotranspiration rates for ongoing orchard acreage.

Evapotranspiration of Applied M&I Water
Evapotranspiration of M&I water primarily includes landscape irrigation demands. It is assumed that all outdoor water use is applied to landscape irrigation. First, the quantity of M&I water used outdoors needs to be determined. When total water deliveries and sewer flows are known, then outdoor water use is simply the difference between the two values. When total pumping or sewer records are not available, then outdoor water use is assumed to be 65% of total water demands. This is based on general experience with other municipalities in the San Joaquin Valley. Local landscape irrigation efficiencies are assumed to be 75% based on efficiencies in other areas of the San Joaquin Valley. Therefore, 75% of outdoor water use is assumed to be consumed through evapotranspiration.

Evapotranspiration of Effective Precipitation

Effective precipitation is the amount of rainfall beneficially used by crops, either directly as transpiration or through storage in the root zone and evapotranspiration in subsequent periods. Annual values of effective precipitation were obtained from DWR's Agricultural Land & Water Use Estimates website (DWR, 2018a). As with annual crop evapotranspiration rates, annual estimates of effective precipitation were available for individual Detailed Analysis Units (DAUs) for the period 1998 through 2010. 2011 estimates were obtained directly from DWR and 1997 was estimated as the average for the period 1998-2011. The unit effective precipitation rates were multiplied by interpolated acreages for the 1997-2011 period as described earlier to develop estimates of overall effective precipitation in the GSA.

Evaporation from Conveyance Channels

Detailed studies estimated channel evaporation and canal bank evapotranspiration (collectively called evaporation losses) to be 0.4% + 0.05% = 0.45% of flows in Consolidated Irrigation District (KRCD, 1993) and 0.75% + 0.25% = 1.0% of flows in Alta Irrigation District (KRWD, 1991). Due to the relatively small volume of water lost due to evaporation, rigorous analyses were not performed for other irrigation/water districts. Rather, channel evaporation losses were assumed to be the average of the two values reported above, or 0.7%.

Evaporation from Reservoirs and Recharge Basins

Long-term evaporation rates were collected from seven California Irrigation Management Information System (CIMIS) stations in and around the Kings Basin. These included Stations No. 2 – Five Points, 15 – Stratford, 39 – Parlier, 80 – Fresno State, 105 – Westlands, 142 – Westlands, 142 – Orange Cove and 190 – Five Points South West. Reservoir and basin evaporation estimates were based on actual evaporation rates during the study period for the closest CIMIS station, or a combination of CIMIS stations. When details were not available on the time of year or length of time waters were in storage, the evaporation rates were assumed to be 4 to 5% of total water supplies.

Evaporation and Runoff of Precipitation

Evaporation and runoff of precipitation are a residual value in the water budget, and were calculated with the following formula:

$$\begin{aligned}&Evalporation\ and\ Runoff\ of\ Precipitaion\\&\qquad = Precipitation - Effective\ Precipitation - Deep\ Percolation\ of\ Precipitation\end{aligned}$$

This represents a non-recoverable loss that does not impact either water supplies or demands.

Operational Spills

This represent spills of surface water outside of an irrigation or water district and is considered a non-recoverable loss to that district. They are based on measured spills, or estimates provided by the district. If the spills were unknown, and believed to be small, they were assumed to be zero.

Groundwater Exports

This represents the export of groundwater from one agency into another. It is based on metered well pumping. It can occur from water transfers, exchanges, banking agreements, or groundwater deeds. Groundwater exports by landowners that own adjacent properties on an agency boundary (one in the agency and one just outside) were neglected, as they are assumed to be minor and tend to balance each other out.

3.3.7 Change in Groundwater Storage

Regulation Requirements:

§354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:
4) The change in the annual volume of groundwater in storage between seasonal high conditions.
6) The water year type associated with the annual supply, demand, and change in groundwater stored.

3.3.7.1 Unconfined Groundwater Storage Change

Water storage change in the unconfined aquifer for the 1997-2011 hydrologic period was estimated based on measured groundwater levels. Water surface elevation contour maps were generated for Spring 1997 and Spring 2012 based on the available data from more than 900 wells within the Kings Subbasin. In preparing the contour maps, well levels that appeared inconsistent with the majority of other wells in an area were not used. Wells with significantly different water levels could be erroneous or anomalous because they are: 1) composite wells pumping from two or more aquifers; 2) confined wells pumping from below the Corcoran Clay; 3) or for other reasons included errors in the data.

Specific yield is defined as the ratio of the volume of water that a given mass of saturated rock or soil will yield by gravity to the volume of that mass. Specific yield is represented as a percentage. Groundwater storage change can be estimated by multiplying the change in groundwater level by the specific yield. Specific yield values for use in the storage change calculation were estimated from USGS reports and other sources as documented in P&P Technical Memorandum #2 (TM2) (P&P, 2018a). Specific yield values also vary by depth and TM2 describes unique values at depth zones from 0'-50', 50'-100', 100'-200' and 200'-300'. The storage change was estimated based on the water above 300' below the groundwater surface.

Groundwater storage change for the range of years was computed using the procedure documented in P&P Technical Memorandum #4 (P&P, 2018b). The estimated change in unconfined groundwater storage in South and Central Kings GSAs was about 17,000 AF/year during the historical period.

The change in storage in the confined in aquifer was not calculated due to lack of sufficient data, and because of the connection between the confined and unconfined aquifer. Muir (1977) states that "*Water removed from storage in the confined part of the aquifer is replaced by subsurface inflow from the unconfined part of the aquifer*." In other words, when water is pumped from the confined aquifer, it induces flow from the unconfined to the confined aquifer. As a result, confined aquifer pumping directly impact groundwater levels in the unconfined aquifer.

3.3.7.2 Groundwater Released from Aquifer Compaction

Water release from aquitard compaction occurs when clay soils in confined aquifers collapse during land subsidence caused by groundwater over-pumping. This essentially squeezes water out of the clay and creates a new one-time water source that would otherwise not be available. Hence, the water is mined from the clay layers. It is assumed that a 1-foot drop in land subsidence results in an equivalent 1-foot of new groundwater supply from the confined aquifer.

Available data indicates that land subsidence has been minimal in SKGSA. Therefore, there has been no measurable groundwater release from aquitard compaction.

3.3.8 Historical Water Budget

Regulation Requirements:

§354.18

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

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

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

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

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

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

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

A historical water budget was prepared for the entire Kings Basin and for Central/South Kings GSA (combined). The water budget covers the hydrologically average period of 1997-2011 (see **Section 3.3.2** for discussions on the selection of this period). The water budget includes average-annual values over the entire period; hence a single water budget is presented rather than one showing values for each year from 1997-2011. An average-annual water budget is considered the most practical representation of the data.

Kings Basin Water Budget

Table 3-4 shows a water budget for the Kings Subbasin as a whole along with the equivalent individual water budgets for the seven GSAs within the Kings Subbasin. The water budget for Central Kings GSA and South Kings GSA were combined into a single water budget. The inflows and outflows to the groundwater basin are used to estimate the change in groundwater storage based on the water budget components (Method 1), and this estimated change in storage is compared to the calculated change in groundwater storage from the groundwater level data (Method 2).

Table 3-4: Kings Basin Historical Water Budget

Description	Total	McMulllin GSA	NFKings GSA	North Kings GSA	Central/South GSA	Kings River East GSA	James ID GSA
Total Supply	3,532,000	379,500	616,200	1,167200	614,700	666,400	88,000
Consumptive Subtotal	2,080,900	277,500	399,100	544,500	358,000	428,200	73,600
GW Recharge Subtotal	1,362,300	239,800	202,300	460,900	216,100	210,200	33,000
Nonrecoverable Subtotal	656,900	50,400	65,500	325,000	110,400	79,700	25,900
Method 1							
Estimated Annual Change in GW Storage	-193,000	-61,600	-91,500	-6,500	-10,500	-18,500	-4,400
GW Recharge	1,362,300	239,800	202,300	460,900	216,100	210,200	33,000
GW Pumping	-1,334,700	-282,900	-277,600	-345,400	-191,200	-222,000	-15,600
GW Outflow	-220,600	-18,500	-16,200	-122,000	-35,400	-6,700	-21,800
Method 2							
Calculated Annual Change in GW Storage (unconfined and confined)	-134,000	-18,000	-59,000	-24,000	-17,000	-11,000	-5,000

As shown in **Table 3-4**, the water budget for the Subbasin indicates an annual decline in groundwater storage of 193,100 AF (Method 1), which is about 59,000 AF higher than the estimate of 134,000 AF based on groundwater levels (Method 2). While not exactly matching, the two estimates are considered to be satisfactory considering the uncertainty involved in both estimates. The difference in groundwater storage change estimate of 59,000 AF is less than 3% of the estimate of Evapotranspiration of Applied Water, which typically is considered to have a range of uncertainty of 10-15%. The estimate of groundwater storage change interpreted directly from measured water levels is itself subject to uncertainty of potentially 10-20%. Other components of the water budget are also subject to uncertainty, making the remaining residual difference between the water budget and the direct "measurement" of groundwater storage change sufficient considering the currently available data. Generally, the estimated change in storage from groundwater levels (Method 2: 134,000 AF/year) is considered the more accurate value. The water budget helped to validate this number.

Central and South Kings GSAs Historical Water Budget

The detailed historical water budget for Central and South Kings GSA is shown in **Table 3-5.** Water Budgets were developed for normal, wet and dry year scenarios. The wet and dry year water budgets are similar to the normal year water budgets, with changes made for precipitation and surface water supplies. The normal year water budget reflects average conditions and is used for long-term planning. The wet and dry year water budgets essentially show bookend conditions, including significant overdraft in dry years and water surpluses in wet years.

An important component of the historical water budget is groundwater outflow to McMullin GSA and North Fork Kings GSA. Through coordinated meetings with all of the GSAs, it was determined that groundwater pumping and lack of surface water in McMullin GSA has induced additional groundwater flow out of CKGSA. Recent flows were compared to historical flows from the 1920s before there was considerable development. This induced flow shows up in the historical water budget but is removed in the future water budget, discussed later, since McMullin GSA is expected to mitigate these groundwater flows through water supply and demand reduction projects.

Table 3-5: Average Annual Historic Water Budget for Central and South Kings (WY 1997-2011)

Description		Volume (AF)		
Supply		Average WY	Wet WY	Dry WY
1)	Surface Water for Irrigation and Recharge	281,900	476,400	95,600
2)	Surface Water for M&I	0	0	0
3)	Groundwater Pumping for Irrigation (Private Wells, calculated/estimated)	0	0	0
4)	Groundwater Pumping for Irrigation (Private Wells, unknown)	158,000	5,000	288,900
5)	Groundwater Pumping for M&I (South Kings)	14,200	14,200	14,200
6)	Groundwater Pumping for M&I (Central Kings)	19,000	19,000	19,000
7)	Precipitation	141,600	208,400	109,100
8)	Spill Inflows	0	0	0
9)	Other Supply:	0	0	0
	Total Supply	**614,700**	**723,000**	**526,800**
Demand				
Consumptive Use				
10)	Evapotranspiration met by Applied Water	287,300	246,700	303,000
11)	Evapotranspiration met by Effective Precipitation	54,500	95,100	38,800
12)	Evapotranspiration of M&I	16,200	16,200	16,200
13)	Other Consumptive Use:	0	0	0
	Consumptive Subtotal	**358,000**	**358,000**	**358,000**
Groundwater Recharge				
14)	Groundwater Inflow	400	400	400
15)	Deep Percolation of Irrigation Water	54,500	46,800	57,500
16)	Deep Percolation of Precipitation	14,800	45,900	1,300
17)	Deep Percolation of M&I Water	10,600	10,600	10,600
18)	Seepage of Channels & Pipelines	72,700	115,800	23,200
19)	Seepage - Reservoirs	0	0	0
20)	Urban Stormwater - Recharge	2,000	3,100	1,700
21)	Local Streams/Rivers - Recharge	31,200	53,800	29,400
22)	Groundwater - Intentional Recharge	22,700	67,100	0
23)	Other Recharge:	7,200	7,200	7,200
	GW Recharge Subtotal	**216,100**	**350,700**	**131,300**
Nonrecoverable Losses				
24)	Groundwater - Outflow	35,400	35,400	35,400
25)	Evaporation - Channels	1,400	2,400	500
26)	Evaporation - Reservoirs & Recharge Basins	1,300	2,600	300
27)	Precipitation - Evaporation and Runoff	72,300	67,400	69,000
28)	Operational Spills	0	0	0
29)	Groundwater - Export	0	0	0
30)	Other Losses:	0	0	0
	Nonrecoverable Subtotal	**110,400**	**107,800**	**105,200**
Method 1				
	Estimated Annual Change in Groundwater Storage	**(10,500)**	**277,100**	**(226,200)**
	GW Recharge - #14 thru #23	216,100	350,700	131,300
	GW Pumping - #3 thru #6	(191,200)	(38,200)	(322,100)
	GW Outflow - #24 and #29	(35,400)	(35,400)	(35,400)
	Calculated Annual Change in Groundwater Storage	**(17,000)**		

On an average annual basis, the combined water budget for CKGSA and SKGSA shows an overdraft of approximately 10,500 AF, while the calculated average annual value for overdraft is approximately 17,000 AF. Historically, water year type has a direct effect on groundwater overdraft on a year-to-year basis. If it is a dry water year and expected surface supplies do not arrive, dependence on groundwater resources will increase. Extremely wet years have the opposite effect. More surface supplies mean less dependence on groundwater; however, infrastructure is not available to reach every parcel of land throughout the Central Kings GSA. Groundwater is still necessary even in wet years for those not located near CID canals.

Uncertainty in Water Budgets

There is considerable uncertainty in many of the water budget parameters. The parameters with the least uncertainty, estimated as plus or minus 5%, are limited to surface water diversions which are directly measured. Most other water budget parameters are indirectly estimated. For example, precipitation is estimated based on a limited number of sparsely distributed precipitation stations. Water budget parameters using precipitation (such as effective precipitation) start with the uncertainty of the precipitation value itself, which is increased by the need to estimate crop evapotranspiration, soil moisture storage and movement through the soil surface to provide recharge. The largest single component of water use, evapotranspiration of applied water, is estimated to have an accuracy of plus or minus 15%, with uncertainty resulting from infrequent surveys of cropping patterns, indirect estimates of unit evapotranspiration rates for crop types, and variations in agricultural management practices that result in variations in unit crop water use.

For the historical period, the estimated annual change in groundwater storage was 6,500 AF based on the water budget, which differs from the "direct" estimate of groundwater storage change of 24,000 AF. The "direct" estimate of groundwater storage change is based on specific yield estimates and water levels from groundwater contour maps. There is some uncertainty in the specific yields used for this estimate and water level changes map be questionable on a year to year basis. However, over a 15-year period like WY 1997-2011, the total change in groundwater levels should be relatively definite. With improved data collection, it is expected that this discrepancy could reduce over time and result in specific future refinements to the water budgets that achieve the same outcome. The water budget (including the historical, current and future versions) should therefore be considered an approximate model for the hydrologic system, and the values should be used as guides rather than precise values.

3.3.9 Current Water Budget

Regulation Requirements:

§354.18

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

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

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

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

A Current Water Budget was prepared for the GSA based on the following criteria:

- Urban water demands were based on the average demands for 2016 and 2017. These represent a dry year and wet year, respectively. This period was selected since it best represented both current and average conditions. No recent single year was considered a better representation of current hydrology than these two years.
- Agricultural demands were based on 2014 DWR land use maps, which are the most recent comprehensive land use maps for the area.
- Surface water supplies were based on the long-term average supplies from the historical water budget, and not the actual supplies delivered in 2016 and 2017.

- Other variables not described above were assumed to be the same as the historical water budget.

The Current Water Budget including Wet and Dry Year water budgets, with variations in surface water supplies and precipitation based on the year type, are shown in **Table 3-6**. Overall, the water budget shows improved conditions over the historical conditions, for the following reasons:

- Increased surface water treatment by urban agencies
- Conservation measures during the drought which was still present in 2016
- Drought conservation measures were still in-place or still part of water user culture in 2017
- Implementation of water metering in some urban areas
- Reduction in groundwater pumping
- Reduction in cropping demand, as indicated with 2014 land use maps

The current water budget is a short snapshot of water conditions and not considered as accurate as a long-term average water budget. The water budget was not compared to changes in groundwater levels since it would be inaccurate due to time lags from various forms of recharge, and inaccuracies that tend to balance out over longer time periods. Lastly, some of the measures, such as water conservation, may not persist long-term. Nevertheless, this water budget is still the best representation of current water budget conditions available.

Table 3-6: Current Water Budget for Central and South Kings (WY 2016-2017)

Description		Volume (AF)		
Supply		Average WY	Wet WY	Dry WY
1)	Surface Water for Irrigation and Recharge	281,900	469,900	89,100
2)	Surface Water for M&I	0	0	0
3)	Groundwater Pumping for Irrigation (Private Wells, calculated/estimated)	0	0	0
4)	Groundwater Pumping for Irrigation (Private Wells, unknown)	149,800	4,800	285,500
5)	Groundwater Pumping for M&I (South Kings)	12,000	12,000	12,000
6)	Groundwater Pumping for M&I (Central Kings)	19,600	19,600	19,600
7)	Precipitation	141,600	208,400	109,100
8)	Spill Inflows	0	0	0
9)	Other Supply:	0	0	0
	Total Supply	**604,900**	**714,700**	**515,300**
Demand				
Consumptive Use				
10)	Evapotranspiration met by Applied Water	280,400	239,800	296,100
11)	Evapotranspiration met by Effective Precipitation	54,500	95,100	38,800
12)	Evapotranspiration of M&I	15,400	15,400	15,400
13)	Other Consumptive Use:	0	0	0
	Consumptive Subtotal	**350,300**	**350,300**	**350,300**
Groundwater Recharge				
14)	Groundwater Inflow	400	400	400
15)	Deep Percolation of Irrigation Water	53,200	45,500	56,100
16)	Deep Percolation of Precipitation	16,000	45,900	1,300
17)	Deep Percolation of M&I Water	10,200	10,200	10,200
18)	Seepage of Channels & Pipelines	72,700	114,200	21,700
19)	Seepage - Reservoirs	0	0	0
20)	Urban Stormwater - Recharge	2,000	3,100	1,700
21)	Local Streams/Rivers - Recharge	31,200	53,800	29,400
22)	Groundwater - Intentional Recharge	22,700	70,300	0
23)	Other Recharge:	7,300	7,300	7,300
	GW Recharge Subtotal	**215,700**	**350,700**	**128,100**
Nonrecoverable Losses				
24)	Groundwater - Outflow	35,400	35,400	35,400
25)	Evaporation - Channels	1,400	2,300	400
26)	Evaporation - Reservoirs & Recharge Basins	1,300	2,600	300
27)	Precipitation - Evaporation and Runoff	71,100	67,400	69,000
28)	Operational Spills	0	0	0
29)	Groundwater - Export	0	0	0
30)	Other Losses:	0	0	0
	Nonrecoverable Subtotal	**109,200**	**107,700**	**105,100**
Method 1				
	Estimated Annual Change in Groundwater Storage	**(1,100)**	**278,900**	**(224,400)**
	GW Recharge - #14 thru #23	215,700	350,700	128,100
	GW Pumping - #3 thru #6	(181,400)	(36,400)	(317,100)
	GW Outflow - #24 and #29	(35,400)	(35,400)	(35,400)

3.3.10 Projected Water Budget

Regulation Requirements:

§354.18

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

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

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

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

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

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

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

Projected water budgets (future water budgets) have been developed for 2040 and 2070. The 2040 water budget is the focus of this analysis as it represents near term periods and requires less speculative estimates of projected future climate change impacts, population growth and land use change.

Projected water budgets are based initially on the Current water budget, with changes made to various variables, as shown in Figure 3-42 below.

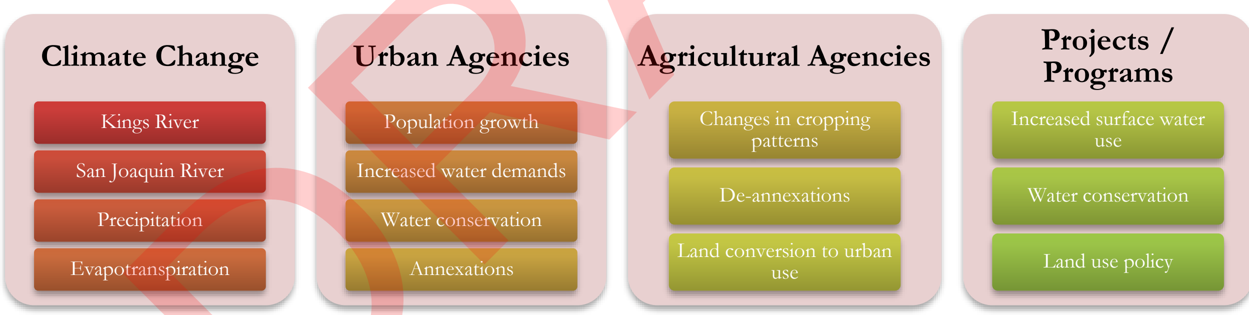


Figure 3-42: Variables Impacting Projected Water Budget

Climate Change

Climate change impacts were based on *Guidance for Climate Change Data Use during Groundwater Sustainability Plan Development* and the related SGMA climate change website (DWR, 2018c). This document provided estimates for 2030 and 2070. Since 2040 is the deadline for sustainability, and therefore the focus of the water budgets, impacts from 2040 were interpolated between the 2030 and 2070 results.

The DWR climate change datasets were developed for the California Water Commission's Water Storage Investment Program (WSIP). As described by DWR, the WSIP dataset is consistent with other DWR programs, is based on best available science, builds on previous efforts, incorporates the latest advances in projections, and follows Climate Change Technical Advisory Group guidance. The available datasets include central tendency projections of ensembles of general circulation models for 2030 and 2070 levels. The datasets also include climatic bookends for 2070 conditions, with a drier, extreme warming scenario and a wetter, moderate warming scenario being provided. Only the central tendency simulations were used for preparing water budgets for the Kings Subbasin.

For the Kings Subbasin, three DWR datasets were used – projected Kings River inflows to Pine Flat Dam, projected precipitation in the Kings Subbasin and projected evapotranspiration. Kings River inflows for early future and late future conditions were analyzed based on the WSIP water supply projections. As shown in **Figure 3-43**, the central tendency projections for both 2030 and 2070 show a slight increase in projected Kings River inflows; however, there was a major shift in the timing of runoff. The simple interpretation of this shift is that predicted warmer temperatures in the future will result in more precipitation in the Sierra Nevadas occurring as rainfall and less as snowfall. Additionally, warmer temperatures mean that snowfall will tend to melt earlier that it would have melted historically.

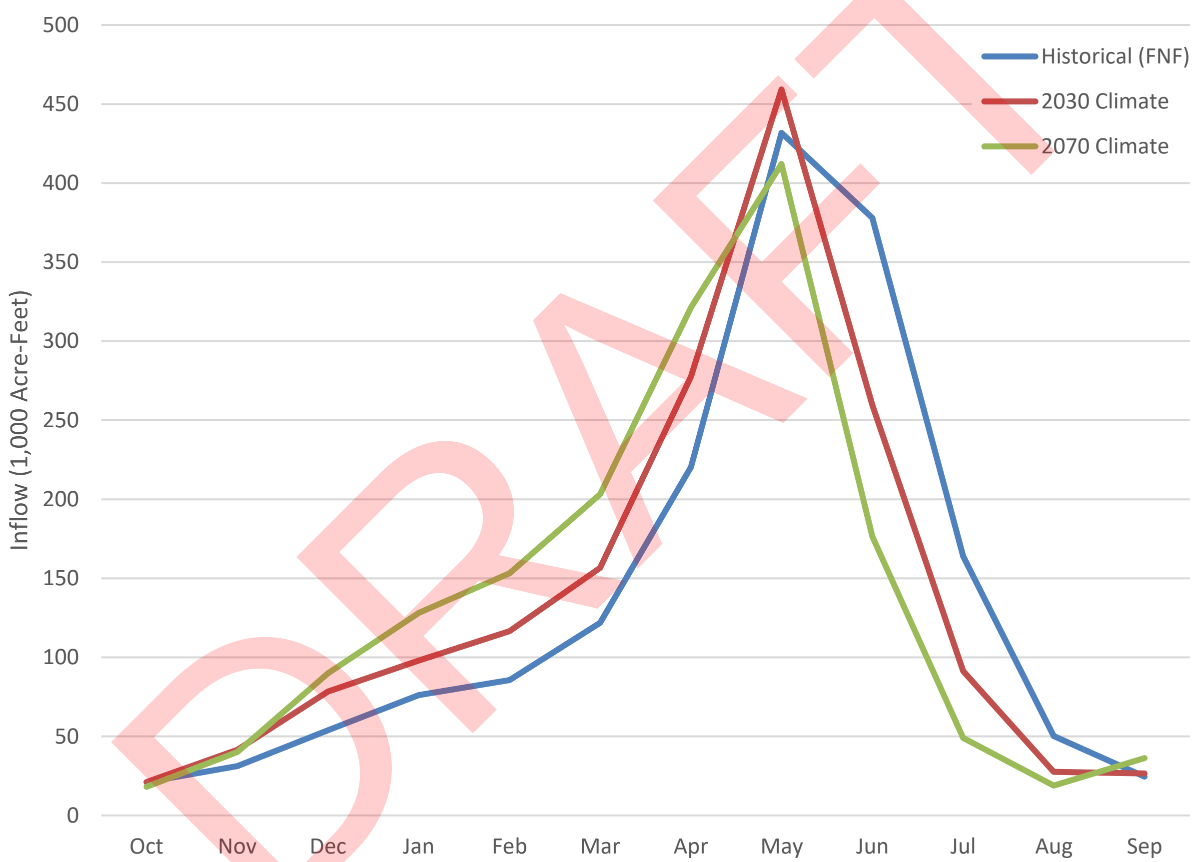


Figure 3-43: Projected Kings River Inflow by Month

As noted earlier, the overall change in predicted Kings River inflows is a very slight increase. Inflows increased about 0.7% between historical and early future (2030) conditions and increased 0.3% between historical and late future (2070) conditions. However, there were some major shifts in timing of runoff, with large drops in runoff occurring in the late spring/early summer months of June, July and August. Runoff during winter months tended to increase significantly for winter and early spring months. While the overall change in runoff is essentially negligible, there would be significant changes in water management based on the change in runoff patterns. Historically, significant amounts of Kings River runoff occurred during the irrigation season when inflows could be directly used for water deliveries without needing storage. In the future more of this runoff will now occur during non-irrigation or low-irrigation months. Maintaining the same level of water supply from the Kings River in the future will require modifications in water management practices including increased use of surface water storage, increased recharge during the non-irrigation and low-irrigation periods, and expansion of diversion facilities to accommodate higher peak flows in non-irrigation and low-irrigation periods. In addition to management changes by local water agencies, maintaining historical surface water supplies will also be affected by water rights allocations, which assign available water to local water agencies on defined schedules that vary by period.

Quantification of the impacts of predicted Kings River inflows on surface water supplies would require a sophisticated, theoretical operations model that considers inflow availability, water rights and management practices by local water agencies. No such operations model is available and development of such a model was not feasible during preparation of the current GSPs. Additionally, water management on the Kings River is based on numerous factors in addition to those that could be incorporated into a monthly operations model such as operational availability of facilities, cropping patterns, daily water supply allocations, availability of recharge facilities, management practices and other factors. It is expected that future SGMA analyses will continue to consider the potential quantification of future water supply, however there is no certainty that such an analysis will be pursued or would improve predictive capability even if it was available.

Based on the uncertainty described above, the assumption was made that Kings River water supplies available to the Kings Subbasin water supplies will be managed in the future to maintain historical levels of water supplies. This assumption is based on the slight overall increase in runoff, flexibility of existing water management to absorb changed timing of inflows and projected changes in the timing of irrigation demands corresponding to warming. For the Central Kings GSA, the historical values described earlier will be used for both the early future and late future conditions.

The WSIP climate change datasets provided by DWR were also reviewed for precipitation and evapotranspiration conditions. For precipitation, the datasets generally showed minimal overall changes (**Figure 3-44**).

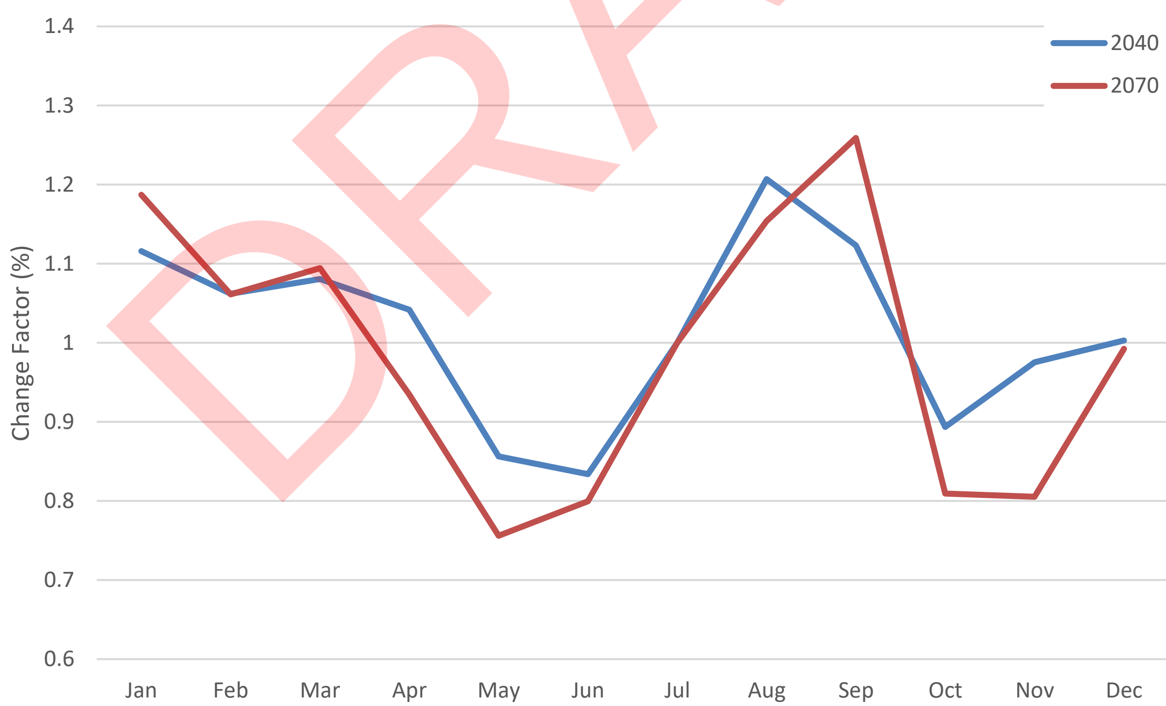


Figure 3-44: Central and South Kings GSA Precipitation Climate Change Adjustment Factors

Overall, the precipitation change factors were projected to increase by 1.6% for early future (2040) conditions and to decrease by 1.2% for late future (2070) conditions. Moreover, the average monthly adjustment factors understate the effect on precipitation, as many of the months with projected decreases in precipitation (e.g., May, June and October) are low precipitation months while months indicated increased precipitation tend to be wetter (e.g., January and February). Adjusting for monthly average precipitation, the total volume of precipitation for CKGSA and SKGSA is estimated to increase by 4% for early future and 2% for late future conditions. Given the generally low amount of precipitation in the Kings Subbasin and the slight increased projected with climate change, a conservative assumption has been made that projected rainfall, and amounts available for water supply such as effective precipitation and recharge from precipitation, will remain the same for early future and late future projection as estimated for the historical period.

Shown in **Figure 3-45**, the WSIP climate change projections provided by DWR project consistently higher evapotranspiration rates for early future and late future conditions. For early future (2040) conditions, the projected adjustments indicate an average increase of 4.4%, with very little variation by month on average. For late future (2070) conditions, the projected adjustments indicate an average increase of 8.2%. Although the late future projections show more variation by month, the outlier (higher) rates are in relatively low evapotranspiration months (e.g., November, December and January) and relatively consistent during the irrigation season (April through September).

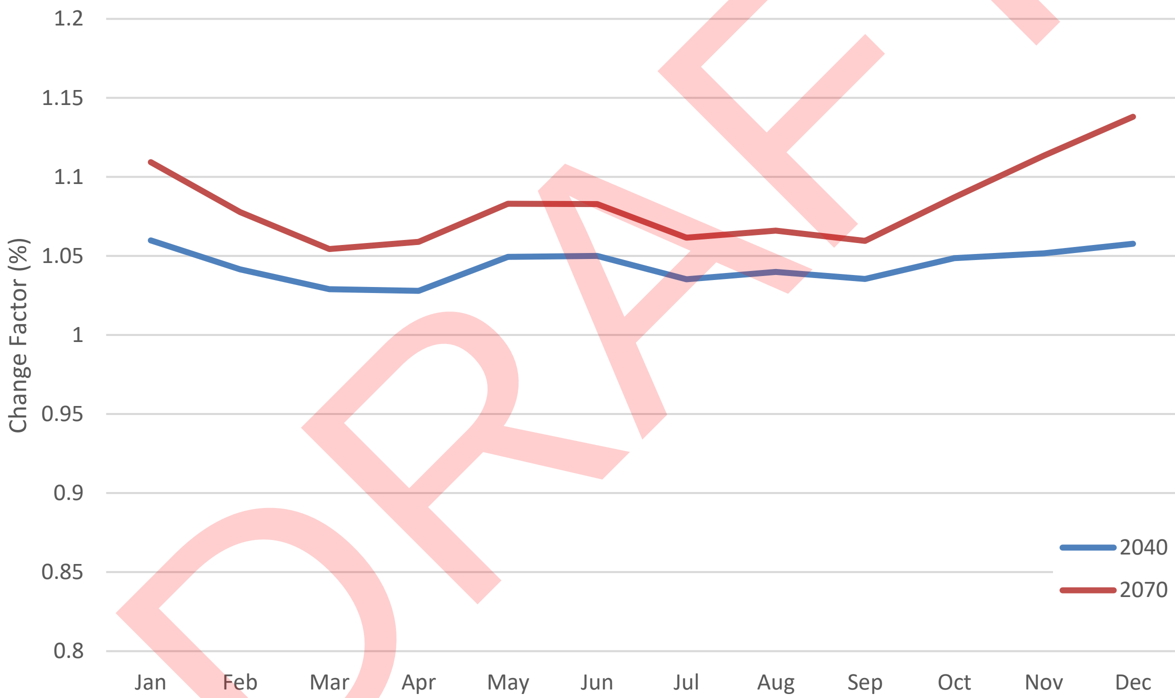


Figure 3-45: Central and South Kings GSA ET Climate Change Adjustment Factors

The effect of projected increased evapotranspiration rates on irrigated water use were reviewed, with reference to the U.S Bureau of Reclamation report on effects of climate change as follows:

> "Annual crop ET is projected to increase for perennial crops, with smaller increases, and sometimes slight decreases, for annual crops. Perennial crop ET increases are due to longer growing seasons and increases in ETo. While annual crops also experience increased ET rates, earlier potential planting dates and reduced growing season due to increased temperatures and crop development sometimes result in decreased annual crop ET." (USBR, 2018)

For the Kings subbasin, evapotranspiration adjustment factors were applied based on the documentation in the USBR report. For annual crops, unit water use was left at rates identified in the historical period. For perennial crops, unit water use was increased corresponding to the increasing projected for the early future and late future WSIP projections.

Future water use for municipal areas has been updated based on projected population rates and updated per capita water use. Where available, Urban Water Management Plans have been used as the source of population projections and per capita water use rates. Projected municipal populations for smaller urban areas are taken from available State of California projections for counties. The ratios of indoor use, outdoor use and resulting recharge were left as developed for the historical period.

Projected 2040 Water Budget

The projected water budget for 2040 is shown in **Table 3-7**. The 2040 water budget includes the aforementioned impacts from climate change (crop evapotranspiration and San Joaquin River supplies), and estimated demand changes provided by the water agencies.

Note, the estimate in annual groundwater storage change does not account for projects and demand reduction by management actions. **Section 4** explains the Sustainable Management Criteria and sets interim goals to keep track of progress. A phased mitigation approach to achieving sustainability is proposed for the Kings Subbasin, including the following:

- 10% of the overdraft addressed during the first 5-year period, then
- 20% during the next five-year period for a total 30% of the overdraft addressed during the first 10 years, then
- 30% during the next five-year period for a total 60% of the overdraft addressed within the first 15 years, then the remaining 40% during the last five-year period to achieve 100% of the overdraft addressed during the 20-year implementation period.

Note that these are minimum goals and progress may be faster than described. Projects and Management Actions are being developed to achieve sustainability within the SKGSA as explained in **Section 6**. The initial focus will be on project development, with management actions implemented as needed to meet the identified interim milestones.

Table 3-7: Future Conditions Water Budget for Central and South Kings GSAs (2040)

Description		Volume (AF)		
Supply		Average Year	Wet Year	Dry Year
1)	Surface Water for Irrigation and Recharge	281,900	469,851	89,104
2)	Surface Water for M&I	0	0	0
3)	Groundwater Pumping for Irrigation (Private Wells, calculated/estimated)	0	0	0
4)	Groundwater Pumping for Irrigation (Private Wells, unknown)	159,300	11,500	303,000
5)	Groundwater Pumping for M&I (South Kings)	18,700	18,700	18,700
6)	Groundwater Pumping for M&I (Central Kings)	21,200	21,200	21,200
7)	Precipitation	145,900	208,400	109,100
8)	Spill Inflows	0	0	0
9)	Other Supply:	0	0	0
	Total Supply	**627,000**	**729,651**	**541,104**
Demand				
Consumptive Use				
10)	Evapotranspiration met by Applied Water	289,100	254,500	310,800
11)	Evapotranspiration met by Effective Precipitation	54,500	95,100	38,800
12)	Evapotranspiration of M&I	19,400	19,400	19,400
13)	Other Consumptive Use:	0	0	0
	Consumptive Subtotal	**363,000**	**369,000**	**369,000**
Groundwater Recharge				
14)	Groundwater Inflow	400	400	400
15)	Deep Percolation of Irrigation Water	56,000	48,300	58,900
16)	Deep Percolation of Precipitation	16,000	45,900	1,300
17)	Deep Percolation of M&I Water	12,000	12,000	12,000
18)	Seepage of Channels & Pipelines	72,700	114,200	21,700
19)	Seepage - Reservoirs	0	0	0
20)	Urban Stormwater - Recharge	2,100	3,100	1,700
21)	Local Streams/Rivers - Recharge	31,200	53,800	29,400
22)	Groundwater - Intentional Recharge	20,700	59,500	0
23)	Other Recharge:	8,400	8,400	8,400
	GW Recharge Subtotal	**219,500**	**345,600**	**133,800**
Nonrecoverable Losses				
24)	Groundwater - Outflow	35,400	35,400	35,400
25)	Evaporation - Channels	1,400	2,300	400
26)	Evaporation - Reservoirs & Recharge Basins	1,300	2,600	300
27)	Precipitation - Evaporation and Runoff	75,400	67,400	69,000
28)	Operational Spills	0	0	0
29)	Groundwater - Export	0	0	0
30)	Other Losses:	0	0	0
	Nonrecoverable Subtotal	**113,500**	**107,700**	**105,100**
Method 1				
	Estimated Annual Change in Groundwater Storage	**(15,100)**	**258,800**	**(244,500)**
	GW Recharge - #14 thru #23	219,500	345,600	133,800
	GW Pumping - #3 thru #6	(199,200)	(51,400)	(342,900)
	GW Outflow - #24 and #29	(35,400)	(35,400)	(35,400)

Projected 2070 Water Budget

A projected water budgets for 2070 conditions was also prepared using the following criteria:

- Crop evapotranspiration rates increased by 8% over current levels. This results in an overall increase in demands of 13,700 AF above 2040 levels, all of which must be met with groundwater supplies.
- No changes were made to precipitation or Kings River supplies (similar to the 2040 water budget)
- No changes were made to urban water demands. The year 2070 is beyond a practical planning horizon for most urban water agencies and little data was available for estimated demands in 2070. Some agencies may even reach buildout before 2040. In the area, urban growth typically takes over irrigated farmland. While the two use different quantities of water, only the difference in water usage is relevant, so growth impacts may be moderate. These assumptions will be re-addressed in future GSP updates.

Table 3-8 summarizes the impacts to groundwater storage from climate change impacts in 2070

Table 3-8: South and Central Kings GSA 2070 Groundwater Storage Change

Description	Volume (AF)
Groundwater Storage Change (2040)	-15,100
Climate Change Impacts (2040 to 2070)	-13,700
Groundwater Storage Change (2070)	-28,800

While the local water agencies do not generally plan projects or funding 50 years in advance, the 2070 water budget does provide useful insight into potential challenges. As 2070 approaches, and the true impacts of climate change are better understood, this water budget will be modified and updated.

3.3.11 Quantification of Overdraft

Regulation Requirements:

§354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:
(5) If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.

DWR Bulletin 118 defines the Kings Subbasin as being subject to critical overdraft. The existence of overdraft in the Kings Subbasin is documented by historical decline in groundwater levels and is confirmed by the historical water budget presented previously. The historical water budget for the period of Water Year 1996-97 through 2010-11 represents an average hydrological period on the Kings River. The estimated annual decline in groundwater storage for the Central and South Kings GSAs during this period, as “directly” estimated based on groundwater levels, specific yields and measured groundwater subsidence, is 17,000 AF/year. This result was corroborated by the computed water budget, which identified an estimated annual groundwater storage decrease of 10,500 AF/year. As described earlier, the level of uncertainty for components of the water budget is such that the two estimated changes in groundwater storage (17,000 AF and 10,5000 AF) are substantially similar when considering computational uncertainty. The value estimated based on groundwater contours is considered the more accurate values, since it was based primarily on measured data, whereas the water budget contains numerous assumptions and estimates. However, the two values are reasonably similar, thus helping to validate the estimate of 17,000 AF/year.

SKGSA and CKGSA determined the overdraft responsibility for each of the GSAs by estimating their Groundwater Impact, which is essentially their groundwater pumping minus any natural and artificial forms of recharge. Based on these discussions, an agreement was drafted for SKGSA to account for approximately 42 percent of their groundwater extraction in recharge projects or through purchasing water from CKGSA. The SKGSA anticipates recharging an annual average of approximately 8,000 AF, based on population projections through 2040. As the member agencies grow and water use changes, that number may change and will increase after 2040.

3.3.12 Water Year Type Associated with Water Budget Comparisons

Regulation Requirements:

§354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:
6) The water year type associated with the annual supply, demand, and change in groundwater stored.

Water year types were identified for the Kings Subbasin based on Kings River diversions, since the Kings River is the largest source of water supply to the Subbasin. Water types were identified for Wet, Normal and Dry Years, with Wet Years occurring when diversions are more than 125% of normal and Dry Years occurring when diversions are less than 75% of normal. In the 15-year Historical period of WY 1997-2011, there were four wet years, three dry years and eight normal years. The water year type for each year is shown in **Table 3-2**.

3.3.13 Estimate of Sustainable Yield for the Basin

Regulation Requirements:

§354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:
7)An estimate of sustainable yield for the basin.

The 'sustainable yield' is defined as the amount of groundwater pumping that can occur while maintaining groundwater at sustainable levels and avoiding undesirable results. The sustainable yield can be estimated as the Total Groundwater Recharge (from natural and artificial sources) minus the Groundwater Outflow. Using the Current Kings Basin Water Budget (**Table 3-6**), the sustainable yield is estimated to be:

1,360,000 AF – 220,000 AF = **1,140,000 AF/year**

Note: Values are rounded to the nearest 10,000 AF

Due to the numerous uncertainties, assumptions and estimates in the water budgets, the sustainable yield is considered approximate in nature, but gives a good general idea of the groundwater available. This sustainable yield value is based on long-term average supplies under current demand and development conditions. The sustainable yield can, and will likely, change over time due to increased surface usage, increases in demands, and climate change impacts. As a result, the sustainable yield may go up or down over time.

It should be noted that this is a basin-wide sustainable yield, and this value cannot be used to estimate sustainable yield in local areas. The effective sustainable yield on a per acre basis will be different for each GSA and may also vary in different parts of a GSA.

3.4 Water Supply Availability for Augmentation

A number of management actions and projects are described in **Section 6** of this GSP. The potential projects presented there have a surface water supply that was identified as being the most likely to be available. Each of the current projects described in **Section 6** identifies the water supplies that could be available to the project, and the historical water supply availability of the various identified water sources is discussed below. Due to the location of the projects, only certain surface water supplies might be available for a particular project. This section describes the water supplies currently identified as being available for potential projects in the Kings Subbasin.

3.4.1 Water Rights

In California, a system of permits, licenses, and registrations give the right to beneficially use reasonable amounts of surface water within a specific area or Place of Use. Based on the location of SKGSA, it is located within the Place of Use for the USBR Central Valley Project (CVP) and the majority of the GSA is located within the Place of Use for the Kings River, called the Kings River Service Area. The Kings River is the primary water source for the GSA and is deemed fully appropriated upstream of Mendota Dam according to the California Division of Water Rights. However, appropriated Kings River pre-1914 water rights available to member units could be delivered to areas outside the Kings River service area since pre-1914 supplies are not limited to a specific Place of Use. In addition to Kings River water, entities could purchase surface water supplies from the CVP and use it for beneficial uses within the GSA after going through the various regulatory and environmental processes for a water transfer when there is a willing seller.

3.4.2 Kings River Supplies

Appropriation of Kings River flows for irrigation and other uses dates back to before California was admitted as a state. Local irrigation/water districts and agricultural entities hold riparian and pre-1914 appropriative rights to the historic flows of the Kings River. These entities formed the Kings River Water Association (KRWA) in 1927 and KRWA oversees Kings River entitlements and water deliveries. There are 28 member agencies (or "units" as they are known) of the KRWA, which as the name implies, is a private unincorporated association. All member units are public districts or private water companies, which collectively serve nearly 20,000 central San Joaquin Valley farms, covering an area of approximately 1.1 million acres of highly productive farmland. The member agencies party to this GSP are not one of the member units of the KRWA; however, the CID is a member unit and as discussed later in this GSP, the SKGSA has negotiated to purchase surface water supplies from the CID.

Like most Sierra Mountain rivers, runoff on the Kings River primarily occurs during the period of April through July. The amount of unimpaired Kings River runoff is referred to as “Pre-Project Piedra”, which is the calculated natural daily average discharge of the Kings River at Piedra (just downstream of Pine Flat dam) as it would have occurred without interference by any upstream reservoir operations.

The Kings River is prone to highly variable annual runoff that directly relates to mountain precipitation and winter snowpack. The average annual runoff of the Kings River is approximately 1.7 million acre-feet, ranging from a high of 4,476,400 acre-feet in water year 1982-83 (265% of average) to a low of 361,000 acre-feet in water year 2014-15 (21% of average).

Storage in Pine Flat Reservoir helps regulate this fluctuation, but the hydrology of the Kings River has produced flood years, on average, about once every three years. However, several flood years often occur in sequence, with significant below-average water years in between those high flow years. The graph shown below as **Figure 3-46**: Kings River Cumulative Runoff Deviation from the Mean indicates the cumulative annual Kings River runoff deviation from the mean and shows the variability of the Kings River water supply with periods of above average and below average runoff. Several sustained wetter than normal and drought periods can be observed.

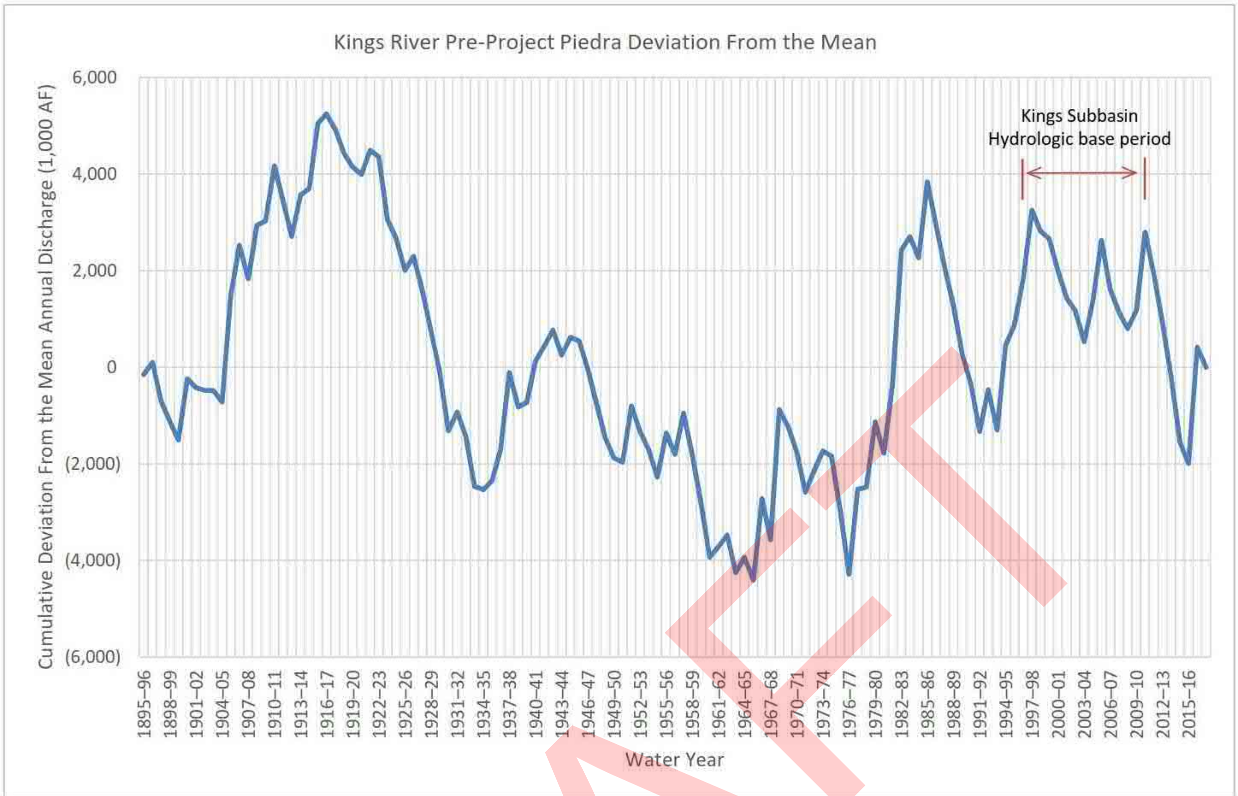


Figure 3-46: Kings River Cumulative Runoff Deviation from the Mean

A water schedule developed by KRWA includes tables and charts that indicate which entities or canal owners are entitled to divert or store water at specific flow increments in the river. The earliest Kings River schedules were developed as an annual schedule, and later schedules were developed as monthly schedules with tables and charts for each month indicating which entities or canal owners were entitled to divert water at specific flow increments during that month. The current schedule has been used since 1949. The schedule generally follows how the river operated under natural flow, with the member units further upstream on the river, referred to as the "upper river units", receiving water first and at lower flows. Those units further downstream on the river, referred to as the "lower river units", generally do not come on schedule until the river runoff reaches a certain level when the river naturally would have reached their diversion point. The schedule is different each month, with differing amount of entitlement received by a given member unit depending on what month it is and what the river runoff is. The CID is considered an "upper river unit".

In high flow events, floodwater in the North Fork of the Kings River is measured near the point that the water leaves the Kings River Service Area on the James Bypass at the gaging station just downstream of Placer Avenue. High flow water or floodwater from Pine Flat Reservoir has historically been available in the North Fork of the Kings River on average about once every 3 years, 23 out of 64 years (for the years 1954/55 to 2017/18). As shown in **Table 3-9**: James Bypass Gaging Station Floodwater Discharge Since the Construction of Pine Flat Dam, historical floodwater discharges at James Bypass average about 500,000 AF in years that they occur and last on average about 115 days. On an average annual basis, the historical record indicates that approximately 180,000 AF over about a 40-day period could have been available based on the record of flows leaving the Kings River service area, although several extraordinarily wet years are included in the historical record such as 1968-69 and 1982-83.

Table 3-9: James Bypass Gaging Station Floodwater Discharge Since the Construction of Pine Flat Dam

Water Year	% of Average	Total (AF)	Duration (Days)
1955-56	153%	91,205	46
1957-58	150%	212,797	109
1966-67	199%	484,870	113
1968-69	258%	1,551,343	205
1969-70	78%	62,173	44
1973-74	123%	86,353	63
1977-78	203%	551,189	138
1978-79	102%	11,763	46
1979-80	179%	579,581	192
1981-82	183%	452,756	122
1982-83	264%	2,309,290	332
1983-84	116%	568,609	169
1985-86	192%	667,750	130
1986-87	46%	1,347	22
1994-95	204%	586,510	149
1995-96	123%	74,542	38
1996-97	156%	437,113	103
1997-98	183%	986,453	166
1998-99	74%	20,043	29
2004-05	149%	63,194	36
2005-06	173%	612,148	84
2010-11	195%	503,465	150
2016-17	242%	688,812	164
Average		504,490	115

However, this historical amount of floodwater leaving the Kings River Service Area would not be available today, even if the hydrology repeated itself, because water demands have increased when high flow water is available and the Kings River water rights holders have constructed numerous groundwater recharge projects over the years that capture floodwater now that was not able to be utilized previously. The amount of floodwater leaving the service area is expected to be significantly less on average in the future because of the additional projects that have been built and future projects that are planned to be built by the water rights holders on the Kings River to utilize this high flow water when it is available. It is expected that the frequency of available high flow water and relative magnitude of the volume of high flow water available will be similar in future years, but the water will be utilized within the Kings River area and the amount of water discharged out of the service area is expected to be significantly less on average in the future.

As shown in **Figure 3-47** below, the amount of Kings River water being used within the Service Area has been increasing and this trend is expected to continue as additional projects are developed. **Figure 3-47** indicates the total amount of "Kings River for Irrigation" (KRI), which is an indication of actual measured releases into the river, and breaks the river releases each year into two components – discharges out James Bypass and the remainder being use within the Kings River Service Area. Items to note in **Figure 3-47** about recent high flow water years on the Kings River include:

- the releases in WY 2010-11 were larger than in WY 2005-06, but less floodwater was discharged out James Bypass and more water was used within the Kings River Service Area,
- KRI was significantly larger in WY 2016-17 than most of the previous years and the amount used in the service area was also significantly more than prior years, partly a result of large river losses following the drought, and
- the amount of water used within the Kings River Service Area in WY 2016-17 (approximately 2.9 million acre-feet) would essentially eliminate the historical James Bypass discharges in nearly all prior years except extraordinarily wet years like WY 1968-69 and 1982-83.

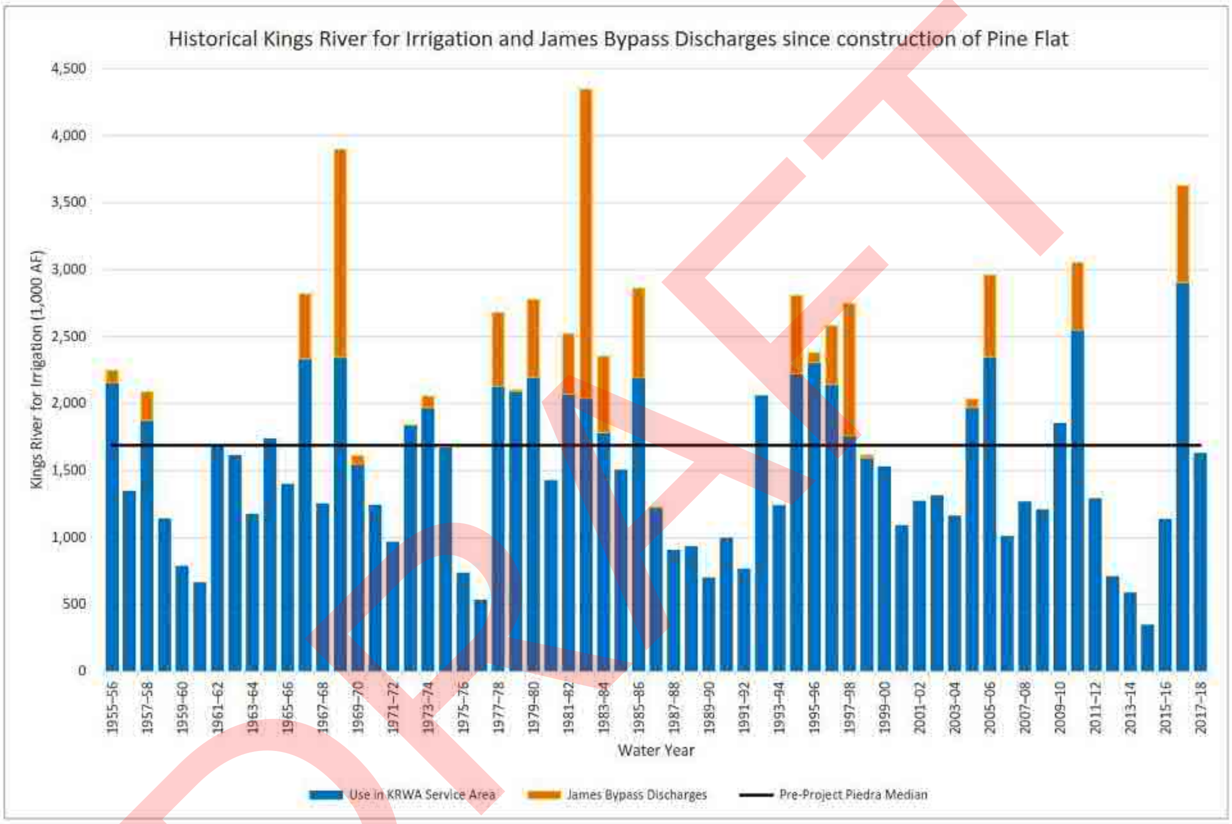


Figure 3-47: Historic Kings River for Irrigation and James Bypass Discharge (AF)

For planning purposes, it is assumed at this time that high flow water would be available for project development on the same duration and frequency as the historical record, approximately once every three (3) years for an average duration of approximately 40 days, for those projects described herein with the potential for a Kings River water supply. This planning assumption has been compared to estimates of water available for replenishment that have been developed by DWR (DWR, 2018a). In their estimates of water supply availability, DWR identified an average of 222,000 acre-feet of outflow at James Bypass for the period of 1948-2009 that potentially could be available for recharge. DWR also developed estimates of the portion of this flow that could be recharged based on presumed capacities of recharge capability for potential projections. This second step of project recharge capability is described for individual projections in **Section 6**. Based on the similar level of amount available, the historical James Bypass supplies identified above are being used to evaluate water supplies developed by projects in **Section 6**.

3.4.2.1 Possible Kings River Implications

While most of the SKGSA lies within the Kings River Service Area (Place of Use), a portion of the GSA is not located within the Kings River Place of Use for the water rights held in trust by the KRWA for their member units. These water rights include various appropriated rights including pre-1914 rights. The State Water Resources Control Board, Division of Water Rights (State Board) regulates the appropriation and beneficial use of water in California and has determined that the Kings River is fully appropriated, which means that the State Board is not accepting new applications to appropriate water from the Kings River unless a petition for reconsideration of the fully appropriated stream status is also submitted.

Fresno, Alta and Consolidated Irrigation Districts together filed an application to modify the Place of Use for the Kings River Service Area and appropriate Kings River high flows on May 9, 2017, to retain the local water rights for use in the Kings Subbasin. The application included several projects outside the current KRWA service area but within the Kings Subbasin. By changing the Place of Use and identifying the specific projects, Kings River waters besides pre-1914 water could potentially go to these projects if the water rights application is approved. However, Semitropic Water Storage District (Semitropic) in Kern County also filed an application to appropriate water from the Kings River on May 25, 2017, along with a petition for reconsideration of the fully appropriated stream status of the Kings River, in an attempt to export Kings River water out of the area of origin. The State Board could consider the fully appropriated status at a State Board hearing at some point in the future, and if the fully appropriated stream status is rescinded, then both water rights applications would be considered. The draft Environmental Impact Report prepared for the proposed Semitropic project indicates Semitropic intends to use all flood flows in excess of 100 cubic feet per second (cfs), up to 2,200 cfs, that leaves the Kings River service area through the North Fork of the Kings River. As indicated in **Figure 3-47** though, the historical amount of floodwater discharged out of the Kings River Service Area through the James Bypass will not be available in the future for appropriation.

If the State Board determines that sufficient evidence exists for a public hearing to reconsider the fully appropriated stream status and if the fully appropriated stream status is revoked, then the two competing water rights applications would be considered before a water rights permit could be issued. A water rights permit must identify the amounts, conditions, and construction timetables for the proposed water project. Before the State Board issues a permit, it takes into account all prior rights and the availability of water in the basin. The State Board also considers the flows needed to preserve instream uses such as fish and wildlife habitat.

The State Board indicates that it has more than 500 pending water right applications, and even if all information needed is provided, they indicate it may take 3 to 4 years to obtain a permit. If others protest the project or the project has the capacity to harm threatened or endangered species, it could take even longer to get a permit. The process of the State Board reviewing the fully appropriated stream status will likely increase the time required due to the public review. The fact that there are two competing water rights applications will also lengthen the time before any permit could be issued. In the meantime, the Kings River water rights holders, including those within the SKGSA, will be developing additional projects to utilize high flow water when it is available.

3.4.3 Central Valley Project Supplies

For those projects within the GSA that are located outside of the Kings River Service Area, a source of water in addition to pre-1914 Kings River water would be Central Valley Project (CVP) Friant Division Section 215 water or contracted CVP Class I or Class II supplies that might be available for purchase and could be permitted and delivered within the SKGSA since the GSA is located within the CVP Place of Use.

Quantifying the water that might be available presumes that historical hydrology will repeat itself, but this is difficult to estimate because predicting future availability is unknown. The most likely CVP water that could be available in the future is Section 215 water, a high flow federal designation for floodwater. Section 215 water is available when conditions cause Millerton Lake (on the San Joaquin River) to rise to the point that flood control releases are necessary, as mandated by the U.S. Army Corps of Engineers flood control criteria. Priority allocation for Section 215 water is made available to the Friant Division Long-Term and Cross Valley Canal Contractors. Section 215 water can then also be made available to other parties (Non-Long-Term Contractors) in accordance with Reclamation law and contractual requirements.

Section 215 water has typically occurred between December and July, with historical data showing the most prolific months for water availability being March through July. Section 215 water is usually available at least as often as Kings River high flow water, typically available approximately every 2 years out of every 5 years. Some Section 215 has been purchased in the past by the CID when available.

It should be noted that the San Joaquin River Restoration Program (SJRRP) can be expected to utilize flood releases when available prior to the water being designated as Section 215 water. As part of the SJRRP, existing Friant Contractors will have priority for what would previously have been Section 215 water under Paragraph 16(b) of the SJRRP settlement. The SJRRP Paragraph 16(b) program will have the effect of decreasing the amount of water available for use or recharge when Section 215 water does become available. A recent update of future Friant Division Supplies indicated that future 215 water supply availability will be significantly reduced in the future and may be presumed to be nearly zero for planning purposes. Another option, but costlier alternative would be to purchase Class 1 or Class 2 supplies from Friant contractors, which is far more reliable compared to Section 215 water.

3.5 Management Areas

Regulation Requirements:

§354.20 (a) Each Agency may define one or more management areas within a basin if the Agency has determined that creation of management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin.

The GSA has not defined any management areas; each member agency will work cooperatively towards the sustainability goals discussed in this GSP. There are no situational or geographical reasons for management areas.

4 Sustainable Management Criteria

Regulation Requirements:

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

The SGMA defines Sustainable Groundwater Management as "*the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.*" The avoidance of undesirable results is important to the success of the GSP. Several requirements from GSP regulations have been grouped together under the heading of sustainable management criteria, including a sustainability goal, undesirable results, minimum thresholds, and measurable objectives for various indicators of groundwater conditions. These terms are provided in the table below:

Table 4-1: Sustainability Criteria Definitions

Term	Definition
Sustainability Goal	A succinct qualitative statement including objectives and desired conditions of the groundwater basin, how the basin will get to that desired condition, and why the measures planned will lead to success.
Measurable Objective	Quantitative goals that reflect the basin's desired groundwater conditions and allow the GSA to achieve the sustainability goal within 20 years.
Minimum Threshold	The quantitative value that represents the groundwater conditions at a monitoring site that, when exceeded individually or in combination with minimum thresholds at other monitoring sites, may cause undesirable result(s) in the basin.
Undesirable Result	A situation that occurs when conditions related to any of the six sustainability indicators become significant and unreasonable.

Indicators for the sustainable management of groundwater were identified in the SGMA legislation based on what is important to the health and general well-being of the public. The six indicators that must be monitored throughout the planning and implementation period of the GSP are shown below:

Figure 4-1: Sustainability Indicators

This section will describe each indicator, explain why they are significant, and define the management thresholds. Development of these Sustainable Management Criteria is dependent on basin information developed and presented in the hydrogeologic conceptual model, groundwater conditions, and water budget sections of this GSP.

4.1 Sustainability Goal

Regulation Requirements:

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

The sustainability goal of the Kings Basin and this GSA is to ensure that by 2040 the basin is being operated to maintain a reliable water supply for current and future beneficial uses without experiencing undesirable results. This goal will be met by balancing water demand with available water supply to stabilize declining groundwater levels without significantly and unreasonably impacting water quality, land subsidence or interconnected surface water. The goal of the Basin is to correct and end the long-term trend of a declining water table understanding that water levels will fluctuate based on the season, hydrologic cycle and changing groundwater demands within the basin and its proximity.

The conditions with the basin and this GSA will be considered sustainable when:

- The basin is continuously operated within its sustainable yield.
- The current rate of decline of the groundwater table within the basin monitoring network indicator wells has been corrected and the multi-year trend of water elevations in these wells has been stabilized.
- Groundwater levels are maintained to prevent Undesirable Results of the applicable sustainability indicators.

The seven GSAs within the Kings Basin have been coordinating within the basin for several years on how to reach and maintain sustainability within the Basin. As described in **Section 3**, the Kings Basin includes significantly varied geologic conditions, water supplies and land uses that lead to different conditions and obligations within each GSA. The basin setting describes the trend of declining groundwater levels within the basin and this GSA. The degree of decline varies by location based primarily on land use and available surface water supplies. The Basin setting information, including historic groundwater conditions, surface supplies, groundwater flows, land use and other information were used to establish the water budget, estimates of overdraft within each GSA and sustainable yield. The coordination efforts between the GSAs have resulted in agreed to initial quantities for each GSA to correct in order to correct current and future conditions. These quantities and each GSAs respective obligation will continue to be monitored and evaluated as additional information is gathered.

Each GSA in the Kings Basin is responsible for implementing projects and management actions required to reach sustainability and meet their initial mitigation requirements for overdraft. The measures that will be implemented to ensure the basin will be operated within the sustainable yield are identified in detail in **Section 6** of the GSP for each GSA in the basin. Collectively, these projects and programs have been identified to ensure the basin reaches sustainability by 2040. The projects and programs include technical data and estimates of project benefit, and the total of these benefits within the basin meet the initial estimates for reaching sustainability within the basin.

The basin has agreed to a phased approach of increasing mitigation to achieve sustainability. The proposed mitigation schedule is shown in the table below.

Table 4-2: Overdraft Mitigation Schedule

Period	Percent of Overdraft Mitigated	Cumulative Mitigation
2020-2025	10%	10%
2025-2030	20%	30%
2030-2035	30%	60%
2035-2040	40%	100%

Note these are minimum goals and progress may be faster than described. A phased approach with gradually increasing progress was selected since time will be necessary to secure funding, plan, design and build projects, and finalize water transfer deals. Furthermore, if recharge or banking projects are developed, a wet period will be needed before projects are realized. Consequently, efforts will be consistent throughout the 20-year period, but many benefits will not be seen until the latter years. Each GSA in the basin is planning to implement projects and management actions in accordance with the agreed mitigation targets. The GSAs will continue to meet regularly to review data to ensure all GSAs are meeting their milestones and progress is being made toward sustainability.

4.2 Groundwater Levels

4.2.1 Undesirable Results

4.2.1.1 Criteria to Define Undesirable Results

Regulation Requirements:

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

The terms "significant and unreasonable" are not defined by regulations, rather the conditions leading to this classification are determined by the GSA, beneficial users, and the basin they are a part of. The process used to develop criteria for determining undesirable results began with discussions with stakeholders and landowners.

The GSAs within the Kings Basin have defined the Undesirable Result for groundwater levels to be significant and unreasonable when either the water level has declined to a depth that a new productive well cannot be constructed, or when the water level has declined to a depth that water quality cannot be treated for beneficial use.

As defined by the Basin, the Undesirable Result in much of the Basin is actually below the elevation of the Minimum Threshold. The Kings Basin has a very large unconfined aquifer with existing water levels well above the base of the unconfined aquifer. Much of the basin has a significant amount of water available above a level where an Undesirable Result would occur. Because the aquifer is so significant and of such good quality in most of the Basin, the requirement to stabilize water levels by 2040 becomes the controlling condition for setting target water levels. The water level elevation at the point of stabilization is the Measurable Objective. The measurable objective was set based on the historic decline in each Indicator Well within the monitoring network, and an incremental mitigation used to determine the future water levels. A more detailed description of the measurable objective is included later in this section.

The minimum threshold was set at an elevation to allow operational flexibility of the anticipated water level decline during a 5-year drought. The actual decline during the historic 2012-2016 drought was determined and the minimum thresholds were set by adding that distance below the measurable objective for each Indicator Well in the network. A more detailed description is provided later in this section.

Therefore, for much of the basin there will still be a significant aquifer of suitable quality below the levels set as the minimum threshold. Meaning a productive well of suitable water quality could still be constructed if the water level drops below the minimum threshold. The figure below illustrates this idea that for much of the basin, the minimum threshold is actually set at a level above the level of Undesirable Result (where there is no longer adequate water supply of suitable water quality).

Although the undesirable result (as defined) may not occur until water levels are well below the minimum threshold, the requirement to operate at the basin at the Measurable Objective will control and the basin will use the milestone and minimum threshold levels as the indicator level for the need for operational change. Therefore, unless otherwise defined for a portion of a GSA, the basin will use the Minimum Threshold level as the point at which the effects of the groundwater decline become significant and unreasonable.

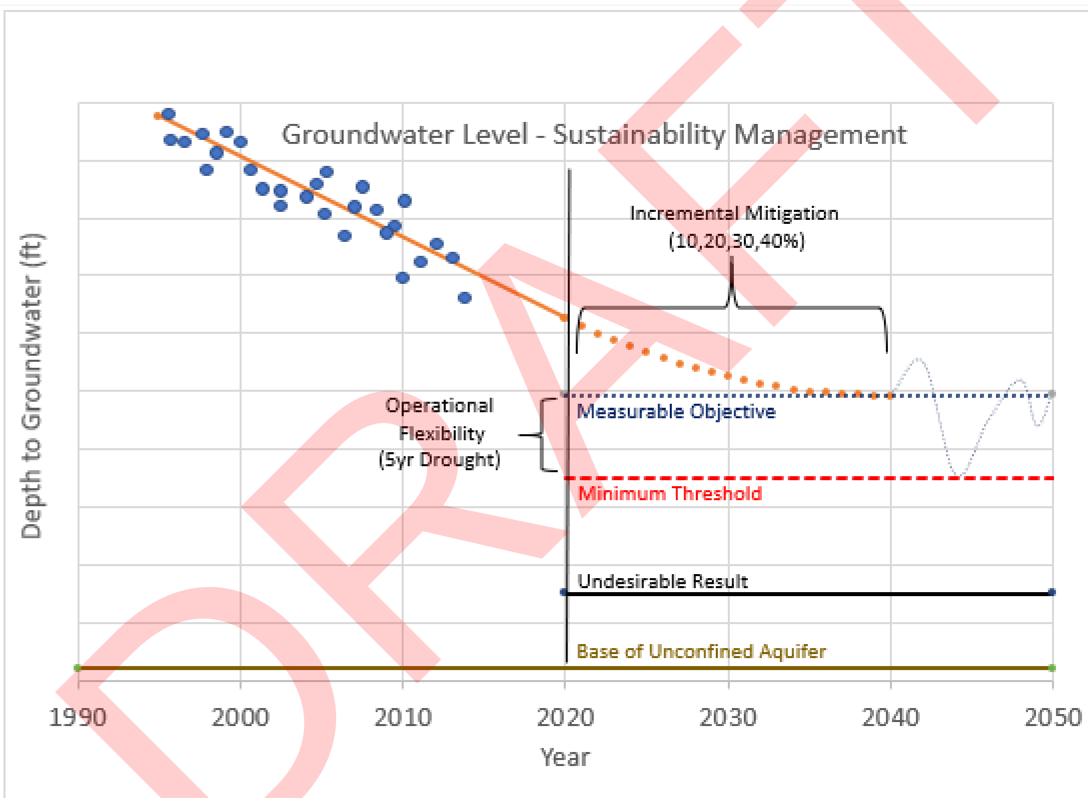


Figure 4-2: Groundwater Level – Sustainability Management

The GSAs in the basin recognize that water levels will continue to decline until the overdraft within the basin, and the impact of pumping from neighboring basins has been corrected. The GSAs also recognize that during this time, the water level may decline below the depth of some wells within the basin. Well construction has varied over the years and wells have been constructed at varying depths, and the construction depth of all wells in the basin is not known at this time. Some wells, even recently constructed wells, may have been poorly constructed or constructed too shallow for long term operation. SGMA does not require the GSA to maintain current water levels or prevent any wells from going dry. Rather, the GSA is required to stabilize and correct groundwater decline. Until water levels have been stabilized and the basin has reached sustainability, the GSA does not view a well going dry as an undesirable result.

Within each GSA there may be exceptions or additional considerations for the groundwater level undesirable result described within each GSA's GSP. The SKGSA has no exceptions or additions to this definition.

4.2.1.2 Causes of Groundwater Conditions That Could Lead to Undesirable Results

Regulation Requirements:

> **§354.26** (b) The description of undesirable results shall include the following:
> (1) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.

The elevation at which an undesirable result occurs varies throughout the basin and each GSA. The continued decline of water levels below the minimum threshold would be the undesired result. The decline of the water table below minimum threshold levels could be caused by:

- GSAs not correcting the overdraft at the basin-agreed incremental mitigation rates described later in this section.
- Hydrologic cycle significantly drier than historic average conditions.
- Extended or worse drought conditions than the historic 2011-15 drought.
- Neighboring GSAs and Basins not correcting boundary flow losses to the Kings Basin and its GSAs.
- Increased demand and pumping beyond what are planned for in the water budget

As noted above, for much of the basin there will still be a significant amount of suitable water supply well below the minimum threshold and above the point at which a productive well of suitable water quality could no longer be constructed.

Regulation Requirements:

> **§354.26** (b) The description of undesirable results shall include the following:
> (2) The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.

Water level declining below the minimum threshold in one of the GSA's indicator wells in the monitoring network will be considered significant. The regulations and DWR BMP for chronic lowering of groundwater levels recommend significant and unreasonable being considered when some percentage of wells have dropped below minimum thresholds. However, with the monitoring network having indicator wells represent large areas, the exceedance of the minimum threshold at just one well location is significant based on how the basin has determined the minimum thresholds described later in this section. The water level decline to this point would potentially be significant to the stakeholders in the proximity of this indicator well and warrant further evaluation by the GSA and potential action. Therefore, the exceedance of one minimum threshold will trigger further action by the GSA.

Regulation Requirements:

> **§354.26** (b) The description of undesirable results shall include the following:
> (3) Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.

The primary effect of the chronic lowering of the groundwater table has caused wells to be drilled deeper and deeper to maintain productivity. Without correcting the basin to sustainability and stabilizing the water table, the decades long trend of drilling deeper and deeper wells would continue causing increased financial burden on stakeholders. In some areas of the basin, bedrock is shallow and the availability of supply above the bedrock could be diminished such that productive wells could not be constructed if water levels are not stabilized above these levels. In some portions of the basin, as water levels decline, the water quality changes significant enough to require additional treatment. Stabilizing the water table will reduce the changing conditions and provide for more sustainable long-term conditions within the basin.

4.2.1.3 Evaluation of Multiple Minimum Thresholds

Regulation Requirements:

> **§354.26** (c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.

The GSA, in coordination with the other GSAs in the basin will utilize multiple wells to monitor and manage the GSA and basin. Indicator wells of approximately two per township (with more where necessary and available) have been identified, and Measurable Objectives and Minimum Thresholds will be set at each of these wells. A detailed description of the GSA's monitoring network is included in **Section 5** of this GSP.

4.2.2 Minimum Thresholds

Regulation Requirements:

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

The GSA, in coordination with the other GSAs in the basin, has established a monitoring network with multiple indicator wells. A measurable objective and minimum threshold for groundwater levels have been determined at each of these indicator wells for the unconfined aquifer. The minimum threshold was set at an elevation to allow operational flexibility of the anticipated water level decline during a 5-year drought. The actual decline during the historic 2011-2015 drought was determined and the minimum thresholds were set by adding that distance below the measurable objective for each indicator well in the network. A more detailed description is provided later in this section.

Regulation Requirements:

> **§354.28** (d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.

Groundwater elevation will of course be used as the indicator for the chronic lowering of groundwater levels. The minimum thresholds used for groundwater levels will set the overall groundwater storage volume desired to be maintained below the groundwater levels. Water levels will not be used as proxy for the other sustainability indicators and there are separate discussions on each indicator later in this section.

4.2.2.1 Criteria to Define Minimum Thresholds

Regulation Requirements:

> **§354.28**
> (b) The description of minimum thresholds shall include the following:
> (1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.
> (c) Minimum thresholds for each sustainability indicator shall be defined as follows:
> (1) Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:
> (A) The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.

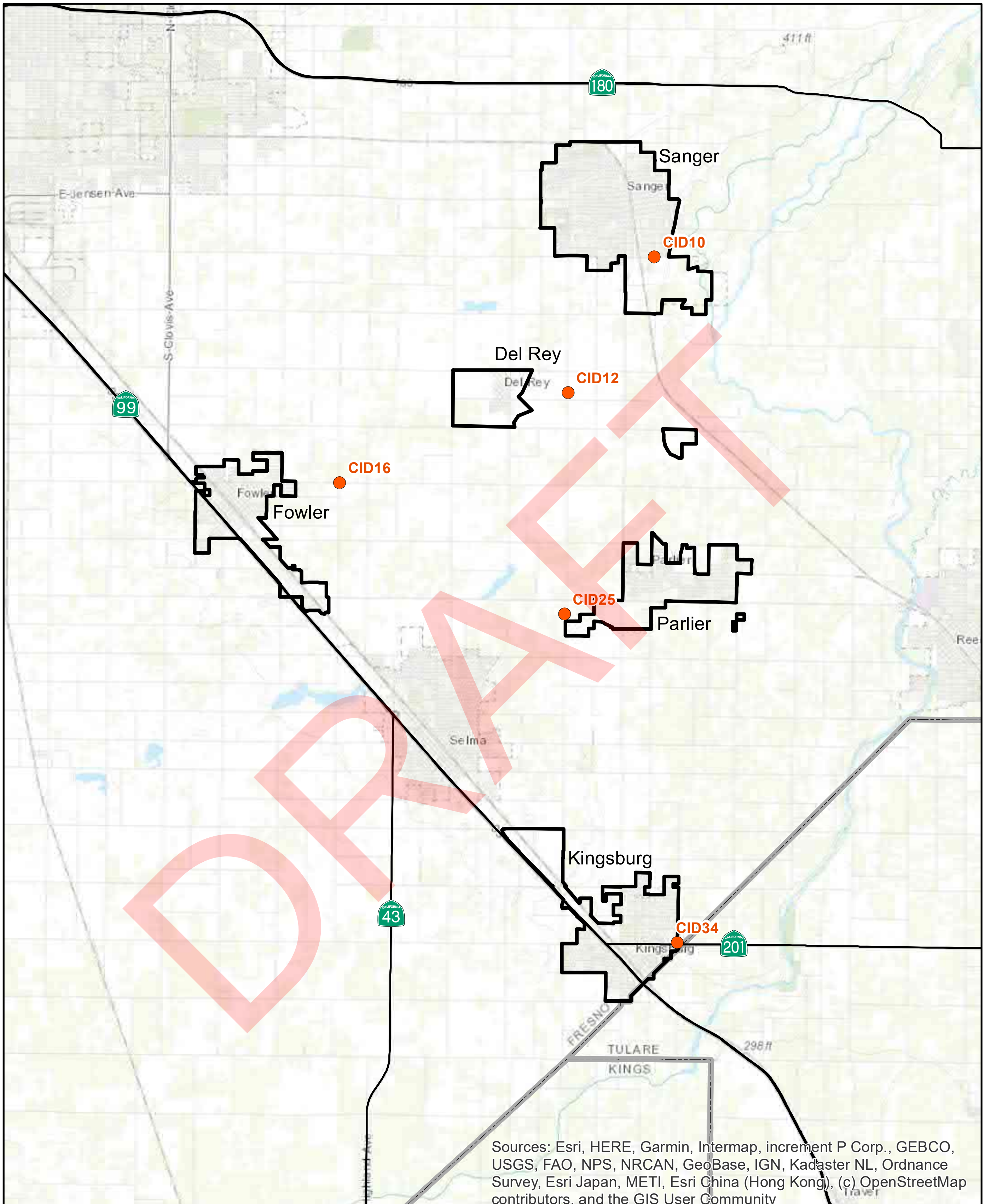
As shown in **Figure 4-2** above, the minimum threshold is the elevation below the measurable objective that provides the operational flexibility to allow for periods of increased groundwater pumping during dry periods. As mentioned, the minimum threshold was set at an elevation to allow operational flexibility of the anticipated water level decline during a 5-year drought. The actual decline during the historic 2011-2015 drought was determined at each Indicator Well in the monitoring network. The amount of decline during the historic drought was then used to determine the Minimum Threshold by deducting that amount from the elevation set for the Measurable Objective at that Indicator Well. At some of the Indicator wells, there is incomplete or inconsistent water level readings during the drought period. For those wells, the average rate of decline was multiplied by 15 (three times the standard rate of decline for 5 years) to determine the total depth of decline for operational flexibility.

The establishment of the minimum threshold was based on actual water level readings at each of the wells chosen to be Indicator Wells in the Monitoring Network. A hydrograph was generated for each well and the historic rate of decline identified for each well individually. The trendline was developed using the recent water level reading from the 1990s to the end of the Basin base period (2012). This considers recent base period conditions for the basin which factors in recent land use changes, different water year types and the water use within the basin. The amount of decline during the recent drought (2012-2016) was also determined. **Figure 4-3** shows the indicator wells for all SMCs except Water Quality, which is discussed further in **Section 4.5**.

A table listing the minimum threshold for each Indicator Well is included as **Table 4-3** and a hydrograph for each Indicator Well showing the Minimum Threshold is included as **Figure 4-4** through **Figure 4-8**. In addition to the Minimum Thresholds, the hydrographs include the rate of decline of each specific well, and the Measurable Objective elevation based on the incremental rate of mitigation.

Table 4-3: Summary of SMCs for Groundwater Levels

Well ID		CID10	CID12	CID16	CID25	CID34
Nearest Member Agency		Sanger	Del Rey	Fowler	Parlier	Kingsburg
Rate of Decline (ft/yr)		-0.45	-2.21	-1.08	-1.25	-1.04
Well Elevation (ft)		366.2	341.0	318.8	327.3	296.8
Last Water Surface Elevation Measured (ft)		317.3	286.3	246.8	261.6	240
Last Measured Depth (ft)		48.9	54.7	72.0	65.7	56.8
Measurable Objective Depth (ft)	2025	50.3	61.6	75.4	69.6	60.1
	2030	51.7	68.6	78.8	73.6	63.3
	2035	53.1	75.5	82.1	77.5	66.6
	2040	54.5	82.4	85.5	81.4	69.8
Measurable Objective Depth (ft)		54.5	82.4	85.5	81.4	69.8
Proposed MO Elevation		311.7	258.6	233.3	245.9	227.0
Minimum Threshold Depth (ft)		78.2	118.2	101.6	123.1	102.4
Proposed MT Elevation		288.0	222.8	217.2	204.2	194.4



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Well - Water Level Monitoring

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Water Level Indicator Wells

Figure 4-3

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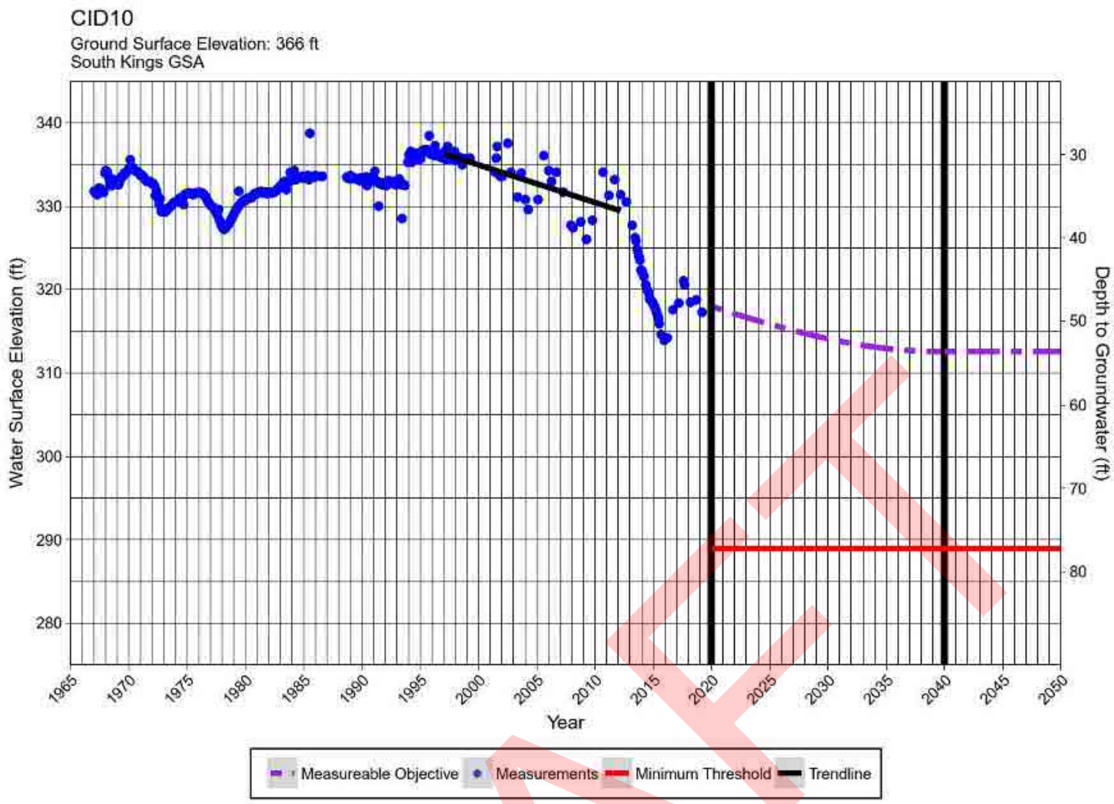


Figure 4-4: Well CID10 Hydrograph

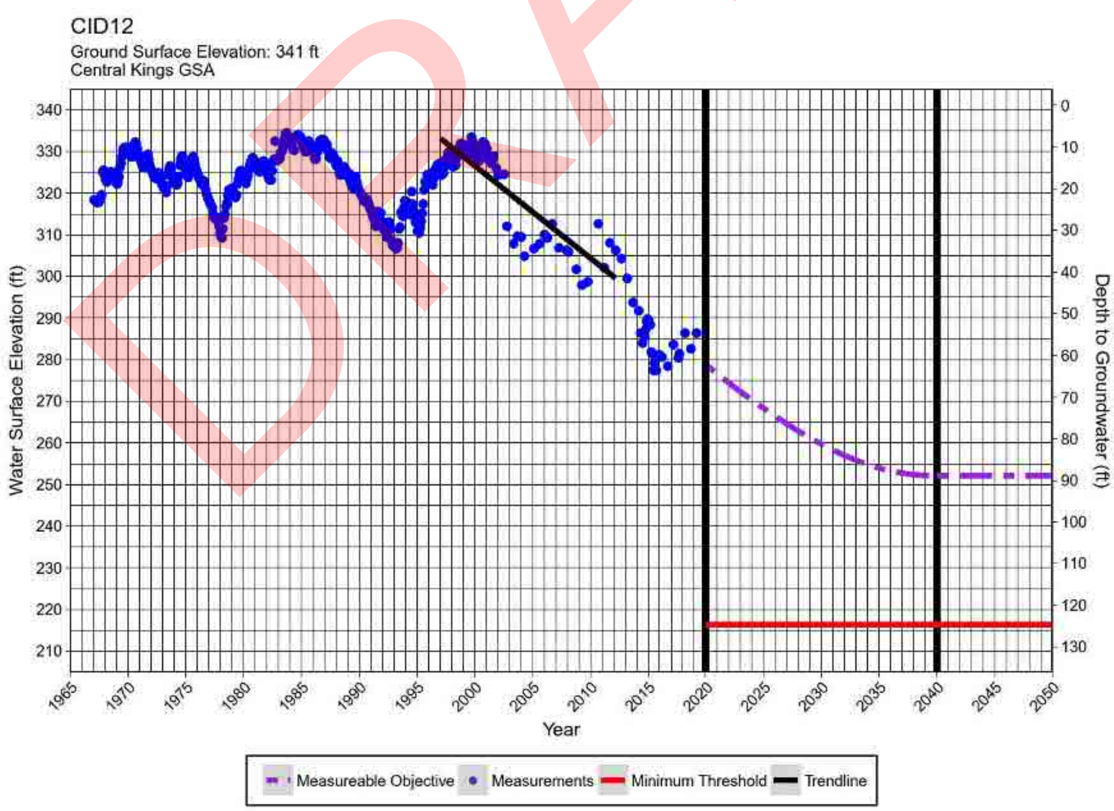


Figure 4-5: Well CID12 Hydrograph

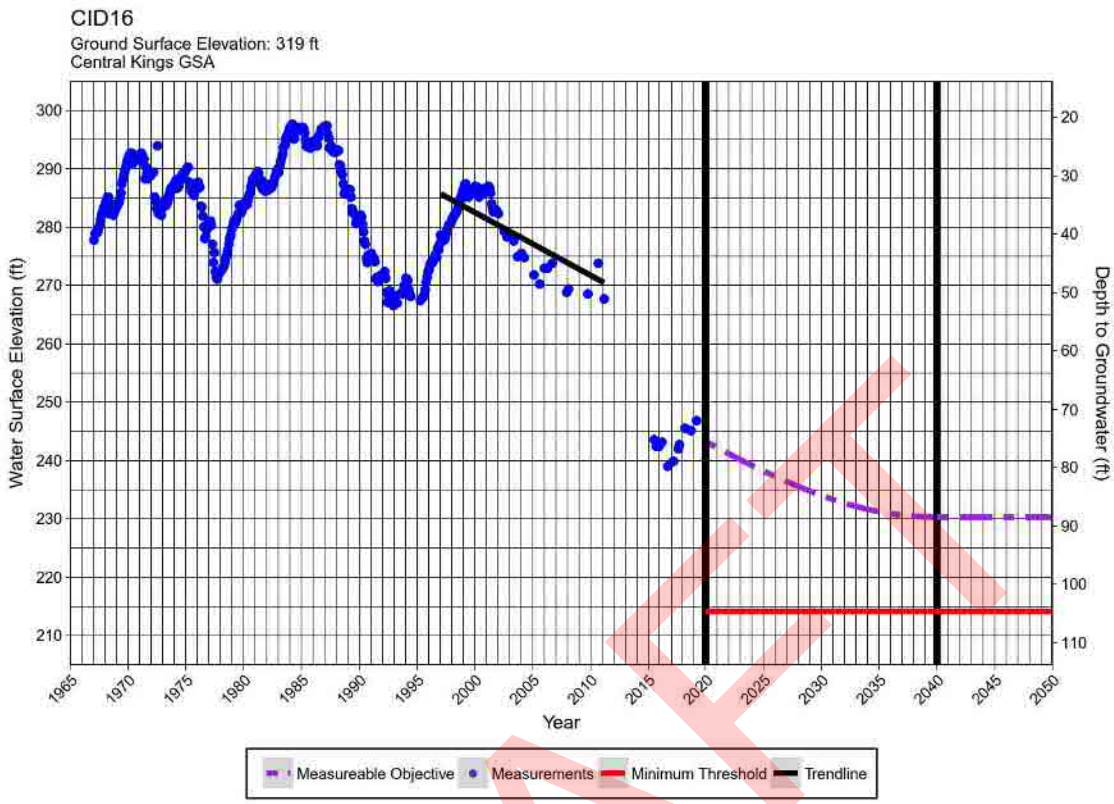


Figure 4-6: Well CID16 Hydrograph

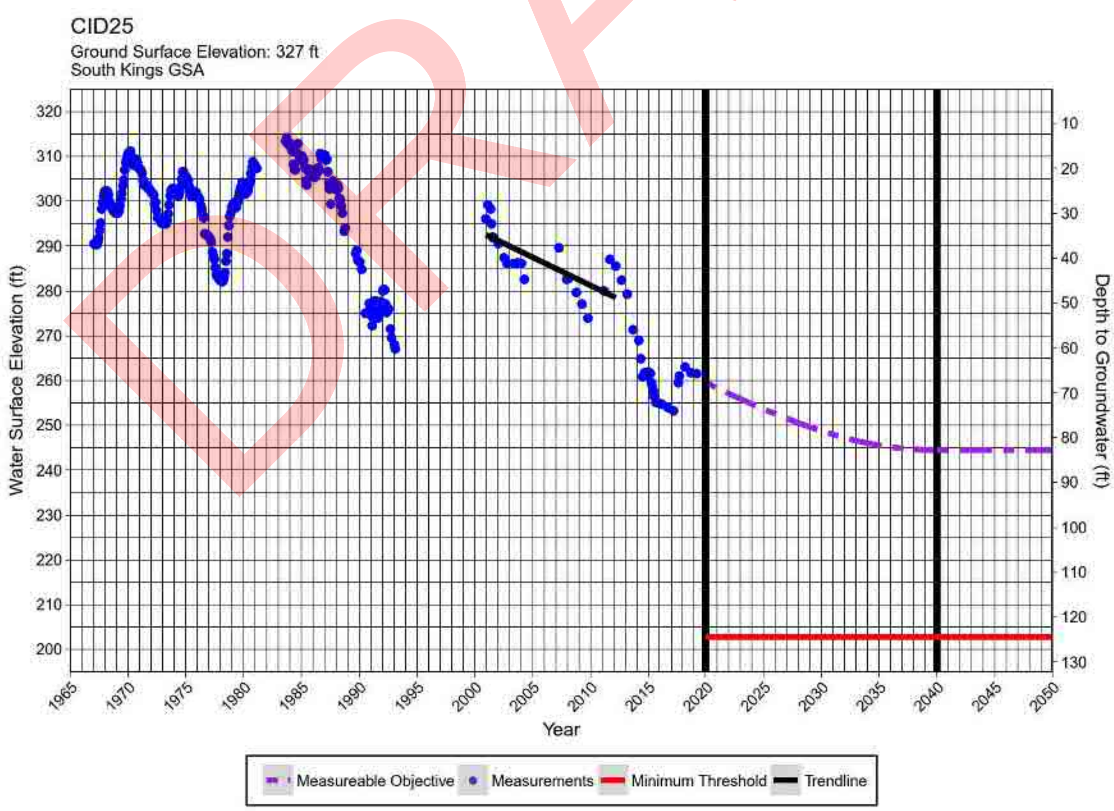


Figure 4-7: Well CID25 Hydrograph

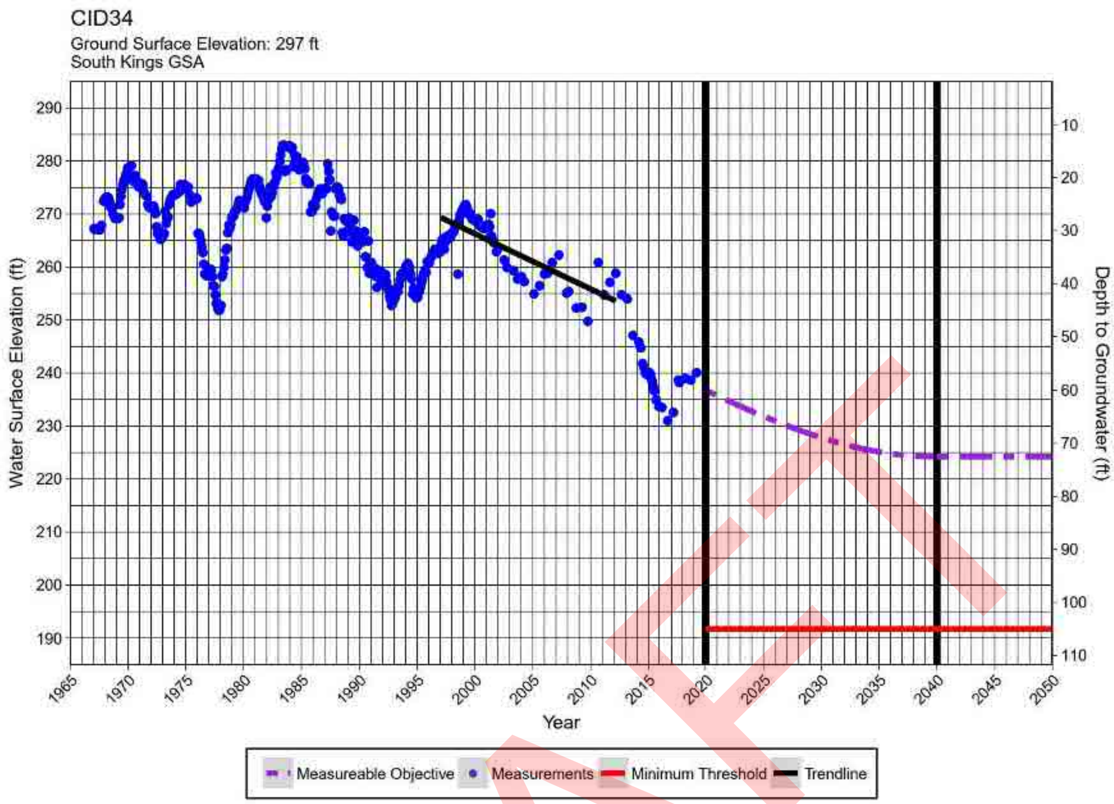


Figure 4-8: Well CID34 Hydrograph

4.2.2.2 Relationships Between Minimum Thresholds and Sustainability Indicators

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(2) The relationship between the minimum thresholds for each sustainability indictor, including and explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.

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

- Groundwater Storage. The minimum thresholds used for groundwater levels will set the overall groundwater storage volume desired to be maintained below the minimum threshold groundwater levels. As mentioned in much of the GSA and the basin, there will remain a very significant amount of groundwater below the minimum threshold elevations. In areas of shallow bedrock, the minimum thresholds were compared to elevations of the top of bedrock in effort to restrict decline of water table below alluvial material. The SMC section on Groundwater Storage describes this further.
- Groundwater Quality. Changing groundwater levels can affect groundwater contaminant concentrations positively and negatively. The minimum thresholds were compared with known contaminants of concern where data and quality information by elevation was available. Groundwater levels are not used as proxy for groundwater quality conditions. GSA has set separate groundwater quality Sustainable Management Criteria and will monitor water quality condition changes as water levels change and reach sustainability.
- Land Subsidence. The GSA has experienced small amounts of subsidence and has limited area with soil conditions for land subsidence. Water levels, and primarily pumping from beneath clay layers, can cause land subsidence. The majority of pumping in the GSA is from others above or outside of clay layer areas encountering subsidence. The water level minimum thresholds have been established based on historic rates of decline that have not caused land subsidence of significance. The SMC section on Land Subsidence describes this further.
- Interconnected Surface Water. This indicator is not applicable to this GSA.
- Sea Water Intrusion. This indicator is not applicable to this basin.

4.2.2.3 Minimum Thresholds in Relation to Adjacent Basins

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.

The minimum thresholds established are based on implementation of incremental correction of the historic decline starting immediately and reaching stabilization by 2040. This approach is believed to be conservative and correct the trend of existing groundwater decline. The SKGSA does not have direct surface water rights but has negotiated purchase of surface water from CID which has significant surface water rights and has experienced minimal impacts compared to other basins. The Kings Basin is primarily negatively impacted by surrounding basin pumping as adjacent basins with limited surface water supplies have caused declining groundwater conditions that negatively impact the Kings basin by increasing groundwater flows across basin boundaries. As described in **Section 2**, these flows have increased overtime. Groundwater pumping in the confined aquifer in adjacent basins has also impacted the Kings Basin as the confined aquifer is primarily fed by the groundwater upgradient in the Kings Basin.

As a basin, the various Kings GSAs have met with their neighboring GSAs outside of the Kings Basin to discuss how thresholds have been established and potential impacts. At the time of the preparation of this GSP, criteria from the neighboring basin was not available. However, it is understood that minimum threshold elevations along the boundaries will not match exactly as the basins and GSAs have likely taken different approaches to establishing thresholds. Once the neighboring basin GSP is completed, the SKGSA will evaluate the potential differences between thresholds and work to coordinate needed resolutions and clarifications.

4.2.2.4 Impact of Minimum Thresholds on Beneficial Uses and Users

Regulation Requirements:

> **§354.28** (b) The description of minimum thresholds shall include the following:
> (4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.

The minimum thresholds have been established based on historic rate of decline, the proposed mitigation rate and enough operational flexibility to maintain delivery during a 5-yr drought. The minimum thresholds have been determined based on the plan to correct the existing overdraft with an incremental approach intended to result in stabilized groundwater levels by 2040. Stabilizing the groundwater levels will provide more certainty of the long-term availability of groundwater supply for all beneficial uses and users. Property values have always been influenced by the presence and depth of a useable well. Minimum Thresholds may affect those property values with existing wells with depths shallower than the Minimum Threshold. Future modifications to reduce demands may be required to mitigate for future impacts to maintain water levels above the minimum thresholds. The GSA recognizes that some shallow wells will likely go dry until water levels have been stabilized. Without SGMA and the proposed incremental mitigation by the GSA, these wells would have gone dry sooner, requiring the landowner to deepen existing wells. The minimum thresholds have been established to allow for continued beneficial use within the GSA and provide improved long-term certainty of groundwater levels within the GSA.

4.2.2.5 Current Standards Relevant to Sustainability Indicator

Regulation Requirements:

> **§354.28** (b) The description of minimum thresholds shall include the following:
> (5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.

There are no known state, federal or local standards for establishment of minimum thresholds for groundwater levels.

4.2.2.6 Measurement of Minimum Thresholds

Regulation Requirements:

> **§354.28** (b) The description of minimum thresholds shall include the following:
> (6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.

Groundwater level readings will be made at Indicator Wells in accordance with water level measurement protocols described in **Section 5** of this GSP.

4.2.3 Measurable Objectives

4.2.3.1 Description of Measurable Objectives

Regulation Requirements:

> **§354.30** (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.
> (b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.

The establishment of the Measurable Objective was based on actual water level readings at each of the wells chosen to be Indicator Wells in the Monitoring Network. The Monitoring Network is described in detail in **Section 5** of this GSP. A hydrograph was generated for each well and the historic rate of decline identified for each well individually. The trendline was developed using the recent water level reading from the 1990s to the end of the recent average base period for the basin period (through 2012). Use of this historic data considers recent base period conditions for the basin which factors in recent land use changes, different water year types and the water use within the basin. The rate of decline was projected through 2020 for each well. The basin wide agreed incremental mitigation rate for correction (shown in

Table 4-2) was applied to each well's hydrograph. The incremental correction provides the calculation of the anticipated water level at 2040. A table listing the minimum threshold for each Indicator Well is included as Table 4-3 and a hydrograph for each Indicator Well showing the Measurable Objective is included as Figure 4-4 through Figure 4-8. In addition to the Measurable Objective, the hydrographs include the rate of decline of each specific well, and the Minimum Threshold elevation based on the desired Operational Flexibility to maintain during a 5-year drought.

The incremental mitigation for correction was selected based on the understanding that correcting decades of overdraft will take many years and implementation is dependent on many factors, including development of funding, project development, environmental and permit compliance, correction by neighboring GSAs and basins that impact the Kings Basin.

4.2.3.2 Operational Flexibility

Regulation Requirements:

> **§354.30** (c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.

As shown in Figure 4-2, the Operational Flexibility is the change in groundwater levels between the Measurable Objective and Minimum Threshold and represents the amount of allowable decline in groundwater levels below the Measurable Objective. The Measurable Objective was established using the basin base period which represents recent average hydrologic conditions and water uses with recent land uses and demands. As mentioned, the Minimum Threshold was set at an elevation to allow operational flexibility of the anticipated water level decline during a 5-year drought and was based on the recent historic drought of 2011-2015.

4.2.3.3 Representative Monitoring

Regulation Requirements:

> **§354.30** (d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.

The GSA is not proposing to use representative Measurable Objectives.

4.2.3.4 Path to Achieve Measurable Objectives

Regulation Requirements:

> **§354.30** (e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.

The SKGSA and the other GSAs in the basin will implement projects and programs to correct the declining groundwater levels and reach sustainability. The SKGSA projects and programs are described in Section 6 of this GSP and implementation discussed in Section 7 of the GSP. The interim milestones for water level correction are unique to each well and are shown on the hydrographs in Appendix E . The measurable objective water levels have been used to determine the estimated volume of overdraft correction that is required within this GSA and the entire basin. The SKGSA has identified the schedule for implementation of each project as well as that project's anticipated benefit or yield. The combined benefit of each project at each milestone shows that the GSA has identified projects to correct the total overdraft by 2040. Future projects are included in the anticipated reduction in demand and overdraft.

4.3 Groundwater Storage

Groundwater storage is directly linked to groundwater levels, and the measurable objective and minimum threshold for groundwater levels dictate the amount of groundwater in storage. The criteria used to determine water level undesirable results, measurable objectives and minimum thresholds dictate groundwater storage items. As described in Section 3.2.3, the calculation of the amount of groundwater in storage is dependent on water level elevations from multiple wells and the depth of groundwater multiplied by specific yield values at various depths down to the base of the aquifer. The amount of groundwater in storage (or change over time) is estimated from these contoured surfaces down to the base of the unconfined aquifer. Once the subbasin reaches sustainability, the estimated volume of groundwater between the measurable objective and the minimum threshold levels provides the operational flexibility. The calculations of this volume are included in **Table 4-4**.

Table 4-4: Estimate of Groundwater in Storage between MO and MT

GSA	Volume (Acre-Feet)
Central/South Kings	
James	Awaiting Data from Other GSAs to Complete
Kings River East	
McMullin	
North Fork Kings	
North Kings	
Total for Subbasin	

Since the water level measurable objectives are lower than current water levels, the amount of groundwater in storage between current water levels and the minimum thresholds is considerably more than the estimate of groundwater in storage between the ultimate measurable objectives and minimum thresholds, however once the subbasin reaches sustainability, the long-term volume of groundwater in storage between the measurable objective and minimum threshold levels is the critical storage volume.

Storage change in the confined aquifer was not estimated since actual changes are small to negligible as long as the aquifer remains fully saturated. Changes in the potentiometric surface only impact the compressibility of the mineral skeleton and pore water, which have a very small impact on the total volume of water. Furthermore, when pumping occurs from the confined aquifer, it ultimately impacts the unconfined aquifer by inducing groundwater flows into the confined aquifer or seepage through the confining layer.

4.3.1 Undesirable Results

4.3.1.1 Criteria to Define Undesirable Results

Regulation Requirements:

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

An undesirable result is the chronic depletion of groundwater storage volume to a significant and unreasonable level. The terms "significant and unreasonable" are not defined by regulations, rather the conditions leading to this classification are determined by the GSA, beneficial users, and the basin they are a part of. SKGSA defines an undesirable storage change in the same way as groundwater levels, therefore, if the volume of water extracted causes 20 percent of wells younger than 25 years old go dry, then an undesirable result has occurred.

4.3.1.2 Causes of Groundwater Conditions That Could Lead to Undesirable Results

Regulation Requirements:

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

Since amount of groundwater in storage is based on water levels, the causes for undesirable results in groundwater storage are the same as causes for undesirable results listed under **Section 4.2.1.2** for water levels. The reasons for chronic lowering of water levels include:

- GSAs not correcting the overdraft at the basin-agreed incremental mitigation rates described later in this section
- Hydrologic cycle significantly drier than historic average conditions
- Extended or worse drought conditions than the historic 2011-15 drought
- Neighboring GSAs and Basins not correcting boundary flow losses to the Kings Basin and its GSAs
- Increased demand and pumping beyond what are planned for in the water budget

As previously stated, for much of the basin there will still be a significant amount of suitable water supply well below the minimum threshold and above the point at which a productive well of suitable water quality could no longer be constructed.

Regulation Requirements:

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

The criteria for undesirable results for water levels are also used for groundwater storage as they define the minimum threshold elevations that are used to calculate the volume of groundwater in storage below the water level minimum thresholds.

Regulation Requirements:

§354.26 (b) The description of undesirable results shall include the following:
(3) Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.

The effects of undesirable results for water levels described in **Section 4.2.1.2** are the same for groundwater storage. The primary effect of the chronic lowering of the groundwater table has caused wells to be drilled deeper and deeper to maintain productivity. Without correcting the subbasin to sustainability and stabilizing the water table, the decades long trend of drilling deeper and deeper wells would continue causing increased financial burden on stakeholders. In some areas of the subbasin, bedrock is shallow and the availability of supply above the bedrock could be diminished such that productive wells could not be constructed if water levels are not stabilized above these levels. In some portions of the subbasin, as water levels decline, the water quality changes significant enough to require additional treatment. Stabilizing the water table will reduce the changing conditions and provide for more sustainable long-term conditions within the subbasin.

4.3.1.3 Evaluation of Multiple Minimum Thresholds

Regulation Requirements:

§354.26 (c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.

The GSA, in coordination with the other GSAs in the subbasin, will utilize multiple wells to develop groundwater contours and estimate the change in groundwater storage. The amount of groundwater in storage (or change over time) will be estimated from these contoured surfaces down to the base of the unconfined aquifer. A water level surface was created from the minimum thresholds and the amount of groundwater in storage below those minimum thresholds estimated using the process described in **Section 3.2.3**.

4.3.2 Minimum Thresholds

Regulation Requirements:

> **§354.28** (a) Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.
> (d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.

The groundwater storage minimum threshold is based on the groundwater level minimum thresholds (described previously) as the basis for the calculation of groundwater in storage below those water levels. Water levels are not used as a proxy, but the water levels determine the water level surface that is used to calculate the volume in storage below those levels. Utilizing the process for groundwater storage calculation described in **Section 3.2.3**, the groundwater in storage between the measurable objective and minimum threshold was estimated and shown in **Table 4-4**.

4.3.2.1 Criteria to Define Minimum Thresholds

Regulation Requirements:

> **§354.28** (b) The description of minimum thresholds shall include the following:
> (1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.
> **§354.28** (c) Minimum thresholds for each sustainability indicator shall be defined as follows:
> (2) Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.

The criteria for minimum thresholds for water levels are also used for groundwater storage as they define the elevations that are used to calculate the volume of groundwater in storage below the water level minimum thresholds. The criteria for water level minimum thresholds are described in **Section 4.2.2.1**.

4.3.2.2 Relationships Between Minimum Thresholds and Sustainability Indicators

Regulation Requirements:

> **§354.28** (b) The description of minimum thresholds shall include the following:
> (2) The relationship between the minimum thresholds for each sustainability indictor, including and explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.

The minimum thresholds used for groundwater levels will set the overall groundwater storage volume desired to be maintained below the minimum threshold groundwater levels. The exceedance of a single water level minimum threshold does not necessarily mean there has been an exceedance of the groundwater storage minimum threshold. As mentioned in much of the GSA and the basin, there will remain a very significant amount of groundwater below the minimum threshold elevations.

4.3.2.3 Minimum Thresholds in Relation to Adjacent Basins

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.

It is understood that the minimum threshold elevations along the boundaries will not match exactly as the basins and GSAs have likely taken different approaches to establishing thresholds. Once the neighboring basin GSP is completed, the GSA will evaluate the potential differences between thresholds and work to coordinate needed resolutions and clarifications.

4.3.2.4 Impact of Minimum Thresholds on Beneficial Uses and Users

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.

The minimum threshold for groundwater storage is based on the water level minimum thresholds which have been established based on historic rate of decline, the proposed mitigation rate and enough operational flexibility to maintain delivery during a 5-yr drought. As described in **Section 4.2.2.4**, the minimum thresholds have been determined based on the plan to correct the existing overdraft with an incremental approach intended to result in stabilized groundwater levels by 2040. The minimum thresholds have been established to allow for continued beneficial use within the GSA and provide improved long-term certainty of groundwater levels within the GSA.

4.3.2.5 Current standards relevant to sustainability indicator

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.

There are no known state, federal or local standards for establishment of minimum thresholds for groundwater storage.

4.3.2.6 Measurement of Minimum Thresholds

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.

Groundwater level readings from wells in the monitoring network will be used to generate a water level surface contour. From this water level contour, the calculation of groundwater in storage will be made in accordance with the process described in **Section 3.2.3**.

4.3.3 Measurable Objectives

4.3.3.1 Description of Measurable Objectives

Regulation Requirements:

§354.30 (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.
(b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.

The groundwater storage measurable objective is based on the groundwater level measurable objective (described previously) as the basis for the calculation of groundwater in storage below those water levels. The groundwater storage minimum threshold is based on the groundwater level minimum thresholds (described previously) as the basis for the calculation of groundwater in storage below those water levels. The groundwater in storage between the ultimate measurable objectives and minimum thresholds provides the operational flexibility for pumping during dry years. With current water levels above the ultimate measurable objectives, there is currently more water in storage than there will be once the basin reaches sustainability at measurable objective levels. As described in **Section 4.2,** the measurable objective for water levels at each five-year milestone have been identified. It is also critical to understand that there is still a significant amount of groundwater in storage below the minimum threshold as discussed in **Section 3** and **Section 4.2**. Utilizing the process for groundwater storage calculation described in **Section 3.2.3**, the groundwater in storage between the measurable objective at each milestone and the minimum threshold was estimated and shown in **Table 4-5** below.

Table 4-5: Estimate of Groundwater in Storage between MT and MO Milestones

GSA	Volume at 2025 Milestone to Minimum Threshold (AF)	Volume at 2030 Milestone to Minimum Threshold (AF)	Volume at 2035 Milestone to Minimum Threshold (AF)	Volume at 2040 Milestone to Minimum Threshold (AF)
Central/South Kings				
James				
Kings River East				
McMullin				
North Fork Kings				
North Kings				
Total for Subbasin				

Awaiting Data from
Other GSAs to Complete

Contour maps at the milestone, measurable objective and minimum threshold used to calculate the storage volume, as well as the supporting calculation tables for the storage volume estimations are included in **Error! Reference source not found.**. Hydrographs included in **Appendix E** graphically display the available water level data, historic trendlines, measurable objective, operational flexibility, and minimum threshold for each indicator well.

4.3.3.2 Operational Flexibility

Regulation Requirements:

> **§354.30** (c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.

The amount of groundwater in storage between the measurable objective and minimum threshold provides the operational flexibility. The volumes are show in **Table 4-5.**

4.3.3.3 Representative Monitoring

Regulation Requirements:

> **§354.30** (d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.

The GSA is not proposing to use representative Measurable Objectives.

4.3.3.4 Path to Achieve Measurable Objectives

Regulation Requirements:

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

The SKGSA and the other GSAs in the basin will implement projects and programs to correct the declining groundwater levels and reach sustainability. The GSA's projects and programs are described in **Section 6** of this GSP and the Plan implementation discussed in **Section 7** of the GSP. The groundwater storage interim milestones are calculated based on the basin wide agreed incremental mitigation rate to reach water level measurable objectives. The GSA has identified the schedule for implementation of each project and management action (when required) as well as that project's anticipated benefit or yield. The combined benefit of each project, at each milestone shows that the GSA has identified projects to correct the total overdraft by 2040.

4.4 Seawater Intrusion

Regulation Requirements:

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

The SKGSA is not hydrologically located near the ocean nor near saline sinks. Therefore, no criteria need to be established for undesirable results.

4.5 Groundwater Quality

Regulation Requirements:

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

Most of SKGSA is comprised of urban areas with municipal water users on public water systems. As discussed in previous sections, groundwater quality in the SKGSA is generally well suited for irrigation and domestic use, although groundwater issues for drinking water exist in localized areas Plan Area. While some of these chemical concerns are caused by humans, several are natural occurring. Groundwater quality concerns within the SKGSA have been identified in this GSP's Groundwater Conditions Section (**Section 3.2**). Groundwater monitoring and reporting by community water systems is a requirement of California Code of Regulations (CCR) Title 22. Community and other public supply wells within the SKGSA monitoring network are already being routinely monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyors under Title 22.

Groundwater pollution characterization and mitigation are typically enforced by local agencies and state level programs. The SKGSA will only have authority related to groundwater pumping policies, however the SKGSA will review and analyze publicly available routine groundwater monitoring data in order to monitor if groundwater pumping may be exacerbating groundwater quality concerns and where to enforce pumping restrictions or other mitigation measures should it become necessary. The minimum thresholds will be set at the screening levels protective of human health as applicable for the respective chemicals of concern identified and discussed in this GSP's Groundwater Conditions Section (**Section 3.2**).

The following constituents are groundwater quality concerns in the SKGSA. Some of these are significant concerns while others are minor or geographically limited. Additional discussion on groundwater quality is presented in **Section 3.2**. The MCLs for each are listed in **Table 4-6**: Water Quality MCLs.

Arsenic
Arsenic occurs in natural deposits. Arsenic has not been noted at concentrations above the MCL in any member agency of the SKGSA.

Dibromo-Chloropropane (DBCP)
DBCP was used as a fumigant to kill nematodes in soil before planting and was widely used in California until 1977. DBCP was used in vineyards and deciduous orchards where sandy soils were present. In general, within the SKGSA concentrations of DBCP above the MCL value have been detected in Fowler, Parlier, and Sanger. DBCP concentration levels and the extent of DBCP has decreased over time due to the degradation process and dilution due to recharge.

Hexavalent Chromium
Hexavalent chromium [Cr(VI)] is one of the valence states (+6) of the element chromium. Hexavalent chromium can be produced by industrial processes but sometimes is also naturally occurring. Inhalation and ingestion of Cr(VI) is known to cause cancer. Hexavalent chromium has been found at low concentrations in Fowler, Kingsburg, Parlier, and Sanger.

Nitrates
Nitrate is commonly found in groundwater as a result of application of nitrogen fertilizers in irrigated agricultural and landscaped areas, seepage from feedlots/dairies, wastewater and food processing waste ponds, winery waste, sewage effluent, and leachate from septic system drain fields. Elevated concentrations have been found in Parlier and Sanger, but only above the MCL in Parlier.

Methyl Tert-Butyl Ether (MTBE)
MTBE is a flammable liquid that has been used as an additive for unleaded gasoline since the 1980s but is now banned in California. MTBE is also used in small amounts as a laboratory solvent and for some medical applications. The primary MCL is 13 μg/L for health concerns and 5 μg/L for taste and odor concerns.

1,2,3-Trichloropropane (TCP)
TCP is used industrially (paint and varnish remover as a cleaning and degreasing agent) and chemically (solvent and intermediate for pesticides). TCP has been detected in shallow groundwater in rural areas, along Highway 99, and in Del Rey, Fowler, Kingsburg, Parlier, and Sanger's public supply wells.

Uranium
Uranium occurs naturally in groundwater in parts of the GSA. Uranium is derived from Sierra Nevada granitics and will preferentially adhere to clays. Uranium has been found in municipal wells in the Del Rey CSD and Sanger.

4.5.1 Undesirable Results

Groundwater quality in the Kings Basin is generally suited for irrigation and domestic use, although groundwater issues for drinking water exist in some areas within the Kings Basin. An undesirable result would be the significant and unreasonable reduction in groundwater quality such that the groundwater is no longer generally suitable for agricultural irrigation and domestic use.

The SKGSA will only have authority related to groundwater pumping policies, however the SKGSA will review and analyze publicly available routine groundwater monitoring data, as it becomes available, in order to monitor if groundwater pumping may be exacerbating groundwater quality concerns and where to enforce pumping restrictions should it become necessary. **Section 5** of this GSP describes the SKGSA monitoring well network.

4.5.1.1 Criteria to Define Undesirable Results

Regulation Requirements:

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

Within the Kings Basin the criteria that will be relied upon to define water quality undesirable results will generally be based on Maximum Contaminant Levels (MCLs) set in California Title 22 Code of Regulations.

The intent of SGMA is for the GSAs to be responsible for groundwater aspects related to pumping only. Other existing agencies and programs are generally responsible for tracking and remediation of groundwater quality. As described in the Plan Area section, these other agencies and programs include IRLP, CV-SALTS, RWQCB, and DTSC.

While there are several existing groundwater monitoring programs, they do not monitor all contaminants of concern within the SKGSA and may not provide depth-specific water quality data. Water quality of private domestic wells is largely unknown as testing of the wells is not required. Due to these limitations, the data from these programs will not be relied on to set sustainable management criteria at this time.

Groundwater monitoring and reporting by community water systems is a requirement of California Title 22 Code of Regulations. Monitoring and reporting schedule requirements can vary based on the service population size, geographic area and population type (i.e., transient vs. non-transient). Under California Domestic Water Quality and Monitoring Regulations, community water systems must distribute, to each customer, an annual water quality report on the water purveyed. This consumer confidence rule requires public water suppliers that serve the same customers throughout the year (community water systems) to provide consumer confidence reports to their customers. These reports are also known as annual water quality reports or drinking water quality reports. These reports are generally publicly available from the water suppliers or through an online data base such as the State Safe Drinking Water Information System (https://sdwis.waterboards.ca.gov/PDWW/). Generally speaking, California Domestic Water Quality and Monitoring Regulations do not require all chemicals and contaminants to be tested at public supply wells, rather the intent is to test for chemicals and contaminants that are known or likely to occur in the area. Therefore, not all chemicals of concern will be tested in every well and the monitoring frequency for individual chemicals can vary from once every 3 to 6 years to once every 1 to 12 months depending on well history and well location relative to known groundwater impacts. Groundwater monitoring results from the wells within the SKGSA monitoring network will be reviewed annually and the analytical results for the chemicals of concern specific to the individual well locations will be compared against the respective MCL values for the chemicals of concern. The State MCL values for the chemicals of concern that have been identified in **Section 3.2** will be relied upon heavily as the criteria for defining undesirable results. Chemical of concern within the SKGSA along with their respective MCL values are listed below in **Table 4-6**.

Undesirable results determinations will be based on the aggregate effect of: 1) the degradation of water quality to excess of MCLs (i.e., California potable water standards) where concentrations of chemicals of concern were recent historically below MCLs; and 2) a significant increase in groundwater degradation where concentrations of chemicals of concern were recent historically above MCLs. The occurrence of an undesirable result will be defined as 15% of the representative monitoring wells having reached either of these two criteria for two consecutive years.

Table 4-6: Water Quality MCLs

Constituent of Concern	California Primary MCL* (mg/L unless otherwise noted)
Arsenic (Ar)	0.010
Dibromo-Chloropropane (DBCP)	0.0002
Hexavalent Chromium [Cr(VI)]**	0.05
Methyl Tert-Butyl Ether (MTBE)	0.013
Nitrate (NO_3)	45
Nitrate as Nitrogen (NO_3-N)	10
Tetrachloroethene (PCE)	0.005
Trichloroethylene (TCE)	0.005
1,2,3-Trichloroprpane (TCP)	0.005µg/L
Uranium (Ur)	20 pCi/L

Notes:
Mg/L = milligrams per liter
µg/L = micrograms per liter
pCi/L = picocuries per liter
** As of June 2019*
*** Regulated under the total Chromium MCL*

4.5.1.2 Causes of Groundwater Conditions That Could Lead to Undesirable Results

Regulation Requirements:

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

There are several potential causes of groundwater quality degradation that could lead to undesirable results. These include:

- The accumulated effects of fertilizer nutrient application and other farming practices leading to accumulation of chemicals of concern in groundwater, such as nitrates;
- DBCP, EDB, and TCE are legacy contaminants and thus no future degradation from them is foreseen, rather efforts include managing current contamination plumes;
- One-time releases from sources of chemical contamination such as from fuel storage tanks or cleaning solvent tanks leading to petroleum hydrocarbon, MTBE, or solvent contaminant plumes;
- The accumulated effects of regulated and unregulated waste discharge streams from wastewater treatment facilities, septic systems, industry, and food processors;
- Declining groundwater levels can cause pumped groundwater to have higher concentrations of some naturally occurring chemicals which may be either health concerns or aesthetic concerns, such as arsenic or uranium; and
- Groundwater pumping mobilizing groundwater contaminant plumes.

Regulation Requirements:

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

The State MCL values for the chemicals of concern that have been identified in **Section 3.2** will be relied upon primarily as the criteria for defining undesirable results. Groundwater quality data from selected public supply wells within the GSA will be reviewed annually and compared against MCLs or historic groundwater quality data.

Undesirable results determinations will be based on the aggerated effect of: 1) the degradation of water quality to excess of MCLs (i.e., California potable water standards) where concentrations of chemicals of concern were recent historically below MCLs; and 2) a significant increase in groundwater degradation where concentrations of chemicals of concern were recent historically above MCLs. The occurrence of an undesirable result will be defined as 15% of the representative monitoring wells having reached either of these two criteria for two consecutive years.

Regulation Requirements:

§354.26 (b) The description of undesirable results shall include the following:
(3) Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.

Groundwater quality degradation has potential effects to urban area and rural residential drinking water quality. Within the SKGSA there are 5 urban agencies operating numerous community groundwater wells. Under California law, agencies that provide drinking water are required to routinely sample groundwater from their wells and compare the results to potable water standards (MCL), as appropriate for the individual chemicals. These results are reported by the water purveyors in Consumer Confidence Reports and are publicly available. Degraded groundwater quality can make drinking water treatment more difficult and expensive.

Residential structures not located within the service areas of the 5 SKGSA urban agencies will typically have private domestic groundwater wells. Such wells are not monitored routinely and groundwater quality from those wells is unknown unless the landowner has initiated testing and shared the data. Degraded water quality could potentially lead to rural residential use of groundwater not meeting potable water standards or the need for installation of new domestic wells to deeper depths to reach groundwater of better quality.

4.5.1.3 Evaluation of Multiple Minimum Thresholds

Regulation Requirements:

§354.26 (c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.

It is not practical for a single exceedance to lead to an undesirable result for the entire GSA; therefore, an undesirable result determination will be based on multiple monitoring locations within the GSA over consecutive years.

4.5.2 Minimum Thresholds

Regulation Requirements:

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

Groundwater quality in the SKGSA is generally suited for irrigation and domestic use, although groundwater issues for drinking water exist in some areas within the SKGSA. The minimum thresholds have been set consistent with State and local water quality standards to be protective of water uses and users and are intended to be protective of human health (Title 22 of the CCR). The publicly available groundwater quality data from the selected representative wells will be obtained annually and either compared against MCL values, if recent historical data has indicated chemicals of concern were initially below MCLs, or evaluated for groundwater quality trends with respect to the chemicals of concern if recent historical data has indicated chemicals of concern were initially above MCLs. MCLs for the chemicals of concern are listed in **Table 4-6**: Water Quality MCLs.

Regulation Requirements:

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

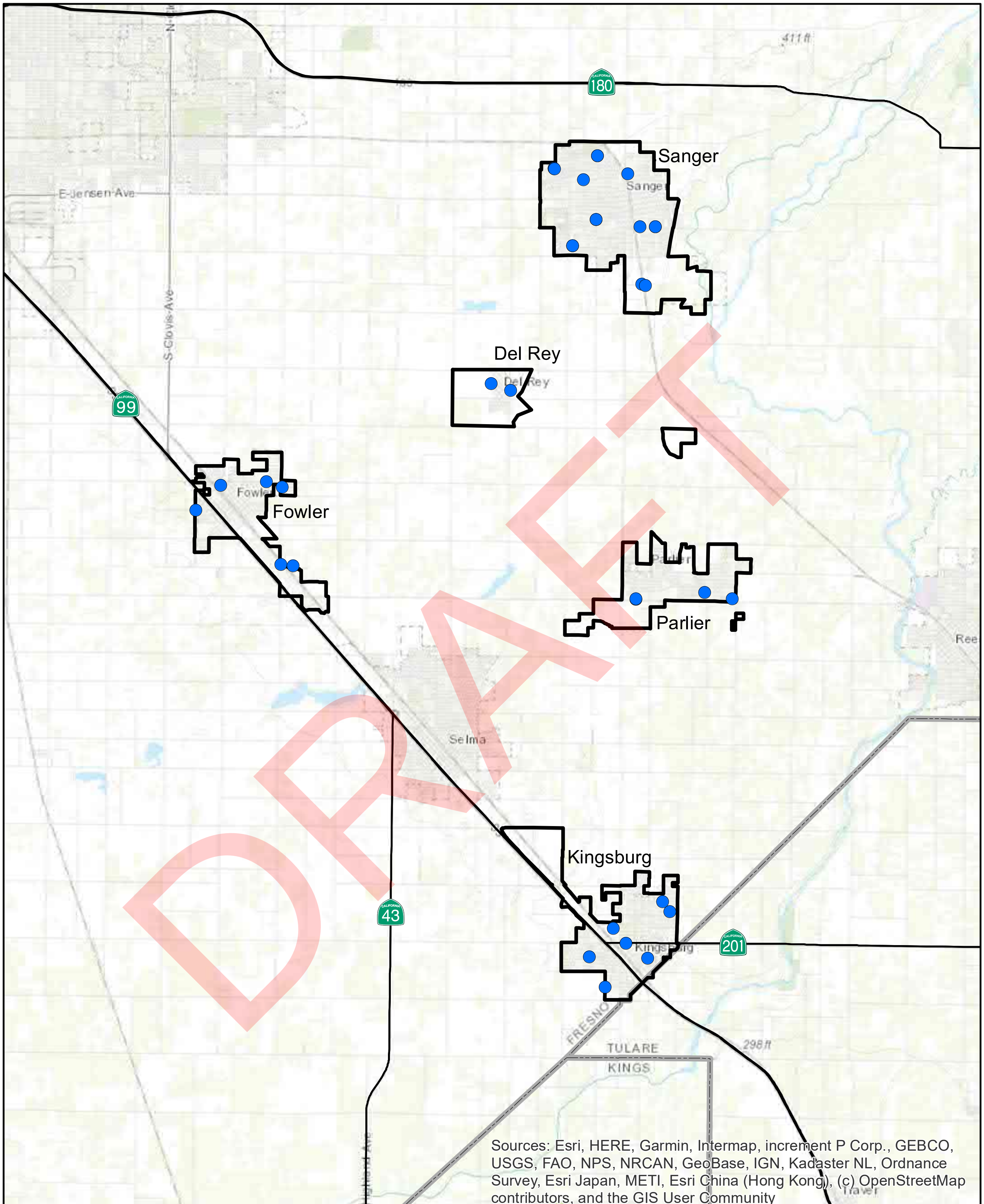
Declining water levels can potentially lead to increased concentrations of some chemicals that reside in larger proportions in deeper aquifer zones, such as arsenic or uranium. Conversely rising water levels can also lead to increased concentrations of some chemicals of concern, for example nitrates, that may reside in unsaturated soils at shallower depths. Groundwater levels will not be used as a proxy for water quality due to a lack of clear correlation between groundwater levels and changes in water quality.

4.5.2.1 Criteria to Define Minimum Thresholds

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following: (1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting. **§354.28** (c) Minimum thresholds for each sustainability indicator shall be defined as follows: (4) Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be used on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.

The criteria to define minimum thresholds will be based on the MCL values of the chemicals of concern discussed in **Section 3.2** of this GSP. The publicly available groundwater quality data from the selected representative wells will be obtained annually and either compared against MCL values, if recent historical data has indicated chemicals of concern were initially below MCLs, or evaluated for groundwater quality trends with respect to the chemicals of concern if recent historical data has indicated chemicals of concern were initially above MCLs.



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South Kings GSA

County

Active Well - Water Quality Monitoring

South Kings GSA

Water Quality Indicator Wells

Figure 4-9

7/9/2019 : G:\South Kings GSA - 2731\273118001 - SGMA On-Call Services\GIS\Map\GW\Monitoring_WQ.mxd

4.5.2.2 Relationships Between Minimum Thresholds and Sustainability Indicators

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(2) The relationship between the minimum thresholds for each sustainability indictor, including and explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.

Changes to groundwater quality can be related to significant changes in groundwater levels and groundwater storage sustainability indicators. Declining water levels, which relate directly with a reduction of groundwater storage, can potentially lead to increased concentrations of chemical of concern for those that reside in larger proportions in deeper aquifer zones, such as arsenic or uranium. Conversely, rising water levels, which relate directly with an increase in groundwater storage, can also lead to increased concentrations of some chemicals of concern, for example nitrates, that may reside in unsaturated soils at shallower depths. Groundwater quality cannot be used to predict responses of other sustainability indicators; however, groundwater quality can potentially be affected by changes in groundwater levels and reduction of groundwater storage indicators. Based on this relationship, groundwater quality minimum thresholds should be established separately from other indicators.

4.5.2.3 Minimum Thresholds in Relation to Adjacent Basins

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.

The minimum threshold for groundwater quality is protective of water uses and users and will prevent causing undesirable results in adjacent basins and will not affect the ability of adjacent basins to achieve sustainability goals.

4.5.2.4 Impact of Minimum Thresholds on Beneficial Uses and Users

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.

The minimum thresholds for groundwater quality will be protective of water uses and users from degradation of groundwater quality by known chemicals of concern to concentrations detrimental to human health. The minimum threshold for degraded water quality maintains existing and potential future beneficial uses of land and property interests.

4.5.2.5 Current Standards Relevant to Sustainability Indicator

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.

The minimum thresholds for water quality are protective of human health and intended beneficial use and are based around MCLs found in Title 22 of the California Code of Regulations. The intent of SGMA is for the GSAs is to be responsible for groundwater aspects related to pumping only. Other existing agencies and programs are generally responsible for groundwater quality remediation. Minimum thresholds may differ from MCLs in locations where recent historically groundwater quality data indicates that MCLs have already been exceeded.

4.5.2.6 Measurement of Minimum Thresholds

Regulation Requirements:

§354.28 (b) The description of minimum thresholds shall include the following:
(6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.

Groundwater monitoring and reporting by community water systems and non-community public supply wells is a requirement of California Code of Regulations (CCR) Title 22. Community and other public supply wells within the SKGSA area are already being monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyors under Title 22. The publicly available groundwater quality data from selected representative wells will be obtained annually and either compared against MCL values, if recent historical data has indicated chemicals of concern were initially below MCLs, or evaluated for groundwater quality trends with respect to the chemicals of concern utilizing appropriate statistical methods, such as the Mann-Kendall trend test. The Mann-Kendall trend test is a nonparametric test used to identify a trend in a series, even if there is a seasonal component to the series.

Selected public supply wells that will form the basis of the representative monitoring wells for groundwater quality are shown on **Table 4-7**. The density of groundwater quality representative monitoring wells is approximately two wells per township. Locations were selected to be representative of large and small communities dependent on groundwater and to spatially cover the GSA. The chemicals of concern that the individual wells are routinely monitored for are summarized in **Table 4-7**. The representative groundwater quality monitoring network will be evaluated and revised if needed in subsequent GSP 5-year revisions.

Table 4-7: Selected Representative Wells and Monitored Chemicals of Concern

Community Name	State Well ID No.	Township	Constituents of Concern Tested for						
			Ar	TCP	Cr6	DBCP	MTBE	Nitrate as NO_3	Ur
Del Rey CSD	1010035-006	T15S/R22E	X	X	--	X	X	X	--
	1010035-007	T15S/R22E	X	X	--	X	X	X	--
City of Fowler	1010006-007	T15S/R21E	X	X	--	X	X	X	--
	1010006-008	T15S/R21E	X	X	--	X	X	X	--
City of Kingsburg	1010019-015	T16S/R22E	X	X	--	X	X	X	--
	1010019-016	T16S/R22E	X	X	--	X	X	X	--
City of Parlier	1010025-010	T15S/R22E	X	X	--	X	X	X	--
	1010025-012	T15S/R22E	X	X	--	X	X	X	--
City of Sanger	1010029-003	T14S/R22E	X	X	--	X	X	X	--
	1010029-022	T14S/R22E	X	X	--	X	X	X	--

Notes: 1010035 = Del Rey CSD, 1010006 = City of Fowler, 1010019 = City of Kingsburg, 1010025 = City of Parlier, 1010029 = City of Sanger

4.5.3 Measurable Objectives

Within the Kings Basin, the measurable objective shall be to maintain water quality at potable water standards, or in other words, below MCLs for the chemicals of concern. In areas where chemical concentrations are initially above MCLs, the measurable objective shall be to maintain stable or improving groundwater quality trends.

4.5.3.1 Description of Measurable Objectives

Regulation Requirements:

§354.30 (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.
(b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.

Groundwater within the SKGSA is generally used beneficially for municipal/domestic consumption or agriculture. Groundwater quality standards are typically higher than those required for agriculture. The minimum threshold for degraded water quality has been set at values that are protective of human health and intended beneficial use and users of groundwater resources (i.e., CCR Title 22).

For wells within the monitoring network (either existing or future wells), where concentrations of the chemicals of concern are recent historically below MCLs, the measurable objective is to maintain water quality at potable water standards, or in other words, below MCLs for the chemicals of concern. In situations where monitoring network wells (either existing or future wells) have recent historically concentrations above MCLs for contaminants of concern, the measurable objective is for the wells to maintain stable or improving groundwater quality trends in regard to the identified chemicals of concern.

4.5.3.2 Operational Flexibility

Regulation Requirements:

§354.30 (c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.
§354.30 (g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for finding of inadequacy of the Plan.

For wells within the monitoring network (either existing or future wells), where concentrations of the chemicals of concern are recent historically below MCLs, the operational flexibility is the difference between the MCL and recent historic concentration of the chemical of concern. No operation flexibility will be set at this time for situations where monitoring network wells (either existing or future wells) have recent historically concentrations above MCLs for contaminants of concern.

4.5.3.3 Representative Monitoring

Regulation Requirements:

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

Groundwater levels will not be used as a proxy for water quality due to a lack of clear correlation between groundwater levels and changes in water quality.

4.5.3.4 Path to Achieve Measurable Objectives

Regulation Requirements:

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

Groundwater pollution characterization and remediation are enforced by local agencies and state level programs. The GSA will only have authority related to groundwater pumping policies, however the GSA will review and analyze publicly available routine groundwater monitoring data reported by the community and non-community public supply wells in order to understand how and if groundwater pumping is exacerbating groundwater quality concerns and when and where to enforce pumping restrictions or other mitigation measures should it become necessary. Management of groundwater pumping will occur over the lifetime of the planning and implementation horizon. No interim milestones have been set for the water quality indicator.

If an undesirable result occurs with regards to groundwater quality, actions may include:

- Increased frequency of monitoring well sampling
- Additional data analysis
- Increased groundwater recharge in the area(s) of concern
- Increased use of surface water in the area(s) of concern
- Working collaboratively with state and local groundwater quality protection agencies and programs

4.5.3.5 Measurable Objectives for Additional Plan Elements

Regulation Requirements:

§354.30 (f) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.
§354.30 (g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for finding of inadequacy of the Plan.

SKGSA will not be setting measurable objectives or interim milestones for additional plan elements described in Water Code Section 10727.4.

4.6 Land Subsidence

Regulation Requirements:

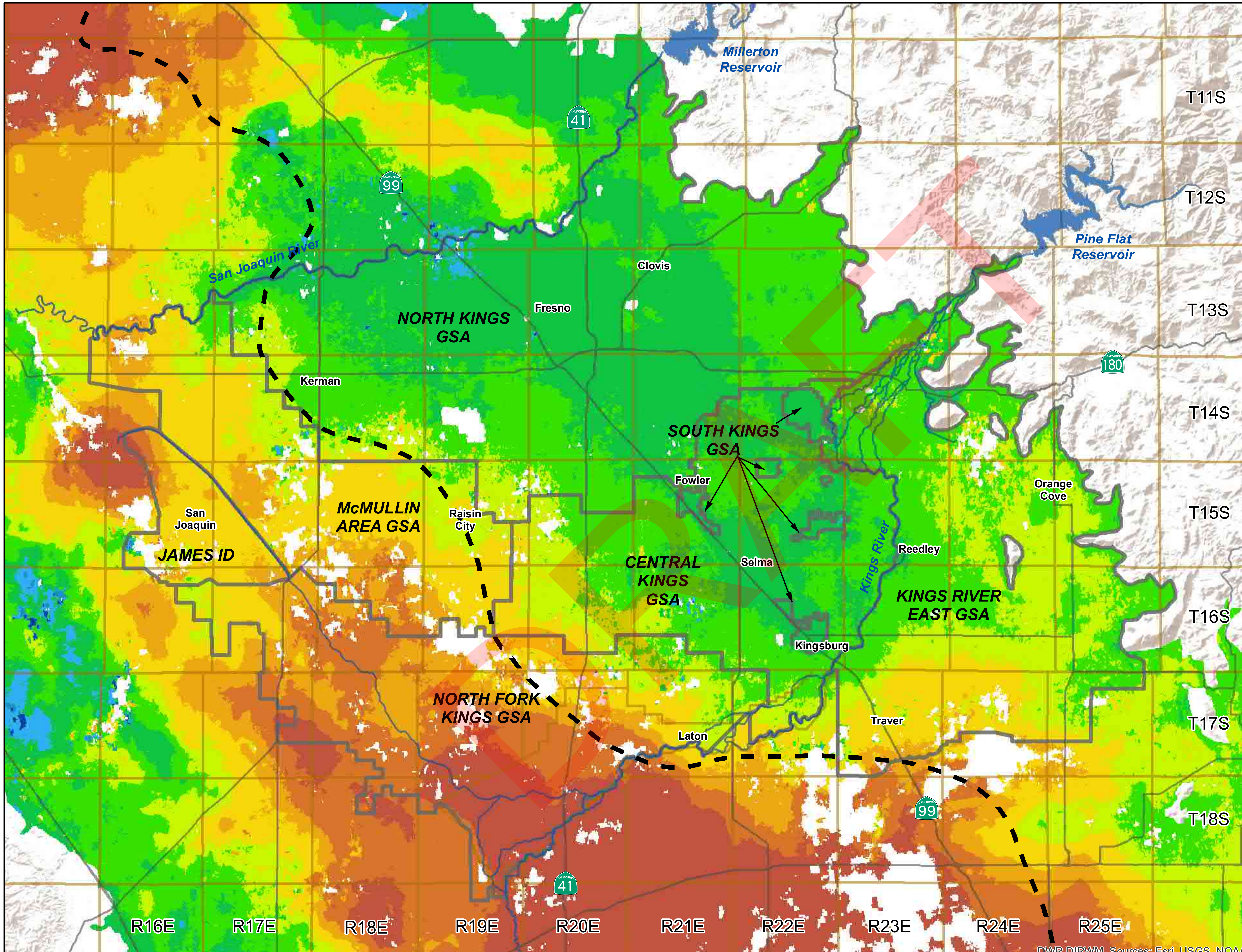
§354.26 (d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.

As seen in the Groundwater Conditions section of the Basin Setting section (**Section 3.2.6**), NASA InSAR data shows that subsidence in most of the SKGSA area was between 0 and 1 inch over a two year period (see **Figure 4-10**). This amount of subsidence is considered very minimal and has had no visual impacts on structures or wells. Furthermore, most inelastic subsidence occurs when there is heavy pumping from below a confining layer such as the E clay; however, this layer does not extend to the SKGSA area, thus subsidence is not anticipated to be an issue. Lastly, as groundwater levels are stabilized over the implementation of this plan, the minimal subsidence is expected to do the same. Therefore, no criteria needs be established for sustainable management criteria. It is planned that there will be periodic checkups to identify if this assertion continues to be true. If trends do not behave as expected, criteria may be established in the future as needed.

Kings Subbasin
Coordinated Effort

Land Subsidence
NASA (via CA Dept. Water Resources)
2015-2017

Figure 4-10



Legend

Kings Subbasin GSAs

Township/Range

E-Clay Eastern Extent

Page and LeBlanc 1969, modified by KDSA

NASA InSAR Data (provided by CA DWR) *

Change from May 2015 to April 2017 (inches)

- 2 to 6
- 1 to 2
- 0 to 1
- -1 to 0
- -2 to -1
- -3 to -2
- -5 to -3
- -7 to -5
- -10 to -7
- -15 to -10

* The legend shows the change in ground surface elevation from May 2015 to April 2017. The positive values indicate rebound while the negative values indicate land subsidence.

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4.7 Interconnected Surface Water and Groundwater

Regulation Requirements:

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

Interconnected surface water has been defined in the California Code of Regulations Title 23, Division 2, Chapter 1.5, Subchapter 2 as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.

The only place that SKGSA may be close enough to affect river flows is in the south east corner of Sanger; however, most of the wells for municipal use are located closer to the center of town, away from the river. The only other surface water in the SKGSA area are a couple of Consolidated ID canals that run through the cities, but groundwater depth throughout the rest of the GSA ranges from 40 to 80 feet, indicating a lack of connection. Lastly, the Kings River Water Association has a fisheries management program that requires instream flows on the river during the fall, winter, and spring months. Since the program maintains flows in the river, seepage from the river helps to keep groundwater levels in the nearby area at a relatively constant level. Due to the current lack of undesirable results and the unlikely event that undesirable results will occur caused by SKGSA pumping, sustainable management criteria will not be evaluated for interconnected surface water.

5 Monitoring Network

Regulation Requirements:

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

A comprehensive monitoring network is a fundamental component of groundwater management and is needed to measure progress toward groundwater sustainability. Below, Figure 5-1 includes the monitoring programs needed to comply with SGMA monitoring and reporting requirements.

Groundwater Levels

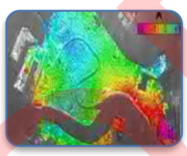
- Monitoring of static groundwater levels each spring and fall.

Groundwater Storage

- Measurement of the annual change in groundwater storage.

Water Quality

- Monitoring for water quality degradation that could impact available groundwater supplies.

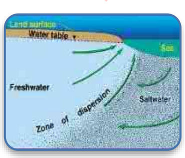


Land Subsidence

- Surface land subsidence caused by groundwater withdrawals.

Depletion of Interconnected Surface Water

- Loss of permanent connections between surface water and groundwater.



Seawater Intrusion

- Intrusion of seawater into local aquifers. This is not applicable to the SKGSA.

Figure 5-1: Monitoring Programs

5.1 Introduction

Regulation Requirements:

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

This section identifies the monitoring network being developed by the SKGSA that collects sufficient data to determine short-term, seasonal, and long-term trends in groundwater and related surface conditions and will yield information necessary to support the implementation of this Plan, evaluation of the effectiveness of this Plan, and decision making by the SKGSA management. This section describes current and future monitoring programs. The results of historical monitoring efforts can be found in **Section 3.2**.

5.1.1 Monitoring Network Objectives

Regulation Requirements:

> **§354.34(b)** Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:
> 1. Demonstrate progress toward achieving measurable objectives described in the Plan.
> 2. Monitor impacts to the beneficial uses or users of groundwater
> 3. Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.
> 4. Quantify annual changes in water budget components.

The objectives of the various monitoring programs include the following:

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

5.1.2 Network Development Process

Regulation Requirements:

> **§354.34(c)** Each monitoring network shall be designed to accomplish the following for each sustainability indicator: [§354.34(c)(1) through §354.34(c)(6) are individually listed below]

Groundwater monitoring has been performed in the area for many decades by the member agencies that pump and supply domestic water; additionally, Consolidated Irrigation District monitors groundwater on a regular basis. These programs will continue to comply with SGMA monitoring requirements. Past monitoring has been performed on a local agency level with data sharing between neighboring agencies to better understand groundwater boundary conditions, such as depth to water and flow. These partnerships will also be maintained and enhanced to provide useful agency and region-wide information.

New monitoring networks will be developed when needed, and existing networks enhanced when necessary, using the Data Quality Objective (DQO) process, which follows the U.S. Environmental Protection Agency (EPA) *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006). The DQO process is also outlined in the DWR's Best Management Practices for monitoring networks (2016a) and monitoring protocols (2016b). The DQO process includes the following:

1. State the problem.
2. Identify the goal.
3. Identify the inputs.
4. Define the boundaries of the area/issue being studied.
5. Develop an analytical approach.
6. Specify performance or acceptance criteria.
7. Develop a plan for obtaining data.

The DQO process helps to ensure a robust approach and that data is collected with a specific goal in mind. Following are descriptions of the GSA's monitoring networks for groundwater levels, groundwater storage, water quality, land subsidence, and depletion of interconnected surface water. **Figure 4-2** and **Figure 4-9** are maps showing the proposed monitoring sites; **Figure 4-2** represents indicator wells for all aspects except Groundwater Quality, which will be monitored utilizing existing municipal production wells as shown in **Figure 4-9**.

5.2 Groundwater Levels

5.2.1 Description of Monitoring Network

Regulation Requirements:

§354.34(c)(1) Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:
A). A sufficient density of monitor wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.
B) Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.

Groundwater levels have been monitored in most of the GSA area since the 1920s. Each agency will continue to manage its groundwater level monitoring network, and the SKGSA may assist with data collection and monitoring. The data will be compiled into a single database to assist with regional evaluations, groundwater contour maps, groundwater flow determination, and annual reporting. Data will also be shared with each of the six other GSAs in the Kings Basin to prepare regional groundwater contour maps and annual reports.

The SKGSA members have measured groundwater levels on a sporadic basis; however, Consolidated Irrigation District (CID) (a member of the CKSGA) monitors groundwater levels on a regular basis. In the future, SKGSA and CKGSA will collaborate to monitor groundwater levels in the spring and fall, on a reliable basis to provide consistency in the measurements.

Groundwater levels are measured in various types of wells including:

- Municipal wells: Most municipal wells are available for monitoring (*this will be a possible source of future data; there is not consistent data available historically from this source).*
- Wells in Adjacent GSAs: Groundwater level data from the CKGSA, as well as other adjoining areas, will also be collected to help provide better interpretation of GSA boundary flow conditions.

There is an unconfined aquifer, covering the entire GSA (see **Figure 3-3**). As indicated in **Section 3.1**, there is an enhanced concept of confined groundwater conditions over most of the SKGSA (outside of the area underlain by the Corcoran Clay). The SKGSA will develop a program to obtain additional construction information on wells in the monitoring network.

5.2.2 Adequacy of Monitoring Network

Regulation Requirements:

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.
§354.34(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

The existing groundwater-level monitoring network has performed adequately for several decades in preparing groundwater contour maps and identifying groundwater level trends. The urban areas have dense well networks and Well Completion Reports are available for some municipal wells. The current density of the monitoring network is adequate throughout the entire GSA (see **Section 5.2.3**).

5.2.3 Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§354.34(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:
1) Amount of current and projected groundwater use.
2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.
3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.
4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

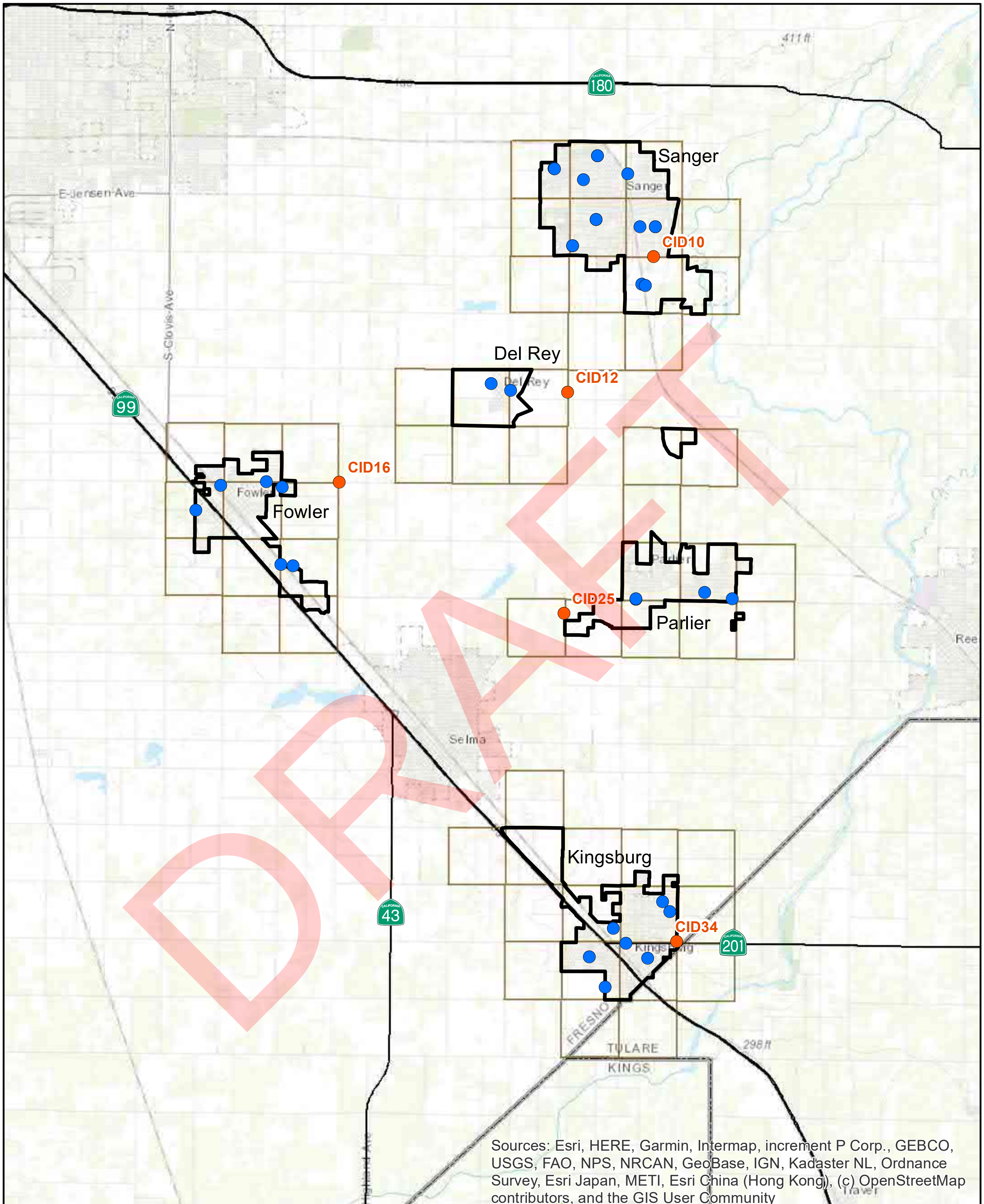
Groundwater levels in the GSA area have been monitored since at least the 1920s. Many wells have been continuously monitored for much of that time. This data has enhanced understanding of long-term trends and the ability of the aquifer to respond to droughts and wet periods.

The groundwater levels will be monitored in the spring (March) and fall (October) of each year. This differs slightly from historical measurements, but the GSA participants have agreed to this schedule to provide consistency in the data. Spring measurements are designed to capture the recovery of the groundwater basin after an extended period of minimal agricultural and landscape irrigation demand, assuming a normal rainfall. The fall measurement would capture a period after peak irrigation and summertime urban demands have ceased, thereby showing the cumulative impacts on the groundwater basin before any natural recovery has taken place.

Hopkins and Anderson (2016) provide recommendations for groundwater-level monitor well densities. The densities range from 1 well per 150 square miles to 1 well per 25 square miles based on the quantity of groundwater pumped. A minimum density of 1 well/50 square miles is recommended for areas using over 10,000 AF and less than 100,000 AF of groundwater per year. Groundwater use in the SKGSA is greater than 10,000 AF and does not currently exceed 100,000 AF/year. As a result, a minimum well density of 1 well/50 square miles will be used. Well density is tracked per 36-square-mile Township, which results in about 1.5 wells per Township. A more practical value of 2 wells/Township is adopted resulting in a minimum density of 1 well/18 square miles.

Figure 5-2 shows the monitored wells density by Township for the SKGSA area and the area just outside the SKGSA boundary. The density ranges from 3 wells to 61 wells per township within the SKGSA boundary and 1 well to 81 wells per township outside the SKGSA boundary.

The minimum density of 2 wells/Township shall include *High Quality Monitoring Points*, which are defined as wells with reliable access each spring and fall, information on the well depth and perforated interval, and sufficient depth to accommodate seasonal fluctuations. Wells that do not meet these guidelines will be maintained in the network, as they can still provide useful information. Well construction information on these wells may be obtained in the future, and it is desired to keep wells that have a long period of record. During development of groundwater contours, those wells with and without well construction information will be labeled to assist with the analysis.



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Section
Active Well - Water Quality Monitoring
Well - Water Level Monitoring

South Kings GSA

Monitoring Well Density

Figure 5-2

5.2.4 Monitoring Network Information

Regulation Requirements:

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

The following sections describe the monitoring network, including scientific rational for the selection; consistency with data and reporting standards; corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone; and the locations of the monitoring sites.

5.2.4.1 Scientific Rational for Site Selection

Regulation Requirements:

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

The scientific rationale for the groundwater level monitoring network includes the following:

- The network meets the minimum density goal of 1 well/18 square miles.
- The network has performed adequately for several decades in providing information for annual reporting, groundwater contour maps, and estimation of storage change.
- Many existing wells have a significant period of record (i.e., greater than 20 years) and are useful for long-term evaluations.

The following scientific rationale will be used to add new wells:

- Add wells whenever necessary to maintain minimum monitor well density (1 well/18 square miles).
- Avoid wells located near water bodies, such as canals, reservoirs, etc.
- Avoid wells perforated across multiple aquifers.
- Select dedicated monitor wells over production wells where feasible.
- Select wells with available construction information (i.e., depth, perforated interval).
- Avoid domestic wells since they are rarely idle.

5.2.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

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

The data gathered through the monitoring networks is consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as Error! Reference source not found..

- Data reporting units (i.e., Water volumes shall be reported in acre-feet, etc.)
- Monitoring site information (i.e., Site identification number, description of site location, etc.)
- Well attribute reporting (i.e., CASGEM well identification number, casing perforations, etc.)
- Map standards (i.e., Data layers, shapefiles, geodatabases shall be submitted in accordance with the procedures described in Article 4, etc.)
- Hydrograph requirements (i.e., Hydrographs shall use the same datum and scaling to the greatest extent practical, etc.)
- Groundwater and surface water models (i.e., The model shall include publicly available supporting documentation, etc.)

5.2.4.3 Quantitative Values

Regulation Requirements:

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

The quantitative values for minimum threshold, measurable objective, and interim milestones will be set for each well in the monitoring network. Refer to **Section 4.2.2.1** in the Sustainable Management Criteria section for the table with the criteria set for each well.

5.2.5 Monitoring Locations

Regulation Requirements:

> **§354.34(h)** The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.

Figure 4-3 shows the monitoring site locations for groundwater levels, land subsidence, and groundwater storage. Figure 4-9 shows the monitoring site locations for groundwater quality.

Monitoring is also performed in areas outside of the GSA to help document more accurate boundary conditions. Groundwater level data is collected up to a few miles outside of the border, except on the eastern edge since the alluvial groundwater basin boundary is coterminous with the GSA boundary. Land subsidence is also monitored up to five miles outside of the border to track possible encroachment of subsidence into the GSA.

5.2.6 Monitoring Protocols

Regulation Requirements:

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

Groundwater level monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, 2016). Refer to **Appendix I** for a copy of the BMP. The GSA may develop standard monitoring forms in the future if deemed necessary.

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

- SGMA regulations require that groundwater levels be measured to the nearest 0.1 feet. The BMP suggests measurements to the nearest 0.01 feet; however, this is not practical for many measurement methods. In addition, this level of accuracy would have little value since groundwater contours maps typically have 10- or 20-foot intervals, and storage calculations are based on groundwater levels rounded to the nearest foot. The accuracy of groundwater level measurements will vary based on the well type and condition. For instance, if significant oil is found in an agricultural well, then readings to the nearest foot are the best one can achieve.
- Wells will be surveyed to a horizontal accuracy of 0.5 feet.
- Unique well identifiers will be labeled on all public wells and on private wells if permission is granted.
- The BMP states that measurements each spring and fall should be taken "preferably within a 1-to-2-week period." This is likely not feasible due to the large number of wells in the GSA, and a 4-week period will be granted for biannual monitoring.
- If a vacuum or pressure release is observed, then water level measurements will be remeasured every 5 minutes until they have stabilized.

- In the field, water level measurements will be compared to previous records; if there is a significant difference, then the measurement will be verified.

5.2.7 Representative Monitoring

Regulation Requirements:

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

5.2.7.1 Description of Representative Sites

Regulation Requirements:

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

DWR has referred to representative monitoring as utilizing one well to represent an entire GSA or Management Area. Use of one representative well in the SKGSA is not practical to cover such a large area with varying conditions. Not all wells within the SKGSA are monitored, so a subset of wells are used as representative of conditions in the GSA. Groundwater conditions can vary substantially across the GSA. The area has a history of using multiple wells to monitor groundwater and will continue to use available water level data from multiple wells to assess groundwater conditions.

5.2.7.2 Use of Groundwater Elevations as Proxy for Other Sustainability Indicators

Regulation Requirements:

§354.36(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:
1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.
2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.
§354.36(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

SKGSA does not plan to use groundwater elevations as a proxy for monitoring other sustainability indicators. As noted, groundwater elevations will be used as a critical component of groundwater storage estimation, but the elevation monitoring will not replace the storage change estimation.

5.2.8 Assessment and Improvement of Monitoring Network

5.2.8.1 Review and Evaluation of Monitoring Network

Regulation Requirements:

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

This section includes a description of the different types of data gaps, a summary of existing data gaps in each monitoring network, and future plans to fill the data gaps.

5.2.8.2 Identification of Data Gaps

Regulation Requirements:

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

There are three general types of data gaps to consider for monitoring networks:

- **Temporal:** Insufficient frequency of monitoring. For instance, data may be available from a well only in the fall since it is rarely idle in the spring. In addition, a privately owned well may have sporadic access due to locked security fencing, roaming dogs, change in ownership, etc.
- **Spatial:** Insufficient number or density of monitoring sites in a specific area.
- **Insufficient quality of data:** Data may be available but be of poor or questionable accuracy. Poor data may at times be worse than no data since it could lead to incorrect assumptions or biases. The data may not appear consistent with other data in the area or with past readings at the monitoring site. The monitoring site may not meet all the desired criteria to provide reliable data, such as having information on perforation depth, etc. Past experiences have shown that well location information on Well Construction Reports is often poor, making it difficult or impossible to match wells with their well logs.

Following are discussions on these data gaps in the existing monitoring network:

Temporal Data Gaps: There are currently no temporal data gaps in the network. The existing network currently has enough redundancy that temporal gaps are not an issue.

Spatial Data Gaps: There are currently no spatial gaps in the network. **Figure 4-3** and **Figure 4-9** show that monitor well density far exceeds the minimum goal of 2 wells/Township in most of the GSA.

Insufficient Quality of Data: The data is from dedicated monitor well information of known construction. The monitoring wells for water quality are often of known construction, but not in all cases. Collecting well attribute information will remain a priority.

5.2.8.3 Plans to Fill Data Gaps

Regulation Requirements:

§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:
1) The location and reason for data gaps in the monitoring network.
2) Local issues and circumstances that limit or prevent monitoring.

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

The data gaps have been identified.

5.2.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

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

The frequency and density of the proposed monitoring programs are discussed in previous sections. The criteria are considered adequate to provide sufficient monitoring data and to satisfy SGMA requirements. Beginning in

2020, when groundwater conditions are compared to sustainability goals, the monitoring network may be modified or enhanced if deemed necessary.

5.3 Groundwater Storage

5.3.1 Description of Monitoring Network

Regulation Requirements:

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

The CID and FID, immediately north of the SKGSA, have estimated groundwater storage change estimates, annually, for many years. The general methodology used in those efforts will continue to be used by the SKGSA, as well as the other GSAs in the subbasin.

Groundwater storage change will be estimated by multiplying local specific yield values by the change in groundwater levels. As part of the GSP development, specific yield values originally identify by FID were reviewed and refined through an extensive literature search and prioritization of several data sources (see map in **Section 3.1.8.1**). Specific yield values were estimated for each designated area, usually by 36-square-mile Townships, for depths of 10-50 feet, 50-100 feet, and 100-200 feet below the ground surface. In some areas, specific yield data is limited to one value from 10-300 feet.

The process for calculating storage capacity includes the following steps:

1. Calculate average depth to groundwater for each specific yield area based on spring groundwater levels.
2. Multiply the height of water within each depth zone by the specific yield for that depth zone and by the area of that specific yield area within the Plan area.
3. Sum the total storage capacity for all areas.
4. Compare storage capacity from one year to the next.

A multi-year average will be evaluated and compared to long-term trends to understand the impact of the implementation of the Plan.

5.3.2 Adequacy of Monitoring Network

Regulation Requirements:

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.
§354.34(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

Groundwater storage capacity has been calculated for many years using local groundwater levels and specific yield values. This methodology has proved adequate in estimating annual change in groundwater storage. The program has been enhanced with a more robust groundwater level network with an adequate density and refined specific yield values. Groundwater storage calculations are largely dependent on the groundwater level network. Collection of well attribute information described above will also benefit groundwater storage monitoring.

5.3.3 Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§354.34(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:
1) Amount of current and projected groundwater use.
2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.
3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.
4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

Groundwater storage change will be estimated annually, based on spring groundwater levels. Groundwater storage changes will generally be reported for each 36-square mile Township, which is based largely on the geographic availability of specific yield data (see **Figure 3-19**: Recommended Specific Yield in **Section 3.1**). The areas used are considered reasonable since overdraft is typically estimated on a regional scale; estimating overdraft on a very small or local scale may provide misleading results. Only wells with reasonable and reliable data will be used to develop groundwater contours and estimate storage change.

5.3.4 Monitoring Network Information

Regulation Requirements:

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

The following sections describe the monitoring network, including scientific rational for the selection; consistency with data and reporting standards; corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone; and the locations of the monitoring sites.

5.3.4.1 Scientific Rational for Site Selection

Regulation Requirements:

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

Change in groundwater storage is based on a simple calculation involving the specific yield and change in groundwater levels. The groundwater level monitoring sites are discussed above. Specific yield values were acquired from several publications (see **Section 3.1.8.1**) and are based on textural analysis of numerous Well Completion Reports. The specific yield values generally cover 36-square mile Townships with some exceptions. While this method is subject to some error, it is considered the most reliable method to estimate storage change since it is based largely on measured data. Storage change can also be estimated with a water balance exercise, but that is subject to significant uncertainty and cumulative errors from numerous parameters.

5.3.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

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

The data gathered through the monitoring networks is consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as Error! Reference source not found..

- Data reporting units (i.e., Water volumes shall be reported in acre-feet, etc.)
- Monitoring site information (i.e., Site identification number, description of site location, etc.)
- Well attribute reporting (i.e., CASGEM well identification number, casing perforations, etc.)

- Map standards (i.e., Data layers, shapefiles, geodatabases shall be submitted in accordance with the procedures described in Article 4, etc.)
- Hydrograph requirements (i.e., Hydrographs shall use the same datum and scaling to the greatest extent practical, etc.)
- Groundwater and surface water models (i.e., The model shall include publicly available supporting documentation, etc.)

5.3.4.3 Quantitative Values

Regulation Requirements:

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

The quantitative values for minimum threshold, measurable objective, and interim milestones will be set for each well in the monitoring network. Refer to **Section 4.2.2.1** for the table with the criteria set for each well.

5.3.5 Monitoring Locations

Regulation Requirements:

§354.34(h) The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.

Figure 4-3 shows the monitoring site locations for groundwater levels, land subsidence, and groundwater storage.

Monitoring is also performed in areas outside of the GSA to help document more accurate boundary conditions. Groundwater level data is collected up to few miles outside of the border, except on the eastern edge since the alluvial groundwater basin boundary is coterminous with the GSA boundary. Land subsidence is also monitored up to five miles outside of the border to track possible encroachment of subsidence into the GSA.

5.3.6 Monitoring Protocols

Regulation Requirements:

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

Monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, 2016). Refer to **Appendix I** for a copy of the BMP. The GSA may develop standard monitoring forms in the future if deemed necessary.

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

- Wells will be surveyed to a horizontal accuracy of 0.5 feet.
- The BMP states that measurements each spring and fall should be taken "preferably within a 1-to-2-week period." This is likely not feasible due to the large number of wells in the GSA, and a 4-week period will be granted for biannual monitoring.
- If a vacuum or pressure release is observed, then water level measurements will be remeasured every 5 minutes until they have stabilized.
- In the field, water level measurements will be compared to previous records; if there is a significant difference, then the measurement will be verified.

5.3.7 Representative Monitoring

Regulation Requirements:

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

5.3.7.1 Description of Representative Sites

Regulation Requirements:

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

DWR has referred to representative monitoring as utilizing one well to represent an entire GSA or Management Area. Use of one representative well in the SKGSA is not practical to cover such a large area with varying conditions. Not all wells within the SKGSA are monitored, so a subset of wells are used as representative of conditions in the GSA. Groundwater conditions can vary substantially across the GSA. The area has a history of using multiple wells to monitor groundwater and will continue to use available water level data from multiple wells to assess groundwater conditions.

5.3.7.2 Use of Groundwater Elevations as Proxy for Other Sustainability Indicators

Regulation Requirements:

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

1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.

2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

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

SKGSA does not plan to use groundwater elevations as a proxy for monitoring other sustainability indicators. As noted, groundwater elevations will be used as a critical component of groundwater storage estimation, but the elevation monitoring will not replace the storage change estimation.

5.3.8 Assessment and Improvement of Monitoring Network

5.3.8.1 Review and Evaluation of Monitoring Network

Regulation Requirements:

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

This section includes a description of the different types of data gaps, a summary of existing data gaps in each monitoring network, and future plans to fill the data gaps.

5.3.8.2 Identification of Data Gaps

Regulation Requirements:

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

There are three general types of data gaps, as discussed previously, Temporal, Spatial, and Insufficient Quality of Data.

No data gaps were identified in the groundwater storage network, except for the groundwater level gaps described above, since storage change is dependent on groundwater level readings.

5.3.8.3 Plans to Fill Data Gaps

Regulation Requirements:

§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:
1) The location and reason for data gaps in the monitoring network.
2) Local issues and circumstances that limit or prevent monitoring.

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

No data gaps were identified.

5.3.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

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

The frequency and density of the proposed monitoring programs are discussed in previous sections. The criteria are considered adequate to provide sufficient monitoring data and to satisfy SGMA requirements. Beginning in 2020, when groundwater conditions are compared to sustainability goals, the monitoring network may be modified or enhanced if deemed necessary.

5.4 Seawater Intrusion

Regulation Requirements:

§354.34(c)(3) Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.
§354.34(j) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.

The GSA is approximately 100 miles from the ocean; therefore, seawater intrusion is not feasible. In addition, there are no saline water lakes in or near the GSA. As a result, seawater intrusion is not discussed hereafter in this section. Saline water intrusion from up-coning of deep saline groundwater is a potential problem and will be monitored as part of general water quality monitoring (see following section).

5.5 Groundwater Quality

5.5.1 Description of Monitoring Network

Regulation Requirements:

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

Groundwater quality in the SKGSA is generally well suited for irrigation and domestic use, although groundwater issues for drinking water exist in localized areas within the SKGSA. While some of these chemical concerns are caused by humans, several are natural occurring. Groundwater pollution characterization and mitigation are typically enforced by local agencies and state level programs. The SKGSA will only have authority related to groundwater pumping policies. The SKGSA will review and analyze publicly available routine groundwater monitoring data reported by the community and non-community public supply wells in order to understand how and if groundwater pumping is exacerbating groundwater quality concerns and where to enforce pumping restrictions or other mitigation measures should it become necessary.

Groundwater quality concerns within the SKGSA have been identified in **Section 3.2**. Groundwater monitoring and reporting by community water systems and non-community public supply wells is a requirement of California Code of Regulations (CCR) Title 22. Community and other public supply wells within the SKGSA monitoring network area already being routinely monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyors under Title 22. The publicly available groundwater quality data from selected representative wells will be obtained annually and evaluated against sustainable management criteria.

Selected public supply wells that will form the basis of the representative monitoring wells for groundwater quality are shown on **Figure 5-2**: Monitoring Well Density. The density of groundwater quality representative monitoring wells is approximately two wells per township. Locations were selected to be representative of large and small communities dependent on groundwater and to spatially cover the GSA. The representative groundwater quality monitoring network will be evaluated and revised if needed in subsequent GSP 5-year revisions.

5.5.2 Adequacy of Monitoring Network

Regulation Requirements:

> **§354.34(d)** The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.
> **§354.34(e)** A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

Groundwater monitoring and reporting by community water systems and non-community public supply wells is a requirement of California Code of Regulations (CCR) Title 22. Community and other public supply wells within the SKGSA are already being routinely monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyors under Title 22. Selected public supply wells will form the basis of the representative monitoring wells for groundwater quality. Locations were selected to be representative of the communities dependent on groundwater and to adequately spatially cover the GSA.

5.5.3 Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§354.34(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:
1) Amount of current and projected groundwater use.
2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.
3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.
4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

Groundwater Quality

Water quality monitoring is performed at every municipal well in the GSA; however, the density of groundwater quality representative monitoring wells is approximately two wells per township wholly within the GSA. Groundwater quality is tested according to state requirements. Testing frequency varies based on the system size and constituents of concern in the area. The frequency and density of monitoring for contaminant plumes are based on project specific monitoring plans developed for each plume.

5.5.4 Monitoring Network Information

Regulation Requirements:

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

The following sections describe the monitoring network, including scientific rational for the selection; consistency with data and reporting standards; corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone; and the locations of the monitoring sites.

5.5.4.1 Scientific Rational for Site Selection

Regulation Requirements:

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

The scientific rationale for the existing water quality monitoring sites is based primarily on state monitoring requirements and specific monitoring programs established by regulatory agencies. The scientific rationale for the ILRP groundwater quality monitoring is currently being established.

5.5.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

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

The data gathered through the monitoring networks is consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as Error! Reference source not found..

- Data reporting units (i.e., Water volumes shall be reported in acre-feet, etc.)
- Monitoring site information (i.e., Site identification number, description of site location, etc.)
- Well attribute reporting (i.e., CASGEM well identification number, casing perforations, etc.)
- Map standards (i.e., Data layers, shapefiles, geodatabases shall be submitted in accordance with the procedures described in Article 4, etc.)

- Hydrograph requirements (i.e., Hydrographs shall use the same datum and scaling to the greatest extent practical, etc.)
- Groundwater and surface water models (i.e., The model shall include publicly available supporting documentation, etc.)

5.5.4.3 Quantitative Values

Regulation Requirements:

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

The quantitative values for minimum threshold, measurable objective, and interim milestones will be set for each well in the monitoring network. Refer to **Section 4.2.2.1** for the table with the criteria set for each well.

5.5.5 Monitoring Locations

Regulation Requirements:

§354.34(h) The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.

Figure 5-2 shows the monitoring site locations for groundwater quality.

Monitoring is also performed in areas outside of the GSA to help document more accurate boundary conditions. Groundwater level data is collected up to few miles outside of the border, except on the eastern edge since the alluvial groundwater basin boundary is coterminous with the GSA boundary. Land subsidence is also monitored up to five miles outside of the border to track possible encroachment of subsidence into the GSA.

5.5.6 Monitoring Protocols

Regulation Requirements:

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

Groundwater quality monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, 2016). Refer to **Appendix I** for a copy of the BMP. The GSA may develop standard monitoring forms in the future if deemed necessary.

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

- If used in a well suspected of contamination or if there are obvious signs of contamination (such as oil), well sounding equipment will be decontaminated after use.
- Unique well identifiers will be labeled on all public wells and on private wells if permission is granted.
- Field parameters for pH, electrical conductivity, and temperature will only be collected when required for the particular parameter being monitored. Determining if a well has been purged adequately may be ascertained by calculating a run time before sampling.

5.5.7 Representative Monitoring

Regulation Requirements:

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

5.5.7.1 Description of Representative Sites

Regulation Requirements:

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

DWR has referred to representative monitoring as utilizing one well to represent an entire GSA or Management Area. Use of one representative well in the SKGSA is not practical to cover such a large area with varying conditions. Not all wells within the SKGSA are monitored, so a subset of wells are used as representative of conditions in the GSA. Groundwater conditions can vary substantially across the GSA. The area has a history of using multiple wells to monitor groundwater and will continue to use available water level data from multiple wells to assess groundwater conditions.

5.5.7.2 Use of Groundwater Elevations as Proxy for Other Sustainability Indicators

Regulation Requirements:

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

1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.

2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

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

SKGSA does not plan to use groundwater elevations as a proxy for monitoring other sustainability indicators. As noted, groundwater elevations will be used as a critical component of groundwater storage estimation, but the elevation monitoring will not replace the storage change estimation.

5.5.8 Assessment and Improvement of Monitoring Network

5.5.8.1 Review and Evaluation of Monitoring Network

Regulation Requirements:

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

This section includes a description of the different types of data gaps, a summary of existing data gaps in each monitoring network, and future plans to fill the data gaps.

5.5.8.2 Identification of Data Gaps

Regulation Requirements:

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

There are three general types of data gaps, as discussed previously, Temporal, Spatial, and Insufficient Quality of Data.

As discussed in **Section 5.2**, the Groundwater Quality Monitoring Network is considered adequate and has no data gaps. The existing network provides sufficient monitoring in areas of urban use, irrigated lands, and contaminated areas.

5.5.8.3 Plans to Fill Data Gaps

Regulation Requirements:

§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:
1) The location and reason for data gaps in the monitoring network.
2) Local issues and circumstances that limit or prevent monitoring.

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

No data gaps have been identified.

5.5.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

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

The frequency and density of the proposed monitoring programs are discussed in previous sections. The criteria are considered adequate to provide sufficient monitoring data and to satisfy SGMA requirements. Beginning in 2020, when groundwater conditions are compared to sustainability goals, the monitoring network may be modified or enhanced if deemed necessary.

5.6 Land Subsidence

5.6.1 Description of Monitoring Network

Regulation Requirements:

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

Land subsidence within the SKGSA is minimal. Most of subsidence in the San Joaquin Valley has happened and is happening west of the SKGSA over the axial trough of the valley. Most significant subsidence is underlain by the Corcoran Clay member of the Tulare Formation. The Corcoran Clay does not extend into the SKGSA.

While some local agencies in the San Joaquin Valley monitor for land subsidence, the majority rely on monitoring performed by regional water agencies or the state and federal government. Measurement and monitoring for land subsidence are performed by a variety of agencies including USGS, DWR, USBR, USACE, University NAVSTAR (Navigation Satellite Timing and Ranging) Consortium (UNAVCO), and various private contractors. Interagency efforts between the USGS, USBR, the U.S. Coast and Geodetic Survey (now the National Geodetic Survey) and DWR resulted in an intensive series of investigations that identified and characterized subsidence in the San Joaquin Valley. NASA also measures subsidence in the Central Valley and has maps on their websites that show the subsidence for a defined period.

As discussed in **Section 3.2.6**, the clay mineralogy outside of the Corcoran Clay area is not conducive for land subsidence, which may explain why subsidence has not been observed in most of the GSA, even as groundwater levels approached historical lows in 2015.

The monitoring network will utilize data collected by KRCD and use the NASA InSAR data to verify the areas of subsidence. KRCD has a 7-mile grid that monitors new and existing benchmarks for land subsidence. This is considered adequate given the minimal occurrence of subsidence in the SKGSA. NASA obtains subsidence data by comparing satellite images of Earth's surface over time. For the last few years, InSAR observations from satellite and aircrafts have been used to produce the subsidence maps. More information can be found on their website: https://www.nasa.gov/jpl/nasa-california-drought-causing-valley-land-to-sink.

KRCD and NASA subsidence maps are provided in **Section 3.2.6** and show the land subsidence for the SKGSA area.

5.6.2 Adequacy of Monitoring Network

Regulation Requirements:

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.
§354.34(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

Land subsidence will be primarily monitored with Kings River Conservation District's land subsidence surveying program. The monitoring network includes benchmark surveying at least every 7 miles with records dating back to 2010. This is considered adequate, especially since there is minimal subsidence in the GSA. An expanded network may be considered if subsidence becomes problematic in the future. The SKGSA will also track land subsidence points just outside of the Plan Area to see if it is encroaching into the area. NASA INSAR remote sensing data will be used to verify any observed subsidence and fill in gaps between the surveyed benchmarks.

5.6.3 Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§354.34(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:
1) Amount of current and projected groundwater use.
2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.
3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.
4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

The subsidence monitoring network has adequate density to determine land subsidence in the SKGSA area. Within the SKGSA, the KRCD land subsidence monitoring program has 15 sites for 487 square miles or around 1 site per 32 square miles. INSAR data will also be used to monitor land subsidence in the SKGSA area. INSAR provides complete coverage of the SKGSA area and may be used to fill in the gaps in the KRCD monitoring network.

5.6.4 Monitoring Network Information

Regulation Requirements:

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

The following sections describe the monitoring network, including scientific rational for the selection; consistency with data and reporting standards; corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone; and the locations of the monitoring sites.

5.6.4.1 Scientific Rational for Site Selection

Regulation Requirements:

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

The KRCD land subsidence monitoring program data was established using National Geodetic Survey (NGS) control points. KRCD chose these points due to the details, history, and stability rankings of the monuments. The control points were the foundation for monitoring subsidence. From the control points, KRCD decided to use a 7-mile grid to monitor subsidence in the Kings Basin. This is considered the best method to monitor subsidence since it involves direct measurements, as opposed to remote sensing which relies on indirect or inferred measurements.

If additional monitoring locations are added, the following scientific rational will be used:

- Add sites to areas of higher subsidence in the SKGSA area.
- Add sites that can be easily surveyed and tied back to a nearby monument.
- Add sites where the ground surface is unlikely to be modified by future construction and will remain undisturbed.
- Add sites in areas where the geology and soil types present the greatest potential for subsidence.

5.6.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

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

The data gathered through the monitoring networks is consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as Error! Reference source not found..

- Data reporting units (i.e., Water volumes shall be reported in acre-feet, etc.)
- Monitoring site information (i.e., Site identification number, description of site location, etc.)
- Well attribute reporting (i.e., CASGEM well identification number, casing perforations, etc.)
- Map standards (i.e., Data layers, shapefiles, geodatabases shall be submitted in accordance with the procedures described in Article 4, etc.)
- Hydrograph requirements (i.e., Hydrographs shall use the same datum and scaling to the greatest extent practical, etc.)
- Groundwater and surface water models (i.e., The model shall include publicly available supporting documentation, etc.)

5.6.4.3 Quantitative Values

Regulation Requirements:

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

The quantitative values for minimum threshold, measurable objective, and interim milestones will be set for each well in the monitoring network. Refer to **Section 4.2.2.1** for the table with the criteria set for each well.

5.6.5 Monitoring Locations

Regulation Requirements:

> **§354.34(h)** The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.

Figure 4-3 shows the monitoring site locations for groundwater levels, land subsidence, and groundwater storage.

Monitoring is also performed in areas outside of the GSA to help document more accurate boundary conditions. Groundwater level data is collected up to few miles outside of the border, except on the eastern edge since the alluvial groundwater basin boundary is coterminous with the GSA boundary. Land subsidence is also monitored up to five miles outside of the border to track possible encroachment of subsidence into the GSA.

5.6.6 Monitoring Protocols

Regulation Requirements:

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

Land subsidence monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, 2016). Refer to **Appendix I** for a copy of the BMP. The GSA may develop standard monitoring forms in the future if deemed necessary.

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

- Wells will be surveyed to a horizontal accuracy of 0.5 feet.
- Unique well identifiers will be labeled on all public wells and on private wells if permission is granted.

5.6.7 Representative Monitoring

Regulation Requirements:

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

5.6.7.1 Description of Representative Sites

Regulation Requirements:

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

DWR has referred to representative monitoring as utilizing one well to represent an entire GSA or Management Area. Use of one representative well in the SKGSA is not practical to cover such a large area with varying conditions. Not all wells within the SKGSA are monitored, so a subset of wells are used as representative of conditions in the GSA. Groundwater conditions can vary substantially across the GSA. The area has a history of using multiple wells to monitor groundwater and will continue to use available water level data from multiple wells to assess groundwater conditions.

5.6.7.2 Use of Groundwater Elevations as Proxy for Other Sustainability Indicators

Regulation Requirements:

§354.36(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:
1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.
2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.
§354.36(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

SKGSA does not plan to use groundwater elevations as a proxy for monitoring other sustainability indicators. As noted, groundwater elevations will be used as a critical component of groundwater storage estimation, but the elevation monitoring will not replace the storage change estimation.

5.6.8 Assessment and Improvement of Monitoring Network

5.6.8.1 Review and Evaluation of Monitoring Network

Regulation Requirements:

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

This section includes a description of the different types of data gaps, a summary of existing data gaps in each monitoring network, and future plans to fill the data gaps.

5.6.8.2 Identification of Data Gaps

Regulation Requirements:

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

There are three general types of data gaps, as discussed previously, Temporal, Spatial, and Insufficient Quality of Data.

No data gaps were identified in the subsidence monitoring network.

5.6.8.3 Plans to Fill Data Gaps

Regulation Requirements:

§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:
1) The location and reason for data gaps in the monitoring network.
2) Local issues and circumstances that limit or prevent monitoring.
(d) Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

No data gaps have been identified.

5.6.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

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

The frequency and density of the proposed monitoring programs are discussed in previous sections. The criteria are considered adequate to provide sufficient monitoring data and to satisfy SGMA requirements. Beginning in 2020, when groundwater conditions are compared to sustainability goals, the monitoring network may be modified or enhanced if deemed necessary.

5.7 Depletion of Interconnected Surface Water

5.7.1 Description of Monitoring Network

Regulation Requirements:

§354.34(c)(6) Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:
A) Flow conditions including surface water discharge, surface water head, and baseflow contribution.
B) Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.
C) Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.
D) Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.
§354.34(j) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.

Interconnected surface water has been defined in the California Code of Regulations Title 23, Division 2, Chapter 1.5, Subchapter 2 as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. Within the SKGSA, interconnected surface water is not potential concern.

Regional reports (Faunt, 2009; Mullen & Nady, 1985) appear to show that surface water is not interconnected along the Kings River or San Joaquin River in the SKGSA. Existing river management programs maintain minimum flows within in the rivers year-round in so depletion of interconnected surface waters, if present, is not likely to occur in the Kings River or San Joaquin River. Additional discussion of interconnected surface water is discussed in **Section 3.2** (Current and Historical Groundwater Conditions) and **Section 4.7** (Sustainable Management Criteria - Interconnected Surface Water and Groundwater).

5.7.2 Adequacy of Monitoring Network

Regulation Requirements:

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.
§354.34(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

The existing Kings River Fisheries Management Program is deemed adequate to direct and implement environmental programs on the river.

5.7.3 Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

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

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

The Kings River Fishery Management Program will be the reporting mechanism for instream flow documentation.

5.7.4 Monitoring Network Information

Regulation Requirements:

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

The following sections describe the monitoring network, including scientific rational for the selection; consistency with data and reporting standards; corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone; and the locations of the monitoring sites.

5.7.4.1 Scientific Rational for Site Selection

Regulation Requirements:

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

Within the SKGSA, interconnected surface water is not potential concern. Surface water is not interconnected along the Kings River or San Joaquin River in the SKGSA. Existing river management programs maintain minimum flows within in the rivers year-round in so depletion of interconnected surface waters, if present, is not likely to occur in the Kings River or San Joaquin River. Additional discussion of interconnected surface water is discussed in **Section 3.2** (Current and Historical Groundwater Conditions) and **Section 4.7** (Sustainable Management Criteria - Interconnected Surface Water and Groundwater).

5.7.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

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

The data gathered through the monitoring networks is consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as Error! Reference source not found..

- Data reporting units (i.e., Water volumes shall be reported in acre-feet, etc.)
- Monitoring site information (i.e., Site identification number, description of site location, etc.)
- Well attribute reporting (i.e., CASGEM well identification number, casing perforations, etc.)
- Map standards (i.e., Data layers, shapefiles, geodatabases shall be submitted in accordance with the procedures described in Article 4, etc.)

- Hydrograph requirements (i.e., Hydrographs shall use the same datum and scaling to the greatest extent practical, etc.)
- Groundwater and surface water models (i.e., The model shall include publicly available supporting documentation, etc.)

5.7.4.3 Quantitative Values

Regulation Requirements:

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

The quantitative values for minimum threshold, measurable objective, and interim milestones will be set for each well in the monitoring network. Refer to **Section 4.2.2.1** for the table with the criteria set for each well.

5.7.5 Monitoring Locations

Regulation Requirements:

§354.34(h) The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.

Monitoring is performed in areas outside of the GSA to help document more accurate boundary conditions. Groundwater level data is collected up to a few miles outside of the border, except on the eastern edge since the alluvial groundwater basin boundary is coterminous with the GSA boundary.

5.7.6 Monitoring Protocols

Regulation Requirements:

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

Groundwater level, groundwater quality, and land subsidence monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, 2016). Refer to **Appendix I** for a copy of the BMP. The GSA may develop standard monitoring forms in the future if deemed necessary.

5.7.7 Representative Monitoring

Regulation Requirements:

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

5.7.7.1 Description of Representative Sites

Regulation Requirements:

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

DWR has referred to representative monitoring as utilizing one well to represent an entire GSA or Management Area. Use of one representative well in the SKGSA is not practical to cover such a large area with varying conditions. Not all wells within the SKGSA are monitored, so a subset of wells are used as representative of conditions in the GSA. Groundwater conditions can vary substantially across the GSA. The area has a history of using multiple wells to monitor groundwater and will continue to use available water level data from multiple wells to assess groundwater conditions.

5.7.7.2 Use of Groundwater Elevations as Proxy for Other Sustainability Indicators

Regulation Requirements:

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

1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.

2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

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

SKGSA does not plan to use groundwater elevations as a proxy for monitoring other sustainability indicators. As noted, groundwater elevations will be used as a critical component of groundwater storage estimation, but the elevation monitoring will not replace the storage change estimation.

5.7.8 Assessment and Improvement of Monitoring Network

5.7.8.1 Review and Evaluation of Monitoring Network

Regulation Requirements:

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

This section includes a description of the different types of data gaps, a summary of existing data gaps in each monitoring network, and future plans to fill the data gaps.

5.7.8.2 Identification of Data Gaps

Regulation Requirements:

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

There are three general types of data gaps, as discussed previously, Temporal, Spatial, and Insufficient Quality of Data.

There are no concerns over interconnected surface water.

5.7.8.3 Plans to Fill Data Gaps

Regulation Requirements:

§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:

1) The location and reason for data gaps in the monitoring network.

2) Local issues and circumstances that limit or prevent monitoring.

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

No data gaps have been identified.

5.7.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§354.38(e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:

1) Minimum threshold exceedances.
2) Highly variable spatial or temporal conditions.
3) Adverse impacts to beneficial uses and users of groundwater.
4) The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.

The frequency and density of the proposed monitoring programs are discussed in previous sections. The criteria are considered adequate to provide sufficient monitoring data and to satisfy SGMA requirements. Beginning in 2020, when groundwater conditions are compared to sustainability goals, the monitoring network may be modified or enhanced if deemed necessary.

5.8 Reporting Monitoring Data to the Department

Regulation Requirements:

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

Monitoring programs are coordinated within the Kings Subbasin. Well location, construction, and level data are shared amongst the different GSAs. In addition, the monitoring programs described in this section were reviewed by the other GSAs, and they are generally consistent throughout the basin. Similarly, data reported to DWR will be collected and reported in a consistent format. A detailed description of the Data Management System and the information that will be reported is included in Sections 7.4 and Section 7.5.

6 Projects and Management Actions to Achieve Sustainability

Regulation Requirements:

§354.42 Introduction to Projects and Management Actions. This Subarticle describes the criteria for projects and management actions to be included in a Plan to meet the sustainability goal for the basin in a manner that can be maintained over the planning and implementation horizon.

§354.44. Projects and Management Actions

(a) Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.

(b) Each Plan shall include a description of the projects and management actions that include the following:

(1) A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:

(A) A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.

(B) The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.

(2) If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.

(3) A summary of the permitting and regulatory process required for each project and management action.

(4) The status of each project and management action, including a timetable for expected initiation and completion, and the accrual of expected benefits.

(5) An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.

(6) An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.

(7) A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.

(8) A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.

(9) A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.

(c) Projects and management actions shall be supported by best available information and best available science.

(d) An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions

6.1 Introduction

GSAs have two primary types of tools which may be used to achieve sustainable groundwater management. This section discusses the two types, potential Projects and Management Actions, that may be implemented by the GSA. The projects identified in this section primarily focus on recharge of groundwater supplies within the GSA. The other management actions primarily focus on the reduction of groundwater demand and increase of data collection including education and outreach, regulatory policies, incentive-based programs, and enforcement actions. The following table illustrates potential projects or management actions, applicable to the SKGSA, for achieving mitigating groundwater extraction.

The potential projects and management actions are further discussed and detailed in the remainder of this section.

Table 6-1: Potential Projects and Actions for Mitigating Groundwater Extraction

Projects and Programs for Mitigating Groundwater Overdraft					
Category	**Description**	**Supply (S) or Demand (D) Side Action**	**Estimated Time to Potential Implementation (years)**		
Conjunctive Use	Groundwater Recharge ○ Recharge basins ○ Dry wells ○ Injection wells ○ Reclaimed water	S	0 - 3	1 - 5	>5
	Groundwater Banking	S		1 - 5	
Surface Water	Direct Use of Flood and Storm Water	S	0 - 3	1 - 5	>5
	Import New Surface Water Supplies	S		1 - 5	>5
	Increase Surface Water Storage	S			>5
Land Management	Urban Land Use Regulations	D	0 - 3		
	Add disclaimer on property purchases	D	0 - 3		
	Prohibition on land development unless proven water supply	D	0 - 3		
Groundwater Use Restrictions	Groundwater Metering and Pumping Restrictions	D	0 - 3		
	Additional Well Permit Requirements ○ Flow meter with ac-ft totalizer ○ Sounding tube for water level	D	0 - 3		
	Prohibition of composite wells ○ Restrictions on new well permits	D	0 - 3		
Water Conservation	Water Use Restrictions in Droughts	D	0 - 3		
	Urban Water Conservation	D	0 - 3		
	Industrial Water Recycling	S		1 - 5	
	Urban Water Recycling	S			>5
	Water Conservation Credits	D	0 - 3		
	Tiered Pricing / Fines for Overuse	D	0 - 3		
	Groundwater Pumping Fees	D	0 - 3	1 - 5	
	Wellhead Fees (annual or new wells)	D	0 - 3		
Other	Establish groundwater allocation	N/A	0 - 3		
	Groundwater credit system	N/A	0 - 3		
	Rainwater Harvesting	S		1 - 5	
	Public Education	D	0 - 3		

Legal Authority

The legal authority and basis for the projects and management actions described in this GSP Section 6 are outlined in the SGMA and related provisions (354.44 (b)(7)). The SGMA describes the powers and authorities, financial authority, and enforcement powers of GSAs in Sections 5, 8, and 9 respectively. These GSA authorities include adopting regulations, regulating groundwater extractions, imposing fees, monitoring, enforcing programs, and more. Though the law grants the GSA these powers, the pursuit and implementation of the projects and management actions is the GSA's responsibility. The GSA must enforce their legal authority to the extent necessary to achieve sustainable groundwater management for all beneficial users within the GSA.

It is the mission of this GSP to promote responsible water resource management, while effectively enforcing the policies and standards set in place by the GSA to conserve and protect the State of California's water resources for future generations to come.

Public Notification

The GSA has initiated a web site and has initiated outreach to its constituency through mailers and public meetings. The web site will be the instrumental to keep the public aware of current conditions and success in managing the groundwater resources.

Each of the projects will allow greater ability to recharge surface water supplies. The recharge basins allow for intentional recharge which allows surface water to be diverted and recharged for later use in the winter and summer months. If the rain/snowmelt patterns change and more surface water is available outside the normal crop irrigation demand season, these facilities will allow the district to take advantage of the timing of the surface water availability and may make even more surface water available for recharge.

Potential Sustainability Projects

Each of the following projects may be implemented to meet sustainability goals. The GSA will maintain a list of potential projects and their characteristics, along with their development status, and will use this list to prioritize and secure funding as opportunities may become available. Projects discussed in this GSP will remain a part of the potential projects that the GSA may choose to implement; however, other projects may come up with higher yield or lower cost and will be considered. The projects that are currently being considered are shown on **Figure 6-1** through **Figure 6-4**. All projects listed are supply projects in the category of conjunctive use, subcategory groundwater recharge. The projects are listed by geographical location, but not in order of implementation, in the following table. The projects may be implemented by either one or more of the member agencies or by the SKGSA, directly.

Each of the projects may allow the member agency the ability to recharge surface water supplies. The recharge basins allow for surface water to be diverted and recharged to replenish the aquifer. If the rain/snowmelt patterns change and more surface water is available outside the normal crop irrigation demand season, these proposed facilities may allow each member agency to take advantage of the timing of the surface water availability and may make more surface water available for recharge.

Table 6-2: Summary of Potential Sustainability Projects

ID	Potential Implementing Agency	Project Title	354.44(a)	354.44(b)(1)	354.44(b)(2)&(4)	354.44(b)(4)			354.44(b)(8)
			Description	Measurable Objective Addressed	Quantified Project Benefit (AFY)	Start Date	Completion Date	Completion Milestone Year	Cost Estimate
DR01	Del Rey CSD	American & Del Rey Avenues Basin	Recharge Basin	Multiple	62	Jan 2023	Dec 2023	2025	$134,000
DR02		Melruna & Carmel Avenues Basin	Recharge Basin	Multiple	131	Jan 2033	Dec 2033	2035	$313,000
DR03		South Del Rey Avenue Basin	Recharge Basin	Multiple	13	Jan 2037	Dec 2037	2040	$142,000
Del Rey CSD Geographic Area Subtotal					**206**				**$589,000**
F01	City of Fowler	19.5-Acre Basin[1]	Recharge Basin	Multiple	1,427	Jan 2023	Dec 2024	2025	$2,462,000
City of Fowler Geographic Area Subtotal					**1,427**				**$2,462,000**
K01	City of Kingsburg	Madsen Avenue Basin	Recharge Basin	Multiple	211	Jan 2023	Dec 2023	2025	$78,000
K02		Athwal Park Basin	Recharge Basin	Multiple	208	Jan 2027	Dec 2027	2030	$78,000
K03		22.5-Acre Basin	Recharge Basin	Multiple	1,656	Jan 2033	Dec 2034	2035	$2,862,000
City of Kingsburg Geographic Area Subtotal					**2,074**				**$3,018,000**
P01	City of Parlier	Industrial Drive Basin	Recharge Basin	Multiple	198	Jan 2023	Dec 2023	2025	$540,000
P02		Milton Avenue Basin	Recharge Basin	Multiple	185	Jan 2028	Dec 2028	2030	$729,000
P03		Tuolumne Street Basin	Recharge Basin	Multiple	224	Jan 2032	Dec 2032	2035	$106,000
P04		Manning Avenue Basin	Recharge Basin	Multiple	79	Jan 2033	Dec 2033	2035	$106,000
P05		Avila Street Basin	Recharge Basin	Multiple	73	Jan 2034	Dec 2034	2035	$106,000
P06		Mendocino Avenue Basin	Recharge Basin	Multiple	93	Jan 2036	Dec 2036	2040	$106,000
P07		Academy Avenue Basin	Recharge Basin	Multiple	144	Jan 2037	Dec 2037	2040	$162,000
P08		4.2-Acre Basin	Recharge Basin	Multiple	278	Jan 2038	Dec 2038	2040	$586,000
City of Parlier Geographic Area Subtotal					**1,274**				**$2,441,000**
S01	City of Sanger	Kelly Basin	Recharge Basin	Multiple	231	Jan 2023	Dec 2023	2025	$106,000
S02		Medrano Basin	Recharge Basin	Multiple	68	Jan 2024	Dec 2024	2025	$134,000
S03		West Sanger Basin	Recharge Basin	Multiple	528	Jan 2028	Dec 2028	2030	$170,000
S04		North Sanger Basin	Recharge Basin	Multiple	2,548	Jan 2038	Dec 2039	2040	$3,482,000
City of Sanger Geographic Area Subtotal					**2,866**				**$3,892,000**
SKGSA Total					**7,848**				**$12,402,000**

Notes:
1. Project is shown in 2025 but will likely happen in phases between 2025 and 2035 to maintain goals for reaching sustainability.

The process being used for project implementation will be as follows:

1. Identify potential projects
2. Prepare conceptual level feasibility study and cost estimate
3. Obtain agreement with project partner(s)
4. Secure funding
5. Prepare environmental documents and obtain permit and regulatory approvals
6. Design and prepare construction documents
7. Implement project construction
8. Operate and maintain project for sustainability

The parameters for estimating groundwater recharge for recharge basin projects are as follows:

- Estimated percolation rate = 1.0 acre-feet per acre per day (AFAD)
    - Estimated percolation rate = 0.5 AFAD for Del Rey CSD
- Water availability = 100 days per year, 4 of every 5 years (effectively 80 days per year)
- Groundwater extraction mitigation = 42% of groundwater volume pumped
    - This accounts for recharge occurring naturally or through other means in the area that is credited to the member agencies, including storm water and wastewater percolation at the wastewater treatment plants.

Water Rights

Neither the SKGSA nor the member agencies have any surface water supply contracts and supplies will need to be obtained for successful projects. The GSA has drafted an agreement with the Consolidated Irrigation District for reliable access and delivery of surface water supply to utilize for groundwater recharge.

Project Benefits

During years of normal or dry precipitation excess water may not be available for recharge during the irrigation season; however, the agreement between SKGSA and CID indicates annual water availability will be shown on a 5-year rolling average to account for potential dry years. By capturing excess surface flow for infiltration, groundwater reservoirs can be replenished. Benefits of recharge include a more reliable water source that is available year-round. If water levels are maintained, the need for drilling deeper wells to reach water tables is mitigated, and if levels rise, the cost of energy for pumping decreases as well. Benefits can be monitored by analyzing groundwater levels and pumping costs over time.

Permitting and Regulatory Processes

Regulation Requirements:

§354.44. Projects and Management Actions
(b) Each Plan shall include a description of the projects and management actions that include the following:
(3) A summary of the permitting and regulatory process required for each project and management action.

Each potential sustainability project will be subject to the following permitting requirements. Additional requirements specific to each unique project are detailed in the subsequent project discussions.

- California Environmental Quality Act (CEQA) – compliance with CEQA for project approval
- Pacific Gas & Electric Company (PG&E), Application for Service – for new electrical connection to serve proposed booster pump
- Consolidated Irrigation District – for construction of turnout and connection to District canal
- State Water Resources Control Board – to obtain a General Permit for Storm Water Discharges Associated with Construction Activity for all projects larger than one acre or to obtain a waiver for projects less than one acre.

- San Joaquin Valley Air Pollution Control District – for Indirect Source Review (ISR) for all projects and Dust Control Plans for projects larger than 5 acres.

Other approvals may be required, to be determined at a later date. These may include, but are not limited to, State Water Resources Control Board for Clean Water Act 401 Water Quality Certification, California Department of Fish and Wildlife for Lake and Streambed Alteration (LSA) notification and LSA agreement, and US Army Corps of Engineers for encroachment permit.

Potential Sustainability Management Actions

Following the discussion of projects below, the subsequent sections will discuss management actions the GSA may consider during initial and ongoing implementation of the GSP. The identified potential management actions (MA) may not be implemented in the order listed or may not be implemented if determined unnecessary based on sustainability achievement through other methods. The management action may be further refined or revised based on stakeholder input and/or updated available information and/or science. Additionally, benefits discussed may take more or less years to realize, depending on a variety of factors, and, depending in success or failure of other actions or projects, the number of additional actions or projects will vary.

Table 6-3: Summary of Potential Sustainability Management Actions

Action ID	Management Action Title	354.44(a)	354.44(b)(4)	
		Description	Start Date	Completion Date
EO1	Regular Communication	Promote education and outreach to all beneficial users and users within the GSA	January 2021	December 2021
EO2	Non-Routine Responses to Minimum Threshold Exceedances	GSA may also immediately notify member agencies of a Minimum Threshold (MT) exceedance		
WH1	Registration of Extraction Facilities	GSA may register existing groundwater extraction facilities and/or complete well canvass study.	January 2021	December 2023
WH2	Installation of Sounding Tubes and Water Quality Sample Ports	GSA may require the installation of a well sounding tube, air line, electric depth gauge, and/or other water level sensor.		
WH3	Self-Reporting of Groundwater Extraction, Level, and Water Quality	GSA may require the well owner to self-report the groundwater extraction volumes, static water levels, and water quality data twice per year		
WH4	Prohibition of Composite Wells	GSA may adopt a policy to prohibit the construction of composite wells		
GP1	Regulate Groundwater Exports	GSA may adopt a policy to prohibit new groundwater exports	January 2030	December 2035
GP2	Require New Developments to Prove Sustainable Water Supply	GSA may adopt a policy to require new developments to prove sustainable water supplies		
GP3	Pumping Restrictions During Droughts	GSA may adopt a policy to immediately reduce or temporarily suspend groundwater pumping		

6.2 Projects

6.2.1 Projects within the Del Rey CSD Geographic Area

The projects discussed below may be implemented to offset a portion of the GSA's groundwater extraction. Figure 6-1 illustrates the locations of the projects.

South Kings GSA

Proposed Recharge Areas

Within Del Rey CSD Geographic Area

Figure 6-1

Legend

- Proposed Recharge Area
- Del Rey CSD
- Proposed Connection
- Canal
- Canal Lateral

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6.2.1.1 American & Del Rey Avenues Basin Project

The first identified project within the Del Rey geographic area is located at the southeast corner of the intersection of East American Avenue and South Del Rey Avenue. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-4: Del Rey CSD, American and Del Rey Avenues Basin Project

Project Title: American & Del Rey Avenues Basin	**Project ID: DR01**
Project Type	
Groundwater Recharge	
Project Location	
Southeast corner of the intersection of East American Avenue and South Del Rey Avenue, Del Rey, CA	
Project Description - 354.44(a)	
The project will consist of converting an existing storm drain retention basin into a recharge basin with a pipeline connected to the basin.	
Measurable Objective(s) Addressed - 354.44(b)(1)	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence.	
☒ Chronic Lowering of Groundwater Levels	☒ Reduction of Groundwater Storage
☐ Seawater Intrusion	☒ Degraded Water Quality
☒ Land Subsidence	☐ Depletion of Interconnected Surface Water
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.	
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	
The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.	
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	
By converting the existing basin into an intentional recharge basin with an area of 2.1 acres, it is anticipated that approximately 62 acre-ft of water will be recharged within the GSA, annually. Flowmeters at the basin will measure the quantity of surface water delivered for recharge.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
It is anticipated that approvals from Fresno County will be required for all work encroaching in the County right-of-way.	
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2025.	
Evaluation of Benefits - 354.44(b)(5)	
The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as Del Rey CSD or SKGSA. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 62 AFY.	

Project Title:	**American & Del Rey Avenues Basin**	**Project ID: DR01**

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

The project will be accomplished by the Del Rey Community Services District or the SKGSA. The water source is Consolidated Irrigation District. South Kings GSA has drafted a water supply agreement with CID for the water supply.

Legal Authority - 354.44(b)(7)

The CSD has legal authority, as discussed above, to manage the groundwater in their area and the CID has the legal authority to deliver surface water to lands within their District. Further, the District or the GSA will acquire the necessary permits to construct, own and operate the project, as detailed above.

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

The following tables summarize the probable construction cost, plus the annual repayment costs for a loan amortized over 30 years with a 5% interest rate. The useful life of the project components is anticipated to be more than 30 years, at which point replacement of some components may be necessary. The project is anticipated to yield 51 acre-ft per year, which equates to a cost of $140 per acre-ft plus the cost of water at $395 per acre-ft; the total cost is approximately $535 per acre-ft.

Item	**Item Description**	**Estimate**
Construction Cost	Basin conversion	$50,000
	Connect basin to CID facility	$36,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$26,000
Contingency	25% based on conceptual design	$22,000
	Total Capital Cost	**$134,000**

Total Capital Cost	**Annual Capital Repayment**	**Annual Yield (AF)**	**Cost Per AF Water (Capital/Total)**
$134,000	$8,717	62	$140/$535

Funding Source - 354.44(b)(8)

Funding will be obtained through the CSD reserves or obtained grants.

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

The project would be managed by the SKGSA or Del Rey CSD. Performance of the project would be a necessary part of the GSA's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding and the willingness of the landowners to sell the necessary property. The CSD and SKGSA are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.1.2 Melruna & Carmel Avenues Basin Project

The Melruna & Carmel Avenues Basin Project would involve constructing a recharge basin on the CSD-owned parcel of land at the southwest corner of Melruna and Carmel Avenues. The parcel is partially developed as a park; however, it is underutilized due to other facilities in the community. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-5: Melruna & Carmel Avenues Basin Project

Project Title: **Melruna & Carmel Avenues Basin** **Project ID: DR02**

Project Type

Groundwater Recharge

Project Location

Southwest corner of Melruna and Carmel Avenues, Del Rey, CA

Project Description - 354.44(a)

The project will consist of the construction of a new basin and required piping to connect to CID facilities.

Measurable Objective(s) Addressed - 354.44(b)(1)

The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence.

- ☒ Chronic Lowering of Groundwater Levels
- ☐ Seawater Intrusion
- ☒ Land Subsidence
- ☒ Reduction of Groundwater Storage
- ☒ Degraded Water Quality
- ☐ Depletion of Interconnected Surface Water

Circumstances and Criteria for Implementation - 354.44(b)(1)(A)

This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.

Process to Provide Notice of Implementation - 354.44(b)(1)(B)

The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.

Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)

Developing the approximately 4-acre recharge basin will result in approximately 131 acre-ft of water recharged within the GSA, annually. Surface water that is delivered to the basin will be measured through flowmeters at the basin.

Permitting and Regulatory Requirements - 354.44(b)(3)

It is anticipated that approvals from Fresno County will be required for all work encroaching in the County right-of-way.

Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits

Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2035.

Evaluation of Benefits - 354.44(b)(5)

The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as Del Rey CSD. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 131 AFY.

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

The project will be accomplished by the Del Rey Community Services District or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The CSD has legal authority, as discussed above, to manage the groundwater in their area and the CID has the legal authority to deliver surface water to lands within their District.

Project Title:	**Melruna & Carmel Avenues Basin**	**Project ID: DR02**

Further, the District or GSA will acquire the necessary permits to construct, own and operate the project, as detailed above.

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

The tables below show the probable construction costs and annual repayment costs for a 30-year loan with an interest rate of 5%. The infrastructure for the project is predicted to last for more than 30 years; however, some components may need to be replaced following this period. The project is estimated to provide 131 acre-ft per year of recharge, which results in a cost of approximately $156 per acre-ft plus the cost of water at $395 per acre-ft. In total, the cost of converting and expanding the existing basin into a functioning recharge basin will be approximately $551 per acre-ft.

Item	Item Description	Estimate
Construction Cost	Basin construction	$183,000
	Connect basin to CID facility	$18,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$61,000
Contingency	25% based on conceptual design	$51,000
	Total Capital Cost	**$313,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$313,000	$20,361	131	$156/$551

Funding Source - 354.44(b)(8)

Funding will be obtained through the CSD reserves or obtained grants.

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

The project would be managed by the Del Rey CSD or the GSA. Performance of the project would be a necessary part of the GSA's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding. The CSD has reserve funds available and are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.1.3 South Del Rey Avenue Basin Project

The South Del Rey Avenue Basin Project would involve converting and expanding the existing retention basin south of the residential development at South Del Rey Avenue and East Jefferson Avenue. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-6: South Del Rey Avenue Basin Project

Project Title:	**South Del Rey Avenue Basin**	**Project ID: DR03**

Project Type

Groundwater Recharge

Project Location

South of the residential development at South Del Rey Avenue and East Jefferson Avenue, Del Rey, CA

Project Title:	**South Del Rey Avenue Basin**	**Project ID: DR03**

Implementing Agency

The Del Rey CSD or SKGSA will implement the program.

Project Description - 354.44(a)

The basin conversion and expansion will consist of any modifications and additions to existing pipelines to allow conveyance of surface water from CID facilities to the basin, additional excavation, fencing, and any other work required to increase the capacity of the existing basin.

Measurable Objective(s) Addressed - 354.44(b)(1)

The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence.

- ☒ Chronic Lowering of Groundwater Levels
- ☐ Seawater Intrusion
- ☒ Land Subsidence
- ☒ Reduction of Groundwater Storage
- ☒ Degraded Water Quality
- ☐ Depletion of Interconnected Surface Water

Circumstances and Criteria for Implementation - 354.44(b)(1)(A)

This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.

Process to Provide Notice of Implementation - 354.44(b)(1)(B)

The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.

Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)

Developing the existing 0.46-acre retention basin into an approximately 0.75-acre recharge basin will result in approximately 13 acre-ft of water recharged within the GSA, annually. Surface water that is delivered to the basin will be measured through flowmeters at the basin.

Permitting and Regulatory Requirements - 354.44(b)(3)

It is anticipated that approvals from Fresno County will be required for all work encroaching in the County right-of-way.

Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits

Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2040.

Evaluation of Benefits - 354.44(b)(5)

The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as Del Rey CSD. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 13 AFY.

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

The project will be accomplished by the Del Rey Community Services District or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The CSD has legal authority, as discussed above, to manage the groundwater in their area and the CID has the legal authority to deliver surface water to lands within their District.

Further, the District will acquire the necessary lands and permits to construct, own and operate the project, as detailed above.

Project Title: South Del Rey Avenue Basin **Project ID: DR03**

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

The tables below show the probable construction costs and annual repayment costs for a 30-year loan with an interest rate of 5%. The infrastructure for the project is predicted to last for more than 30 years; however, some components may need to be replaced following this period. The project is estimated to provide 13 acre-ft per year of recharge, which results in a cost of approximately $684 per acre-ft plus the cost of water at $395 per acre-ft. In total, the cost of converting and expanding the existing basin into a functioning recharge basin will be approximately $1,079 per acre-ft.

Item	Item Description	Estimate
Land Acquisition	Purchase 0.25 Acres	$10,000
Construction Cost	Basin conversion	$50,000
	Basin construction	$13,000
	Connect basin to CID facility	$18,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$28,000
Contingency	25% based on conceptual design	$23,000
	Total Capital Cost	**$142,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$142,000	$9,237	13	$684/$1,079

Funding Source - 354.44(b)(8)

Funding will be obtained through the CSD reserves or obtained grants.

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

The project would be managed by the Del Rey CSD. Performance of the project would be a necessary part of the GSA's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding and the willingness of the landowners to sell the necessary property. The CSD has reserve funds available and are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.2 Projects within the City of Fowler Geographic Area

The projects discussed below may be implemented to offset a portion of the GSA's groundwater extraction.

6.2.2.1 19.5-Acre Recharge Basin Project

The 19.5-Acre Recharge Basin will consist of one (1) 19.5-acre recharge basin or several smaller basins to satisfy all water recharge requirements. Locations will be determined through the City of Fowler processes. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-7: 19.5-Acre Recharge Basin Project

Project Title: 19.5-Acre Recharge Basin	**Project ID: FO01**

Project Type

Groundwater Recharge

Project Location

Undeveloped land to be determined later in and around the City of Fowler

Implementing Agency

The City of Fowler will implement the program.

Project Description - 354.44(a)

In addition to construction of the basin itself, all infrastructure needed to convey surface water from CID facilities to the basin will be a part of the project. The main components of the project will include excavation, turnouts, piping, outlet structures, and fencing.

Measurable Objective(s) Addressed - 354.44(b)(1)

The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence.

- ☒ Chronic Lowering of Groundwater Levels
- ☐ Seawater Intrusion
- ☒ Land Subsidence
- ☒ Reduction of Groundwater Storage
- ☒ Degraded Water Quality
- ☐ Depletion of Interconnected Surface Water

Circumstances and Criteria for Implementation - 354.44(b)(1)(A)

This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.

Process to Provide Notice of Implementation - 354.44(b)(1)(B)

The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.

Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)

The proposed recharge basin fulfills the requirement for recharge inside of the GSA. This basin will be 19.5 acres in size and will provide approximately 1,427 acre-ft of water that will be recharged into the GSA every year. In order to monitor the amount of water delivered to the basin each year, flowmeters will be placed at the basin.

Permitting and Regulatory Requirements - 354.44(b)(3)

No additional permits or regulatory approvals are anticipated other than those mentioned above.

Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits

Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone years 2025 through 2040, as needed to offset groundwater pumping.

Evaluation of Benefits - 354.44(b)(5)

The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Fowler. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 1,427 AFY.

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

The project will be accomplished by the City of Fowler or the SKGSA. The water source is Consolidated Irrigation District.

Project Title:	**19.5-Acre Recharge Basin**	**Project ID: FO01**

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary lands and permits to construct, own and operate the project, as detailed above.

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

The following tables show the costs related to constructing a new 19.5-acre recharge basin, which includes land acquisition costs. The costs related to a loan over a 30-year period with a 5% interest rate are also shown below. It is estimated that the constructed basin will last for over 30 years. It should be noted that some infrastructure will need to be replaced following the 30-year mark. This project involves constructing a basin that will result in 1,427 acre-ft of recharge annually. The construction of this basin will cost $112 per acre-ft in addition to the $395 per acre-ft cost for water. The overall cost of recharge is estimated to be $507 per acre-ft.

Item	Item Description	Estimate
Land Acquisition	Purchase 19.5 Acres	$683,000
Construction Cost	Basin construction	$887,000
	Connect basin to CID facility	$18,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$477,000
Contingency	25% based on conceptual design	$397,000
	Total Capital Cost	**$2,462,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$2,462,000	$160,157	1,427	$112/$507

Funding Source - 354.44(b)(8)

Funding will be obtained through the City of Fowler reserves or obtained grants.

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

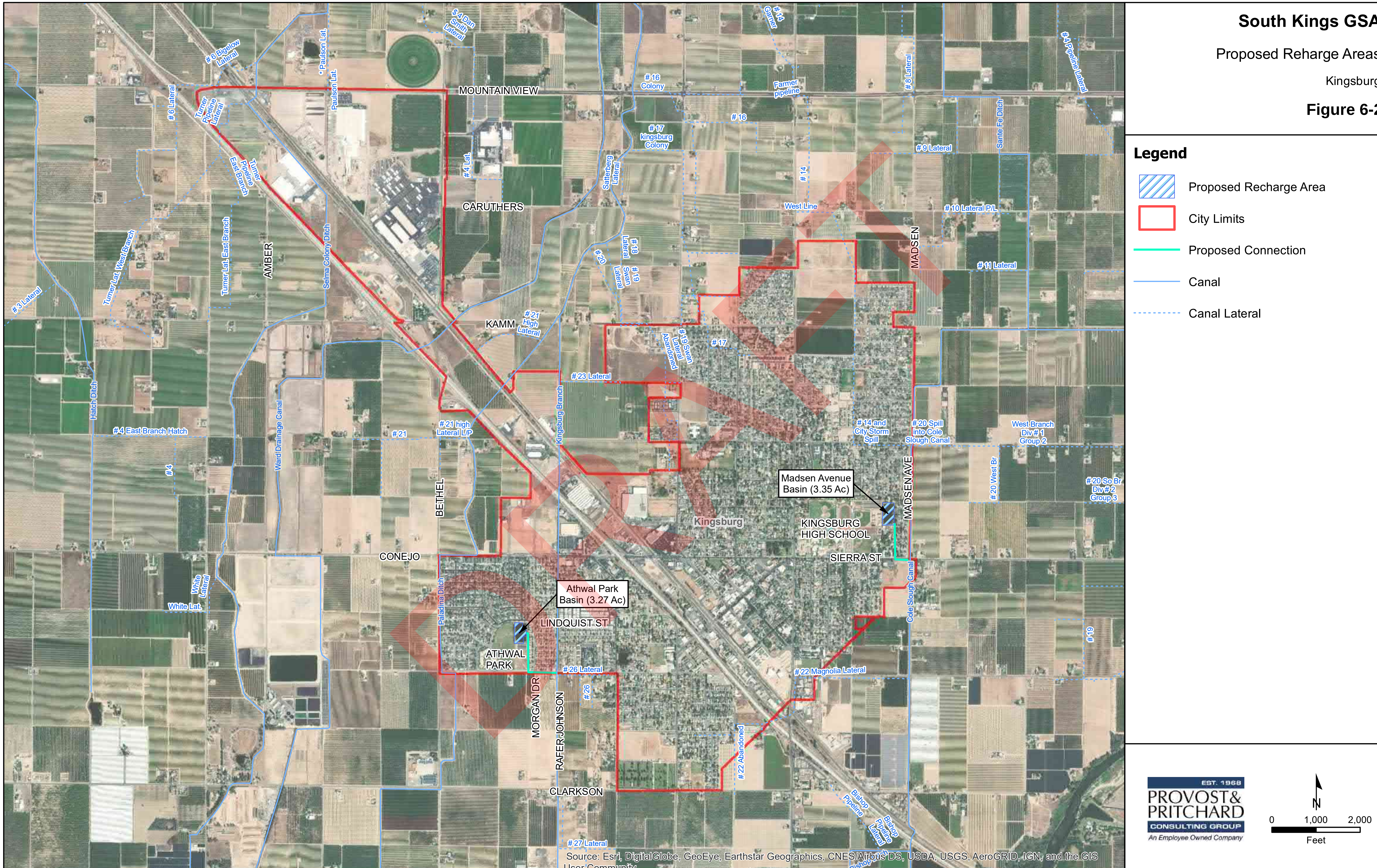
The project would be managed by the City of Fowler. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding and the willingness of the landowners to sell the necessary property. The City has reserve funds available and are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.3 Projects within the City of Kingsburg Geographic Area

The projects discussed below may be implemented to offset a portion of the GSA's groundwater extraction **Figure 6-2** illustrates the locations of the projects.



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6.2.3.1 Madsen Avenue Basin Project

The Madsen Avenue Basin project is a basin conversion project, in which the existing retention basin to the east of Kingsburg High School, near the intersection of Madsen Avenue and Sierra Street, will be modified to serve as a recharge basin. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-8: Madsen Avenue Basin Project

Project Title: Madsen Avenue Basin	**Project ID: KB01**
Project Type	
Groundwater Recharge	
Project Location	
East of Kingsburg High School, near the intersection of Madsen Avenue and Sierra Street, Kingsburg, CA	
Implementing Agency	
The City of Kingsburg or the SKGSA will implement the program.	
Project Description - 354.44(a)	
In addition to any work required on the basin itself, efforts will include modifications or additions to the basin's piping that are needed to convey surface water from CID facilities to the basin.	
Measurable Objective(s) Addressed - 354.44(b)(1)	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence. ☒ Chronic Lowering of Groundwater Levels ☐ Seawater Intrusion ☒ Land Subsidence	☒ Reduction of Groundwater Storage ☒ Degraded Water Quality ☐ Depletion of Interconnected Surface Water
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.	
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	
The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.	
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	
Developing the existing basin will provide the city with an additional 3.3 acres of recharge and will result in roughly 211 acre-ft of water being recharged inside of the GSA annually. Flowmeters will be installed at the basin to measure the quantity of water that is being delivered for recharge.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
No additional permits or regulatory approvals are anticipated other than those mentioned above.	
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2025.	

Project Title: Madsen Avenue Basin	**Project ID: KB01**

Evaluation of Benefits - 354.44(b)(5)

The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Kingsburg. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 211 AFY.

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

The project will be accomplished by the City of Kingsburg or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary permits to construct, own and operate the project, as detailed above.

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

The project has a probable construction cost of approximately $78,000 as seen in the table below, and the repayment cost shown is based on a loan lasting 30 years with a 5% interest rate. The lifetime of the new basin is projected to be at least 30 years and will produce 211 acre-ft of recharge on an annual basis. Construction of the basin will cost around $24 per acre-ft and the cost of water is approximately $395 per acre-ft, totaling approximately $419 per acre-ft.

Item	Item Description	Estimate
Construction Cost	Basin conversion	$50,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$15,000
Contingency	25% based on conceptual design	$13,000
	Total Capital Cost	**$78,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$78,000	$5,074	211	$24/$419

Funding Source - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Kingsburg reserves or obtained grants.

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

The project would be managed by the City of Kingsburg. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding and the willingness of the landowners to sell the necessary property. The City has reserve funds available and are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.3.2 Athwal Park Basin Project

The second identified project within the City of Kingsburg geographic area is located next to Athwal Park, southwest of the intersection of Morgan Drive and Lindquist Street. The existing storm drainage basin at this location will be converted into a recharge basin. Modifications to the basin and its piping will allow surface water to flow from CID facilities to the basin for intentional recharge. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-9: Athwal Park Basin Project

Project Title: Athwal Park Basin	**Project ID: KB02**
Project Type	Groundwater Recharge
Project Location	Next to Athwal Park, southwest of the intersection of Morgan Drive and Lindquist Street, Kingsburg, CA
Implementing Agency	The City of Kingsburg or the SKGSA will implement the program.
Project Description - 354.44(a)	In addition to any work required on the basin itself, efforts will include modifications or additions to the basin's piping that are needed to convey surface water from CID facilities to the basin.
Measurable Objective(s) Addressed - 354.44(b)(1)	The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence. ☒ Chronic Lowering of Groundwater Levels ☐ Seawater Intrusion ☒ Land Subsidence ☒ Reduction of Groundwater Storage ☒ Degraded Water Quality ☐ Depletion of Interconnected Surface Water
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	The existing basin will be transformed into a 3.3-acre recharge basin, which will have the capacity to recharge approximately 208 acre-ft of water per year within the GSA. Flowmeters will serve the purpose of measuring the quantity of water being delivered for recharge and will be installed at the converted basin.
Permitting and Regulatory Requirements - 354.44(b)(3)	No additional permits or regulatory approvals are anticipated other than those mentioned above.
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2030.
Evaluation of Benefits - 354.44(b)(5)	The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Kingsburg. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 208 AFY.

Project Title:	**Athwal Park Basin**	**Project ID: KB02**

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

The project will be accomplished by the SKGSA or the City of Kingsburg. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary permits to construct, own and operate the project, as detailed above.

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

The following tables show the probable construction cost and annual repayment costs for a 30-year loan with a 5% interest rate. The new basin is projected to last more than 30 years, which is when some of the infrastructure may need to be replaced. The project is expected to yield 208 acre-ft per year, at a cost of $24 per acre-ft, plus the cost of water at $395 per acre-ft; the total cost is approximately $419 per acre-ft.

Item	Item Description	Estimate
Construction Cost	Basin conversion	$50,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$15,000
Contingency	25% based on conceptual design	$13,000
	Total Capital Cost	**$78,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$78,000	$5,074	208	$24/$419

Funding Source - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Kingsburg reserves or obtained grants.

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

The project would be managed by the City of Kingsburg. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding and the willingness of the landowners to sell the necessary property. The City has reserve funds available and are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.3.3 22.5-Acre Recharge Basin Project

This project will include as much area as necessary to meet recharge requirements; 22.5-acres is anticipated. The following table summarizes the parameters, benefits, and other pertinent information regarding the project.

Table 6-10: 22.5-Acre Recharge Basin Project

Project Title: 22.5-Acre Recharge Basin **Project ID: KB03**

Project Type

Groundwater Recharge

Project Location

Undeveloped land to be determined later in and around the City of Kingsburg, CA

Implementing Agency

The City of Kingsburg will implement the program.

Project Description - 354.44(a)

The project will consist of the construction of a new basin or basins and required piping to connect to CID facilities. Placement of the basin near these facilities will reduce piping and maintenance costs and should be considered when further developing the project.

Measurable Objective(s) Addressed - 354.44(b)(1)

The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence.

- ☒ Chronic Lowering of Groundwater Levels
- ☐ Seawater Intrusion
- ☒ Land Subsidence
- ☒ Reduction of Groundwater Storage
- ☒ Degraded Water Quality
- ☐ Depletion of Interconnected Surface Water

Circumstances and Criteria for Implementation - 354.44(b)(1)(A)

This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.

Process to Provide Notice of Implementation - 354.44(b)(1)(B)

The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.

Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)

This project's basin or basins will have a total area of approximately 22.5 acres and will have the ability to recharge 1,656 acre-ft per year. Water quantities delivered for recharge will be measured by flowmeter at the basin(s). The addition of this supplemental project fulfills the volume requirement for the Kingsburg GSA.

Permitting and Regulatory Requirements - 354.44(b)(3)

No additional permits or regulatory approvals are anticipated other than those mentioned above.

Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits

Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2035.

Evaluation of Benefits - 354.44(b)(5)

The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Kingsburg. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 1,656 AFY.

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

The project will be accomplished by the City of Kingsburg. The water source is Consolidated Irrigation District.

Project Title: 22.5-Acre Recharge Basin	**Project ID:** KB03

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary lands and permits to construct, own and operate the project, as detailed above.

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

The tables below show the probable construction cost for the project and the repayment costs based on a loan that lasts 30 years with a 5% interest rate. The new basin area is projected to yield 1,656 acre-ft of recharge on an annual basis. With the cost of water ($395 per acre-ft) and the cost to construct the basin ($112 per acre-ft), the total cost of the functioning recharge basin will be approximately $507 per acre-ft.

Item	Item Description	Estimate
Land Acquisition	Purchase 22.5 Acres	$787,000
Construction Cost	Basin construction	$1,023,000
	Connect basin to CID facility	$36,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$554,000
Contingency	25% based on conceptual design	$462,000
	Total Capital Cost	**$2,862,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$2,862,000	$186,177	1,656	$112/$507

Funding Source - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Kingsburg reserves or obtained grants.

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

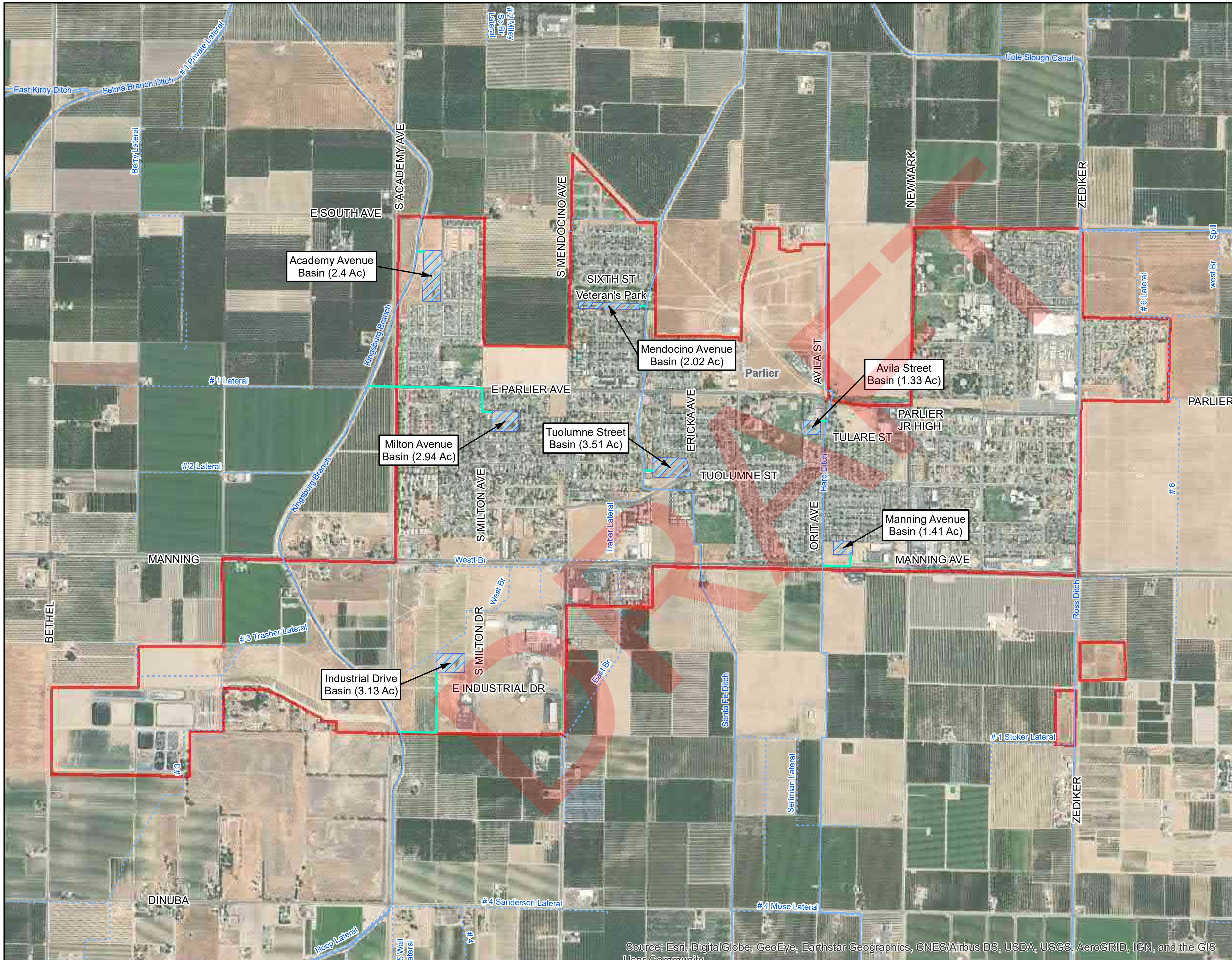
The project would be managed by the City of Kingsburg. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding and the willingness of the landowners to sell the necessary property. The City has reserve funds available and are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.4 Projects within the City of Parlier Geographic Area

The projects discussed below may be implemented to offset a portion of the GSA's groundwater extraction. Figure 6-3 illustrates the locations of the projects.



South Kings GSA

Proposed Recharge Areas

Parlier

Figure 6-3

Legend

- Proposed Recharge Area
- City Limits
- Proposed Connection
- Canal
- Canal Lateral

EST. 1968 PROVOST& PRITCHARD CONSULTING GROUP An Employee Owned Company

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0 750 1,500 Feet

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6.2.4.1 Industrial Drive Basin Project

The first project identified for within the City of Parlier geographic area will convert the existing stormwater retention basin northwest of the intersection of East Industrial Drive and South Milton Avenue into a larger recharge basin. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-11: Industrial Drive Basin Project

Project Title: Industrial Drive Basin	**Project ID: PA01**
Project Type	
Groundwater Recharge	
Project Location	
Northwest of the intersection of East Industrial Drive and South Milton Avenue, Parlier, CA	
Implementing Agency	
The City of Parlier or the SKGSA will implement the program.	
Project Description - 354.44(a)	
The project will include modifying the existing basin, providing any infrastructure needed to convey surface water from CID facilities to the basin for recharge. The basin will not be increased from its current size of 3.1 acres.	
Measurable Objective(s) Addressed - 354.44(b)(1)	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence.	
☒ Chronic Lowering of Groundwater Levels	☒ Reduction of Groundwater Storage
☐ Seawater Intrusion	☒ Degraded Water Quality
☒ Land Subsidence	☐ Depletion of Interconnected Surface Water
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.	
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	
The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.	
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	
The project will develop 3.1 acres of intentional recharge basins, resulting in approximately 198 acre-ft of water recharged within the GSA, annually. The project will also require the installation of flow meters at the basins. Surface water that is delivered to the basin will be measured through the new flowmeters.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
No additional permits or regulatory approvals are anticipated other than those mentioned above.	
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2025.	

Project Title: Industrial Drive Basin **Project ID: PA01**

Evaluation of Benefits - 354.44(b)(5)

The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Parlier. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 198 AFY.

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

The project will be accomplished by the City of Parlier or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary permits to construct, own and operate the project, as detailed above.

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

The tables below show the probable construction cost for the project and the repayment costs based on a loan that lasts 30 years with a 5% interest rate. The new basin area is projected to yield 198 acre-ft of recharge on an annual basis. With the cost of water ($395 per acre-ft) and the cost to construct the basin ($177 per acre-ft), the total cost of the functioning recharge basin will be approximately $572 per acre-ft.

Item	Item Description	Estimate
Construction Cost	Basin conversion	$50,000
	Connect basin to CID facility	$298,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$105,000
Contingency	25% based on conceptual design	$87,000
	Total Capital Cost	**$540,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$540,000	$35,128	198	$177/$572

Funding Source - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Parlier reserves or obtained grants.

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

The project would be managed by the City of Parlier. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding. The City is eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.4.2 Milton Avenue Basin Project

This project is located in a residential development southeast of the intersection of South Milton Avenue and East Parlier Avenue. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-12: Milton Avenue Basin Project

Project Title: Milton Avenue Basin	**Project ID: PA02**
Project Type	
Groundwater Recharge	
Project Location	
Residential development southeast of the intersection of South Milton Avenue and East Parlier Avenue, Parlier, CA	
Implementing Agency	
The City of Parlier or the SKGSA will implement the program.	
Project Description - 354.44(a)	
The project entails the conversion of the existing stormwater retention basin at this location into a recharge basin. Modifications and additions to the existing basin and its related infrastructure will allow for conveyance of surface water from CID facilities for recharge.	
Measurable Objective(s) Addressed - 354.44(b)(1)	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence.	
☒ Chronic Lowering of Groundwater Levels	☒ Reduction of Groundwater Storage
☐ Seawater Intrusion	☒ Degraded Water Quality
☒ Land Subsidence	☐ Depletion of Interconnected Surface Water
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.	
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	
The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.	
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	
The converted recharge basin will be 2.9 acres and have the potential to recharge 185 acre-ft of water over the course of a year. Flowmeters installed at the newly converted basin will measure the quantity of water delivered for recharge.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
No additional permits or regulatory approvals are anticipated other than those mentioned above.	
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2030.	

Project Title: **Milton Avenue Basin**	**Project ID: PA02**

Evaluation of Benefits - 354.44(b)(5)

The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Parlier. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 185 AFY.

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

The project will be accomplished by the City of Parlier or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary permits to construct, own and operate the project, as detailed above.

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

The following tables show the probable construction cost and annual repayment costs for a loan amortized over 30 years with a 5% interest rate. The useful life of the project components is anticipated to be more than 30 years, at which point replacement of some components may be necessary. The project is anticipated to yield 185 acre-ft per year, which equates to a cost of $256 per acre-ft plus the cost of water at $395 per acre-ft; the total cost is approximately $651 per acre-ft.

Item	Item Description	Estimate
Construction Cost	Basin conversion	$50,000
	Connect basin to CID facility	$420,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$141,000
Contingency	25% based on conceptual design	$118,000
	Total Capital Cost	**$729,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$729,000	$47,422	185	$256/$651

Funding Source - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Parlier reserves or obtained grants.

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

The project would be managed by the City of Parlier. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding. The City is eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.4.3 Tuolumne Street Basin Project

The third project identified for with the City of Parlier geographic area will provide an opportunity for recharge by converting the existing stormwater basin at the northwest corner of Tuolumne Street and Erica Avenue. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-13: Tuolumne Street Basin Project

Project Title: Tuolumne Street Basin	**Project ID: PA03**
Project Type	
Groundwater Recharge	
Project Location	
Northwest corner of Tuolumne Street and Erica Avenue, Parlier, CA	
Implementing Agency	
The City of Parlier or the SKGSA will implement the program.	
Project Description - 354.44(a)	
The project will consist of any needed modifications or additions to the existing basin, its piping, and connection to CID facilities to allow water to be delivered for recharge.	
Measurable Objective(s) Addressed - 354.44(b)(1)	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence. ☒ Chronic Lowering of Groundwater Levels ☐ Seawater Intrusion ☒ Land Subsidence	☒ Reduction of Groundwater Storage ☒ Degraded Water Quality ☐ Depletion of Interconnected Surface Water
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.	
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	
The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.	
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	
The conversion of the existing basin into a recharge basin will provide a recharge area of 3.5-acres and will yield a recharge volume of 224 acre-ft per year. Since the volume of water delivered to the basin will need to be measured, flowmeters will be installed at the basin.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
No additional permits or regulatory approvals are anticipated other than those mentioned above.	
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2035.	
Evaluation of Benefits - 354.44(b)(5)	
The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Parlier. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 224 AFY.	

Project Title: Tuolumne Street Basin **Project ID: PA03**

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

The project will be accomplished by the City of Parlier or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary permits to construct, own and operate the project, as detailed above.

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

The tables below show the costs related to converting an existing storm drain basin into a basin that can be used for recharge, as well as the costs related to a loan over a 30-year period with a 5% interest rate. It is estimated that the constructed basin will last for over 30 years. It should be noted that some infrastructure will need to be repaired or replaced following the 30-year mark. This completed basin is expected to have capacity for 224 acre-ft of recharge annually. The construction of this basin will cost $31 per acre-ft in addition to the $395 per acre-ft cost for water; the total cost is approximately $426 per acre-ft.

Item	Item Description	Estimate
Construction Cost	Basin conversion	$50,000
	Connect basin to CID facility	$18,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$21,000
Contingency	25% based on conceptual design	$17,000
	Total Capital Cost	**$106,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$106,000	$6,895	224	$31/$426

Funding Source - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Parlier reserves or obtained grants.

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

The project would be managed by the City of Parlier. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding. The City is eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.4.4 Manning Avenue Basin Project

The Manning Avenue Basin Project will convert the existing basin at the north east corner of Orit Ave and Manning Ave. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-14: Manning Avenue Basin Project

Project Title: Manning Avenue Basin	**Project ID: PA04**
Project Type	
Groundwater Recharge	
Project Location	
Northwest of the intersection of East Industrial Drive and South Milton Avenue, Parlier, CA	
Implementing Agency	
The City of Parlier or the SKGSA will implement the program.	
Project Description - 354.44(a)	
The project will involve the conversion of the existing stormwater basin to a recharge basin, which will likely include additions and modifications to the basin's existing piping in order to deliver water from CID facilities to the basin.	
Measurable Objective(s) Addressed - 354.44(b)(1)	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence. ☒ Chronic Lowering of Groundwater Levels ☐ Seawater Intrusion ☒ Land Subsidence	☒ Reduction of Groundwater Storage ☒ Degraded Water Quality ☐ Depletion of Interconnected Surface Water
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.	
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	
The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.	
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	
In total, the basin conversion will provide the GSA with 1.4 acres of recharge basins and a recharge volume of 79 acre-ft each year. Flow meters will be installed at the basin to measure the volume of surface water delivered.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
No additional permits or regulatory approvals are anticipated other than those mentioned above.	
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2035.	
Evaluation of Benefits - 354.44(b)(5)	
The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Parlier. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 79 AFY.	

Project Title: Manning Avenue Basin **Project ID: PA04**

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

The project will be accomplished by the City of Parlier or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary permits to construct, own and operate the project, as detailed above.

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

The probable construction cost to convert a 1.4-acre basin is shown in the tables below. The repayment cost estimated using a 30-year loan with a 5% interest rate, and cost per acre-ft, is also shown. The annual yield of the newly constructed recharge basin will be 79 acre-ft. It is anticipated that the cost of building the new basin will be $88 per acre-ft with a cost of $395 per acre-ft for water delivery, totaling approximately $483 per acre-ft.

Item	Item Description	Estimate
Construction Cost	Basin conversion	$50,000
	Connect basin to CID facility	$18,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$21,000
Contingency	25% based on conceptual design	$17,000
	Total Capital Cost	**$106,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$106,000	$6,895	79	$88/$483

Funding 106 - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Parlier reserves or obtained grants.

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

The project would be managed by the City of Parlier. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding. The City is eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.4.5 Avila Street Basin Project

This project entails the conversion of the existing stormwater basin east of Parlier Junior High School near the intersection of Avila Street and Tulare Street. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-15: Avila Street Basin Project

Project Title: Avila Street Basin	**Project ID: PA05**
Project Type	
Groundwater Recharge	
Project Location	
East of Parlier Junior High School near the intersection of Avila Street and Tulare Street, Parlier, CA	
Implementing Agency	
The City of Parlier or the SKGSA will implement the program.	
Project Description - 354.44(a)	
The efforts to convert the basin into a recharge basin may include modifying or adding to the existing storm drainage system connected to the basin to allow water to flow from CID facilities to the basin.	
Measurable Objective(s) Addressed - 354.44(b)(1)	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence.	
☒ Chronic Lowering of Groundwater Levels	☒ Reduction of Groundwater Storage
☐ Seawater Intrusion	☒ Degraded Water Quality
☒ Land Subsidence	☐ Depletion of Interconnected Surface Water
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.	
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	
The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.	
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	
This project is expected to supply 1.3 acres of recharge basin area and aid in producing 73 acre-ft of recharge on a yearly basis. This project requires the installation of flowmeters at the basins, which will serve the purpose of measuring the amount of surface water that is delivered to the basin.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
No additional permits or regulatory approvals are anticipated other than those mentioned above.	
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2035.	
Evaluation of Benefits - 354.44(b)(5)	
The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Parlier. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 73 AFY.	

Project Title:	**Avila Street Basin**	**Project ID: PA05**

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

The project will be accomplished by the City of Parlier or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary permits to construct, own and operate the project, as detailed above.

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

The tables below display the probable construction cost of the project, as well as the capital repayment costs and cost per acre-ft based on a 30-year loan with a 5% interest rate. This project is expected have an annual yield of 73 acre-ft of recharge. The total cost of the project is estimated to be $94 per acre-ft, which includes $395 per acre-ft for water delivery and $489 for construction of the project.

Item	Item Description	Estimate
Construction Cost	Basin conversion	$50,000
	Connect basin to CID facility	$18,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$21,000
Contingency	25% based on conceptual design	$17,000
	Total Capital Cost	**$106,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$106,000	$6,895	73	$94/$489

Funding Source - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Parlier reserves or obtained grants.

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

The project would be managed by the City of Parlier. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding and the willingness of the landowners to sell the necessary property. The City has reserve funds available and are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.4.6 Mendocino Avenue Basin Project

This project will convert the stormwater basin directly south of Veterans Park at South Mendocino Avenue and Sixth Street into a recharge basin. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-16: Mendocino Avenue Basin Project

Project Title: Mendocino Avenue Basin	**Project ID: PA06**
Project Type	
Groundwater Recharge	
Project Location	
Directly south of Veterans Park at South Mendocino Avenue and Sixth Street, Parlier, CA	
Implementing Agency	
The City of Parlier or the SKGSA will implement the program.	
Project Description - 354.44(a)	
The project will convert an existing stormwater basin into a recharge basin. In order to deliver water from CID facilities to the basin, additions and modifications to the existing structures and piping at the basin and CID lateral may be included in the project.	
Measurable Objective(s) Addressed - 354.44(b)(1)	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence.	
☒ Chronic Lowering of Groundwater Levels	☒ Reduction of Groundwater Storage
☐ Seawater Intrusion	☒ Degraded Water Quality
☒ Land Subsidence	☐ Depletion of Interconnected Surface Water
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.	
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	
The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.	
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	
The existing 2.0-acre basin will be converted into a recharge basin that is expected to recharge 93 acre-ft of water annually inside of the GSA. Flowmeters will need to be installed at this basin, so the volume of surface water delivered to the basin can be measured.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
No additional permits or regulatory approvals are anticipated other than those mentioned above.	
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2040.	
Evaluation of Benefits - 354.44(b)(5)	
The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Parlier. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 93 AFY.	

Project Title:	**Mendocino Avenue Basin**	**Project ID: PA06**

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

The project will be accomplished by the City of Parlier or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary permits to construct, own and operate the project, as detailed above.

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

The tables below summarize the probable construction costs for the new basin and repayment costs for a loan that lasts 30 years and has a 5% interest rate. The new basin is projected to yield 93 acre-ft of recharge on an annual basis. With the cost of water ($395 per acre-ft) and the cost to construct the basin ($74 per acre-ft), the total cost is expected to be approximately $469 per acre-ft.

Item	Item Description	Estimate
Construction Cost	Basin conversion	$50,000
	Connect basin to CID facility	$18,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$21,000
Contingency	25% based on conceptual design	$17,000
	Total Capital Cost	**$106,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$106,000	$6,895	93	$74/$469

Funding Source - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Parlier reserves or obtained grants.

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

The project would be managed by the City of Parlier. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding and the willingness of the landowners to sell the necessary property. The City has reserve funds available and are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.4.7 Academy Avenue Basin Project

The Academy Avenue Basin Project is a basin conversion project located in the residential development to the southeast of the intersection of South Academy Avenue and East South Avenue. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-17: Academy Avenue Basin Project

Project Title: Academy Avenue Basin	**Project ID: PA07**
Project Type	
Groundwater Recharge	
Project Location	
Northwest of the intersection of East Industrial Drive and South Milton Avenue, Parlier, CA	
Implementing Agency	
The City of Parlier or the SKGSA will implement the program.	
Project Description - 354.44(a)	
This project will involve converting the existing stormwater basin into a recharge basin by making additions and modifications to the basin's piping and allowing the flow of water from the Kingsburg Branch canal to the basin.	
Measurable Objective(s) Addressed - 354.44(b)(1)	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence.	
☒ Chronic Lowering of Groundwater Levels	☒ Reduction of Groundwater Storage
☐ Seawater Intrusion	☒ Degraded Water Quality
☒ Land Subsidence	☐ Depletion of Interconnected Surface Water
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.	
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	
The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.	
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	
The conversion of the existing basin will result in 2.4 acres of recharge basin, which will have the ability to recharge 144 acre-ft per year. The converted basin will require the installation of flowmeters to measure the quantity of water that is delivered for recharge.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
No additional permits or regulatory approvals are anticipated other than those mentioned above.	
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2040.	
Evaluation of Benefits - 354.44(b)(5)	
The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Parlier. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 144 AFY.	

Project Title:	**Academy Avenue Basin**	**Project ID: PA07**

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

The project will be accomplished by the City of Parlier or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary permits to construct, own and operate the project, as detailed above.

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

The following tables show the probable construction cost and annual repayment costs for a loan amortized over 30 years with a 5% interest rate. The useful life of the project components is anticipated to be more than 30 years, at which point replacement of some components may be necessary. The project is anticipated to yield 144 acre-ft per year, which equates to a cost of $73 per acre-ft plus the cost of water at $395 per acre-ft; the total cost is approximately $468 per acre-ft.

Item	Item Description	Estimate
Construction Cost	Basin conversion	$50,000
	Connect basin to CID facility	$54,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$32,000
Contingency	25% based on conceptual design	$26,000
	Total Capital Cost	**$162,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$162,000	$10,538	144	$73/$468

Funding Source - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Parlier reserves or obtained grants.

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

The project would be managed by the City of Parlier. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding and the willingness of the landowners to sell the necessary property. The City has reserve funds available and are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.4.8 4.2-Acre Recharge Basin Project

This project provides any additional area required that was not provided by the construction, conversion, and expansions of basins identified in the previous projects. The location of the basin(s) included in this project is yet to be determined but will have reduced piping costs with close proximity to CID facilities. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-18: 4.2-Acre Recharge Basin Project

Project Title: 4.2-Acre Recharge Basin	**Project ID: PA08**
Project Type	
Groundwater Recharge	
Project Location	
Undeveloped land to be determined later in and around the City of Parlier, CA	
Implementing Agency	
The City of Parlier or the SKGSA will implement the program.	
Project Description - 354.44(a)	
This project will consist of the construction of a new basin or basins and required piping to connect to CID facilities.	
Measurable Objective(s) Addressed - 354.44(b)(1)	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence. ☒ Chronic Lowering of Groundwater Levels ☐ Seawater Intrusion ☒ Land Subsidence	☒ Reduction of Groundwater Storage ☒ Degraded Water Quality ☐ Depletion of Interconnected Surface Water
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.	
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	
The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.	
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	
This new basin will have an area of approximately 4.2 acres, which is expected to generate an annual recharge volume of 278 acre-ft. Flowmeters at the basin will measure the quantity of surface water delivered for recharge.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
No additional permits or regulatory approvals are anticipated other than those mentioned above.	
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2040.	
Evaluation of Benefits - 354.44(b)(5)	
The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Parlier. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 278 AFY.	

Project Title: **4.2-Acre Recharge Basin**	**Project ID: PA08**

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

The project will be accomplished by the City of Parlier or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary lands and permits to construct, own and operate the project, as detailed above.

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

The tables below show the probable construction costs and repayment costs based on a 30-year loan with an interest rate of 5%. The new basin is projected to have an annual yield of 278 acre-ft and cost $137 per acre-ft to construct. With the cost of water at approximately $395 per acre-ft, the total cost of the operational basin is $532 per acre-ft.

Item	Item Description	Estimate
Land Acquisition	Purchase 4.2 Acres	$148,000
Construction Cost	Basin construction	$193,000
	Connect basin to CID facility	$36,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$114,000
Contingency	25% based on conceptual design	$95,000
	Total Capital Cost	**$586,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$586,000	$38,120	278	$137/$532

Funding Source - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Parlier reserves or obtained grants.

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

The project would be managed by the City of Parlier. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding and the willingness of the landowners to sell the necessary property. The City has reserve funds available and are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.5 Projects within the City of Sanger Geographic Area

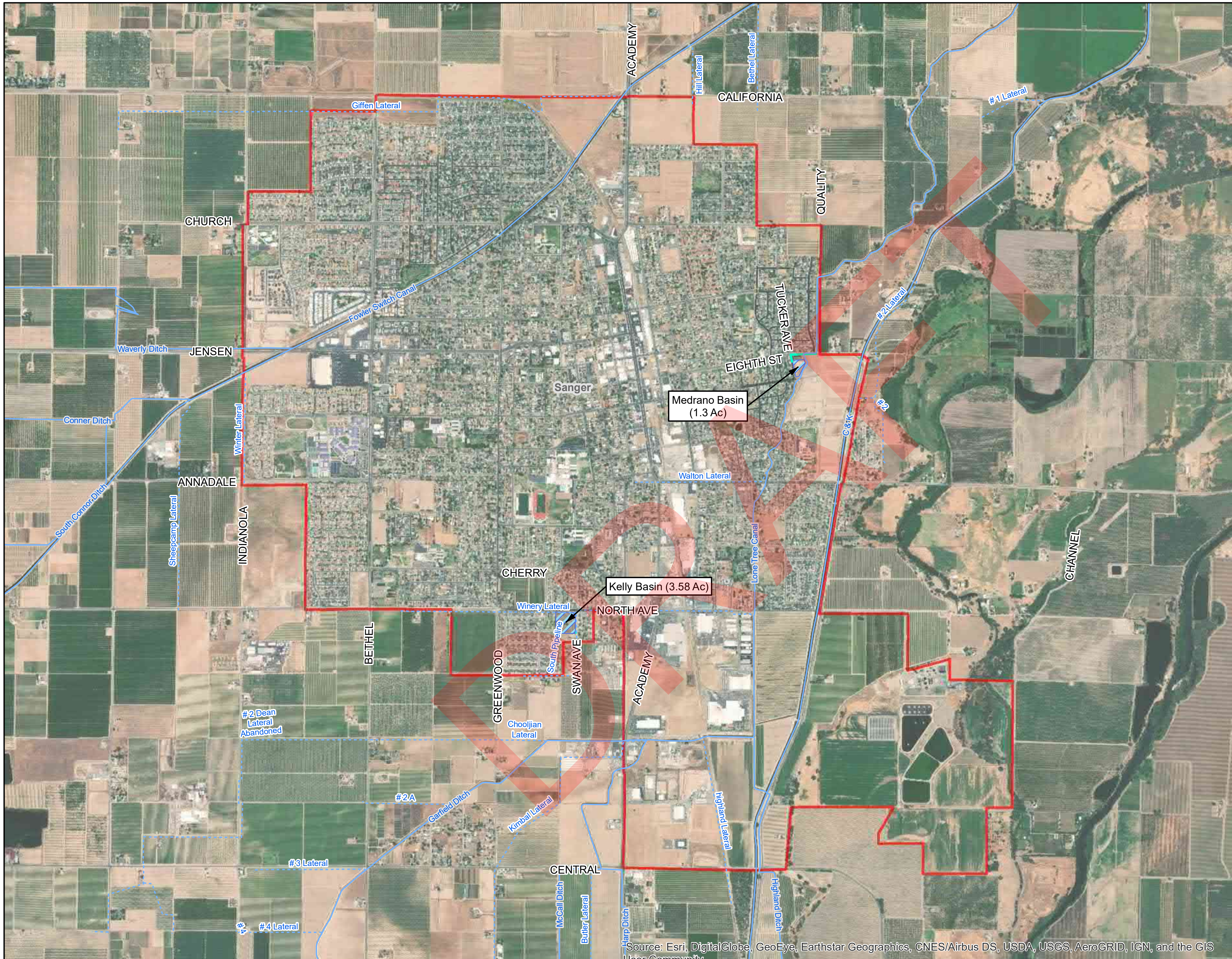
The projects discussed below may be implemented to offset a portion of the GSA's groundwater extraction. Figure 6-4 illustrates the locations of the projects.

South Kings GSA

Proposed Recharge Areas

Sanger

Figure 6-4



Legend

- Proposed Recharge Area
- City Limits
- Proposed Connection
- Canal
- Canal Lateral

EST. 1968 PROVOST & PRITCHARD CONSULTING GROUP An Employee Owned Company

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0 1,000 2,000 Feet

5/31/2019 : G:\South Kings GSA - 2731\273118001 - SGMA On-Call Services\GIS\Map\Recharge\Sanger.mxd

6.2.5.1 Kelly Basin Project

The first identified project for within the City of Sanger geographic area involves the conversion of an existing stormwater basin on the southwest side of the Swan Avenue and North Avenue intersection. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-19: Kelly Basin Project

Project Title: Kelly Basin	**Project ID: SA01**
Project Type	
Groundwater Recharge	
Project Location	
Southwest side of Swan Avenue and North Avenue, Sanger, CA	
Implementing Agency	
The City of Sanger or the SKGSA will implement the program.	
Project Description - 354.44(a)	
The existing basin will be converted to a recharge basin and will be connected to CID facilities through existing storm drain mains, which can be dual purposed for conveyance of surface water to the basin.	
Measurable Objective(s) Addressed - 354.44(b)(1)	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence. ☒ Chronic Lowering of Groundwater Levels ☐ Seawater Intrusion ☒ Land Subsidence	☒ Reduction of Groundwater Storage ☒ Degraded Water Quality ☐ Depletion of Interconnected Surface Water
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.	
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	
The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.	
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	
The project will convert an existing basin into 3.6 acres of intentional recharge basin, resulting in approximately 231 acre-ft of water recharged within the GSA on an annual basis. Flowmeters at the basin will measure the quantity of water that is being delivered to the basin for recharge.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
No additional permits or regulatory approvals are anticipated other than those mentioned above.	
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2025.	
Evaluation of Benefits - 354.44(b)(5)	
The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Sanger. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 231 AFY.	

Project Title: Kelly Basin **Project ID: SA01**

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

The project will be accomplished by the City of Sanger or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary permits to construct, own and operate the project, as detailed above.

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

The following tables show the probable construction cost and annual repayment costs for a loan amortized over 30 year with a 5% interest rate. The useful life of the project components is anticipated to be more than 30 years, at which point replacement of some components may be necessary. The project is anticipated to yield 231 acre-ft each year, which equates to cost of $30 per acre-foot plus the cost of water at $395 per acre-foot; the total cost is approximately $425 per acre-foot.

Item	Item Description	Estimate
Construction Cost	Basin conversion	$50,000
	Connect basin to CID facility	$18,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$21,000
Contingency	25% based on conceptual design	$17,000
	Total Capital Cost	**$106,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$106,000	$6,895	231	$30/$425

Funding Source - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Sanger reserves or obtained grants.

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

The project would be managed by the City of Sanger. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding. The City has reserve funds available and are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.5.2 Medrano Basin Project

This project will involve converting the existing stormwater basin at the southeast corner of 8th Street and Tucker Avenue into a basin that can be used for groundwater recharge. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-20: Medrano Basin Project

Project Title: Medrano Basin	**Project ID: SA02**
Project Type	
Groundwater Recharge	
Project Location	
Southeast corner of 8th Street and Tucker Avenue, Sanger, CA	
Implementing Agency	
The City of Sanger or the SKGSA will implement the program.	
Project Description - 354.44(a)	
The Medrano Basin Project will convert an existing stormwater basin into a recharge basin. Additions and modifications to the existing nearby storm drain system will be needed to allow conveyance of water from the Lonetree Channel to the basin for recharge.	
Measurable Objective(s) Addressed - 354.44(b)(1)	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence.	
☒ Chronic Lowering of Groundwater Levels	☒ Reduction of Groundwater Storage
☐ Seawater Intrusion	☒ Degraded Water Quality
☒ Land Subsidence	☐ Depletion of Interconnected Surface Water
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.	
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	
The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.	
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	
This basin conversion will provide 1.3 acres of basin that can be used for recharge. The new basin is estimated to recharge approximately 68 acre-ft of water each year. Flowmeters will need to be installed at the converted basin to measure the quantity of surface water that is being delivered to the recharge basin.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
No additional permits or regulatory approvals are anticipated other than those mentioned above.	
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2025.	
Evaluation of Benefits - 354.44(b)(5)	
The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Sanger. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 68 AFY.	

Project Title: Medrano Basin **Project ID: SA02**

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

The project will be accomplished by the City of Sanger or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary lands and permits to construct, own and operate the project, as detailed above.

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

The tables below summarize the probable construction costs and the repayment costs for a 30-year loan with a 5% interest rate. The lifetime of the new basin is projected to be at least 30 years and will produce 68 acre-ft of recharge on an annual basis. Construction of the basin is expected to cost around $128 per acre-ft and the cost of water is approximately $395 per acre-ft, totaling approximately $523 per acre-ft.

Item	Item Description	Estimate
Construction Cost	Basin conversion	$50,000
	Connect basin to CID facility	$36,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$26,000
Contingency	25% based on conceptual design	$22,000
	Total Capital Cost	**$134,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$134,000	$8,717	68	$128/$523

Funding Source - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Sanger reserves or obtained grants.

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

The project would be managed by the City of Sanger. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding. The City has reserve funds available and are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.5.3 West Sanger, 7.6-Acre Basin Project

The West Sanger Basin Project will consist of the construction of a new recharge basin on the west side of the City. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-21: West Sanger, 7.6-Acre Basin Project

Project Title: West Sanger, 7.6-Acres Recharge Basin	**Project ID:** SA03
Project Type	
Groundwater Recharge	
Project Location	
Undeveloped land on the west side of the City of Sanger, CA	
Implementing Agency	
The City of Sanger or the SKGSA will implement the program.	
Project Description - 354.44(a)	
In addition to excavation efforts, work will include construction and installation of necessary turnout and outlet structures, piping, and fencing.	
Measurable Objective(s) Addressed - 354.44(b)(1)	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence. ☒ Chronic Lowering of Groundwater Levels ☐ Seawater Intrusion ☒ Land Subsidence ☒ Reduction of Groundwater Storage ☒ Degraded Water Quality ☐ Depletion of Interconnected Surface Water	
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.	
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	
The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.	
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	
The new basin constructed with this project will provide an area of 7.6 acres with a recharge volume of 528 acre-ft per year. Flowmeters will be installed so the delivered water for recharge can be measured at the basin.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
No additional permits or regulatory approvals are anticipated other than those mentioned above.	
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2030.	
Evaluation of Benefits - 354.44(b)(5)	
The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Sanger. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 528 AFY.	

Project Title: West Sanger, 7.6-Acres Recharge Basin **Project ID: SA03**

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

The project will be accomplished by the City of Sanger or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary permits to construct, own and operate the project, as detailed above.

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

The tables below show the probable construction costs and repayment costs estimated based on a 30-year loan with an interest rate of 5%. The new basin is projected to have an annual yield of 528 acre-ft and cost $21 per acre-ft to construct. With the cost of water being approximately $395 per acre-ft, the total cost of the operational basin is $416 per acre-ft.

Item	Item Description	Estimate
Construction Cost	Basin construction	$100,000
	Connect basin to CID facility	$9,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$33,000
Contingency	25% based on conceptual design	$28,000
	Total Capital Cost	**$170,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$170,000	$11,059	528	$21/$416

Funding Source - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Sanger reserves or obtained grants.

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

The project would be managed by the City of Sanger. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding and the willingness of the landowners to sell the necessary property. The City has reserve funds available and are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.2.5.4 North Sanger, 27.4-Acre Recharge Basin Project

The 27.4-Acre Basin Project will consist of the construction of a new recharge basin on the north side of the City. The following table summarizes the parameters, benefits and other pertinent information regarding the project.

Table 6-22: North Sanger, 27.4 Acre Basin Project

Project Title: North Sanger, 27.4-Acre Recharge Basin	**Project ID: SA04**
Project Type	
Groundwater Recharge	
Project Location	
Undeveloped land on the north side of the City of Sanger, CA	
Implementing Agency	
The City of Sanger or the SKGSA will implement the program.	
Project Description - 354.44(a)	
In addition to excavation efforts, work will include construction and installation of necessary turnout and outlet structures, piping, and fencing.	
Measurable Objective(s) Addressed - 354.44(b)(1)	
The project will primarily help stabilize groundwater levels and increase the amount of groundwater in storage. The project could also provide some groundwater quality benefits and/or impact on reducing land subsidence. ☒ Chronic Lowering of Groundwater Levels ☐ Seawater Intrusion ☒ Land Subsidence	☒ Reduction of Groundwater Storage ☒ Degraded Water Quality ☐ Depletion of Interconnected Surface Water
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
This is a high priority project and will be implemented, if determined feasible, as soon as the program is established.	
Process to Provide Notice of Implementation - 354.44(b)(1)(B)	
The SKGSA will provide notice of the program as part of SGMA outreach and education and will notify landowners.	
Estimated Annual Project Benefits (AF/yr) - 354.44(b)(2)	
The new basin constructed with this project will provide an area of 27.4 acres with a recharge volume of 2, 548 acre-ft per year. Flowmeters will be installed so the delivered water for recharge can be measured at the basin.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
No additional permits or regulatory approvals are anticipated other than those mentioned above.	
Project Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
Construction of this project will be undertaken as soon as funding is available. The completion is targeted for milestone year 2040.	
Evaluation of Benefits - 354.44(b)(5)	
The volume of water delivered for recharge will be measured daily and summarized monthly by the delivering water agency as well as the City of Sanger. The rate of accrual of benefits will depend on the availability and frequency of Kings River water. The anticipated annual benefit is 2,548 AFY.	

Project Title:	**North Sanger, 27.4-Acre Recharge Basin**	**Project ID: SA04**

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

The project will be accomplished by the City of Sanger or the SKGSA. The water source is Consolidated Irrigation District.

Legal Authority - 354.44(b)(7)

The City has legal authority, as discussed above, to manage the groundwater in their area and the City has the legal authority to deliver surface water to lands within their City.

Further, the City will acquire the necessary lands and permits to construct, own and operate the project, as detailed above.

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

The tables below show the probable construction costs and repayment costs estimated based on a 30-year loan with an interest rate of 5%. The new basin is projected to have an annual yield of 2,548 acre-ft and cost $111 per acre-ft to construct. With the cost of water being approximately $395 per acre-ft, the total cost of the operational basin is $506 per acre-ft.

Item	Item Description	Estimate
Land Acquisition	Purchase 27.4 Acres	$961,000
Construction Cost	Basin construction	$1,249,000
	Connect basin to CID facility	$36,000
Non-Contract Costs	Design Data, Data Collection, Design, Permitting & Construction Management	$674,000
Contingency	25% based on conceptual design	$562,000
	Total Capital Cost	**$3,482,000**

Total Capital Cost	Annual Capital Repayment	Annual Yield (AF)	Cost Per AF Water (Capital/Total)
$3,482,000	$226,509	2,548	$111/$506

Funding Source - 354.44(b)(8)

Funding will be obtained through the SKGSA, the City of Sanger reserves or obtained grants.

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

The project would be managed by the City of Sanger. Performance of the project would be a necessary part of the City's reporting requirements.

Level of Uncertainty - 354.44(d)

The level of uncertainty primarily involves the availability of funding and the willingness of the landowners to sell the necessary property. The City has reserve funds available and are eligible for several grants or low-interest loans, therefore the level of uncertainty is relatively low.

6.3 Potential Management Actions

The following sections will discuss potential management actions the SKGSA may consider during the GSP implementation. The menu of management actions discussed below may not be implemented in the order they are presented, and some may not be implemented at all, based on progress in achieving sustainability through other actions or projects. Additionally, other management actions may be introduced as new technology or techniques become available and/or based on stakeholder input. In the development of the management actions, the GSA intends to embody the lessons learned from other groundwater managed basins (EDF, 2017) and strive to accomplish the following:

- Develop trust by being inclusive and transparent.
- Use a portfolio of approaches to achieve sustainability.
- Ensure efficient and accurate data collection.
- Devise a fair groundwater allocation.
- Craft a groundwater trading structure that reflects local hydrologic conditions.
- Address concerns of funding GSA management actions.
- Assure performance by rigid penalties and enforcement.

It is the mission of this GSP to promote responsible water resource management, while effectively enforcing the policies and standards set in place by the South Kings GSA to conserve and protect the State of California's water resources for future generations to come.

6.3.1 Education and Outreach Management Actions

EO-1 Regular Communication

The SKGSA will promote education and outreach to all beneficial users and users within the GSA as detailed in **Section 2.5**.

EO-2 Non-Routine Responses to Minimum Threshold Exceedances

In addition to regular correspondence, the GSA may also immediately notify member agencies of a Minimum Threshold (MT) exceedance as defined in **Section 4.3**. In an effort to provide communication and outreach, the notification may contain the following information:

- Description and location of the MT exceedance.
- Notice of increased frequency of water level and/or water quality monitoring.
- The potential effects to the member agency.
- The planned GSA response (i.e., trigger of specific projects and managements actions).
- A written reminder of the GSA powers and authorities granted in SGMA, as well as, State intervention when Undesirable Results occur.

The regular correspondence and notice of MT exceedance may or may not generate a quantifiable groundwater demand reduction.

Table 6-23: Summary of Management Actions EO1 and EO2

Management Action No.:	**EO1 and EO2**
Measurable Objective(s) Addressed - 354.44(b)(1)	
The measurable objectives would be the number of annual correspondence letters and MT exceedance notices that are mailed each year	
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
The education and outreach management action may be developed and implemented shortly after the adoption of the GSP. The policy would remain indefinitely and be reevaluated every 5 years. A trigger for the end of this management action may be that another GSA management action or program provides comparable annual education letters and outreach notices.	
Process for Public Notification - 354.44(b)(1)(B)	

Management Action No.:	**EO1 and EO2**

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

Permitting and Regulatory Requirements - 354.44(b)(3)

Not permits or regulatory requirements are anticipated for this Action.

Status and Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits

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

Evaluation of Benefits - 354.44(b)(5)

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

The expected benefits may mitigate overdraft by educating the public about the current use and quality of groundwater supplies. Without levying penalties, the GSA intends for all correspondence and mailed notices to educate extractors about the GSA's monitoring practices, procedures, and enforcement capabilities. Other program benefits include the transparent and expeditious communication of GSA groundwater overdraft conditions, implementation of specific projects and managements actions, funding opportunities, and potential for State intervention if undesirable results occur.

How will the management action be accomplished? - 354.44(b)(6)

The annual correspondence and escalation letters will be accomplished by utilizing the in-house mailing database that the GSA will develop and maintain. All correspondence will be drafted by GSA staff and will be in accordance with the actions of the Board of Directors. Further detail regarding communication can be found in **Section 2.5.**

Estimated Costs - 354.44(b)(8)

The costs related to the education and outreach management action include one-time expenses and reoccurring annual expenses. The one-time expenses include the labor costs of the GSA, GSA's counsel, and GSA's consultant to prepare the formal program description and adopt the management action policy. The written policy would detail the specific content of the chosen correspondence method, the source of the data being reported, the frequency of the correspondence, mailing or delivery logistics, expected costs, and the intent of the policy. Through a GSA Board resolution, the program would be incorporated into the GSA's policy manual for transparency.

The reoccurring costs for mailed correspondence would include the costs of printing, stuffing envelopes, labeling, and postage among. In terms of the content of all correspondence, the costs associated with the GSA's selected groundwater extraction quantification method are not to be included in this section; these options and costs will be described in **Sections** Error! Reference source not found. through **6.2.5**. The initial costs of implementing this MA will be determined upon implementation. The reoccurring costs associated with the mailing or delivery of MT exceedance notices are difficult to estimate at this time because there are multiple factors that would change the notice frequency. For example, MT exceedances may not start occurring for 15+ years, notices may only be mailed to affected portions of the GSA, and exceedances may occur multiple times within a given year.

6.3.2 Well Head Requirements Management Actions

6.3.2.1 Well Metering and Sampling Requirements

The GSA recognizes that community involvement and outreach alone will not curtail groundwater overdraft. Additional well requirements may be required to more effectively manage and understand the dynamic groundwater conditions. Within the Del Rey CSD, well construction permitting is managed by Fresno County Environmental Health Division (FCEHD) as detailed in **Section 2.3.4**; the remaining member agencies manage new well construction within their respective city boundaries and do not allow new, private wells, to be constructed. Obtaining a well permit through FCEHD is currently a ministerial process, not requiring discretionary action or CEQA. The intent of this management action is to have the SKGSA work cooperatively with the FCEHD to increase well requirements without disrupting the current ministerial permit process. Additionally, the GSA would promote constant communication with the FCEHD and would seek to maintain more monitoring responsibility. The GSA may adopt a policy to augment the current well requirements set by the State/FCEHD and establish new permit criteria, enforce GSA policies, and require GSA approval of all permit paperwork for non-de minimis extractors before FCEHD permit issuance. The policy would affect permits to construct, deepen, destroy, recondition, or repair a well. In order to increase data collection, reporting, and ongoing groundwater management efforts, the additional well requirements policy may contain the following information:

- Registration of extraction facilities with the GSA.
- Require the installation of wellhead meters, sounding tubes, and water quality sample ports.
- Require the well owner to self-report groundwater extraction volumes, static water levels, and water quality data.
- Prohibit the construction of composite wells.
- Curtail or prohibit new well construction.

The GSA may consider separating the additional well requirements management action into multiple policies or be silent on various bulleted components until the GSA deems them necessary. For example, the requirement of installing sounding tubes and water quality sample ports may be enacted before the requirement of a well flow meter. Further explanation and detail of the potential additional well requirements are continued below.

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

WH-1 Registration of Extraction Facilities

As stated in SGMA 10725.6, "a GSA may require the registration of a groundwater extraction facility within the management area of the GSA." The GSA has greatly benefited from the current exchange of well information and use of the online DWR Well Completion Report Map Application tool found here: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37.

However, through research of the proposed well monitoring network, the GSA understands many existing wells do not have well completion reports or have not been entered into the DWR database and may be absent from the existing records. The intent of registration of groundwater extraction facilities would be to complement existing well recordkeeping and ensure that the GSA can fully understand and quantify the potential impacts of groundwater decline. Coupled with the registration of extraction facilities, the GSA may invest in a complete well canvass study to verify the number of wells and presence of a flow meter.

WH-2 Installation of Sounding Tubes and Water Quality Sample Ports

The GSA may require the installation of a well sounding tube, air line, electric depth gauge, and/or other water level sensor for the purpose of measuring water levels throughout the GSA. The accurate and widespread collection of water level data will provide the GSA with the necessary information to monitor the success/failure of the GSP against the established Sustainable Management Criteria in Section 4. The policy would describe the acceptable types of water level measuring devices and sample ports, installation requirements, and penalties for tampering, neglect, or misconduct. The installation must provide or allow for the accurate measurement of static groundwater level in feet below the ground surface. If applicable, the water level measurement device must be routinely maintained by the well owner. Once the well construction, deepening, or destruction work was completed, the contractor would be required to provide a Notice of Completion, also known as a Well Driller's Report or Well Log, within thirty (30) days of completion. The report would document that the work was completed in accordance with the Well Standards Ordinance and GSA additional well requirements policy.

WH-3 Self-Reporting of Groundwater Extraction, Level, and Water Quality

The GSA may require the well owner to self-report to the GSA the groundwater extraction volumes, static water levels, and water quality data twice per year, generally in April and October. The policy would describe the frequency of reporting, various methods of reporting, due dates, and specific instructions for data collection. If there is limited compliance with self-reporting, the GSA may elect to gather the appropriate data with their own staff. The policy would describe that the frequency of the reporting may be temporarily increased if minimum thresholds are exceeded.

WH-4 Prohibition of Composite Wells

The GSA may adopt a policy to prohibit the construction of composite wells, or wells drawing from more than one aquifer. Though wells can benefit from tapping two or more aquifers for increased production, the construction of composite wells create a potential health or water quality concern for cross contamination. In addition, the reporting of static water levels and water quality data from a composite well does not provide clear indication of water source. Misleading or erroneous data would be useless to the GSA in their understanding and management of groundwater.

Table 6-24: Summary of Management Actions WH1 through WH4

Management Action No.: **WH1 through WH4**
Measurable Objective(s) Addressed - 354.44(b)(1)
WH1: The measurable objective would be the number of documented extraction facilities. The method of evaluation may be comparing the number of registered wells to the FCEHD and DWR well records. WH2: The measurable objective would be the number of installed meters, sounding tubes and water quality sample ports. The method of evaluation would be reviewing the number of well permits and confirming whether meters, sounding tubes, and sample ports were installed. WH3: The measurable objective would be number of received reports for each mailing cycle. The method of evaluation would be reviewing the number of responses from groundwater users (excluding de minimis extractors), analyzing data validity/accuracy, and filling data gaps. WH4: The measurable objective would be number of received reports for each mailing cycle. The method of evaluation would be reviewing the number of responses from groundwater users (excluding de minimis extractors), analyzing data validity/accuracy, and filling data gaps.
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)
The current situation of critical groundwater overdraft leading to the unsustainable management of groundwater resources justifies the implementation of additional well requirements. This policy requires the support and coordination of the member agencies for successful implementation. For existing wells, there may be extenuating circumstances where the installation of flow meter, sounding tube, and/or water

Management Action No.:	**WH1 through WH4**

quality sample port are not practical or financially advisable. The policy would remain indefinitely or until another GSA program serves the same purpose.

Process for Public Notification - 354.44(b)(1)(B)

Educational correspondence regarding self-reporting of groundwater extractions would be accomplished through direct communication between the grower and the GSA. This will take place in the form of self-reporting and the monitoring of water level and water quality which is then compiled and distributed through each mailing cycle of correspondence mailings. Should the Board of Directors choose to adopt policy addressing WH-1-WH-4 the public will be notified through established GSA correspondence methods as explained in **Section 2.5**.

Permitting and Regulatory Requirements - 354.44(b)(3)

The regulatory process would require member agency coordination and support to ensure new well permits issued within the GSA adhere to the GSA policy. No other environmental or regulatory permits would be required.

Status and Schedule - 354.44(b)(4)

The additional well requirements policy has not been drafted. The draft policy and GSA discussions may commence shortly after the adoption of the GSP and be completed within 2 years.

Evaluation of Benefits - 354.44(b)(5)

The expected benefits would include a complete geo-database of groundwater extraction locations. Requiring new well permits to provide accurate information on location, depth, perforated zone, and measured water use and level would allow for more accurate data analysis of groundwater extraction, storage change, and water table fluctuations. The expected benefits of water quality sample ports and analytical testing would fill data gaps and provide extractors with useful information. The benefits of self-reporting include the avoidance of GSA staff or consultant time to individually collect data. The benefits of prohibiting composite wells include the avoidance of potential migration of pollutants.

How will the management action be accomplished? - 354.44(b)(6)

WH1: Validating all documented extraction facilities and the GSA may authorize a complete well canvass study to verify the number of wells and presence of a flow meter.

WH2 & WH3: Additional review will take place in order to confirm the number of reported well permits and to verify the installation of meters, sounding tubes and sample ports.

WH-4: Analyzing the received reports from each mailing cycle and assessing the data for accuracy and gaps.

Estimated Costs - 354.44(b)(8)

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

The costs related to the additional well requirements management action include one-time expenses and ongoing monthly expenses. The one-time expenses include the labor costs of the GSA, GSA's counsel and GSA's consultant to prepare the formal program description and adopt the management action policies. Through a GSA Board resolution, the program would be incorporated into the GSA's policy manual for transparency. The database of extraction facilities would be created and include individual fields for owner, location, well construction information, GSA additional requirements (i.e., meter, sounding tube, sample port, etc.), and future measurement data. The costs to implement these management actions will be determined if and when they are selected for implementation.

The adoption of this policy would have other resulting costs for the groundwater extractor including:

- Purchase and installation of the well meter, sounding tube, and sample port.

Management Action No.:	**WH1 through WH4**
• For existing wells, pump discharge modifications to ensure proper meter installation per the manufacturer's specifications. • Labor costs related to self-reporting • Laboratory testing of water quality.	

6.3.3 Groundwater Pumping Restrictions Management Actions

6.3.3.1 Groundwater Pumping Restrictions

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

GP-1 Regulate Groundwater Exports

The GSA may adopt a policy to prohibit new groundwater exports outside of the GSA boundary. The GSA may assure performance by enforcing rigid penalties for illegal actions. The GSA may approve external exports in limited quantities for emergency situations and levy fees for metering the exported amount.

GP-2 Require New Developments to Prove Sustainable Water Supply

The GSA may adopt a policy to require new developments to prove sustainable water supplies. The GSA may review and comment on all new development environmental documents to ensure water balance and corresponding mitigation measures are implemented. This policy requires the support and coordination of the member agencies during their typical project permitting process.

GP-3 Pumping Restrictions During Droughts

The GSA may adopt a policy to immediately reduce or temporarily suspend groundwater pumping during specific intervals such as extreme drought periods. Immediate restrictions may be the result of minimum threshold exceedances. The GSA may consider significant penalties for violators. The GSA may consider liens or cease and desist orders for excessive abuse.

Table 6-25: Summary of Management Actions GP1 through GP3

Management Action No.:	**GP1 through GP3**
Measurable Objective(s) Addressed - 354.44(b)(1)	
GP1: The goal is to ensure all groundwater supplies within the GSA are consumed or retained within the GSA boundary. The measurable objective is the metered volume of exported water with the goal of 0 AFY. GP2: The goal is to ensure all new developments have documented sustainable water supply and groundwater supplies are consumed or retained within the GSA boundary. The measurable objective is proven new development water balance with the goal of 0.0 acre-feet groundwater overdraft /year. GP3: The goal is to immediately reduce groundwater pumping, in the event of a drought. The measurable objective is the volume of groundwater extraction in acre-feet and number of violators.	
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
GP1: Though groundwater exports outside of the GSA are not currently a common practice, the GSA understands the changing water market conditions may entice beneficial users to seek financial gains by exporting groundwater. The policy may be implemented shortly after the adoption of the GSP and remain indefinitely. The policy fees and penalties may be reviewed by the GSA annually.	

Management Action No.: GP1 through GP3

GP2: The policy may be implemented shortly after the adoption of the GSP and remain until GSA overdraft has ended or indefinitely.

GP3: Circumstances of extreme drought or triggers of minimum threshold exceedances may expedite the policy adoption. The policy would remain until extreme drought conditions ended or minimum thresholds were no longer exceeded.

Process for Public Notification - 354.44(b)(1)(B)

The GSA will utilize the established methods of correspondence as described in EO-1 and EO-2 to coordinate directly with the extractor to address necessary actions associated with groundwater pumping restrictions. If deemed necessary the Board of Directors will adopt policy to, address, issue warnings and implement pumping restrictions if the circumstances require it.

Permitting and Regulatory Requirements - 354.44(b)(3)

No permit or regulatory process is required for the GSA to adopt policies to support the regulations described in this Management Action. No other environmental or regulatory permits would be required.

Status and Schedule - 354.44(b)(4)

The policies have not been drafted. They may commence after 10 years of GSP adoption and be completed within 5 years.

Evaluation of Benefits - 354.44(b)(5)

GP1: The expected benefits may mitigate overdraft by ensuring groundwater supplies are consumed or retained within the GSA boundary. Emergency groundwater exports may be metered and recorded by the GSA. The method of evaluation may be reviewing the number of emergency export permits. Estimated 0 - 100 acre-feet per year may be retained within the GSA boundary.

GP2: The expected benefits may mitigate overdraft by ensuring new developments utilize groundwater supplies in accordance with current GSA groundwater allocations and groundwater supplies are consumed or retained within the GSA boundary. The method of evaluation may be quantifying the number of new developments that are approved without GSA comment/approval. Estimated up to 100 acre-feet per year may be retained within the GSA boundary.

GP3: The expected benefits may mitigate local overdraft and minimum threshold exceedances by reducing or temporarily stopping groundwater extractions in a given area. The method of evaluation may be reviewing the financial impacts of reduced or suspended pumping. Estimated up to 6,000 acre-feet per year.

How will the management action be accomplished? - 354.44(b)(6)

GP1: The GSA may adopt a policy to charge a fee for existing groundwater exports and/or prohibit new groundwater exports outside of the GSA boundary.

GP2 and GP3: Additionally, the GSA will assess groundwater conditions as deemed necessary and may adopt policies to support these actions.

Estimated Costs - 354.44(b)(8)

The costs to draft and adopt policies and implement those policies will be determined if and when the management actions are implemented, and the costs are better known.

7 Plan Implementation

The adoption of the GSP will be the official start of the Plan Implementation. The GSA will continue its efforts to engage the public and secure the necessary funding to successfully monitor and manage groundwater resources within the Plan Area in a sustainable manner. While the GSP is being reviewed by DWR, the GSA will coordinate with various stakeholders and beneficial users to improve the monitoring network and begin the implementation of projects and management actions. The plan will be implemented under the existing authorities of both the GSA and the member agencies and, through coordinated activities, the groundwater resources of the region will now be managed.

7.1 Estimate of GSP Implementation Costs

Regulation Requirements:

> **§ 354.6. Agency Information**
> When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:
> **(e)** An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

The Implementation Costs of the GSP can be separated into two categories: Ongoing Administrative Expenses and Project Costs.

Ongoing Administrative Expenses

These include the cost of annually operating the GSA including the executive officer's salary, fiscal agent and staff expenses, audit, annual data collection and reporting, outreach, legal, and other administrative costs. This does not include agency specific project implementation costs but may include GSA wide efforts such as identification of construction information for wells in the monitoring network.

Project Costs

Projects which may include infrastructure or management programs will be required to achieve groundwater sustainability. Project costs may include planning, capital, financing and operations and maintenance of infrastructure. Each agency within the GSA will be responsible for implementing its own projects to reach sustainability. Costs will vary from agency to agency depending on the type and size of projects required to reach sustainability for each service area within the GSA. Total costs for the SKGSA member agency projects and management actions are estimated to be $12.4M from 2020 through 2040.

7.2 Identify Funding Alternatives

Regulation Requirements:

> **§ 354.6. Agency Information**
> When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 107238, with any updates, if necessary, along with the following information:
> **(e)** An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

The funding of the GSP implementation costs are described below.

Ongoing Administrative Expenses

These annual expenses will be spread to the SKGSA member agencies based on a percentage basis of the total acre-foot of groundwater pumped. The administrative expenses are determined for each agency and the GSA invoices each agency. Agency boundaries are based on member agency city limits.

The cost of conducting any necessary Proposition 218 elections will be borne by each individual agency. If necessary, upon mutual agreement of the GSA and the individual agency, the GSA could perform the assessment election for the agency, but the agency will pay all associated costs.

Project Costs

Project costs will be borne by each member agency, as needed, to offset their groundwater extraction.

Grant Funding

The GSA and its member agencies will be exploring other federal and state grant funding opportunities to help finance the initial steps of plan implementation.

7.3 Schedule for Implementation

Regulation Requirements:

§ 350.4. General Principles
Consistent with the State's interest in groundwater sustainability through local management, the following general principles shall guide the Department in the implementation of these regulations.
(f) A Plan will be evaluated, and its implementation assessed, consistent with the objective that a basin be sustainably managed within 20 years of Plan implementation without adversely affecting the ability of an adjacent basin to implement its Plan or achieve and maintain its sustainability goal over the planning and implementation horizon.

The GSA has committed to implementing projects and management actions, as noted in **Section 6**, between adoption of the GSP and 2040, to reach sustainability. **Table 6-2**: Summary of Potential Sustainability Projects and
Table 6-3 highlight the planned schedule for implementing projects and management actions, respectively.

7.4 Data Management System

Regulation Requirements:

§ 352.6. Data Management System
Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the Plan and monitoring of the basin.

The GSA, in coordination with the other GSAs in the Subbasin, have developed a Data Management System (DMS) to share data and store the necessary information for annual reporting. The GSAs have hired a consultant to build a user-friendly accessible database that standardizes the basin-wide data and allows GSA representatives to input their data and use basic tools for viewing, exporting or printing information for their GSA or the Subbasin. The DMS is a web-based software hosted on a cloud server. The DMS is the single repository for data aggregation and analysis for the Subbasin and generate the required annual reporting to DWR. GSA representatives have access to all data in the DMS. The DMS currently includes the necessary elements required by the regulations, including:

- Well location and construction information (where available)
- Water level readings and hydrographs including water year type
- Seasonal groundwater elevation contours
- Estimated groundwater extraction by category
- Total water use by source
- Estimate of groundwater storage change, including map and tables of estimation
- Graph with Water Year type, Groundwater Use, Annual Cumulative Storage Change

The DMS also includes basic data layers for refences including GSA boundaries, topographic information, land use, streets, aerial imagery, geologic information, specific yield information. Additional items may be added to the DMS in the future as required. A screen shot of the DMS is shown in **Figure 7-1**.

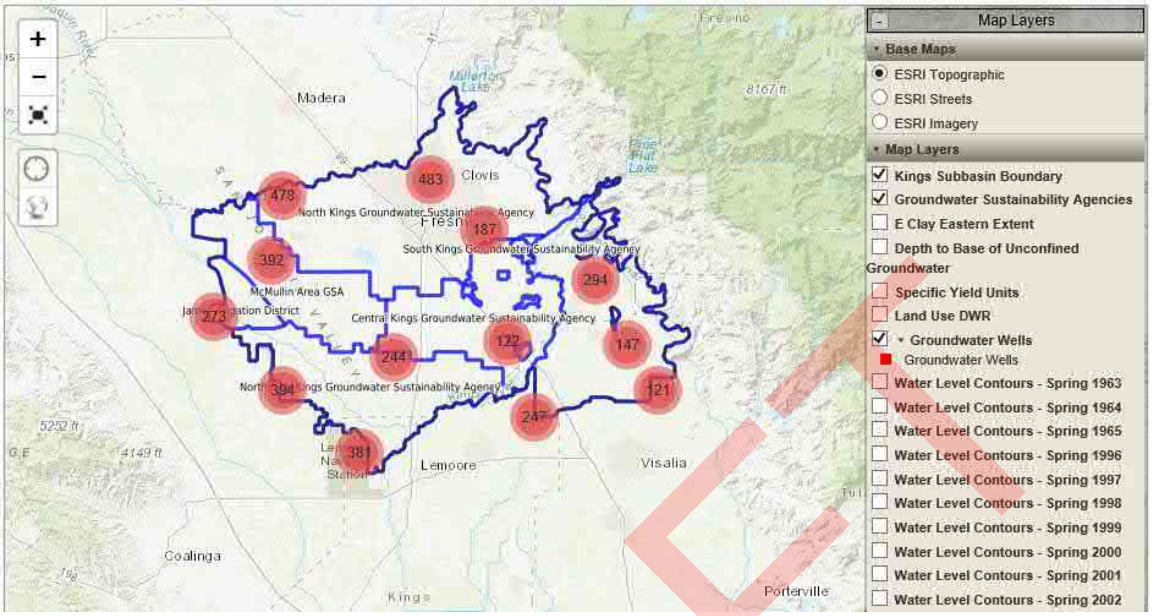

Figure 7-1 Kings Subbasin Data Management System Screenshot

Data is entered into the DMS by each GSA. Much of the data is then aggregated and summarized for reporting to DWR. Groundwater contours are prepared outside of the DMS because of the need to evaluate the integrity of the data collected and generate a static contour set that has been reviewed and will not change once approved. Groundwater storage calculations are performed in accordance with the method described in Section 3.2.3, outside of the DMS, then the results of those calculations uploaded to the DMS for annual reporting and trend monitoring. Since most of the pumping in the GSA (and the Subbasin) is not currently measured, the groundwater pumping estimates are also calculated outside of the DMS using the agreed basin-wide water budget approach then uploaded to the DMS for annual reporting and trend analysis. Surface water deliveries are maintained by the surface water agencies in separate systems already, and that data is collected by each GSA and provided to the DMS as an aggregate total by GSA. Table 7.1 provides of how the DMS addresses each required element of the DMS and annual reporting requirements. SKGSA and the other GSAs may choose to have their own separate system for additional analysis.

Table 7-1 DMS Annual Reporting Requirements

Regulation	Requirement	Input to DMS
356.2(b)(1)(B)	Hydrographs incl water year type from Jan 2015	Generated in DMS from water level data input by GSAs
356.2(b)(1)(A)	GW Elevation Contours (spring & fall)	Generated outside DMS using data from DMS then contour lines uploaded into DMS
356.2(b)(2)	GW extraction by water use sector incl method of determination and map	Determined outside DMS. Total use by sector input by each GSA then summarized for basin in DMS
356.2(b)(3)	Surface Water use by source	Total by GSA input to DMS and summarized for basin in DMS
356.2(b)(4)	Total Water use by sector	DMS summary table of water supplies by sector per GSA
356.2(b)(5)(A)	Change in GW Storage map	Calculated outside DMS from contour data using basin-wide method then total per GSA input into DMS
356.2(b)(5)(B)	Graph with Water Year type, GW use, annual & cumulative GW Storage change	DMS generated basin total graph using data in DMS

7.5 Annual Reporting

Regulation Requirements:

§ 356.2. Annual Reports

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

(a) General information, including an executive summary and a location map depicting the basin covered by the report.

(b) A detailed description and graphical representation of the following conditions of the basin managed in the Plan:

(1) Groundwater elevation data from monitoring wells identified in the monitoring network shall be analyzed and displayed as follows:

(A) Groundwater elevation contour maps for each principal aquifer in the basin illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions.

(B) Hydrographs of groundwater elevations and water year type using historical data to the greatest extent available, including from January 1, 2015, to current reporting year.

(2) Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector, and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions.

(3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.

(4) Total water use shall be collected using the best available measurement methods and shall be reported in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements. Existing water use data from the most recent Urban Water Management Plans or Agricultural Water Management Plans within the basin may be used, as long as the data are reported by water year.

(5) Change in groundwater in storage shall include the following:

(A) Change in groundwater in storage maps for each principal aquifer in the basin. (B) A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.

(c) A description of progress towards implementing the Plan, including achieving interim milestones, and implementation of projects or management actions since the previous annual report.

The GSA will provide the Plan Manager the required information of groundwater levels, extraction volume, surface water use, total water use, groundwater storage change and progress of GSP implementation for the Basin Annual Report in accordance with the timelines required to meet the April 1 deadline each year. The anticipated schedule for completion of the annual report each year will be:

- Dec 31st - Deadline for GSAs to provide GSA specific information

- Feb 28th – completion of draft annual report
- March – review by GSA and Board approval
- April 1 – submittal to DWR by Plan Manager

The Kings Subbasin annual report will have the following outline:

Chapter 1 - Introduction
Chapter 2 - Land use and Surface Water Supplies
Chapter 3 - Groundwater Pumping
Chapter 4 - Sustainable Management Criteria
  4-1 – Sustainable Goal
  4-2 - Groundwater Levels
  4-3 - Groundwater Storage
  4-4 - Groundwater Quality
  4-5 - Land Subsidence
  4-6 - Surface to Groundwater Interconnection
Chapter 5 - Monitoring Network Changes
Chapter 6 - Groundwater Projects and Management Actions Status

In addition to the required Basin wide reporting to DWR, the GSA will generate an annual report that will include the elements reported with other GSAs to DWR, as well as GSA specific information which may include, but is not limited to:

- Member and Participating agency project/program specific progress and status updates
- Newly identify projects and programs added to the project list
- Updates on changes in membership or organizational changes
- Policy changes or modifications
- New information collected in data gaps
- Area specific investigations or improvements
- Stakeholder engagement and outreach efforts
- GSA funding status

7.6 Periodic Evaluations

Regulation Requirements:

§ 356.4. Periodic Evaluation by Agency

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

(a) A description of current groundwater conditions for each applicable sustainability indicator relative to measurable objectives, interim milestones and minimum thresholds.

(b) A description of the implementation of any projects or management actions, and the effect on groundwater conditions resulting from those projects or management actions.

(c) Elements of the Plan, including the basin setting, management areas, or the identification of undesirable results and the setting of minimum thresholds and measurable objectives, shall be reconsidered and revisions proposed, if necessary.

(d) An evaluation of the basin setting in light of significant new information or changes in water use, and an explanation of any significant changes. If the Agency's evaluation shows that the basin is experiencing overdraft conditions, the Agency shall include an assessment of measures to mitigate that overdraft.

(e) A description of the monitoring network within the basin, including whether data gaps exist, or any areas within the basin are represented by data that does not satisfy the requirements of Sections 352.4 and 354.34(c). The description shall include the following:

(1) An assessment of monitoring network function with an analysis of data collected to date, identification of data gaps, and the actions necessary to improve the monitoring network, consistent with the requirements of Section 354.38.

(2) If the Agency identifies data gaps, the Plan shall describe a program for the acquisition of additional data sources, including an estimate of the timing of that acquisition, and for incorporation of newly obtained information into the Plan.

(3) The Plan shall prioritize the installation of new data collection facilities and analysis of new data based on the needs of the basin.

(f) A description of significant new information that has been made available since Plan adoption or amendment, or the last five-year assessment. The description shall also include whether new information warrants changes to any aspect of the Plan, including the evaluation of the basin setting, measurable objectives, minimum thresholds, or the criteria defining undesirable results.

(g) A description of relevant actions taken by the Agency, including a summary of regulations or ordinances related to the Plan.

(h) Information describing any enforcement or legal actions taken by the Agency in furtherance of the sustainability goal for the basin.

(i) A description of completed or proposed Plan amendments.

(j) Where appropriate, a summary of coordination that occurred between multiple Agencies in a single basin, Agencies in hydrologically connected basins, and land use agencies.

(k) Other information the Agency deems appropriate, along with any information required by the Department to conduct a periodic review as required by Water Code Section 10733.

The GSA will include updates to changes to the GSP or policy changes in its annual report and submit to that report to DWR. Certain components of the GSP may be re-evaluated more frequently than every five years, if deemed necessary. This may occur, for example, if sustainability goals are not being met, additional data is acquired, or priorities change. Those results will be incorporated into the GSP when it is resubmitted to DWR every five years.

In addition, the GSA will provide an assessment to DWR in accordance with the regulatory requirements, which are currently set to be at least every five years. The assessment will include providing an update on progress in achieving sustainability including current groundwater conditions, status of projects or management actions, evaluation of undesirable results relating to measurable objectives and minimum thresholds, changes in monitoring network, summary of enforcement or legal actions and agency coordination efforts in accordance with SGMA law §356.4. Periodic Evaluation by Agency.

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Appendix A

Joint Powers Authority Agreement

(Not Included at this Time)

AGREEMENT TO FORM A JOINT POWERS AUTHORITY SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY

THIS AGREEMENT ("Agreement") is made and entered into this 15th day of May, 2017 ("Effective Date") between the cities of Fowler, Kingsburg, Parlier, Sanger, and Selma, hereinafter referred to individually as "Member" and collectively as "Members."

RECITALS

WHEREAS, on September 16, 2014, the Governor of the State of California signed three (3) bills (SB 1168, SB 1319, and AB 1739) into law creating the Sustainable Groundwater Management Act ("SGMA"), which is codified at section 10720, *et seq.*, of the California Water Code; and

WHEREAS, SGMA authorizes the formation of an entity called a Groundwater Sustainability Agency ("GSA"), by any local agency or combination of local agencies overlying a groundwater basin; and

WHEREAS, the Members overly the Kings Sub-Basin of the San Joaquin Valley Basin Sub-Basin; ID 5-022.08 (2016 Department of Water Recourses Bulletin 118) (the "Sub-Basin") an unadjudicated groundwater basin; and

WHEREAS, the Members desire to form a sub-basin GSA referred to herein as the South Kings Groundwater Sustainability Agency ("SKGSA") the boundaries of which are depicted on Exhibit "A" attached hereto, and incorporated by this reference herein; and

WHEREAS, each of the Members to this Agreement is a local entity with either water supply, water management, or land use responsibilities within the SKGSA and is qualified individually to serve as a GSA under the provisions of SGMA; and

WHEREAS, under the provisions of SGMA, a combination of local agencies may elect to form a GSA through a joint powers agreement; and

WHEREAS, the Joint Exercise of Powers Act (Government Code section 6500, *et seq.*) provides that two or more public agencies may by agreement jointly exercise any powers common to those agencies and may by that agreement create an entity separate from the Members to the Agreement; and

WHEREAS, each Member signing this Agreement is a public entity duly organized and operating under the laws of the State of California and/or a public agency as defined in Government Code section 6500 and Water Code section 10721; and

WHEREAS, the Members intend by this Agreement to create a joint powers authority, the SKGSA, for the purpose of acting as a separate and independent public agency and as a single GSA for this area, set forth in the Exhibit "A" to carry out the powers and purposes of SGMA including, the adoption of a Groundwater Sustainability Plan ("GSP").

NOW, THEREFORE, in consideration of the mutual promises, covenants and conditions herein and including the Recitals, which are a substantive part of this Agreement, the Members agree as follows:

Article I: Definitions

As used in this Agreement, unless the context requires otherwise, the meaning of the terms hereinafter set forth shall be as follows:

"Act" shall mean the Sustainable Groundwater Management Act of 2014 and all regulations adopted under the legislation (SB 1168, SB 1319, and AB 1739) which collectively comprise the Act, as that legislation and regulations are or may be amended from time to time.

"Authority", "Agency," or "SKGSA" shall mean the South Kings Groundwater Sustainability Agency Joint Powers Authority, which is the public and separate legal entity created by this Agreement.

"Board of Directors" or "Board" shall mean the governing body of the Authority as established by Section 3.01 of this Agreement.

"Fiscal Year" shall mean that period of twelve (12) months established as the Fiscal Year of the Authority by the Board of Directors.

"Groundwater Sustainability Agency" or "GSA" shall mean an agency enabled by the Act to regulate all or a portion of a subbasin in a coordinated manner with all other surrounding Groundwater Sustainability Agencies in compliance with the terms and provisions of the Act.

"Groundwater Sustainability Plan" or "GSP" shall mean the plan developed, adopted and implemented by the Authority in accordance with the Act.

"Member" or "Members" shall mean any of the signatories to this Agreement individually ("Member") or collectively as ("Members").

"Kings Sub-Basin" shall mean a sub-basin of the San Joaquin Valley Basin as described in the Department of Water Recourses 2016 Bulletin 118 and identified by the Sub-Basin ID No. 5-022.08.

"South Kings Sub-Basin" shall mean the area depicted on Exhibit A.

Article II: Creation of Authority

Section 2.01 – Creation.

A. Pursuant to Government Code section 6500, et seq., and specifically section 6503.5, the Members of this Agreement hereby create a public entity separate and independent from the Members.

B. Pursuant to Government Code section 6509, the City of Sanger is the designated agency with respect to the Authority's exercise of power.

C. Within thirty (30) days after the Effective Date of this Agreement and after any amendment, the Authority shall cause a notice of such Agreement or amendment to be prepared and filed with the office of the California Secretary of State containing the information required by Government Code section 6503.5.

D. Within seventy (70) days after the Effective Date of this Agreement, the Authority shall file with the Secretary of State on a form prescribed by the Secretary of State and also with the county clerk of each county in which the Authority maintains an office, a statement of the following facts:

   1. The full legal name of the Authority.

   2. The official mailing address of the governing body of the Authority.

   3. The name and residence or business address of each member of the governing body of the public agency.
   4. The name, title, and residence or business address of the chairman, president, or other presiding officer, and clerk or secretary of the governing body of the Authority.

E. Within ten (10) days after any change in the facts listed in section 2.01(C), the Authority shall file an amended statement as required in Government Code section 53051.

F. The Members, pursuant to their joint exercise of powers, hereby create a public entity to be known as the "South Kings Groundwater Sustainability Agency."

Section 2.02 - Purpose

A. To create a Joint Powers Authority ("JPA") separate from its members that will elect to be the GSA for a portion of the Kings Sub-Basin described herein as the SKGSA.

B. To develop, adopt, and implement a GSP in order to implement the requirements of and achieve the sustainability goals set forth in SGMA.

C. To enter into a coordination agreement or similar agreement with other GSAs within the Kings Sub-Basin in order to meet the requirements of and achieve the sustainability goals set forth in the SGMA.

Section 2.03 – Powers.

The Agency is hereby authorized, in its own name, to do all acts necessary to exercise all of the powers for a GSA authorized under SGMA and necessary to satisfy the requirements of SGMA.

Section 2.04 – Water Rights.

As provided in Water Code section 10720.5, the Authority and all of its Members confirm that that groundwater management under this Authority shall be consistent with Section 2 of Article X of the California Constitution, and that any GSP adopted by the Authority shall not determine or alter surface water rights or groundwater rights under common law or any provision of law that determines or grants surface water rights or groundwater rights.

Section 2.05 - Obligations of the Authority.

No debt, liability or obligation of the Authority shall constitute a debt, liability or obligation of any of its Members, appointed members of the Board of Directors or their alternates, or committee members.

Section 2.06 - Restrictions on Exercise of Powers.

Pursuant to Government Code §6509 *et.seq.,* the powers of the Authority shall be exercised and restricted in the same manner as those imposed upon the City of Sanger.

Section 2.07 – Member Land Use Authority.

A Member's land use authority, including, without limitation, the Member's general plan, is not superseded by the authority granted the Authority under SGMA as the exclusive GSA for the GSA Management Area or by a GSP approved by the State.

Article III: Governing Body

Section 3.01 – Board of Directors.

A. The Board of Directors. The Board shall consist of five Directors, and each Member shall appoint one Director. Directors shall be elected officials who have been appointed to serve on the Authority's Board by their respective city councils. Filling a vacancy of a Director's seat is the responsibility of the Member who is represented by that Director's seat on the Board.

B. Term. All Board terms shall be two (2) years. For initiation of the Board, three seats shall be three (3)-year terms. The Member seats with an initial three-year term shall be those for the City of Sanger, City of Kingsburg, and the City of Selma.

C. Alternate Directors. Each Member may identify up to two alternates to serve on the Member's behalf on the Board. Alternates need not be elected officials, but must be an authorized representative of the Member.

D. Removal. If the Board of Directors determines that reasonable cause exists to remove a Director from the Board, it can request that the Member who appointed the Director remove the individual and appoint a new Director.

Section 3.02 – Meetings of the Board.

The Board shall provide for the calling and conducting of its regular Board Meetings and Special Meetings in accordance with Government Code section 54950, *et seq.*

Section 3.03 – Minutes.

The Secretary shall cause to be kept a summary minutes of the meetings of the Board of Directors and shall, as soon as possible after each meeting, cause a copy of the summary of minutes to be forwarded to each Director and to each of the Members.

Section 3.04 – Voting.

Each founding Member shall have one (1) vote on the Board.

Section 3.05 – Quorum; Required Votes; Approval.

A quorum of the Board for convening of any meeting shall consist of a majority of all Member Directors, or in the absence of a Member Director, such Directors designated alternate. A quorum of the Board must be present at the time of any vote on any matter before the Board. An affirmative vote of at least a majority of all Directors, or designated alternate Director(s) present in a quorum of the Board, shall be required for any action of the Board. Notwithstanding the forgoing, approval of the following matters will require a super-majority of the entire Board as set forth below:

1. Adoption or Amendment of GSP: Unanimous vote.

2. Annual operating budget: Four affirmative votes.

3. Imposition of any fee, charge, or rate: Unanimous vote.

4. Imposition of any cost sharing contribution on Members: Unanimous vote.

5. Bylaws: Four affirmative votes.

6. Removal of Member: Four affirmative votes.

7. Incur debt, liabilities, or obligations: Four affirmative votes.

8. Amendment of this Agreement: Unanimous vote.

9. Authorization to participate in litigation or other legal proceedings: Four affirmative votes.

Section 3.06 - Conflicts of Interest.

The Authority shall adopt a Conflict of Interest Code.

Article IV: Committees

Section 4.01 – Committee Formation

Committees may be formed by the Board in order to advise the Board on all matters that fall within the scope of the particular committee's assignment. Committees may be standing or *ad hoc* Committees. Committees shall meet as often as directed by the Board or if no such direction is given, as often as necessary, as determined by the Chair of the Committee.

Section 4.02 – Standing Committees

Two (2) Standing Committees shall be formed as soon as reasonably practical, but no event later ninety (90) days of formation of the Authority as follows:

A. Advisory Committee. The Board shall create an Advisory Committee for the purpose of conducting community outreach and involvement to insure that the interests of all beneficial users and interested persons are considered by the Authority in the conduct of it purpose including, but not limited to, the formation and implementation of a GSP. The Advisory Committee shall make recommendations to the Board.

B. Technical Advisory Committee. The Board shall form a Technical Advisory Committee which will be composed of one (1) person appointed by each member and any additional persons appointed by the Board.

Article V: Officers

Section 5.01 – Chair and Vice Chair.

The Board shall elect a Chair and a Vice Chair from among the Directors to serve for one year. The Chair and Vice Chair shall serve at the pleasure of the Board and shall perform the duties normally required of said Officers:

A. The Chair shall preside at and conduct each meeting of the Board; represent the Board as directed by the Board; and perform such other duties as may be imposed by the Board; and may sign all contracts and agreements as approved by the Board.

B. The Vice Chair shall act and perform all of the Chair's duties in the absence of the Chair.

Section 5.02 – Secretary.

The Board shall appoint a Secretary. The appointment may be from among the employees of the Authority, or if no such employees exist, a consultant. The Secretary shall serve at the pleasure of the Board. The Secretary shall act on behalf of the Authority and perform such other duties as may be imposed by the Board. The Secretary may sign agreements for the Authority when authorized by the Board.

Section 5.03 – Treasurer - Auditor; Custodian of Records.

A. Treasurer - Depositary. The City of Sanger shall be the Depositary and custodian of all the money of the Authority from whatever source and shall have the duties and obligations of the Treasurer as set forth in Government Code sections 6505 and 6505.5.

B. Auditor. The Board may also appoint a separate Auditor for the purpose of conducting audits of the Authority's financial records as determined by the Board.

C. Officer in Charge of Records; Funds; and Accounts. Pursuant to Government Code section 6505.1, the City of Sanger shall have charge of, handle and have access to all accounts, funds, and money of the Authority and all records of the Authority relating thereto; and The Secretary shall have charge of, handle and have access to all of the records of the Authority.

D. Bonding. Pursuant to Government Code sections 6505.1 and 6505.5 the Treasurer-Depositary, Custodian of Records, Secretary, or other persons having access to property shall file an Official Bond in an amount to be fixed by the Board.

Section 5.04 – Employees and Consultants.

The Board may hire Employees and Consultants including Engineers, Accountants and Attorneys, to provide services and advise to the Authority to accomplish the purposes of the Authority.

Article VI: Accounts, Reports and Funds

Section 6.01 – Accounts and Reports.

The Authority shall establish and maintain such funds and accounts as may be required by good accounting practice. The books and records of the Authority shall be open to inspection at all reasonable times by the public and representatives of Members. The Authority, within 120 days after the close of each fiscal year, shall give a complete written report of all financial activities for such fiscal year to the Members.

Section 6.02 – Fiscal Year.

The Fiscal Year of the Authority shall be from July 1 through June 30 of each year.

Section 6.03 – Annual Budget.

The Board shall adopt a budget for the Authority on an annual basis. Members shall make contributions that are included in the budget adopted by the Board. A Director's affirmative vote to approve the budget does not constitute consent to finance or otherwise participate in any project or projects within that budget.

Sections 6.04 –Reimbursement for Expenditures

It is the intent of the Members that the advancement of monies by any Members for expenses of the operational needs of the Authority shall be reimbursed from the proceeds of grants, if grant funds are obtained and such reimbursement is allowable under the terms of any grant agreement.

Section 6.05 – Assessment of Members

The Board may vote to assess Members and/or entities within its jurisdiction for a share of the costs incurred by the Authority which are anticipated to be incurred by the Authority. The Board shall comply with all legal requirements for the imposition of such assessments. At the discretion of a majority of the Board of Directors, any Member failing to timely pay an assessment may lose its privilege to vote on any item presented to the Board, until such assessment is paid.

Section 6.06 – Other Revenue.

The Board may approve other revenue, as deemed necessary by the Board, in any form permissible by SGMA or any other provision of law.

Article VII: Separate Entity; Liabilities

Section 7.01 – Separate Entity

In accordance with California Government Code Sections 6506 and 6507, the Authority shall be a public entity separate from the Members. To the greatest extent permitted by law, unless otherwise specifically agreed herein by all Members as to a specific debt, liability and/or obligation, the debts, liabilities and obligations of the Authority shall not be debts, liabilities or obligations of the Members under Government Code section 6508.1. The Authority shall own and hold title to all funds, property and works acquired by it during the term of this Agreement.

No Member has the power to obligate any other Member hereof, and no Member debt, liability, or obligation due any third party may be asserted or collected against this Authority, the GSA, or any individual Member as a result of membership in this GSA by and among the Members.

The Authority may acquire such policies of directors and officers liability insurance and in such amounts as the Board of Directors shall deem prudent.

To the extent authorized under California law, no Director, officer or employee of the Authority shall be responsible for any action made, taken, or omitted, by any other Director, officer or employee.

Section 7.02 – Liabilities of the Authority/Indemnity.

A. The Authority, and those persons, agencies and instrumentalities used by perform the functions authorized herein, whether by contract, employment or otherwise, shall be exclusively liable for any/all injuries, costs, claims, liabilities, damages of whatever kind arising from or related to activities of the Authority.

B. The Authority shall indemnify, defend, and hold harmless the Members, and their officers, agents, and employees, including those appointed to the Board of Directors as Directors or Alternates, as follows: From and against any and all claims and loses whatsoever, including for damage, injury, or death, occurring in connection with the Authority's performance of its obligations under this Agreement. In so doing, the Authority shall provide the Members, and each of them, with legal defense of any and all such claims or liabilities, and shall pay reasonable attorney's fees and costs incurred in providing such defense. Nothing herein shall limit the right or ability of the Authority to purchase insurance or to create a self-insurance mechanism to provide coverage for the foregoing indemnity.

C. Funds of the Authority may be used to defend, indemnify, and hold harmless the Authority, the Members, and any officers, agents, and employees of the Authority and/or the Members, for their actions taken within the scope of their duties while acting on behalf of the Authority.

Article VIII – Membership

Section 8.01 – Other Members.

The Board may vote to approve other entities to be a Member of the Authority. Such approval may come with or without voting rights for the new Member.

Section 8.02 – Removal of Members

The Board may vote to remove a Member, as set forth in Article III, based on a Member's breach of any material term of this Agreement, and the failure to cure that breach within sixty (60) days written notice. A terminated Member shall remain liable for any obligation under this Agreement incurred prior to the date of termination.

Article IX – Term; Termination; Withdrawal

Section 9.01 – Term.

The Members hereby agree to establish the Authority to last in perpetuity, or as long as SGMA remains the law in the State of California.

Section 9.02 – Termination.

This Agreement may be rescinded, and the Authority, terminated by unanimous written consent of all Members.

Section 9.03 – Withdrawal of Member.

A Member may terminate its membership in the Authority at any time upon giving sixty (60) days written notice of withdrawal to the Authority. Such notice shall be given to the Board of Directors. The effective date shall be the conclusion of the first Board Meeting date following the written notice. Any Member who withdrawals shall remain obligated to pay share of all debts, liabilities, and obligation incurred or accrued through the effective date. Such withdrawal does not in any way impair any contracts, resolutions, indentures or other obligations of the Authority then in effect. In the event of a disagreement between the Authority and the withdrawing Member as to whether such withdrawal shall cause the impairment of any contracts, resolutions, indentures, or other obligations of the Authority, such determination shall be made by a majority vote of the Board of Directors. Any Member that withdraws and later seeks reinstatement to the Authority shall provide funds to the Authority, proportionate to their responsibility, as if the Member had never left the Authority.

A withdrawing Member shall in all events remain liable for its proportionate share of (i) its full amount of the adopted fiscal year budget; (ii) any call for funds or assessment levied by the Authority prior to the date it provides its notice of withdrawal; (iii) any contribution in existence at the time the subject act or omission occurred; and (iv) the amount of any annual budget approved prior to the date it provides its notice of withdrawal.

Should a Member choose to withdraw from the Authority in accordance with the terms of this Agreement, that Member expressly retains the right to serve as the GSA for the portion of the groundwater basin underlying its jurisdictional boundaries to the extent permitted by the Act.

Section 9.04 – Disposition of Assets.

Upon termination of the Authority, any assets shall be returned to the Members in the same proportion said Members have funded such assets, reserves or surplus, in accordance with Government Code section 6512. The disposition of assets shall be calculated by quantifying the total contribution made by the Member since the inception of the Authority, and not based on contributions received in the last calendar year prior to termination.

Article X –Miscellaneous Provisions

Section 10.01 – Amendment.

This Agreement may be amended from time to time by the unanimous vote of all of the Members.

Section 10.02 – Severability and Validity of Agreement.

Should the participation of any Member to this Agreement, or any part, term or provision of this Agreement be decided by the courts or the legislature to be illegal, in excess of that Member's authority, in conflict with any law of the State of California, or otherwise rendered unenforceable or ineffectual, the validity of the remaining portions, terms or provisions of this Agreement shall not be affected thereby and each Member hereby agrees it would have entered into this Agreement upon the same terms as provided herein as if that Member had not been party to in this Agreement.

Section 10.03 – Assignment.

Except as otherwise provided in this Agreement, the rights and duties of the Members to this Agreement may not be assigned or delegated without the approval of the Board of Directors.

Section 10.04 – Execution In Parts Or Counterparts.

This Agreement may be executed in parts or counterparts, each part or counterpart being an exact duplicate of all other parts or counterparts, and all parts or counterparts shall be considered as constituting one complete original and may be attached together when executed by the Members hereto. Facsimile and electronic signatures shall be binding.

Section 10.05 – Notices.

Notices authorized or required to be given pursuant to this Agreement shall be in writing and shall be deemed to have been given when mailed, postage prepaid, or delivered during working hours to the addresses set forth for each of the Members beneath their signatures on this Agreement, or to such other changed addresses communicated to the Authority and the Members in writing.

Section 10.06 – Governing Law and Venue.

This Agreement shall be governed by, construed, and enforced in accordance with the laws of the State of California, excluding any conflict of laws rule which would apply the law of another jurisdiction. Venue for purposes of the filing of any action regarding the enforcement or interpretation of this Agreement and any rights and duties hereunder shall be Fresno County, California. The parties to this Agreement hereby expressly waive any right to remove any action to a county other than Fresno County as permitted pursuant to California Code of Civil Procedure section 394.

Section 10.07 – Dispute Resolution.

The Members agree that any dispute regarding the enforcement or interpretation of any term, covenant or condition of this Agreement ("Dispute") shall first, for a period of not less than thirty (30) days, be submitted to mediation before a mutually acceptable mediator prior to initiation of litigation or any other binding arbitration or adjudicative dispute resolution process. The Members shall: (i) mediate in good faith; (ii) exchange all documents which each believes to be relevant and material to the issue(s) in the Dispute; (iii) exchange written position papers stating their position on the Dispute and outlining the subject matter and substance of the anticipated testimony of persons having personal knowledge of the facts underlying the Dispute; and (iv) engage and cooperate in such further discovery as the Members agree or mediator suggests may be necessary to facilitate effective mediation. Each Member shall bear its own costs, fees and expenses of the mediation. Venue of the mediation shall be a mutually agreeable city within Fresno County, California.

Section 10.08 – Attorney Fees.

If any Member commences any proceeding or legal action to enforce or interpret any term, covenant or condition of this Agreement, the prevailing Member in such proceeding or action shall be entitled to recover from the other Member(s) its reasonable attorney's fees and legal expenses.

Section 10.09 – Insurance.

The Authority shall obtain Insurance for all Members, appointed Members, and Committee Members, including, but not limited to, Directors and Officers liability insurance and general liability insurance containing policy limits in such amounts as the Board of Directors shall deem will be necessary to adequately insure against the risks of liability that may be incurred by the Authority.

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IN WITNESS WHEREOF, the Members hereto, pursuant to resolutions duly and regularly adopted by their respective governing boards, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

CITY OF FOWLER

By:______________________________
David Cardenas, Mayor

CITY OF PARLIER

By:______________________________
Alma M. Beltran, Mayor

CITY OF KINGSBURG

By:______________________________
Michelle Roman, Mayor

CITY OF SANGER

By:______________________________
Frank Gonzales, Mayor

CITY OF SELMA

By:______________________________
Michael Derr, Mayor

IN WITNESS WHEREOF, the Members hereto, pursuant to resolutions duly and regularly adopted by their respective governing boards, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

CITY OF FOWLER

By:______________________________
David Cardenas, Mayor

CITY OF PARLIER

By:______________________________
Alma M. Beltran, Mayor

CITY OF KINGSBURG

By:______________________________
Michelle Roman, Mayor

CITY OF SANGER

By:______________________________
Frank Gonzales, Mayor

CITY OF SELMA

By:______________________________
Michael Derr, Mayor

IN WITNESS WHEREOF, the Members hereto, pursuant to resolutions duly and regularly adopted by their respective governing boards, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

CITY OF FOWLER

By:______________________________
David Cardenas, Mayor

CITY OF PARLIER

By:______________________________
Alma M. Beltran, Mayor

CITY OF KINGSBURG

By: Michelle Roman
Michelle Roman, Mayor

CITY OF SANGER

By:______________________________
Frank Gonzales, Mayor

CITY OF SELMA

By:______________________________
Michael Derr, Mayor

DRAFT

IN WITNESS WHEREOF, the Members hereto, pursuant to resolutions duly and regularly adopted by their respective governing boards, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

NAME OF MEMBER:
City of Sanger

By: Tim Chapa
Its: City Manager

Member's Address:
1700 7th Street
Sanger, CA 93657

Dated: 5/25/17

DRAFT

IN WITNESS WHEREOF, the Members hereto, pursuant to resolutions duly and regularly adopted by their respective governing boards, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

NAME OF MEMBER:

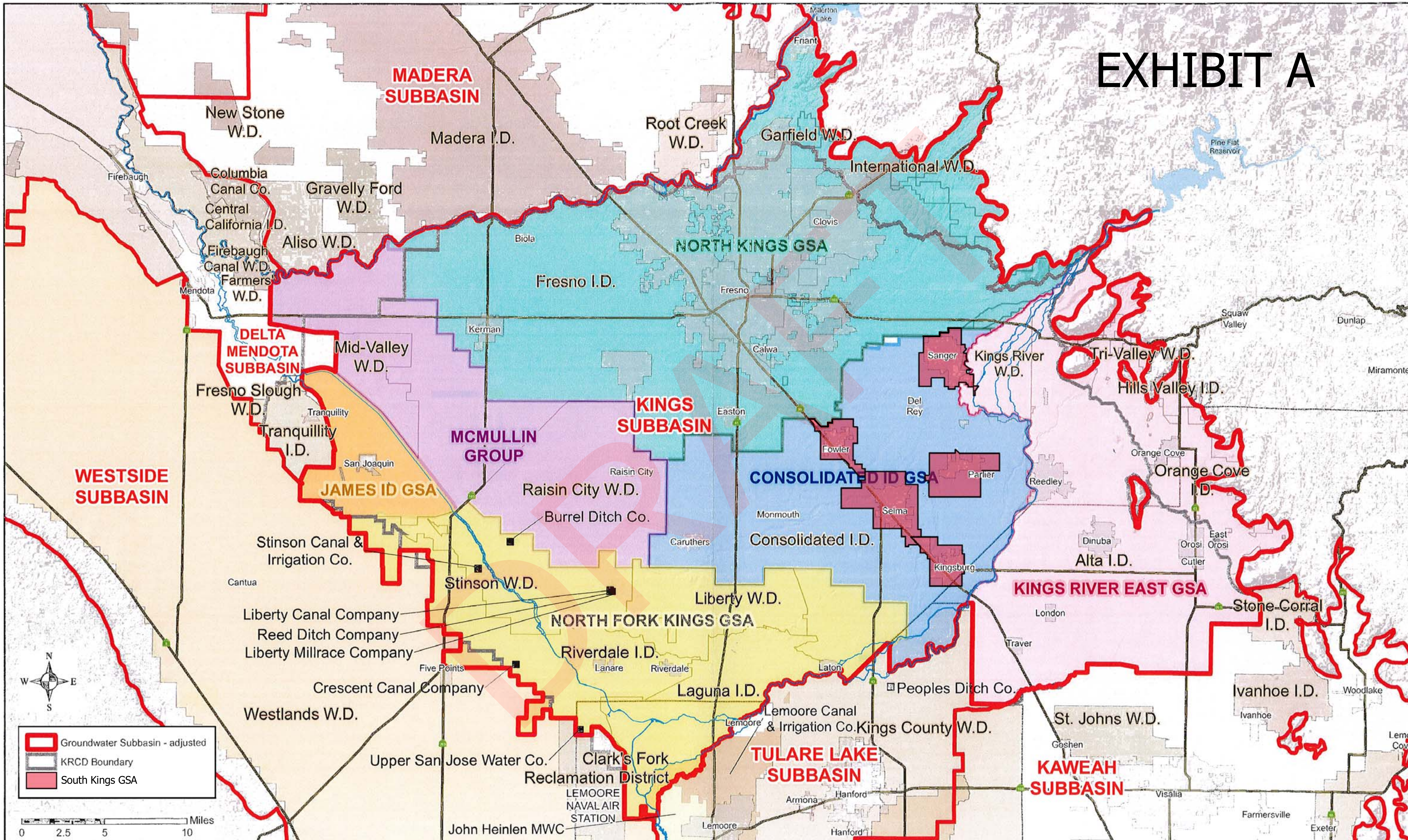
By: MICHAEL DERR
Its: MAYOR

Member's Address:

CITY OF SELMA
1710 TUCKER STREET
SELMA, CA. 93662

Dated: May 15, 2017

EXHIBIT A



MADERA SUBBASIN
New Stone W.D.
Madera I.D.
Root Creek W.D.
Garfield W.D.
International W.D.
Columbia Canal Co.
Gravelly Ford W.D.
Central California I.D.
Aliso W.D.
Firebaugh Canal W.D.
Farmers W.D.
Firebaugh
Mendota
Biola
Clovis
NORTH KINGS GSA
Fresno I.D.
Fresno
Kerman
Calwa
DELTA MENDOTA SUBBASIN
Mid-Valley W.D.
Fresno Slough W.D.
Tranquility
Tranquillity I.D.
KINGS SUBBASIN
Easton
MCMULLIN GROUP
San Joaquin
Raisin City
Raisin City W.D.
WESTSIDE SUBBASIN
JAMES ID GSA
Burrel Ditch Co.
Stinson Canal & Irrigation Co.
Stinson W.D.
Cantua
Liberty Canal Company
Reed Ditch Company
Liberty Millrace Company
NORTH FORK KINGS GSA
Liberty W.D.
Riverdale I.D.
Lanare
Riverdale
Five Points
Crescent Canal Company
Westlands W.D.
Laguna I.D.
Laton
Upper San Jose Water Co.
Clark's Fork Reclamation District
LEMOORE NAVAL AIR STATION
John Heinlen MWC
Lemoore
Lemoore Canal & Irrigation Co.
Kings County W.D.
Peoples Ditch Co.
TULARE LAKE SUBBASIN
Armona
Hanford
CONSOLIDATED ID GSA
Consolidated I.D.
Monmouth
Caruthers
Fowler
Selma
Parlier
Kingsburg
Sanger
Del Rey
Kings River W.D.
Reedley
Tri-Valley W.D.
Hills Valley I.D.
Squaw Valley
Dunlap
Miramonte
Pine Flat Reservoir
Millerton Lake
Friant
Orange Cove
Orange Cove I.D.
Dinuba
Alta I.D.
Orosi
East Orosi
Cutler
KINGS RIVER EAST GSA
London
Traver
Stone Corral I.D.
Ivanhoe I.D.
Ivanhoe
Woodlake
St. Johns W.D.
Goshen
KAWEAH SUBBASIN
Visalia
Farmersville
Exeter
Lemon Cove
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W
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S
Groundwater Subbasin - adjusted
KRCD Boundary
South Kings GSA
0 2.5 5 10 Miles

RESOLUTION NO. 2017-3

A RESOLUTION OF THE BOARD OF DIRECTORS OF THE DEL REY COMMUNITY SERVICES APPROVING AND ADOPTING THE MEMORANDUM OF UNDERSTANDING BETWEEN THE SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY JOINT POWERS AUTHORITY, THE DEL REY COMMUNITY SERVICES DISTRICT, AND THE CARUTHERS COMMUNITY SERVICES DISTRICT

WHEREAS, on September 16, 2014, the Governor of the State of California signed three (3) bills (SB 1168, SB 1319, and AB 1739) into law creating the Sustainable Groundwater Management Act ("SGMA"), which is codified at section 10720, et seq., of the California Water Code; and

WHEREAS, Water Code section 10723.6 authorizes a combination of local agencies overlying a groundwater basin to elect to become a Groundwater Sustainability Agency ("GSA"), by using a Joint Exercise of Powers Agreement, memorandum of understanding or other legal agreement; and

WHEREAS, the Del Rey Community Services District jurisdiction overlays the Kings Sub-Basin of the San Joaquin Valley Basin Sub-Basin; ID 5-022.08 (2016 Department of Water Recourses Bulletin 118) (the "Sub-Basin") which is an unadjudicated groundwater basin; and

WHEREAS, on May 25, 2017, the South Kings Groundwater Sustainability Agency, comprised of the cities of Fowler, Kingsburg, Parlier, Sanger, and Selma, operating pursuant to a Joint Exercise of Powers Agreement entitled the "South Kings Groundwater Sustainability Agency Joint Powers Authority" ("SKGSA"), elected to become a GSA within the Kings Sub-Basin; and

WHEREAS, on June 6, 2017, the SKGSA submitted its GSA formation notice to the Department of Water Resources, as required by Water Code section 10723.8; and

WHEREAS, Del Rey Community Services District is a local entities with either water supply, water management, or land use responsibilities within the SKGSA, and as such are qualified individually to serve as a GSA under the provisions of SGMA; and

WHEREAS, Del Rey Community Services District desires to join the SKGSA; and

WHEREAS, Del Rey Community Services District desires to enter into an memorandum of understanding to further that process; and

WHEREAS, Del Rey Community Services District understands that Caruthers Community Services District may also want to join the SKGSA; and may also enter into a memorandum of understanding with Del Rey Community Services District and SKGSA.

NOW, THEREFORE, BE IT RESOLVED, by the Board of Directors of the Del Rey Community Services District as follows:

Section 1. The foregoing recitals are hereby found to be true and correct and incorporated herein by this reference.

Section 2. The Board of Directors hereby approves and adopts the Memorandum Of Understanding Between The South Kings Groundwater Sustainability Agency Joint Powers Authority, The Del Rey Community Services District, And The Caruthers Community Services District, as to its material terms as attached hereto as Exhibit "A." The Board President is authorized to take all action required to execute and effectuate the same subject to approval as to legal form by the District Attorney. Said approval shall apply regardless whether Caruthers Community Services District elects to participate in said Memorandum of Understanding.

Section 3. This Resolution shall be effective immediately.

I hereby certify that the foregoing Resolution No. 2017-3 is a full, true and correct copy of a resolution duly passed and adopted by the Board of Directors of the Del Rey Community Services District at a meeting thereof duly held on the 12th day of June, 2017, by the vote recorded as follows:

AYES:

NOES:

ABSENT:

ABSTAIN:

ATTEST

____
Carlos Arias, District Manager
Del Rey Community Services District

DEL REY COMMUNITY SERVICES DISTRICT

____
Rumaldo Reyna, President

APPROVED AS TO LEGAL FORM

____
Shannon L. Chaffin, District Counsel

EXHIBIT A

MEMORANDUM OF UNDERSTANDING BETWEEN THE SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY JOINT POWERS AUTHORITY, THE DEL REY COMMUNITY SERVICES DISTRICT, AND THE CARUTHERS COMMUNITY SERVICES DISTRICT

THIS MEMORANDUM OF UNDERSTANDING ("MOU") is made and entered into this 14th day of June, 2017 ("Effective Date") between the South Kings Groundwater Sustainability Agency, comprised of the cities of Fowler, Kingsburg, Parlier, Sanger, and Selma, operating pursuant to a Joint Exercise of Powers Agreement entitled the "South Kings Groundwater Sustainability Agency Joint Powers Authority" ("SKGSA"), the Del Rey Community Services District, a community services district established under the provisions of Government Code Section 61000, *et seq*. ("Del Rey"), and the Caruthers Community Services District, a community services district established under the provisions of Government Code Section 61000, *et seq*. ("Caruthers") (collectively known as the "Parties").

RECITALS

WHEREAS, on September 16, 2014, the Governor of the State of California signed three (3) bills (SB 1168, SB 1319, and AB 1739) into law creating the Sustainable Groundwater Management Act ("SGMA"), which is codified at section 10720, *et seq.*, of the California Water Code; and

WHEREAS, Water Code section 10723.6 authorizes a combination of local agencies overlying a groundwater basin to elect to become a Groundwater Sustainability Agency ("GSA"), by using a Joint Exercise of Powers Agreement, memorandum of understanding or other legal agreement; and

WHEREAS, the Parties overly the Kings Sub-Basin of the San Joaquin Valley Basin Sub-Basin; ID 5-022.08 (2016 Department of Water Recourses Bulletin 118) (the "Sub-Basin") which is an unadjudicated groundwater basin; and

WHEREAS, at a duly-noticed public hearing on May 25, 2017, the SKGSA elected to become a GSA within the Kings Sub-Basin; and

WHEREAS, on June 6, 2017, the SKGSA submitted its GSA formation notice to the Department of Water Resources, as required by Water Code section 10723.8; and

WHEREAS, Caruthers is within the Kings Sub-Basin, and its boundaries are depicted on Exhibit "A-1" attached hereto, and incorporated by this reference herein; and

WHEREAS, Del Rey is within the Kings Sub-Basin, and its boundaries are depicted on Exhibit "A-2" attached hereto, and incorporated by this reference herein; and

WHEREAS, Del Rey and Caruthers are local entities with either water supply, water management, or land use responsibilities within the SKGSA, and as such are qualified individually to serve as a GSA under the provisions of SGMA; and

WHEREAS, Del Rey and Caruthers desire to join the SKGSA; and

WHEREAS, the SKGSA desires to have Del Rey and Caruthers join the SKGSA.

NOW, THEREFORE, in consideration of the mutual promises, covenants and conditions herein and including the Recitals, which are a substantive part of this MOU:

1. This MOU is entered into by and between the Parties to facilitate a cooperative and ongoing working relationship that will allow compliance with SGMA and related State laws, both as amended from time to time.

2. Upon approval of this MOU by Del Rey, the SKGSA will commence the process to add Del Rey as a participant in the SKGSA through this Agreement.

3. Upon approval of this Agreement by Caruthers, the SKGSA will commence the process to add Caruthers as a participant in the SKGSA through this Agreement.

4. Nothing herein shall be construed or interpreted as authorizing the SKGSA to make a binding determination regarding the water rights of any person or entity, including, without limitation, Del Rey and Carruthers. However, Del Rey and Caruthers both acknowledge that upon the approval of this MOU by the SKGSA's governing board, they will participate in the GSA and be subject to the decisions made by the SKGSA's governing board as it is constituted under the South Kings Groundwater Agency Sustainability Agency Joint Powers Authority Agreement attached hereto as Exhibit "B." Until Del Rey or Carruthers become members of the South Kings Groundwater Agency Sustainability Agency Joint Powers Authority Agreement, this MOU will not require either entity to make a Member cost-sharing contribution, or pay a fee, charge or rate imposed pursuant to the South Kings Groundwater Agency Sustainability Agency Joint Powers Authority Agreement.

5. This MOU shall remain in effect until it is terminated. Such termination may be effectuated by a four-fifths vote of the SKGSA's governing board removing Del Rey and/or Caruthers as participants in the SKGSA, with thirty (30) days of written notice. Del Rey and/or Caruthers may also terminate this MOU with thirty (30) days of written notice to the SKGSA's Secretary. Del Rey and/or Caruthers shall remain liable for any obligation, financial or otherwise, incurred prior to the termination of this MOU.

6. The termination of this MOU may also be effectuated by the addition of Del Rey and Caruthers as members of the South Kings Groundwater Agency Sustainability Agency Joint Powers Authority, pursuant the terms of the Joint Powers Authority Agreement attached hereto as Exhibit "B." However, until such time, the conditions under which Del Rey and Caruthers participate in the SKGSA are governed by this MOU.

7. This MOU shall be interpreted, construed, and governed according to the laws of the State of California without regard to conflict of law principles.

8. Should any provision of this MOU be determined by a court of competent jurisdiction to be void, in excess of a Party's authority, or otherwise unenforceable, the validity of the remaining provisions of this MOU shall not be affected thereby.

9. No rights and duties of any of the Parties under this MOU may be assigned or delegated without the express prior written consent of all of the other Parties, and any attempt to assign or delegate such rights or duties without such consent shall be null and void.

10. Notices: Each Party shall designate a principal contact person for that Party, who may be changed from time to time. Any formal notice or other formal communication given under the terms of this MOU shall be in writing and shall be given personally or by certified mail, postage prepaid and return receipt requested. Any notice shall be delivered or addressed to the parties at the addresses set forth below or at such other address or facsimile numbers as shall be designated by notice in writing in accordance with the terms of this Agreement. The date of receipt of the notice shall be the date of actual personal service or three days after the postmark on certified mail.

South Kings Groundwater Sustainability Agency: David Peters, Secretary, City of Fowler, 128 S. 5th Street, Fowler, CA 93625

Carruthers Community Services District, 13617 S Raider Ave, Caruthers, CA 93609

Del Rey Community Services District, 10649 Morro Ave, Del Rey, CA 93616

11. Execution in Counterparts: This MOU may be executed in counterparts such that the signatures may appear on separate signature pages. A copy, or an original, with all signatures appended together shall be deemed a fully executed agreement. Signatures transmitted by facsimile or electronic transmission shall be deemed original signatures.

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IN WITNESS WHEREOF, the Parties hereto, pursuant to resolutions duly and regularly adopted by their respective governing boards, have caused their names to be affixed by their proper and respective officers as of the day and year first above-written.

South Kings Groundwater Sustainability Agency

____

By: Karnig Kazarian
Its:

Del Rey Community Services District

____

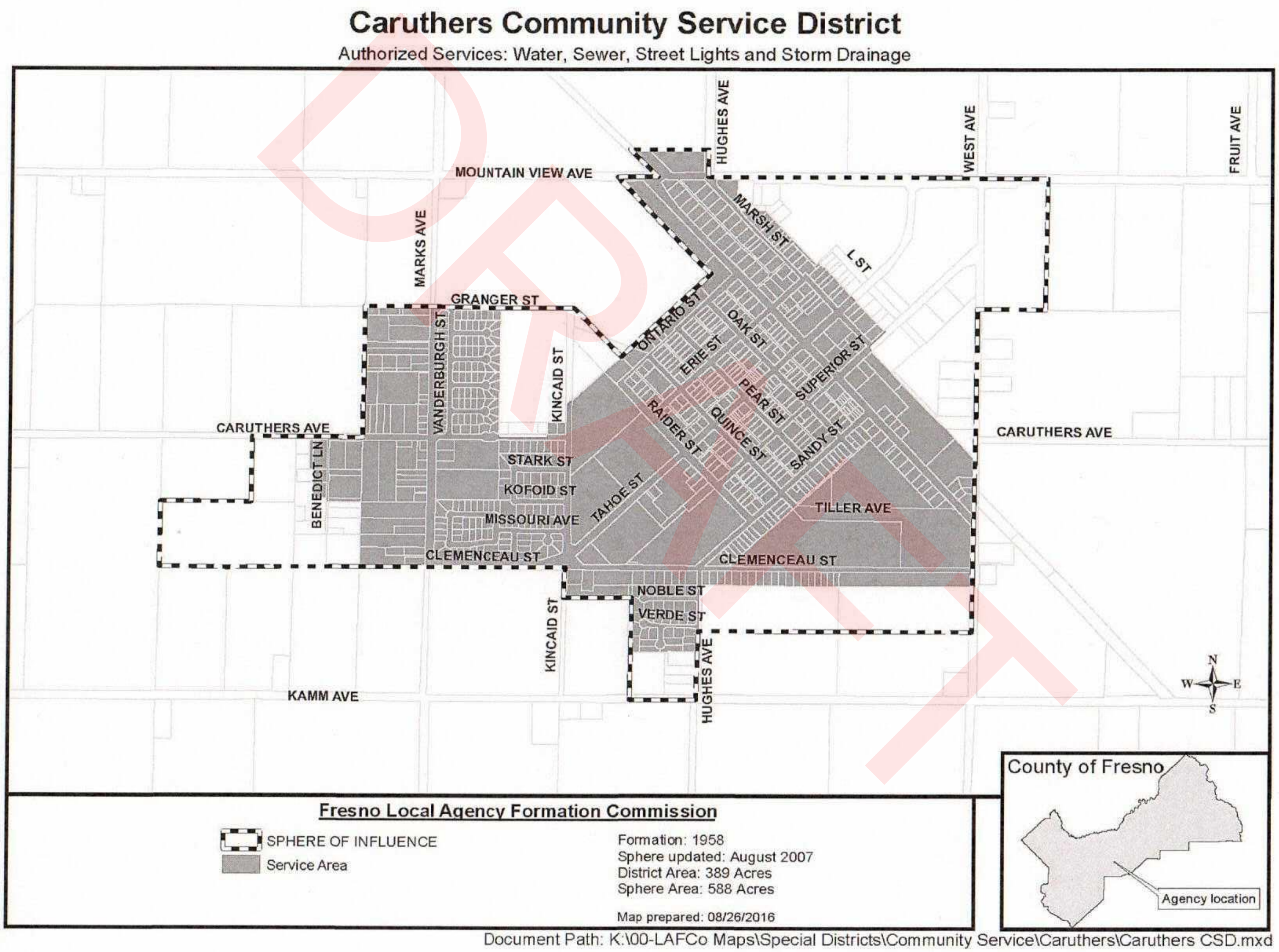
By: Remaldo Reyna
Its: President

Carruthers Community Services District

____

By:
Its:

EXHIBIT A-1

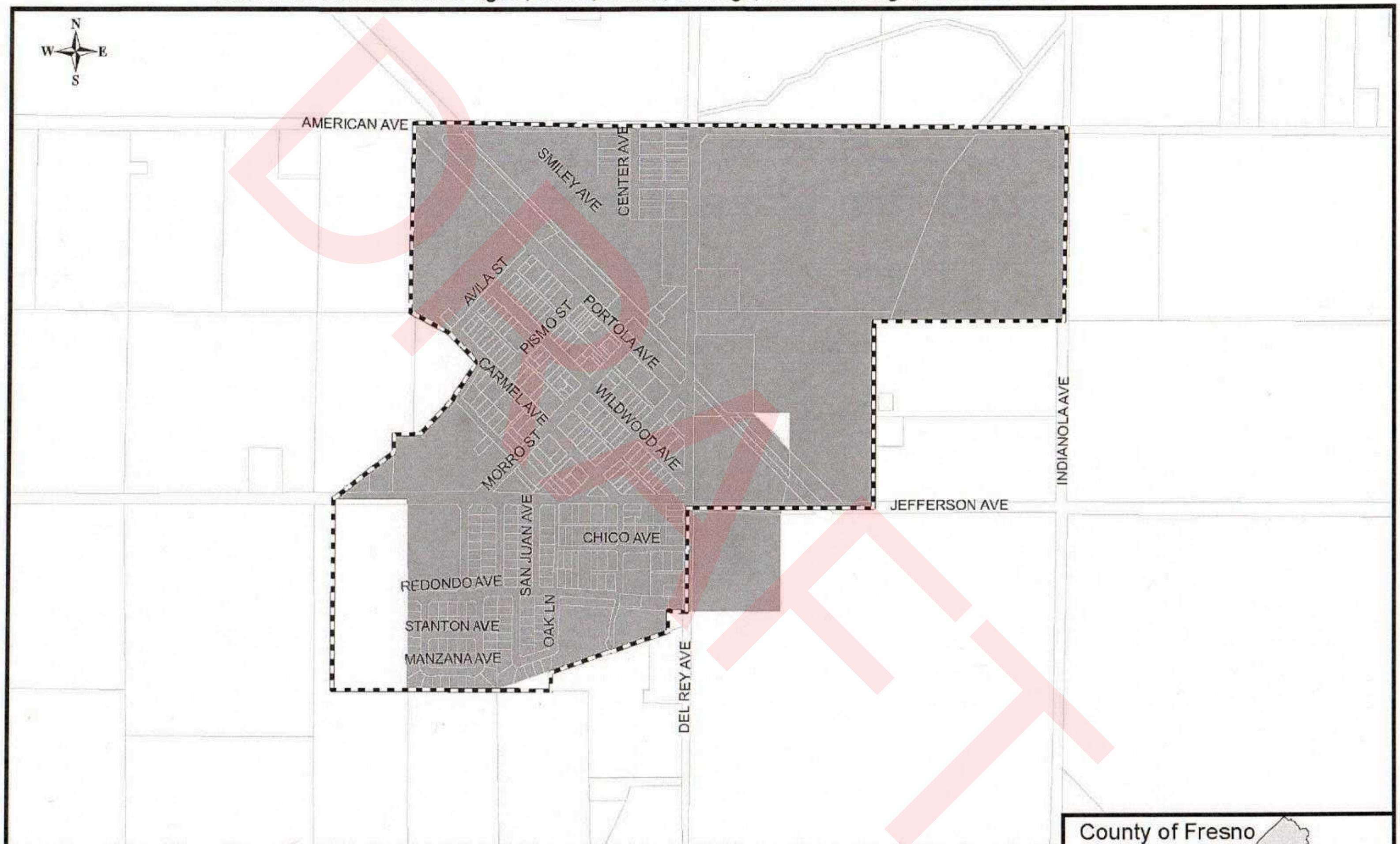


Document Path: K:\00-LAFCo Maps\Special Districts\Community Service\Caruthers\Caruthers CSD.mxd

EXHIBIT A-2

Del Rey Community Service District

Authorized Services: Street Lights, Water, Sewer, Garbage, Storm Drainage, Park Maintenance



Fresno Local Agency Formation Commission

District SOI
District Area

Formation: 1964
Sphere updated: 07/11/2007
District area: 298 Acres
Sphere area: 302 Acres

Map prepared: 09/13/2016

Document Path: K:\00-LAFCo Maps\Special Districts\Community Service\Del Rey\Del Rey CSD.mxd

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SUITE 115
FRESNO, CALIFORNIA 93720-2928
(559) 261-0163

NEAL E. COSTANZO
MICHAEL G. SLATER

FAX (559) 261-0706

OUR FILE NO.

June 29, 2017

Via Email: davidpeters@peters-engineering.com
David Peters
Peters Engineering Group
952 Pollasky Avenue
Clovis, CA 93612

Re: South Kings Groundwater Sustainability Agency (SKGSA) and the Caruthers Community Services District

Dear Mr. Peters:

This will confirm that in my capacity as General Counsel of the Caruthers Community Services District, and the designee of the General Manager who, according to the resolution of the Community Services District's Board of Directors you are in possession of, is fully authorized to take all actions relating to the Community Services District's participation in the SKGSA, I have requested that you eliminate the boundaries of the Community Services District from any amendment to the election or the accompanying map of territory previously filed by SKGSA with the Department of Water Resources. Since Caruthers can only be included in your amended election by virtue of its consent, we presume you recognize that this demand is required to be honored and Caruthers cannot be included in any amendment to the territory identified by the SKGSA election.

Thank you for your attention to this matter.

Sincerely,

COSTANZO & ASSOCIATES

Neal E. Costanzo

00015446.WPD;1

NEC/js

C/C Michael R. Linden: mlinden@lozanosmith.com
Alex Henderson: ahenderson@cityofkingsburg-ca.gov
David Elias: davide@cityofselma.com
Philip Romero: promero@yhmail.com
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NEAL E. COSTANZO
MICHAEL G. SLATER

FAX (559) 261-0706

OUR FILE NO.
01236-503

June 29, 2017

Via Email: davidpeters@peters-engineering.com
David Peters
Peters Engineering Group
952 Pollasky Avenue
Clovis, CA 93612

Re: South Kings Groundwater Sustainability Agency (SKGSA) and the City of Selma

Dear Mr. Peters:

At a special council meeting on June 28, 2017, the City Council of the City of Selma adopted a Resolution directing the Mayor to issue a Notice of Withdrawal from the Joint Powers Authority Agreement, South Kings Groundwater Sustainability Agency. During our conference call of June 29, 2017, and based upon the authority granted to me and the City Manager of the City of Selma we requested that any amended or amendment to the election to serve as Groundwater Sustainability Agency previously filed by SKGSA with the Department of Water Resources completely exclude the City of Selma and its Sphere of Influence. In light of Selma's request, SKGSA has no authority to file any amended election that includes the City of Selma or its Sphere of Influence. Any election or accompanying map filed by SKGSA that does include the City of Selma or any part of its Sphere of Influence will be unauthorized and Selma will pursue all remedies legally available to it to eliminate any such unauthorized filing with the Department of Water Resources.

As an aside, it appears the two representatives for Kingsburg and Parlier appearing at the meeting of SKGSA on June 27, 2017, were not the designated representative or designated alternate. The addition of the inclusion of SKF Sanitation District to the territory covered by SKGSA was not on the agenda and was not properly added to the agenda. The City of Selma believes the resolution adopted on that date may be invalid. If so, it would not provide any authorization for the filing of an amended election.

We would ask that you confirm that you will honor our request so that we know prior to the June 30, 2017, deadline whether it is necessary to pursue a different course of action to ensure that our demand is being honored. The request is made by the City Attorney of the City of Selma and you are required by law to treat the request as authorized by the City.

(Sarracino v. Superior Court (1974) 13 Cal.3d 1, 13; In Re Helen W (2007) 150 Cal.4th 71, 78). Thank you.

Very truly yours,

COSTANZO & ASSOCIATES

Neal E. Costanzo

NEC/js
C/C Michael R. Linden: mlinden@lozanosmith.com
Alex Henderson: ahenderson@cityofkingsburg-ca.gov
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Tim Chapap: Tchapa@ci.sanger.ca.us
Shannon L. Chaffin: schaffin@awattorneys.com
Carlos Arias: drcsd@pacbell.net

Appendix B

GSP Comments and Responses

PUBLIC REVIEW DRAFT GSP COMMENTS **SKGSA 8-29-2019**

This table summarizes the comments received from the member agencies on the August 2019 Public Review Draft GSP for the South Kings GSA.

Commented By: ____

No.	Section/Page	Comment
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Appendix C

Technical Memorandum No. 1

Technical Memorandum 1
Base of the Unconfined Aquifer

The six Groundwater Sustainability Agencies (GSAs) in the Kings Groundwater Sub-basin (Kings Basin) are in the process of developing data and analyses to evaluate historical changes in groundwater storage. The attached memorandum from Kenneth D. Schmidt and Associates (KDSA) provides a description of the base of the unconfined aquifer within the Kings Sub-basin and describes the extent of the existing significant clay layers within the Sub-basin.

KDSA Est. 1972

EST. 1968 PROVOST& PRITCHARD CONSULTING GROUP An Employee Owned Company

TECHNICAL MEMORENDUM ON DETERMINATION OF BASE OF UNCONFINED GROUNDWATER IN THE KINGS SUB-BASIN

INTRODUCTION

In order to estimate changes in groundwater in storage, it is important to distinguish between shallow unconfined conditions and deeper confined conditions. For unconfined aquifers, water-level changes can be multiplied by specific yields to estimate the changes in groundwater storage. Storage changes in confined aquifers are usually insignificant, as they stay full of water, despite water-level declines, as long as the water level stays above the top of the aquifer. Another purpose of separating the shallow unconfined and deep confined groundwater is for groundwater flow determinations. In general, the direction of groundwater flow may not be the same for the shallow and deep groundwater at specific locations. This is particularly true near the southwest edge of the Kings Basin. Thus water-level slopes and transmissivities need to be known for both the unconfined and confined groundwater, in order to estimate groundwater flows.

HISTORICAL CONTEXT

As of the 1950's and 1960's, when many of the earlier U.S. Geological Survey groundwater reports were done for the westside of Fresno County and for the Fresno and Hanford Visalia areas, the concept was that there were two aquifers beneath the westerly areas, where the Corcoran Clay was present. Groundwater above this clay was generally considered to be unconfined, whereas the underlying groundwater was considered to be confined. In contrast, one unconfined aquifer was assumed at that time for the eastside lands, east of the Corcoran Clay. As of the mid-1960's, there were few deep water wells that had been drilled in the east part of the Fresno and Hanford-Visalia areas. The cable-tool method was widely used in this area through the mid-1960's. Most water wells were no deeper than about 300 to 400 feet, and electric logs were not available, as they could not be run in cased wells. Many of the eastside water supply wells prior to the mid-1960's tapped the upper coarse-grained deposits, termed the "Quaternary older alluvium" by the U.S. Geological Survey. For the most part, this groundwater was unconfined, and information on the deeper deposits was lacking in many areas along the eastside.

With the advent of reverse rotary drilled wells in the mid-1960's, deeper wells were drilled and eventually many electric logs became available. Along with geologic logs for many City and school wells drilled after the late 1970's, a much better understanding of the deposits below a depth of 300 to 400 feet was obtained along the eastside. These Tertiary-Quaternary continental deposits are generally much finer grained than the overlying deposits, and clay layers are often present. After the 1960's, test holes and wells were commonly drilled to depths ranging from about 700 to 900 feet, or deeper. While no laterally continuous single confining bed like the Corcoran Clay (a geological marker bed) was indicated, a number of important, less continuous, local confining beds were identified.

In the Fresno urban area alone, there are more than 150 sites where nested monitor wells were installed during the past several decades. Electric logs and geologic logs are available, as well as water levels and groundwater quality for the shallow (about 200 feet deep), intermediate (about 400 feet deep), and deep (about 700 feet deep) groundwater. Major confining beds were identified. These were normally below 200 feet in depth and above 400 feet in depth. Monitoring of these wells allowed water-level differences and vertical hydraulic gradients to be determined. Differences in groundwater quality are consistent with the separation of shallow (above the confining bed) and deep (below the confining bed) groundwater. Information on vertical differences in water levels and groundwater quality, and the depths of confining beds has also been developed at hundreds of sites for wells in other cities, small water systems, schools, and industries in the Kings Sub-Basin. These were obtained from test well and pilot hole programs associated with the development of new water supply wells. Subsurface geologic cross sections showing the deeper subsurface geologic conditions have been prepared in many parts of the Kings Sub-Basin. Together, these sources of information provide a good indication of the base of the unconfined groundwater in most of the Kings Sub-Basin east of the Corcoran Clay.

ENHANCED CONCEPT OF AQUIFER CONFINEMENT

The enhanced concept of aquifer confinement in the San Joaquin Valley is that the shallow groundwater throughout most of the valley is unconfined. In contrast, groundwater at depth in most of the valley is confined in most of the valley. Generally, confining beds east of the Corcoran Clay in the Kings Sub-Basin are below a depth of several hundred feet, and appear to often be near the base of the Quaternary older alluvium or in the upper part of the underlying continental deposits. As one drills deeper into the underlying continental deposits, local clay layers are more common than in the overlying deposits, and even though they are not continuous over distances of tens or hundreds of miles, like the Corcoran Clay, they are important locally. Some of these localized clays are much thicker than the Corcoran Clay, and they tend to be found at specific depths in specific parts of the sub-basin.

As part of the City of Fresno Nitrate Study in 2006, KDSA defined confining beds at an average depth of about 250 feet in south and southeast Fresno. In general, high nitrate and DBCP concentrations were found in groundwater above the beds in those areas, whereas concentrations were much lower in the groundwater below these beds. Throughout much of the Kings Sub-Basin, unconfined groundwater beneath irrigated areas has usually been affected by irrigation practices. Based on its chemical composition and some age dating, this groundwater is generally indicated to be younger than about 70 years old. This groundwater has higher concentrations of total dissolved solids (TDS) and nitrate than does the underlying deeper groundwater. In much of the Kings Sub-Basin, groundwater beneath the confining beds is indicated to either not have been affected by irrigation practices, or to have been minimally affected by such practices.

Vertical hydraulic gradients are determined by dividing the difference in water levels (above and below the confining bed(s)) by the thickness of the confining bed(s). Vertical hydraulic gradients have been determined at many sites, and commonly range from about 10 to 20 feet per 100 feet, much greater than for lateral hydraulic gradients (commonly about 5 to 10 feet per mile).

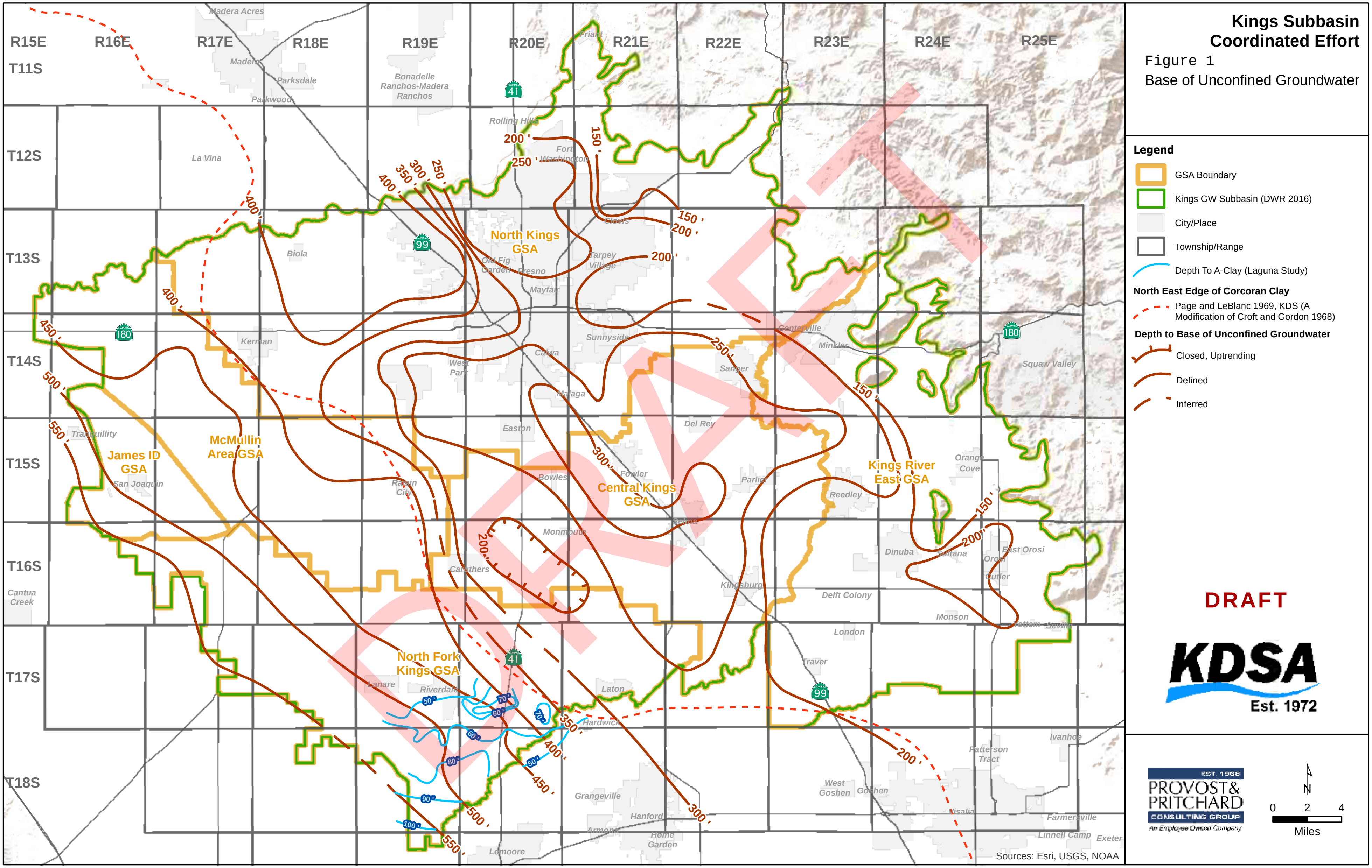
UNCONFINED GROUNDWATER IN
THE KINGS SUB-BASIN

Figure 1 shows contours of depth to the base of the unconfined groundwater in most of the Kings Sub-Basin. The extent of the Corcoran Clay is shown on this figure. To the southwest, where the Corcoran Clay is present, the base of the unconfined groundwater is considered to be the top of this clay. The depth to the top of this clay was determined by reviewing a number of subsurface geologic cross sections, where the clay was identified, and several maps where the top of the Corcoran Clay was contoured. This information was supplemented by evaluating electric logs, where the clay was clearly identifiable. The depth to the top of the Corcoran Clay ranges from about 200 feet deep south of Traver to more than 550 feet to the southwest, near the southwest boundary of the Kings Sub-Basin.

The base of the unconfined groundwater generally becomes shallower to the northeast, and in some places it is less than 150 feet deep. In some parts of the sub-basin, such as in the Orange Cove I.D., no confined groundwater is indicated to be present. This is supported by the vertical distribution of nitrate, which doesn't indicate any influence of a confining bed. In the Fresno urban area, the base of the unconfined aquifer deepens rather quickly to the southwest, from less than 250 feet to more than 400 feet. Between most of the area between northwest Fresno and Kerman, the base of the unconfined groundwater is more than 400 feet deep. This area includes the locations of the Fresno Irrigation District water banking projects. In contrast, the base of the unconfined groundwater is less than 200 feet deep in the area east of the Fresno Air Terminal, in an interfan area, where fine-grained deposits are predominant.

CALCULATING STORAGE CHANGES

Once the base of the unconfined groundwater has been established, then water-level measurements are selected for wells that only tap these deposits (not deeper ones). Also, specific yield estimates are made only for the unconfined groundwater (between the water level and the base of the unconfined groundwater). Storage changes for the groundwater are then calculated by multiplying the change in water levels during a base period by the specific yields.



6/28/2017 : G:\Kings River East GSA-2664\266417001-Kings Basin SGMA Coordination\GIS\Map\KDS\base_of_unconfined11x17.mxd

Appendix D

Technical Memorandum No. 2

Technical Memorandum 2
Specific Yield Values

The six Groundwater Sustainability Agencies (GSAs) in the Kings Groundwater Sub-basin (Kings Basin) are in the process of developing data and analyses to evaluate historical changes in groundwater storage. This memorandum provides a recommendation of the specific yield values to be used for each portion of the Kings basin for the groundwater storage calculation, and documents the research and reasoning for the recommendation. The recommendations are based on published sources and additional analysis by Kenneth D. Schmidt and Associates (KDSA).

Background

Specific yield is defined as the ratio of the volume of water a rock or soil will yield by gravity drainage to the volume of rock or soil (Meinzer, 1932). Specific yield data derived from subsurface material textures are generally considered to be the most accurate values that can be obtained. To calculate storage change, specific yield for unconfined groundwater is multiplied by the change in groundwater level for an area. For instance, if over a 1,000 acre area there is a 10-foot per year decline in the groundwater level, and an estimated specific yield of 8%, then the volume of overdraft would be equivalent to 1,000 acres x 10 feet x 8% = 800 acre-feet per year. The Sustainable Groundwater Management Act (SGMA) requires, among other things, annual reporting of change in storage per GSA.

Historically, the Fresno Irrigation District (FID) has used specific yield values from U.S. Geological Survey Water Supply Paper 1469 (Davis et al., 1959), referred to herein as USGS 1469 to calculate changes in groundwater storage. The main emphasis of this evaluation focused on comparing specific yields from other published sources to USGS 1469 specific yields and to research additional sources of data in areas not covered by USGS 1469.

The six GSAs desire to use specific yield information from published sources where possible.

Storage change estimations will be limited to the unconfined aquifer which is described in Technical Memorandum 1 (TM 1).

Survey of Published Sources of Specific Yield

Table 1, below, is a list of published sources of specific yield information used in this evaluation, and a general description of what areas and depths these sources cover in the Kings Basin. **Attachment 1** is a Specific Yield Data Sources Coverage map showing the area covered by each source in **Table 1**.

Table 1 - Summary of Specific Yield Data Sources and General Coverage

Publication Information	Title	Data Coverage*	Depth of Coverage
USGS WSP 1469, (Davis and others,1959)	Ground-Water Conditions and Storage Capacity in	San Joaquin Valley, except Fresno Slough Area and locations against the foothills	10-50 feet 50-100 feet 100-200 feet

	the San Joaquin Valley, California		
Page and Leblanc, 1969	Geology, Hydrology, and Water Quality in the Fresno Area, California	San Joaquin Valley, except portions of Fresno Slough Area and locations against the foothills	O - 300 feet
USGS PP 1401-D, (Williamson, Prudic and Swain, 1989)	Ground-Water Flow in the Central Valley, California	San Joaquin Valley, except locations against the foothills	Variable from 150 feet near the foothills to greater than 600 feet to the west
Kings River Conservation District, 1992	Alta Irrigation District, Groundwater Study	Alta Irrigation District and portions of Orange Cove Irrigation District	Unknown
USBR, 1947	Geologic Study of the Orange Cove Irrigation District	Orange Cove Irrigation District	20 to 234 feet
* See **Attachment 1**			

USGS WSP 1469

In USGS Water-Supply Paper (WSP) 1469 specific yield was estimated down to depths of 200 feet for most of the valley floor. The general method employed by USGS 1469 was to group the 300 drillers' terms commonly used to describe alluvial subsurface materials into five principal classes. These groupings were then assigned specific yield values that ranged from 25 percent for Group G – gravels, sand and gravel and similar materials down to a low of 3 percent for Group C materials - clay and related material. The data for the total footage for each Group of material were summarized for a given well and an average specific yield calculated for the depth intervals of 10 to 50 feet, 50 to 100 feet, and 100 to 200 feet by Township and Range. The Township and Range grid was modified by groundwater storage units so that the data more accurately represented the varying geologic conditions in the valley. Therefore, a given Township and Range may have two or more specific yield values, depending on how many different geologic units (which in USGS 1469 are referred to as storage units) are intersected by the overlying Township and Range. The authors recognized that in 1959 water levels in certain parts of the valley already exceeded depths of 200 feet, but the methodology they used could readily be made to determine specific yield in strata deeper than 200 feet. USGS 1469 data covers most of the Kings Basin, except in some areas near the foothills, and areas of lake beds deposits and overflows lands (the area termed the Fresno Slough Area in the Kings Basin). The extent of the Kings Basin covered by USGS 1469 is shown in **Attachment 1**.

Page and Leblanc (1969)

Page and Leblanc (1969) working for the USGS derived specific yield estimates based on geologic facies. Facies is a geologic term that means the appearance and characteristics of a sedimentary deposit that is used to distinguish a subsurface material from contiguous subsurface materials. The facies data are based on descriptions of alluvial texture. Six facies categories were defined from Facies A with an estimated specific yield of 5.3 percent to Facies F with an estimated specific yield of 18.7 percent. These data were plotted on a map and an average specific yield was generated by Township and Range based on the relative percentage of each facies. The data were compared to USGS 1469, and in general are within 2 to 3 percent, which is considered good agreement. There is a general trend between the two data sets where in the northeast portion of the basin, the Page and Leblanc (1969) estimated specific yields tend to be slightly higher than those in USGS 1469, and in the western portion of the basin the Page and Leblanc (1969) estimated specific yields tend to be slightly lower.

USGS PP 1401-D

USGS Professional Paper (PP)1401-D, was one of the original groundwater modeling efforts by the USGS in the Central Valley. Specific yield was estimated using methods and groupings of deposits by descriptions into five categories with similar properties as described in USGS 1469. The authors indicated that more than 7,400 driller's logs in the San Joaquin Valley were coded for analysis. Specific yield was assigned to subsurface materials according to a model grid oriented northwest along the axis of the valley. This report did not report specific yield by depth range but rather for the entire saturated thickness of the aquifer. Specific yield data from this report appears to be reasonable along the east side of the Kings Basin near the foothills where bedrock is shallow, and in most of North Fork GSA area. These data are not reasonable in areas where wells are much deeper than the upper confined groundwater.

KRCD 1992

The Kings River Conservation District (KRCD) prepared a groundwater study for the Alta Irrigation District (KRCD 1992). This study addressed a list of objectives through a District-wide water balance and groundwater/surface water model. As part of model development, KRCD used unpublished data from the California Department of Water Resources (DWR) that we could not verify. The KRCD report indicates that the DWR data was developed for each quarter-Township and Range from well drillers logs. This data was mapped as specific yield contours, and, to compare these data to USGS 1469, the average specific yield was used between two specific yield contours. For example, the area between the 11 percent and 12 percent specific yield contours would be 11.5 percent. The KRCD specific yields were averaged by Township and Range and compared to USGS 1469 specific yield data. The two sets of data matched within 2 or 3 percent where they overlap except for two small areas on the north part of the KRCD study area where the differences were 4.3 and 3.5 percent. A limitation of this information is that the depths of deposits corresponding to specific yield was not provided.

USBR 1947

The U.S. Bureau Reclamation prepared a Geologic Study and a Water Supply Study both for the Orange Cove Irrigation District (OCID) in 1947 (USBR 1947a & USBR 1947b). They divided the OCID into seven investigational subareas and estimated specific yield for each sub area. Specific yield values for standard textural descriptions were based on previous work done in the Mokelumne area (115 miles northwest of OCID) and from twenty percolation tests in OCID. These values were used along with the stratigraphy in 52 local well logs, and 115 large diameter auger holes drilled along the Friant Kern Canal, to estimate local specific yield. Specific yields ranged from a low of 6.5 percent to 8.3 percent. In most areas where USBR 1947 and USGS 1469 overlap, specific yields from both sources are within less than one percent. The maximum difference in specific yields between the studies is 2.1 percent in the south part of the investigational area. For those areas outside of USGS 1469 coverage, mainly near the foothills, the specific yields from USBR 1947 was used.

USDA Technical Bulletin 1604

USDA Technical Bulletin 1604 provides estimates of specific yield in the Fresno-Clovis northeast area at depths from 0 to 20 feet, 0 to 50 feet, 50 to 100 and 100 to 150 feet. This report develops estimated specific yield from soil texture as described on well drillers logs and in similar groupings as USGS 1469. However, for this study the descriptive terms were regrouped into four categories that reflected the reduced number of descriptive terms on the area's well logs. This report and analysis was done to aid in recharge investigations and is a resource for that purpose, but does not provide detailed specific yield coverage in some areas, and to the depths desired. The intent of this publication was to help focus future recharge studies, so areas where specific yield is higher are clearly delineated. However, there are significant portions of the USDA study area where specific yield data is sporadic or not estimated, and thus is not readily comparable to the more extensive data from the other sources.

McMullin Area Evaluation

KDSA prepared a memorandum documenting their estimates of specific yield in the McMullin Area GSA, James ID GSA and the northwestern most portion of North Fork Kings GSA area (**Attachment 3**). Additional evaluation was needed in this area where USGS PP 1401-D specific yields were estimated over the entire saturated thickness of the aquifer, i.e., down to depths of several thousand feet or more. As noted by Page and Leblanc (1969) the deeper Continental Deposits of Tertiary and Quaternary are finer grained than the overlying deposits of Quaternary age. These deep, finer deposits have lower specific yield and therefore the overall specific yield based on the entire saturated thickness of the aquifer are lower than specific yields in the unconfined aquifer above the Corcoran Clay. As previously noted the change in groundwater storage is based on water level changes in the unconfined aquifer, and in this area the base of the unconfined aquifer is the top of the Corcoran Clay. The KDSA analysis was based on electric logs, geologic logs and DWR Well Completion Reports with good descriptions of texture. The data were used to develop several subsurface geologic cross sections in the area. On the subsurface cross sections, three types of deposits; sand or coarser materials, clay or silt, and intermediate type materials such as sandy clay were shown. These deposit types were assigned specific yield values of 20 percent, 3 percent, and 8 percent, respectively. Specific yield was estimated from the Spring 2005 water table to the top of the Corcoran Clay. Based on this evaluation, average specific yields in the area above the Corcoran Clay range from 10 percent southwest of the City of San Joaquin to 15 percent south of the City of San Joaquin near McMullin Grade and the Fresno Slough (**Attachment 2**). Proposed specific yields for deposits above the Corcoran Clay in this area based on the KDSA evaluation are shown on **Attachment 2**.

Friant Area Evaluation

The northernmost portion of the North Kings GSA is not covered by any of the referenced specific yield data sources. Previous work by KDSA in 2012 (described in **Attachment 11**) included development of a subsurface geologic which extends from near Friant to south of Little Dry Creek. Specific yield was estimated for three segments along the subsurface cross section as follows; from near Friant to the southern part of Beck Ranch, south end of Beck Ranch to north end of Ball Ranch, and from Ball Ranch to near Little Dry Creek. Specific yield was estimated to be 25 percent, 20 percent and 14 percent, respectively, for a proposed average of 20 percent for this portion of the North Kings GSA (**Attachment 10**).

Depth to Water and Specific Yield

For the overall Kings Basin, USGS 1469 appears to have the best data for the area covered in the publication. As mentioned above, USGS 1469 provides specific yield estimates in the depth range from 10-50 feet, 50 to 100 feet and 100-200 feet, and therefore does not apply in areas where depth to water is greater than 200 feet. In the areas covered by USGS 1469 and water levels shallower than 200 feet, the depth to water will be used to determine which depth interval specific yield is appropriate to use for calculating storage change, if the water levels are shallower than the base of the unconfined aquifer. For example, if an average depth to water of 185 feet is obtained for a Township and Range, then the depth interval specific yield used would be 100 to 200 feet from USGS 1469. However, recent depth to water maps indicate that in some areas, the depth to water has already exceeded 200 feet. In those areas, providing there is coverage by USGS 1969, the average specific yield from that study would be used for depths to water between 200 and 300 feet. The subsurface geologic cross section derived specific yield is proposed to be used in the west part of the Kings Basin where the base of the unconfined groundwater is deeper.

Kings Basin – Eastside Specific Yield Coverage

The three main sources consulted for this study, USGS 1469, USGS 1969, and USGS 1401-D all have gaps in coverage on the valley floor near the foothills on the east side of the Kings Basin. A few gaps are covered by the USGS PP 1401-D model grid which indicate that specific yield in those areas is about 6 to 7 percent for most of the area, which is in the interfan area, and is likely about 20 percent along the San Joaquin River below Friant, based on subsurface geologic cross sections available in this area. Because of the shallow depth to bedrock, USGS PP 1401-D can be used along the east edge of the area. In those areas not covered by one of the USGS studies, use of KRCD 1992 or USBR 1947 is appropriate where information from these reports is available. However, this still leaves gaps in coverage against the foothills, and, as the sources indicate that specific yield is lower in these areas, it is proposed that a specific yield of 6 percent is used along the foothills in interfan areas lacking data coverage. A specific yield of 6 percent, except near Friant, appears reasonable and agrees well with adjacent USGS 1401-D model grid cells, USGS 1969 and USGS 1469 estimates of specific yield. In addition, these areas are relatively small and probably have few wells, so the impact to storage change estimates will likely be minimal.

Conclusions

The following is a list of specific yield data prioritized by publication source:

1. USGS 1469 – use in areas covered by that study
2. Page and Leblanc (1969) – use in areas lacking USGS 1469 coverage and for areas where base of unconfined water is between 200 and 300 feet where covered by this study.
3. Use subsurface geologic cross sections evaluation in west part of area, near Friant, and in parts Fresno urban area.
4. USGS 1401-D – use in North Fork Kings GSA Area where base of unconfined aquifer is greater than 300 feet, and along foothills in areas not covered by other studies or additional evaluation.
5. In areas along the foothills in interfan areas lacking specific yield coverage, use a specific yield of 6 percent.
6. Use only values below the water level, i.e., only for saturated strata.

Attachment 4 shows the recommended sources of specific yield data for all areas in the Kings Basin. **Attachment 5 to 10** are maps of each GSA showing the recommended specific yields for use in calculating storage change.

Attachments

1 – Kings Basin, Specific Yield Data Sources Coverage
2 – McMullin GSA Area of Evaluation, Location of Subsurface Geologic Cross Sections and Specific Yield Values
3 – KDSA, Memorandum on Specific Yield Estimates from Subsurface Geologic Cross Sections, June 19, 2017
4 – Kings Basin, Recommended Sources of Specific Yield
5 – Central Kings GSA, Data Sources and Recommended Specific Yield
6 – James ID GSA, Data Sources and Recommended Specific Yield
7 – Kings River east GSA, Data Sources and Recommended Specific Yield
8 – McMullin Group GSA, Data Sources and Recommended Specific Yield
9 – North Fork Kings GSA, Data Sources and Recommended Specific Yield
10 – North Kings GSA, Data Sources and Recommended Specific Yield
11 – KDSA, Memorandum on Friant area Specific Yield Estimates

References

Cehrs, D., Soenke, S., and Bianchi, W.C., (1980), *A Geologic Approach to Artificial Recharge Site Selection in the Fresno-Clovis Area, California*, U.S. Department of Agriculture, Technical Bulletin 1604

Davis, G.H., Green, J.H., Olmstead, F.H., and Brown, D.W., (1959), *Ground-Water Conditions and Storage Capacity in the San Joaquin Valley, California*, U.S. Geological Survey Water-Supply Paper 1469. Prepared in cooperation with the California Department of Water Resources.

Meinzer, O.E., (1932), *Outline of Methods for Estimating Ground-water Supplies*, U.S. Geological Survey Water Supply Paper 638-C

Page, R.W., and Leblanc, R.A., (1969). *Geology, Hydrology and Water Quality in the Fresno Area, California*, U.S. Geological Survey, Water Resources Division, Open File Report. Prepared in cooperation with the California Department of Water Resources

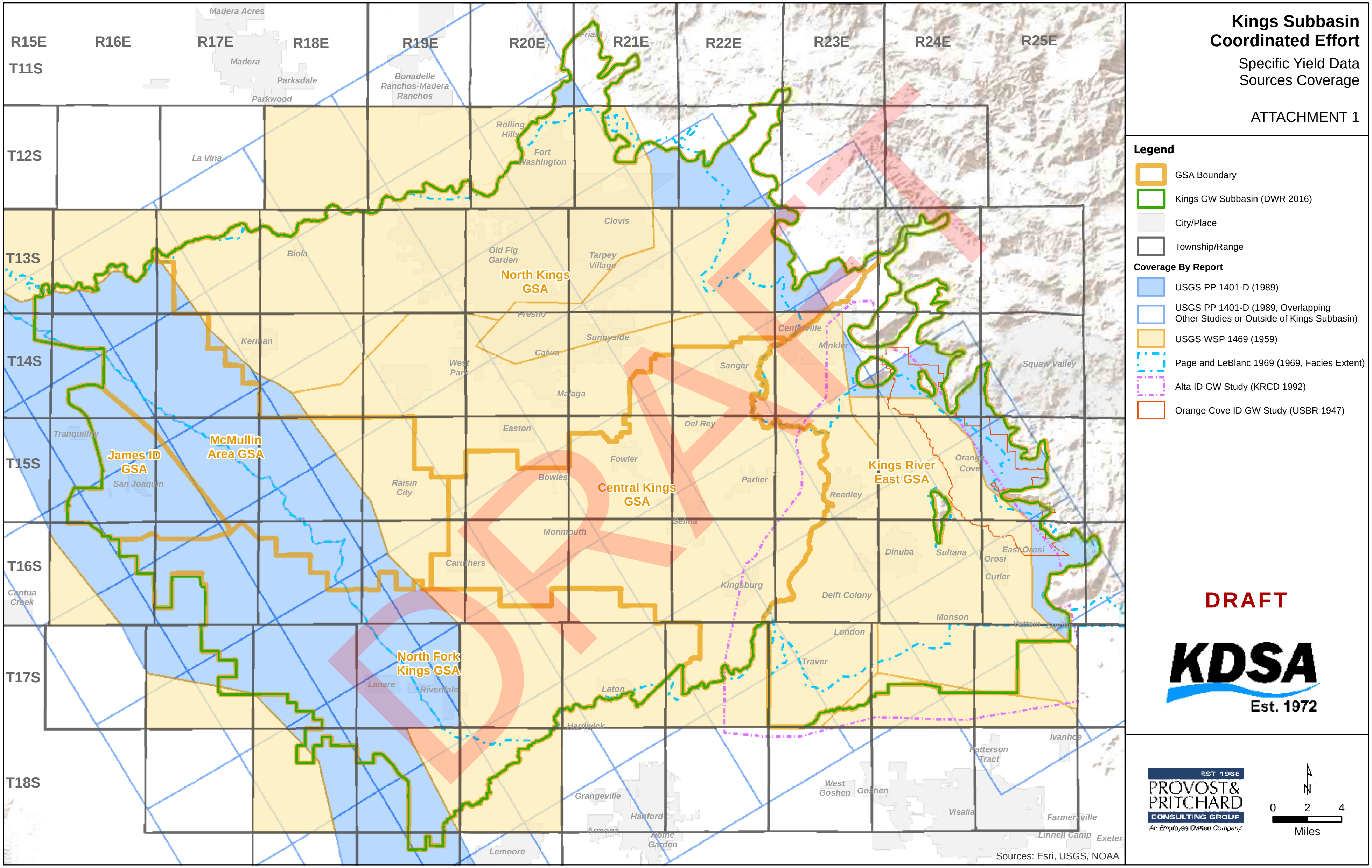
U.S. Bureau of Reclamation, Tulare Basin District (1947a), *Geologic Study of the Orange Cove Irrigation District*.

U.S. Bureau of Reclamation, Tulare Basin District (1947b), *Water Supply Study, Orange Cove Irrigation District.*

Williamson, A.K., Prudic, D.E., and Swain, L.A., (1989). *Ground-Water Flow in the Central Valley, California, Regional Aquifer System Analysis-Central Valley, California*, U.S. Geological Survey Professional Paper 1401-D.

Attachments 1

Kings Basin, Specific Yield Data Sources Coverage



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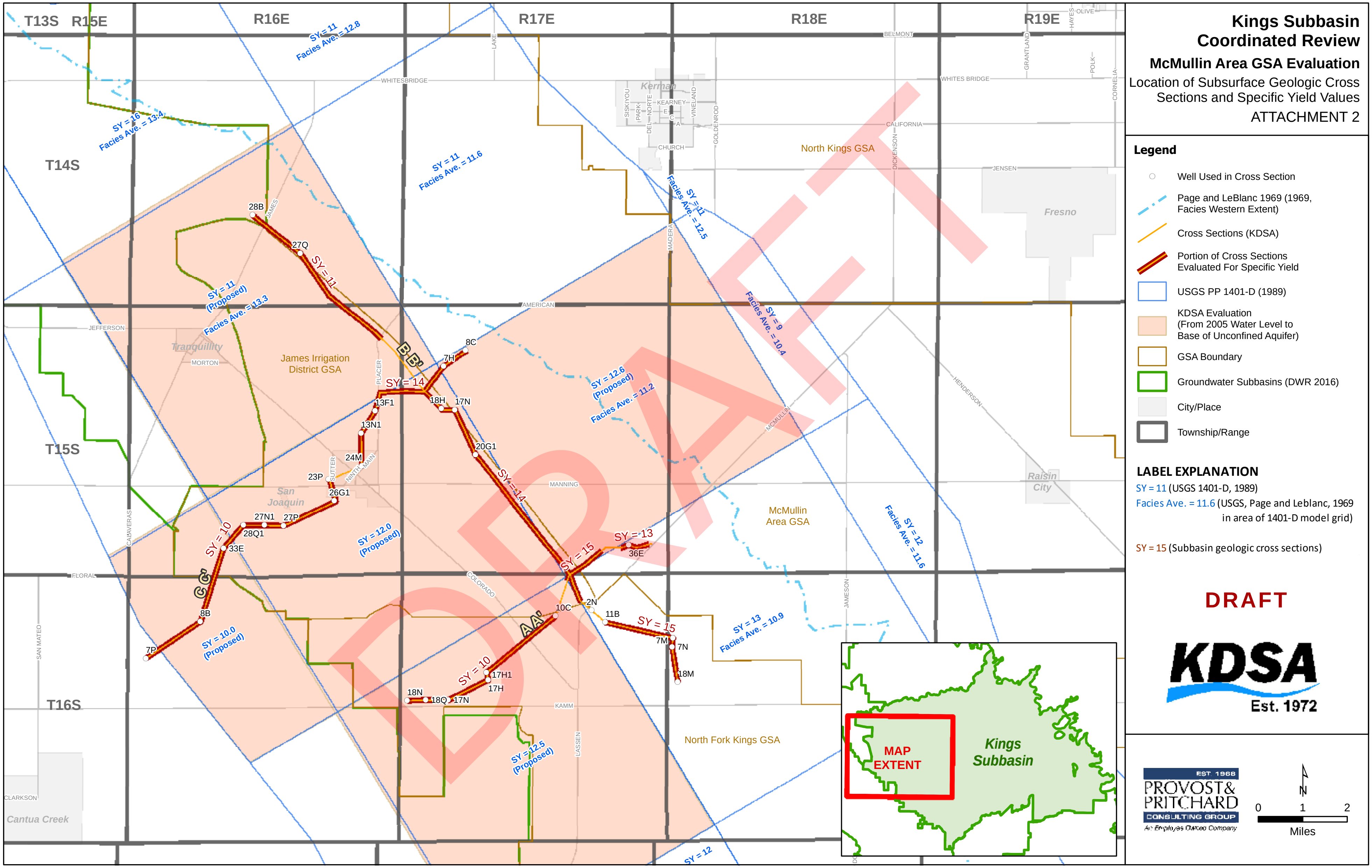
Attachments 2

McMullin GSA Area of Evaluation,
Location of Subsurface Geologic Cross Sections and Specific Yield Values



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Attachments 3

KDSA, Memorandum on Specific Yield Estimates from Subsurface Geologic Cross Sections, June 19, 2017

MEMO

To: Ron Samuelian, Provost & Pritchard
From: Ken Schmidt
Topic: Specific Yield Estimates from Subsurface Geologic Cross Sections
Date: June 19, 2017

As part of an evaluation for the James Irrigation District (JID), KDSA developed four subsurface geologic cross sections that extend through the District and its associated well fields (Figure 1). The westerly parts of these cross sections are located where the base of the unconfined aquifer is relatively deep, beyond the depths of where specific yields have been estimated in U.S. Geological Survey reports. These cross sections show three types of deposits: 1) sand or coarser material, 2) clay or silt, and 3) intermediate type materials, such as sandy clay. Specific yield values were assigned to these three types as follows: 20 percent, 3 percent, and 8 percent, respectively. The cross sections also show static water levels for the upper aquifer as of Spring 2005. The specific yield estimates were made to cover deposits between the water level and the top of the Corcoran Clay

Cross Section A-A′ extends along McMullin Grade to the southwest, to the west edge of the Kings Sub-Basin. The part of this section that was evaluated extended from the southwest edge of the section (Well T16S/R16E-18N) to the northeast to James I.D. Well D-34, located near McMullin Grade and Huntsman Avenue. Eleven wells with the best logs were evaluated. For the westernmost segment, the calculated specific yields for five wells ranged from 7 to 11 percent and averaged 10 percent. The 1401-D specific yield values in the nearest T&R were 8 and 15 percent, or an average of 11.5 percent. For the next segment to the northeast, extending from C-76 at the Fresno Slough to D-32 (three wells), the specific yields ranged from 13 to 17 percent and averaged 15 percent. The closest 1401-D T&R values were 15 percent and 16 percent. For the northeasternmost segment, extending from Well D-35 to D-34, the specific yields ranged for 12 to 13 percent and averaged 13 percent. The closest 1401-D T&R value was 13 percent. Overall, specific yields derived from Cross Section A-A′ are in good agreement with the 1401-D estimates.

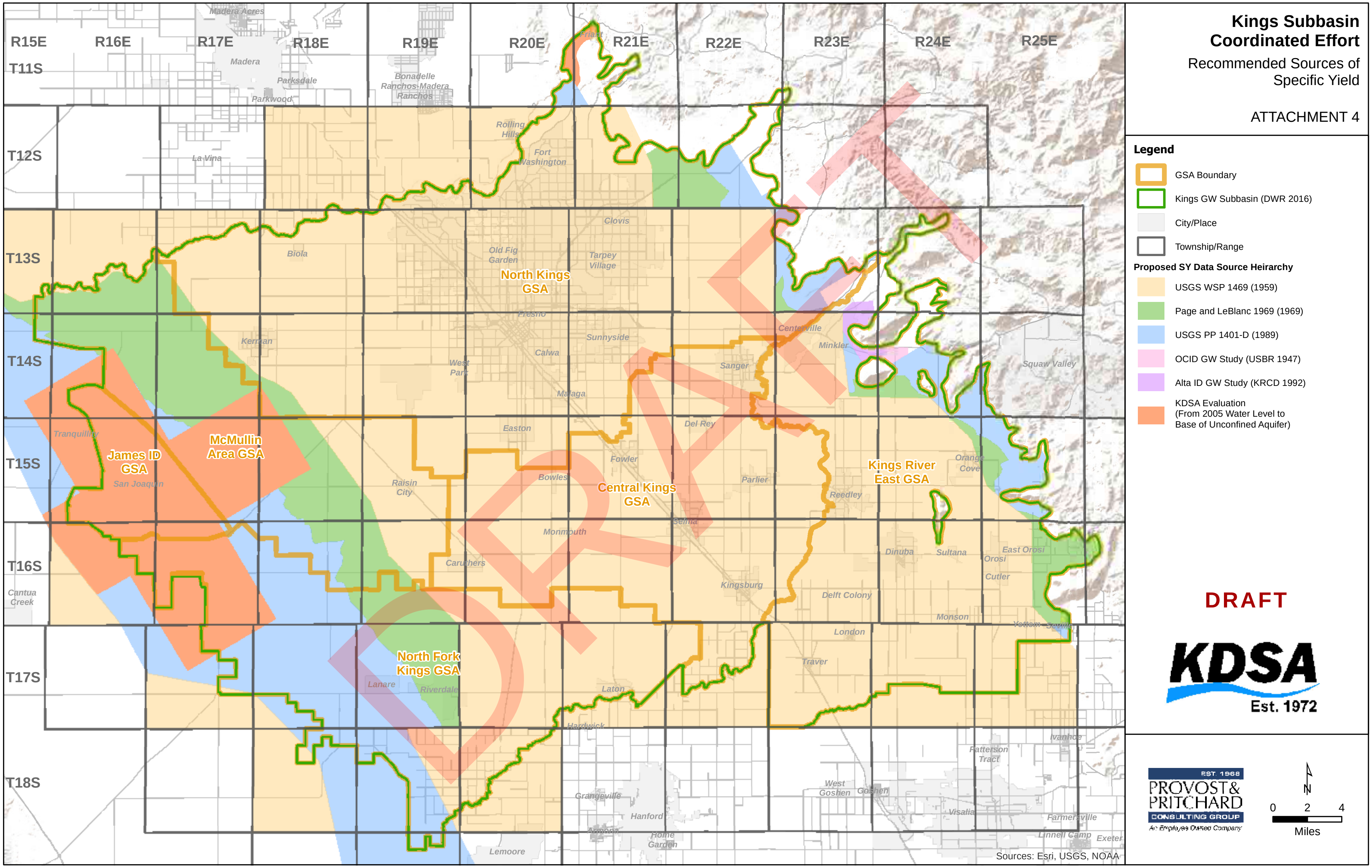
Cross Section B-B′ extends along the Fresno Slough. Fifteen wells with good logs were selected for evaluation. The northwestmost segment evaluated comprised five wells (28B to C-65). Specific yields ranged from 9 to 15 percent and averaged 11 percent. The closest 1401-D T&R values ranged from 10 to 11 percent. The next segment evaluated along the cross section extended from D-59 to D-30 (seven wells). Specific yields ranged from 12 to 17 percent and averaged 14 percent. The closest 1401-D T&R values ranged from 9 to 10 percent, and are considered too low for the area. The last part of the segment included three wells (11B to 18M). Specific yields ranged from 12 to 20 percent and averaged 15 percent. The closest 1401-D T&R values were 13 and 15 percent, in good agreement. Overall, specific yields along Cross Section B-B′ were in good agreement with the 1401-D values, except in T15S/R17E, where the 1401-D value appears to be too low.

Cross Section C-C′ extends from the west edge of the Kings Sub-Basin (7P) to the northeast to well 8C. This section passes through San Joaquin, and nine wells with good logs were selected for evaluation. For the segment southwest of San Joaquin (4 wells), specific yields ranged from 5 to 14 percent and averaged 10 percent. The nearest 1401-D T&R values were 9 and 10 percent. For the other five wells (24M to 8C) along the section, specific yields ranged from 6 to 20 percent and averaged 14 percent. The nearest 1401-D T&R values were 9 to 10 percent, and are indicated to be too low. Again, the 1401-D value for T15S/R17E appears to be too low.

Please call me if you have any questions

Attachments 4

Kings Basin, Recommended Sources of Specific Yield



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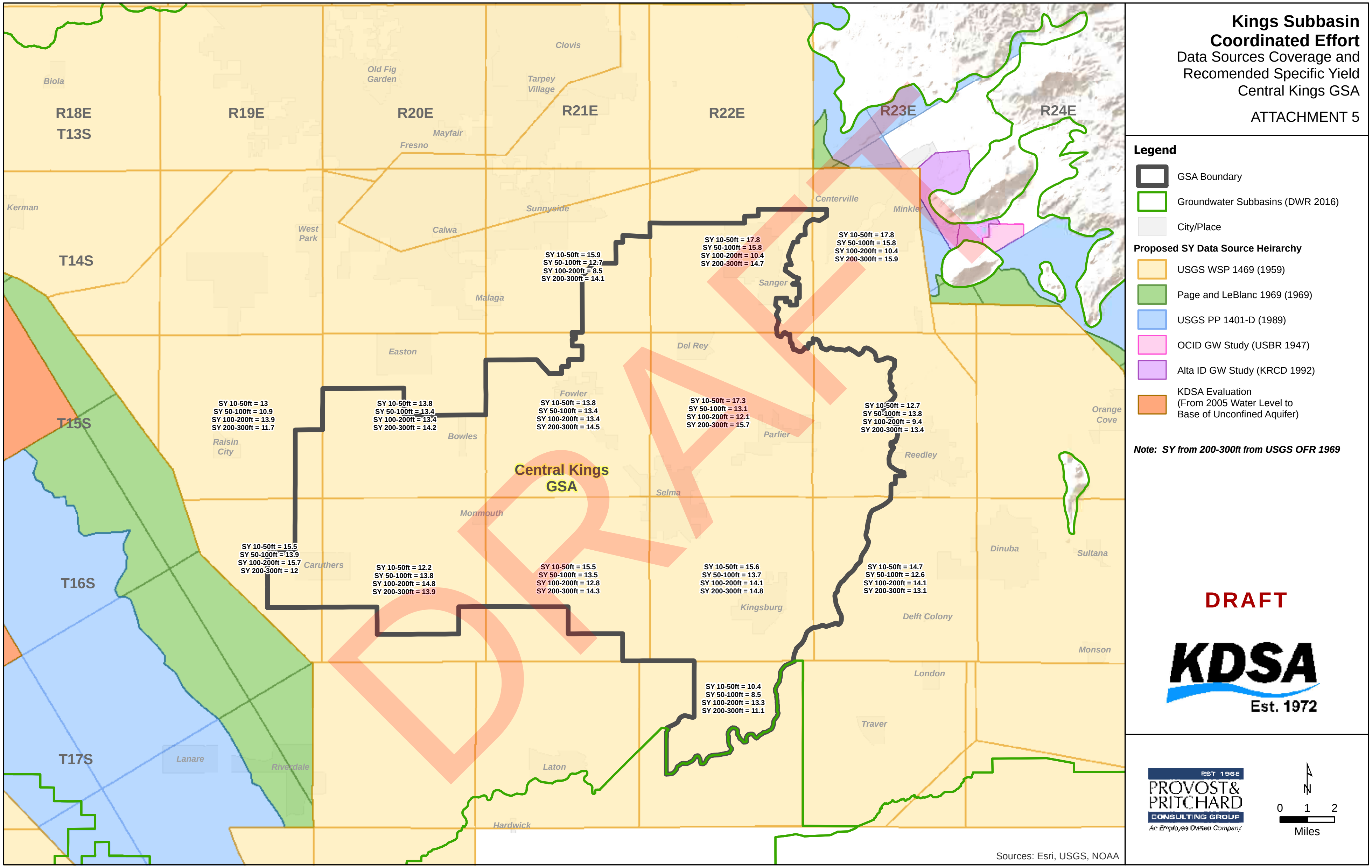
Attachments 5

Central Kings GSA, Data Sources and Recommended Specific Yield



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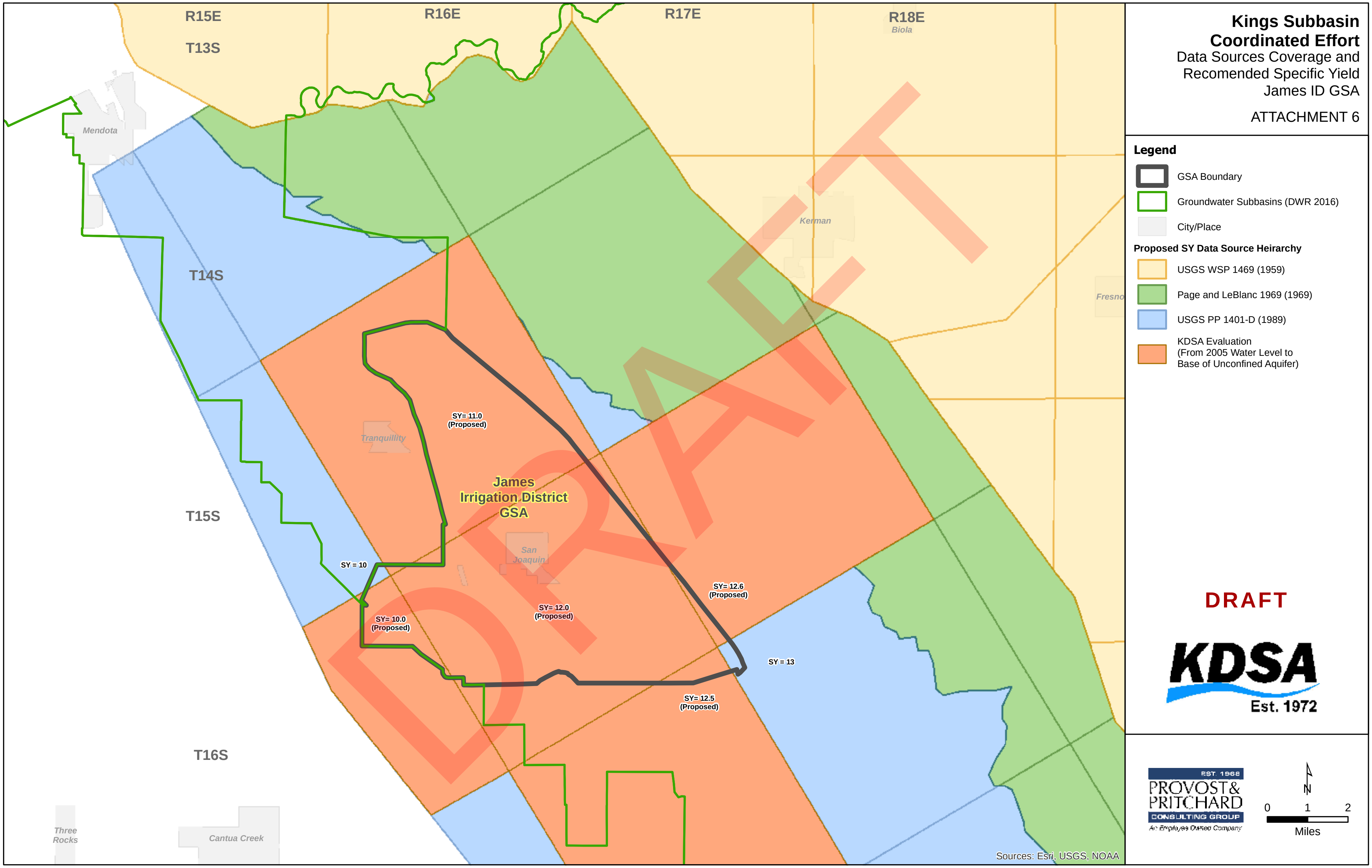
Attachments 6

James ID GSA, Data Sources and Recommended Specific Yield



Kings Subbasin
Coordinated Effort
Data Sources Coverage and
Recomended Specific Yield
James ID GSA
ATTACHMENT 6
Legend
GSA Boundary
Groundwater Subbasins (DWR 2016)
City/Place
Proposed SY Data Source Heirarchy
USGS WSP 1469 (1959)
Page and LeBlanc 1969 (1969)
USGS PP 1401-D (1989)
KDSA Evaluation
(From 2005 Water Level to
Base of Unconfined Aquifer)
DRAFT
KDSA
Est. 1972
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PRITCHARD
CONSULTING GROUP
An Employee Owned Company
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R18E
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T15S
T16S
Biola
Mendota
Kerman
Fresno
Tranquillity
San
Joaquin
Three
Rocks
Cantua Creek
James
Irrigation District
GSA
SY= 11.0
(Proposed)
SY = 10
SY= 10.0
(Proposed)
SY= 12.0
(Proposed)
SY= 12.6
(Proposed)
SY = 13
SY= 12.5
(Proposed)
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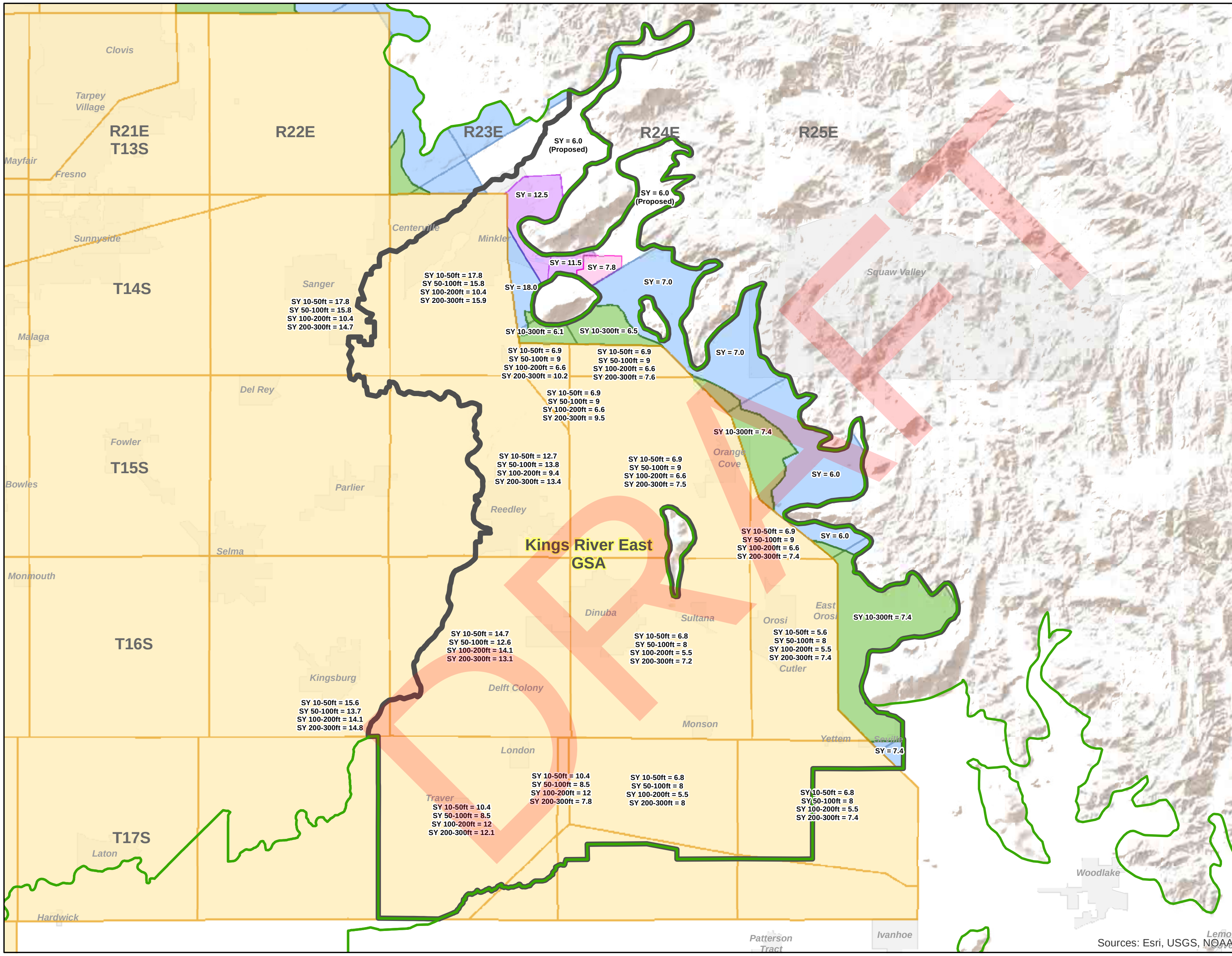
Sources: Esri, USGS, NOAA

Attachments 7

Kings River east GSA, Data Sources and Recommended Specific Yield

Kings Subbasin Coordinated Effort
Data Sources Coverage and Recomended Specific Yield
Kings River East GSA

ATTACHMENT 7



Legend

- GSA Boundary
- Groundwater Subbasins (DWR 2016)
- City/Place

Proposed SY Data Source Heirarchy

- USGS WSP 1469 (1959)
- Page and LeBlanc 1969 (1969)
- USGS PP 1401-D (1989)
- OCID GW Study (USBR 1947)
- Alta ID GW Study (KRCD 1992)

Note: SY from 200-300ft from USGS OFR 1969

DRAFT

KDSA Est. 1972

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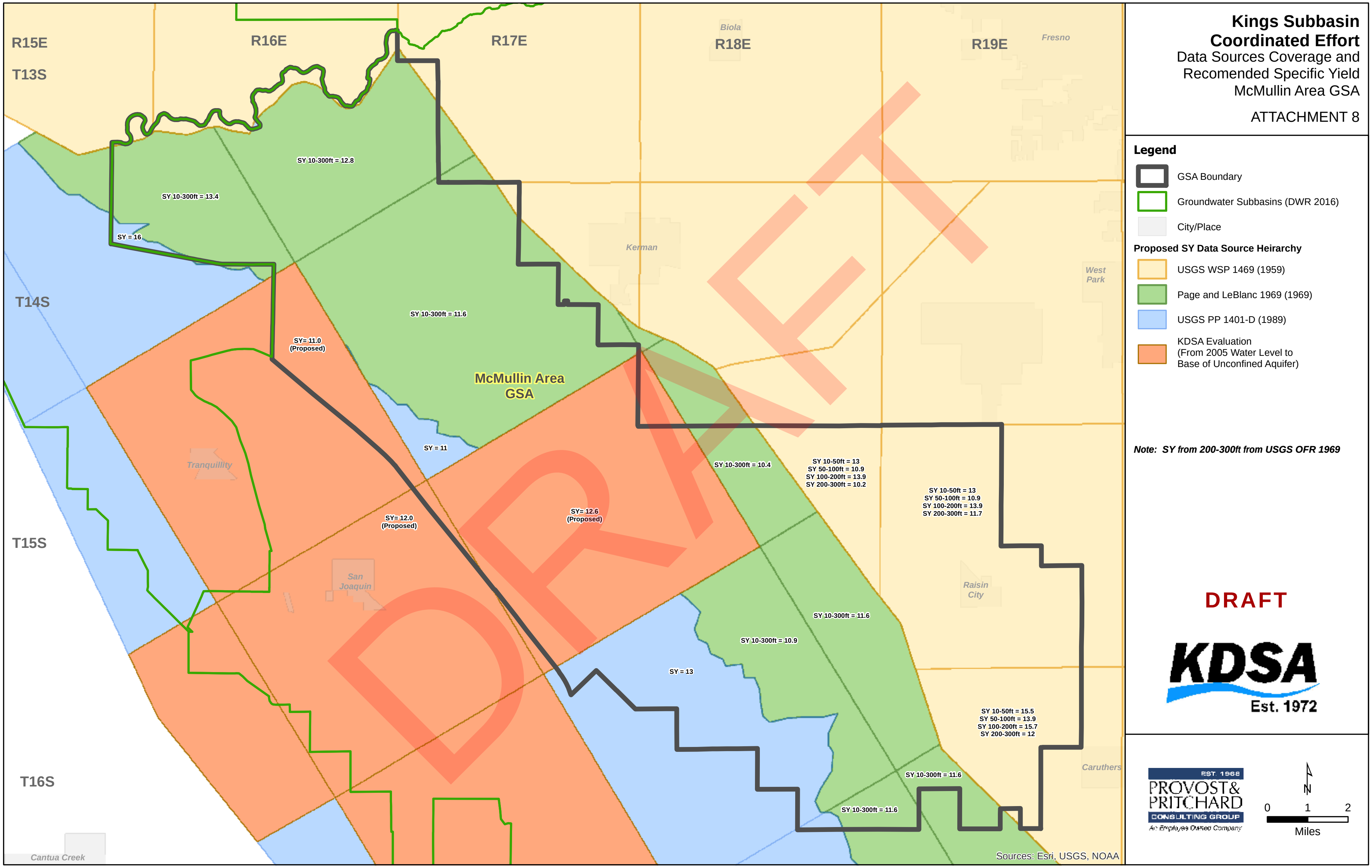
Attachments 8

McMullin Group GSA, Data Sources and Recommended Specific Yield



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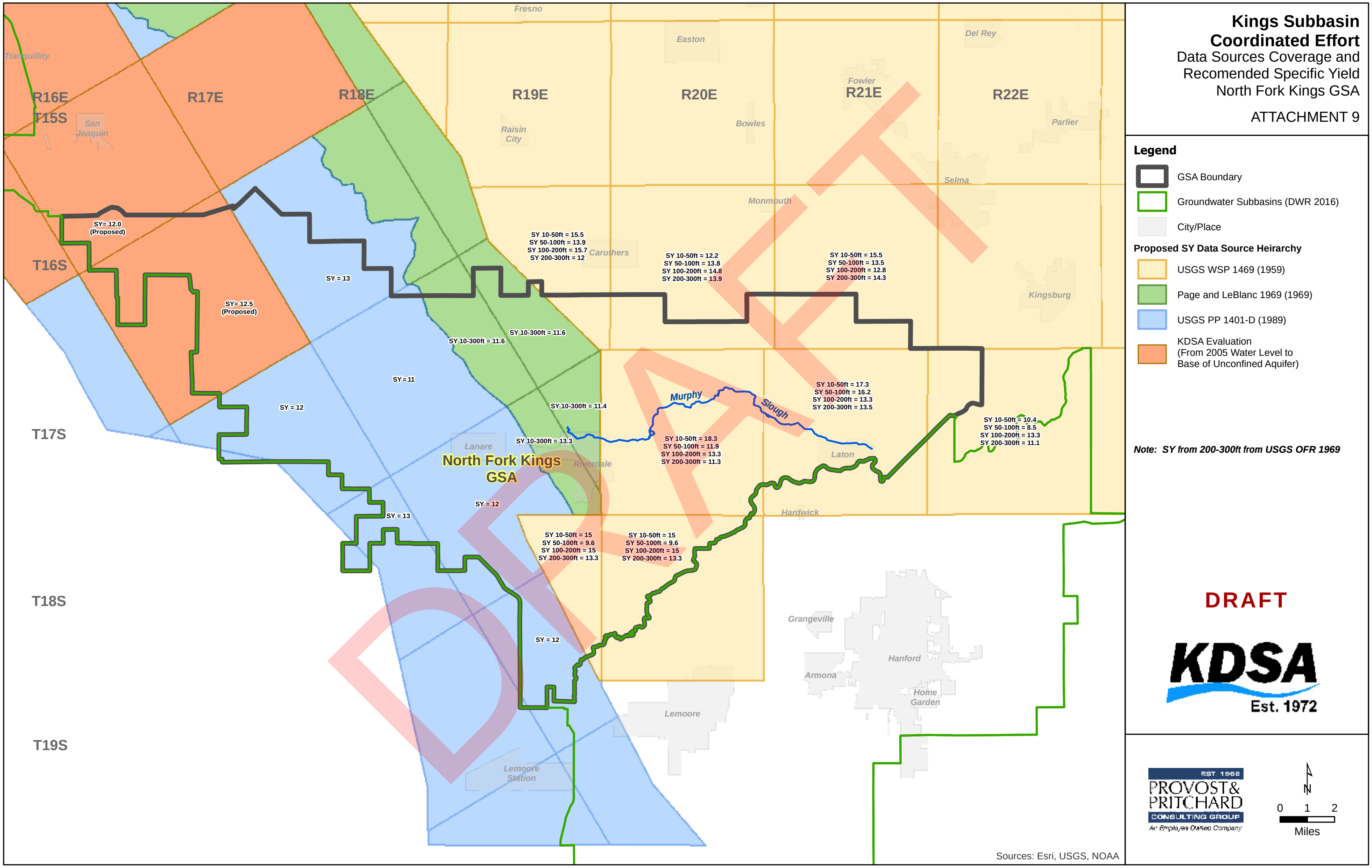
Attachments 9

North Fork Kings GSA, Data Sources and Recommended Specific Yield



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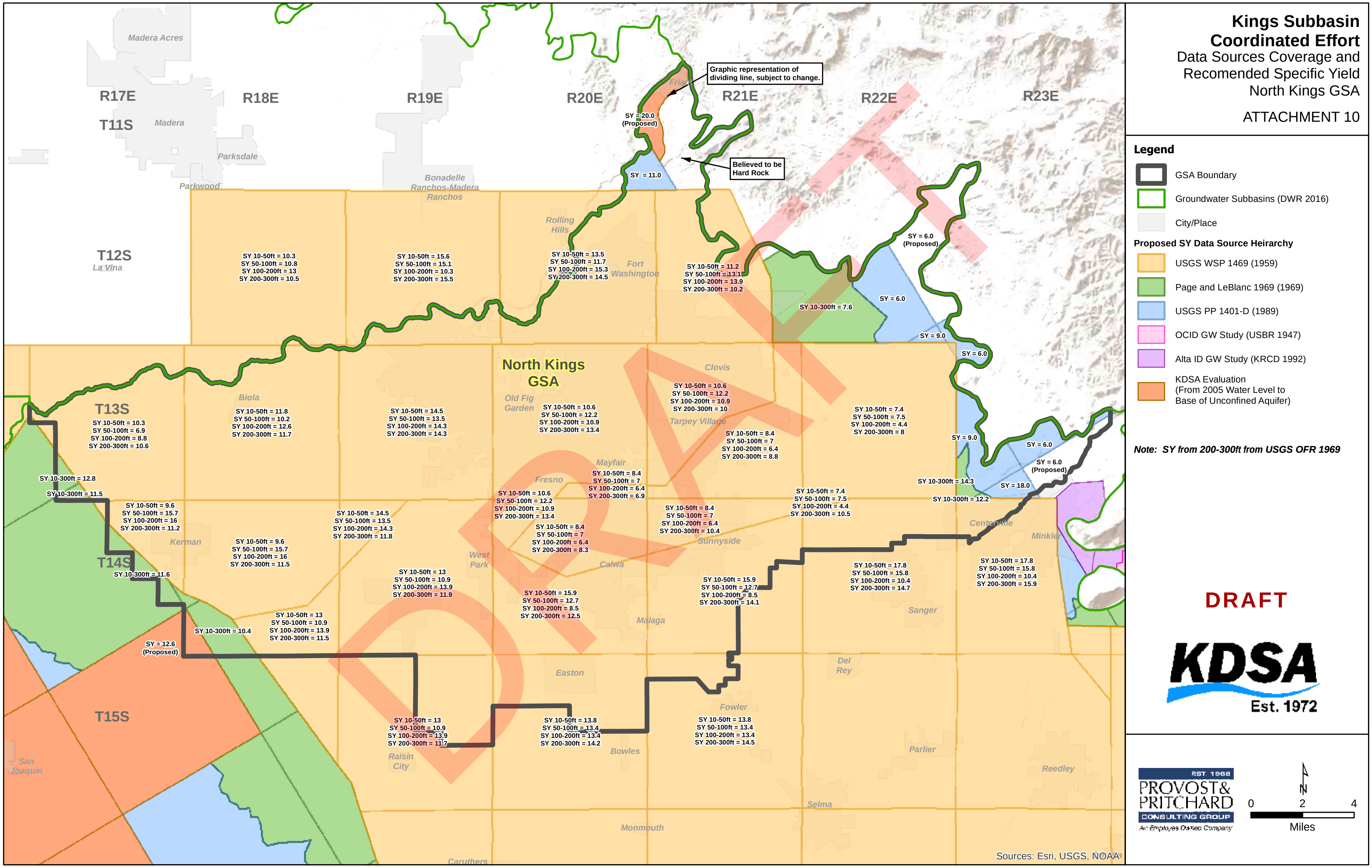
Attachments 10

North Kings GSA, Data Sources and Recommended Specific Yield



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Attachments 11

KDSA, Memorandum on Friant area Specific Yield Estimates

REACH ALONG SAN JOAQUIN RIVER BELOW FRIANT

For the alluvium along the San Joaquin River between Friant and the confluence of Little Dry Creek, a subsurface geologic cross section from a KDSA report of November 2012 on the Beck Ranch was used. This cross section essentially shows three reaches. The upper reach, extending from near Friant to the south end of the Beck Ranch, is predominantly underlain by cobbles and gravel, having an estimated specific yield of 25 percent. The middle reach, extending from the south end of Beck Ranch to the north end of Ball Ranch, is underlain primarily by sand and gravel, with an estimated specific yield of 20 percent. The southernmost reach, along Ball Ranch near and south of Little Dry Creek, is underlain by alternating layers of cobbles and gravel, sand, and clay. The average specific yield of these deposits is 14 percent. Combining the three reaches, the average specific yield in the reach below Friant is 20 percent.

Appendix E

Technical Memorandum No. 4

Technical Memorandum 4
Estimate of Groundwater Storage Change

This Technical Memorandum (TM) summarizes the process used to estimate the groundwater storage change within the unconfined aquifer of the Kings Subbasin. This TM utilizes the information presented in TMs 1, 2 and 3. Storage change in the confined aquifer or above the A-Clay is not calculated in this TM. It is also critical to note that this estimation does not include an estimate of boundary flow as that is covered in a separate TM.

Water Level Data and Contour Maps

TM3 recommended evaluating the range of years from Spring 1997 to Spring 2012 as the hydrologic base period of average conditions. Well water level readings were requested from the GSA representatives, and data from DWR's well data library was collected. Well construction information was not evaluated at this time. The following table lists the well water level data sources:

Alta Irrigation District	Fresno Irrigation District
Kings River Water District	Consolidated Irrigation District
Orange Cove Irrigation District	Kings River Conservation District
Laguna Irrigation District	California Department of Water Resources
James Irrigation District	Kaweah Delta Water Conservation District

Water surface elevation contour maps were generated for Spring 1997 and Spring 2012 based on the available water level data. A total of more than 900 wells were evaluated. Well locations and water levels were plotted on the Kings Subbasin map. Well water level elevations that appeared inconsistent with the majority of other wells in an area were not used. Wells with significantly different water levels may be pumping from the confined aquifer below the Corcoran Clay. In some locations where a well reading was significantly different than other wells in the immediate vicinity, it was discarded because it was believed that these readings were erroneous or anomalous. Elevation of water in well contours were generated utilizing ArcGIS software and reviewed and edited for consistency. If ground surface elevations were provided with the water level data, those elevations were used to generate the water surface elevation. For wells that did not have ground or measuring point elevations, the ground surface from the State's Digital Elevation Model was used.

At the time of this memo, spring data in the unconfined aquifer outside the western boundary within the Westlands Water District (WWD) was limited. There was also limited data in the western portion of the North Fork Kings GSA for the Spring of 1997.

A copy of the Spring 1997 and Spring 2012 water level contours for the entire Kings Subbasin are included in Attachment 1 to this Technical Memorandum. Water level readings for each of the wells used in the contour generation are included in Attachment 2.

Storage Change Calculation Method

Technical Memorandum 2 identified the specific yield values to be used in the storage change calculation, and the unique specific yield areas are shown in the Attachments to TM2. Specific yield values also vary by depth and TM2 describes unique values at depth zones from 0'-50', 50'-100', 100'-200' and 200'-300'. The storage change was estimated based on the water above 300' below the groundwater surface.

The process for estimating the groundwater storage change for the range of years being evaluated included the following steps:

1. The final wells selected for the water surface elevation review were used to create depth to water surfaces. The depth to water contour maps are included as Attachment 3.
2. Using the depth to water surfaces, the average depth value was determined for each unique Specific Yield area. The average depth was determined using ArcGIS Spatial Analyst.
3. For each Specific Yield area, the average depth to water of that area was used to determine the height of water within each specific yield depth zone.
4. The height of water in each depth zone was multiplied by the specific yield for that depth zone and then by the total acreage within that Specific Yield area. Specific Yield values were zeroed and storage volume not calculated for areas below base of unconfined aquifer.
5. Values for each depth zone were added to determine Specific Yield area total.
6. The Specific Yield area totals for each GSA area were added to determine the GSA total for that year.
7. Steps 1 through 6 were repeated for the ending year being considered.
8. The total volume determined for the starting year was subtracted from the total volume determined for the ending year to determine the total change in volume between the two years.
9. The difference between the two years was divided by the number of years in the range to estimate the average annual storage change per year.

Attachment 4 is a table showing the values used in the storage change estimation. The table is sorted by unique Specific Yield area and shows the average depth to water used for that area, along with the total volume calculated for the two years considered, and the difference between the total for the two years considered. Refer to the figures in Attachment 4 of TM2 for a map of the location of the unique Specific Yield areas within each GSA.

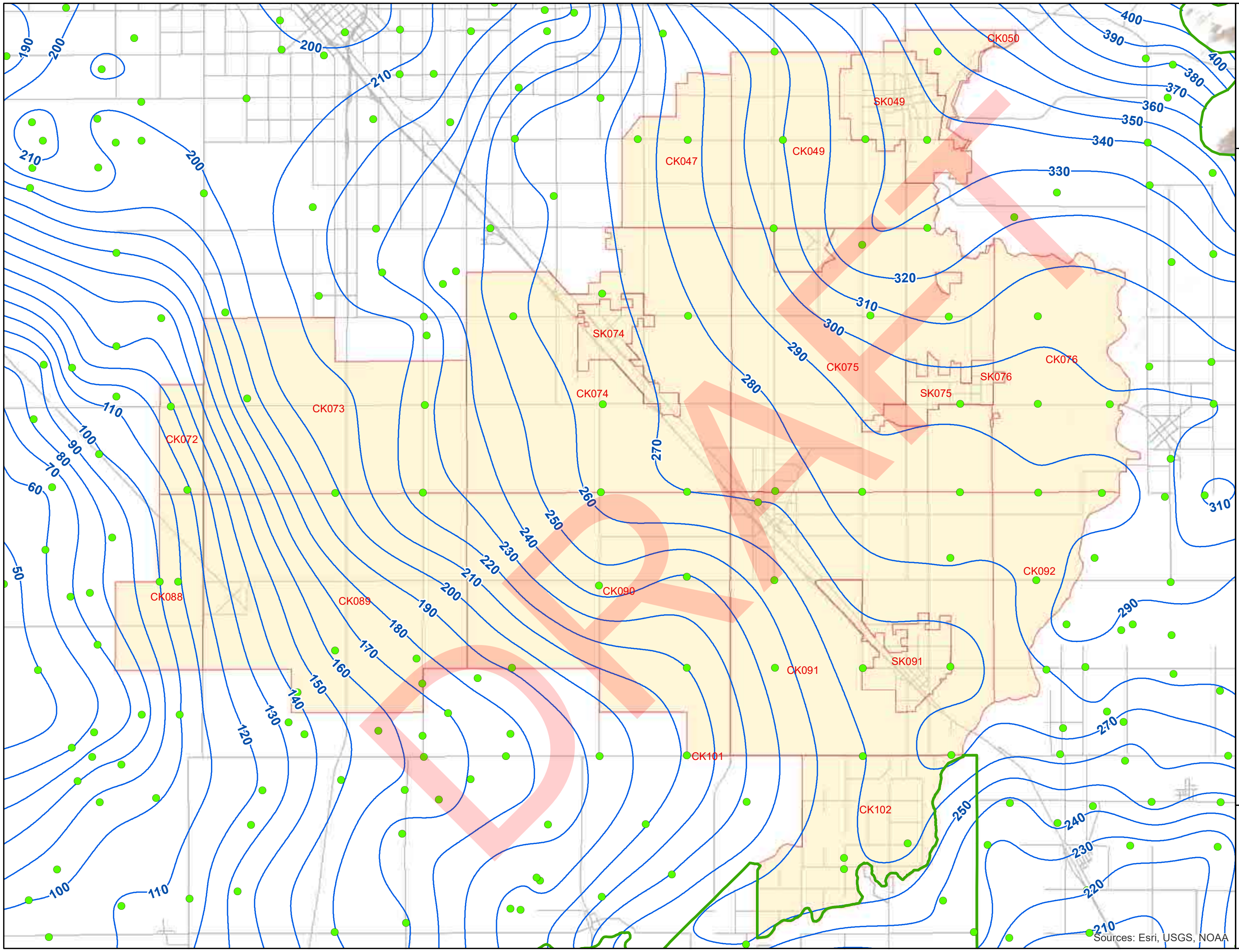
Results of Initial Estimation

The calculated storage change for the entire basin from Spring 1997 to Spring 2012 was calculated to be approximately 1,827,000AF. Dividing that by the 15-year base period, the average annual change was estimated to be approximately 122,000AF/yr. The table below shows the total storage change by year per GSA for the Spring 1997 to Spring 2012 base period with values rounded to the nearest thousand acre-feet.

GSA	Estimated Storage Change per Year Spr 1997 to Spr 2012 (WY 96/97-10/11)
Central/South	-17,000
James	-5,000
Kings River East	-11,000
McMullin	-16,000
North Fork Kings	-49,000
North Kings	-24,000
Total	-122,000

Attachment 1

Elevation of Water in Wells Contour Maps



Kings Subbasin
Coordinated Effort

Central Kings GSA

Spring 1997 - Water Level Elevations
(feet above mean sea level)

Legend

Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

KDSA
Est. 1972

EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company

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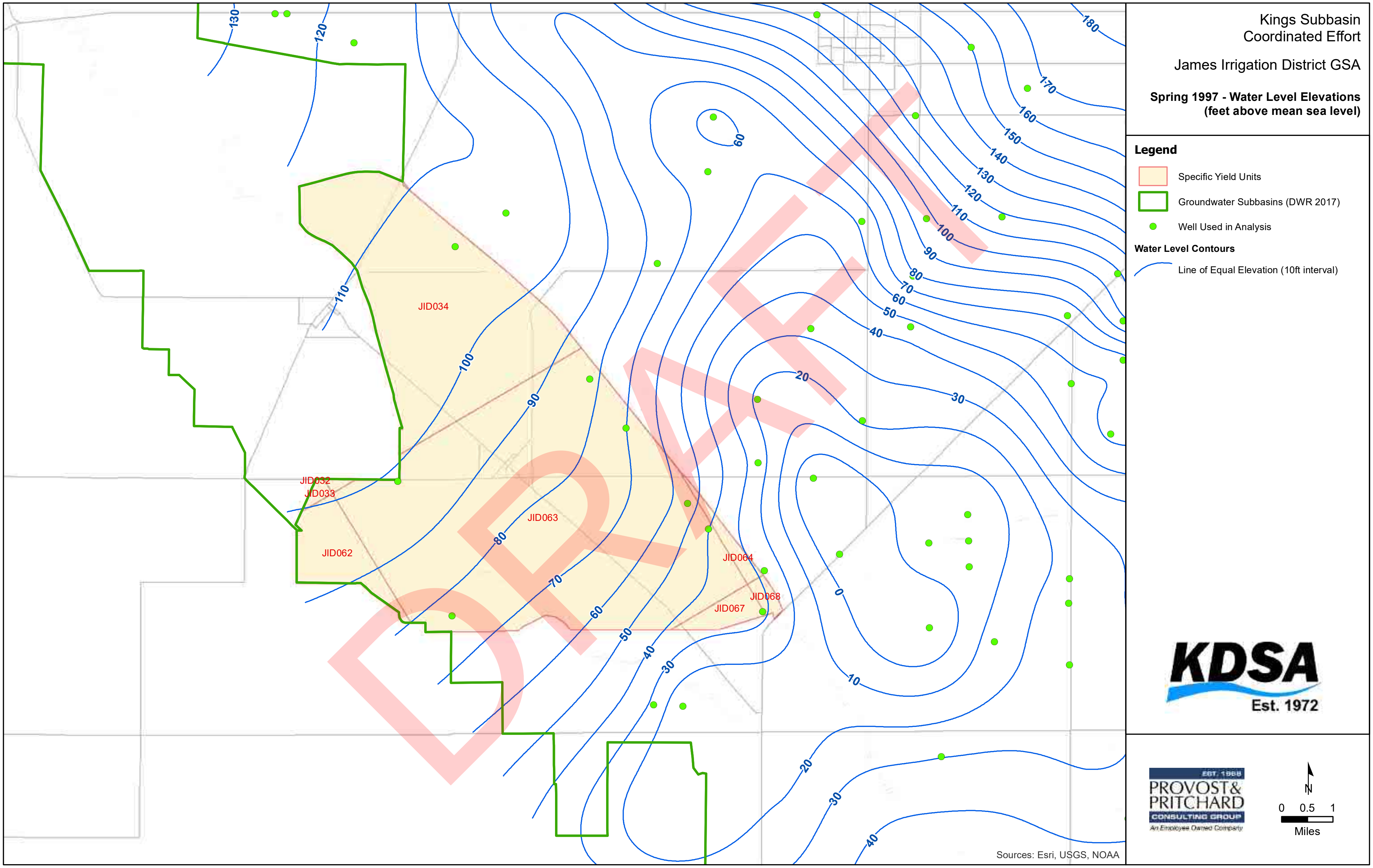

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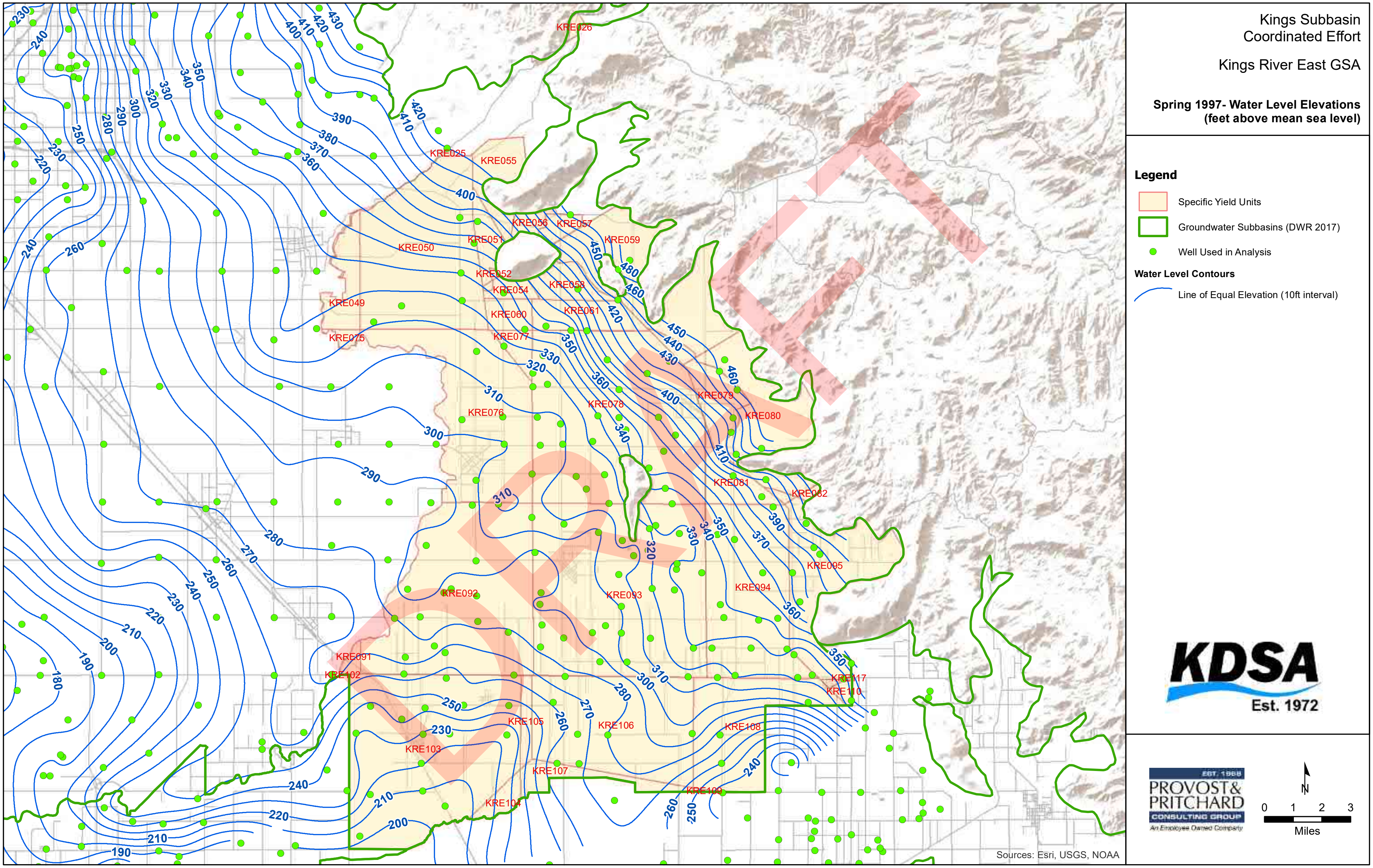

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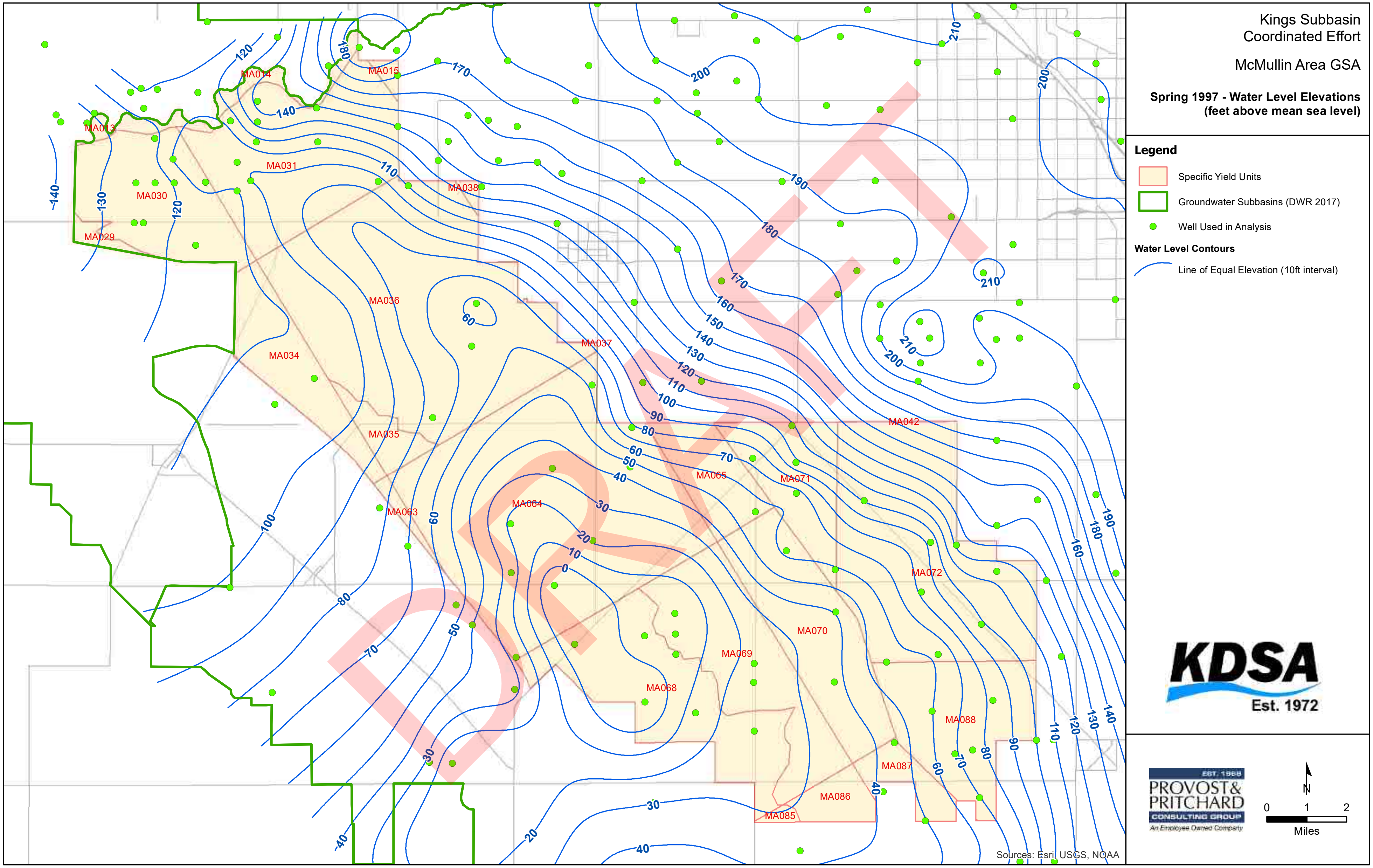

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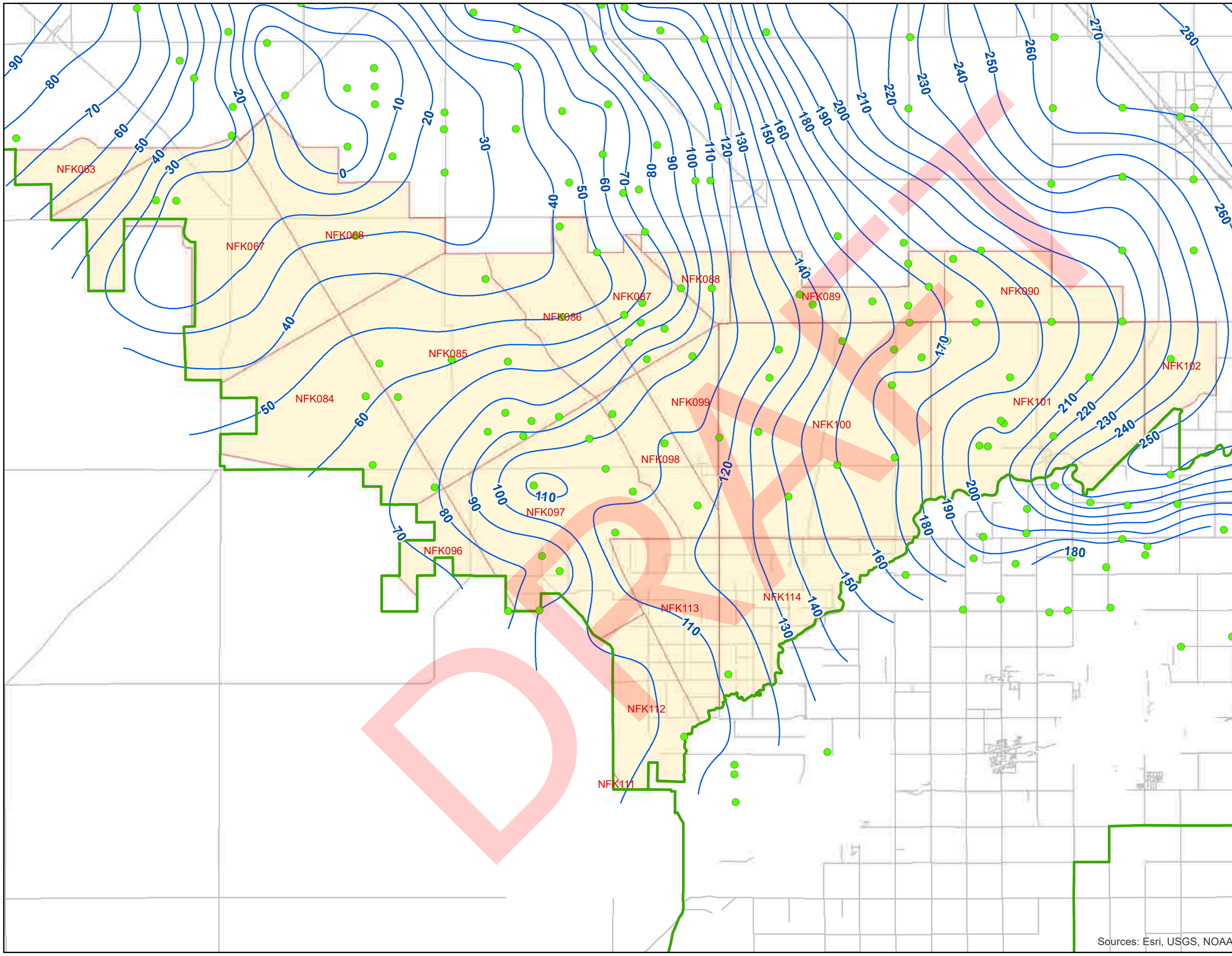

Kings Subbasin
Coordinated Effort

North Fork Kings GSA

Spring 1997 - Water Level Elevations
(feet above mean sea level)

Legend

Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

KDSA
Est. 1972

EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company

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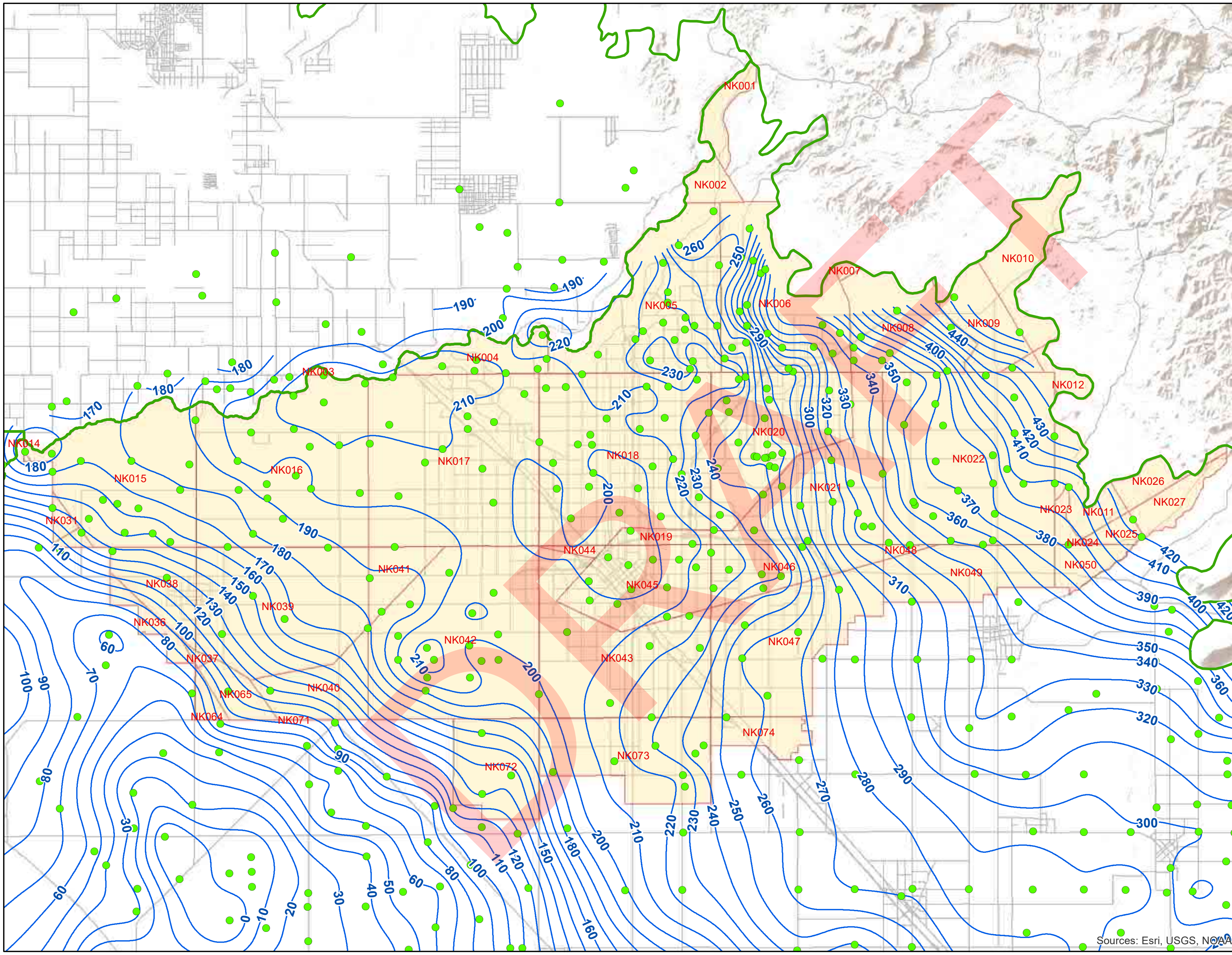

Kings Subbasin
Coordinated Effort

North Kings GSA

Spring 1997 - Water Level Elevations (feet above mean sea level)

Legend

Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

KDSA Est. 1972

PROVOST & PRITCHARD CONSULTING GROUP EST. 1968 An Employee Owned Company

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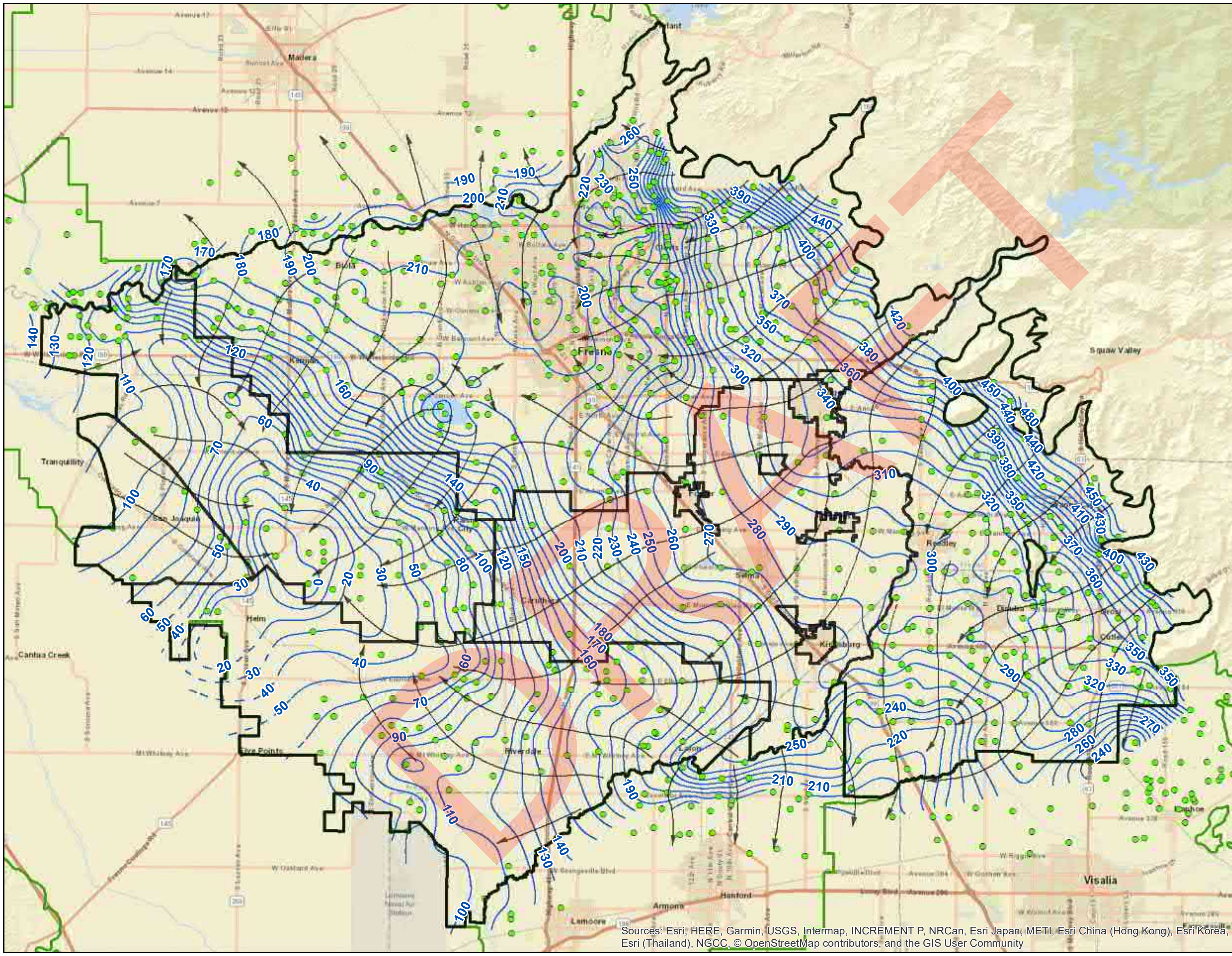

Kings Subbasin Coordinated Effort

Kings Coordinated Effort GSAs

Spring 1997 - Water Level Elevations (feet above mean sea level)

Legend

Kings Coordinated Effort GSAs

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

Direction of Groundwater Flow

KDSA Est. 1972

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Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

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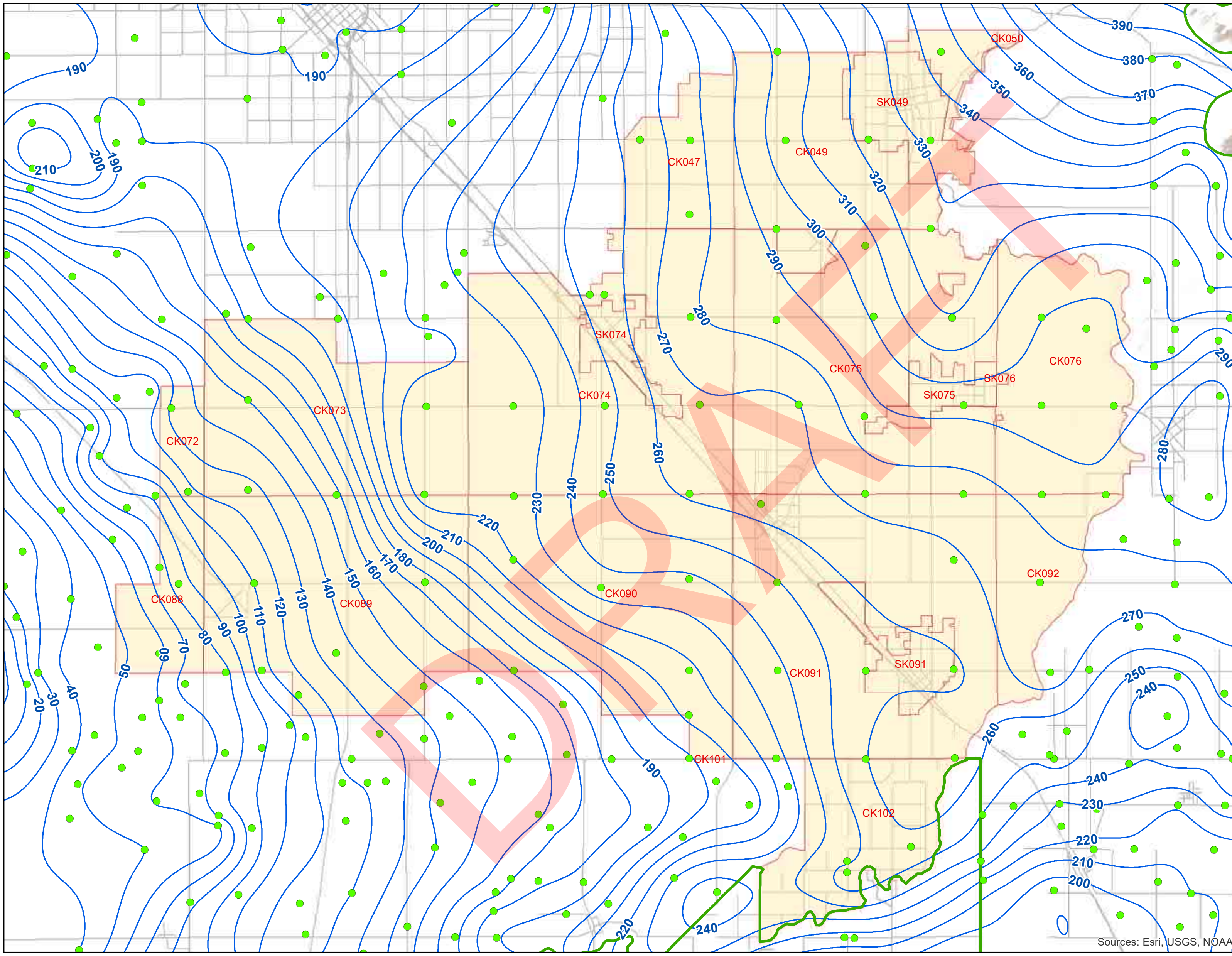
Kings Subbasin
Coordinated Effort

Central Kings GSA

Spring 2012 - Water Level Elevations
(feet above mean sea level)



Legend

Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

KDSA
Est. 1972

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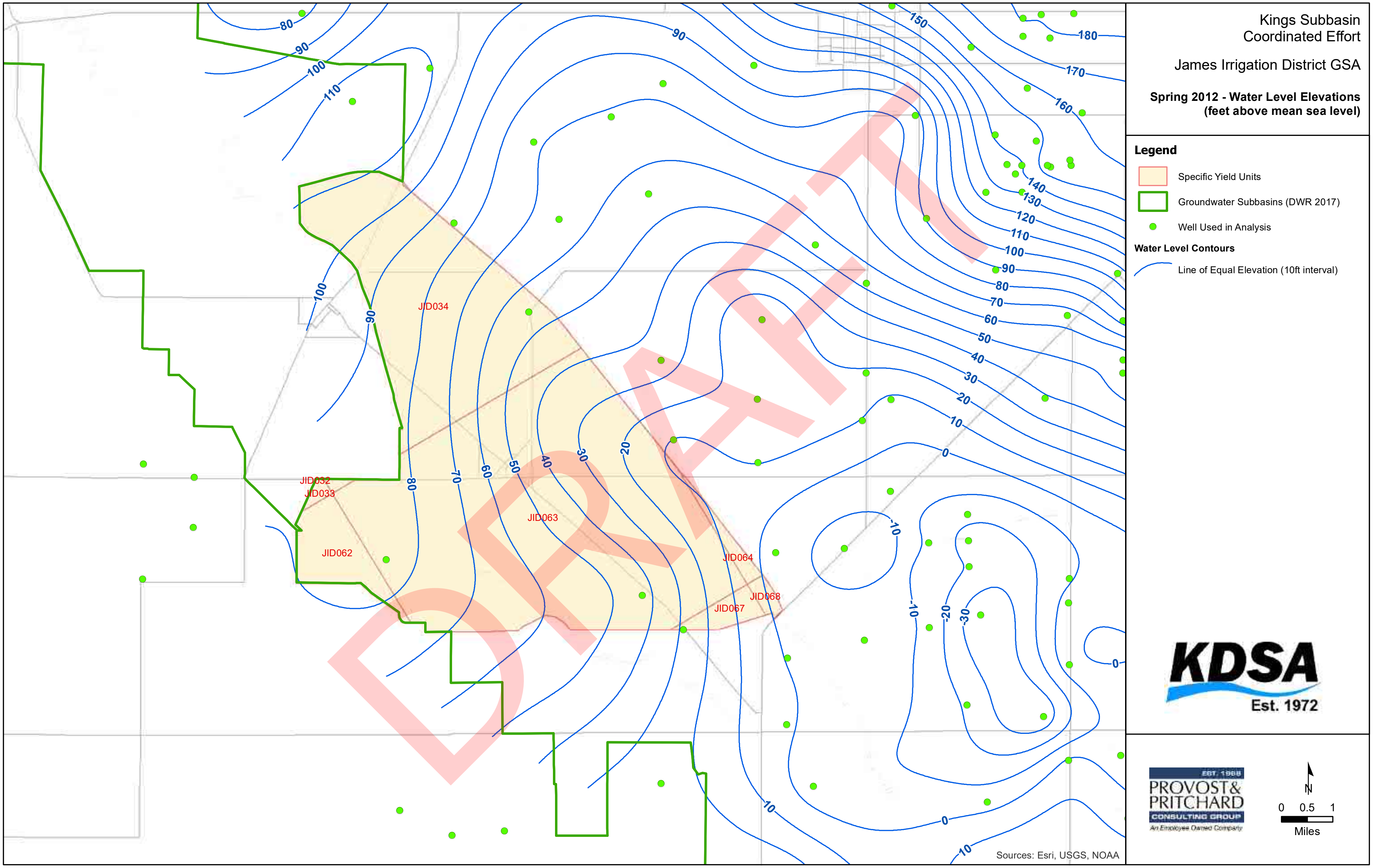

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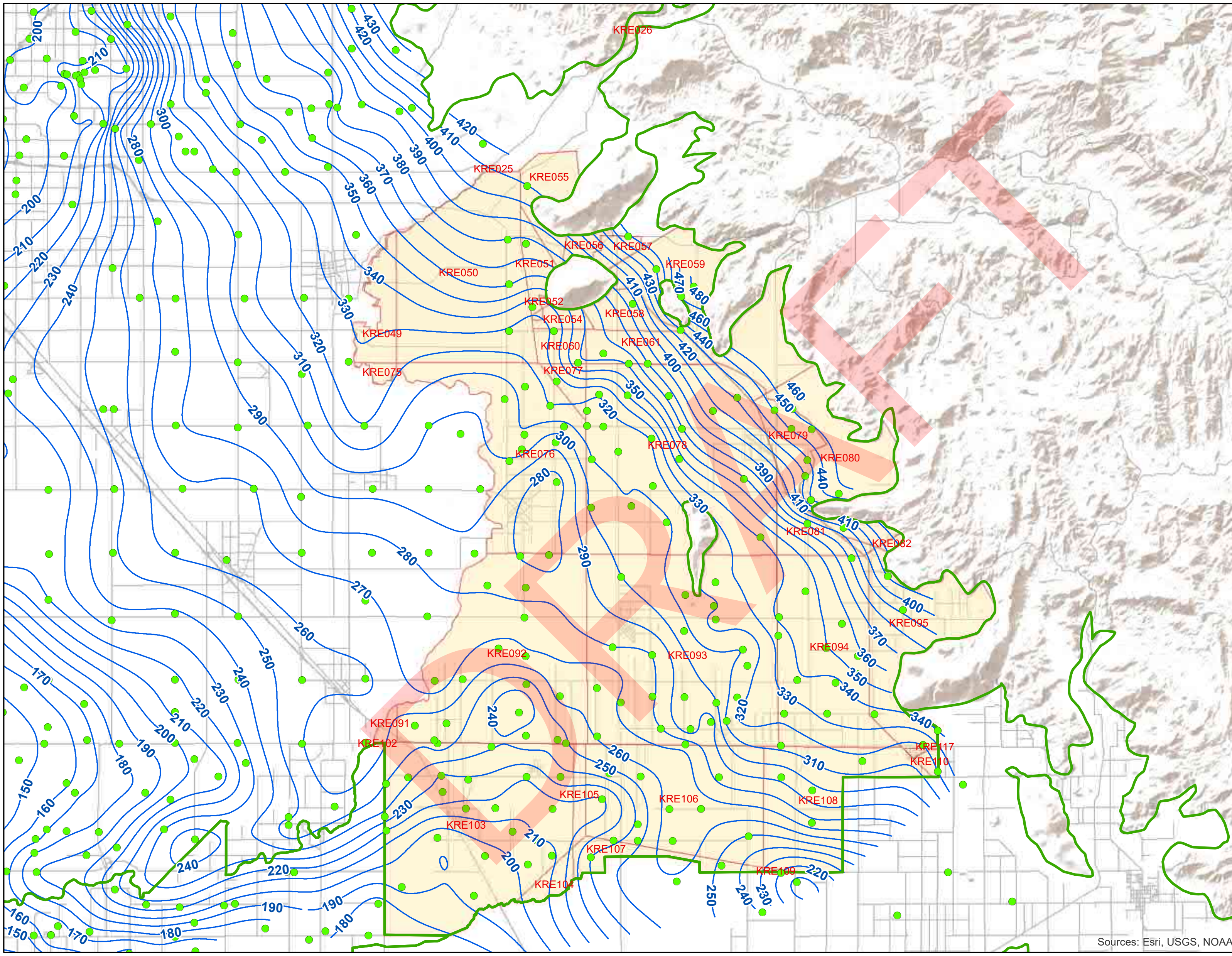
Kings Subbasin
Coordinated Effort

Kings River East GSA

Spring 2012 - Water Level Elevations
(feet above mean sea level)



Legend

Specific Yield Units
Groundwater Subbasins (DWR 2017)
Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

KDSA
Est. 1972

EST. 1968
PROVOST & PRITCHARD
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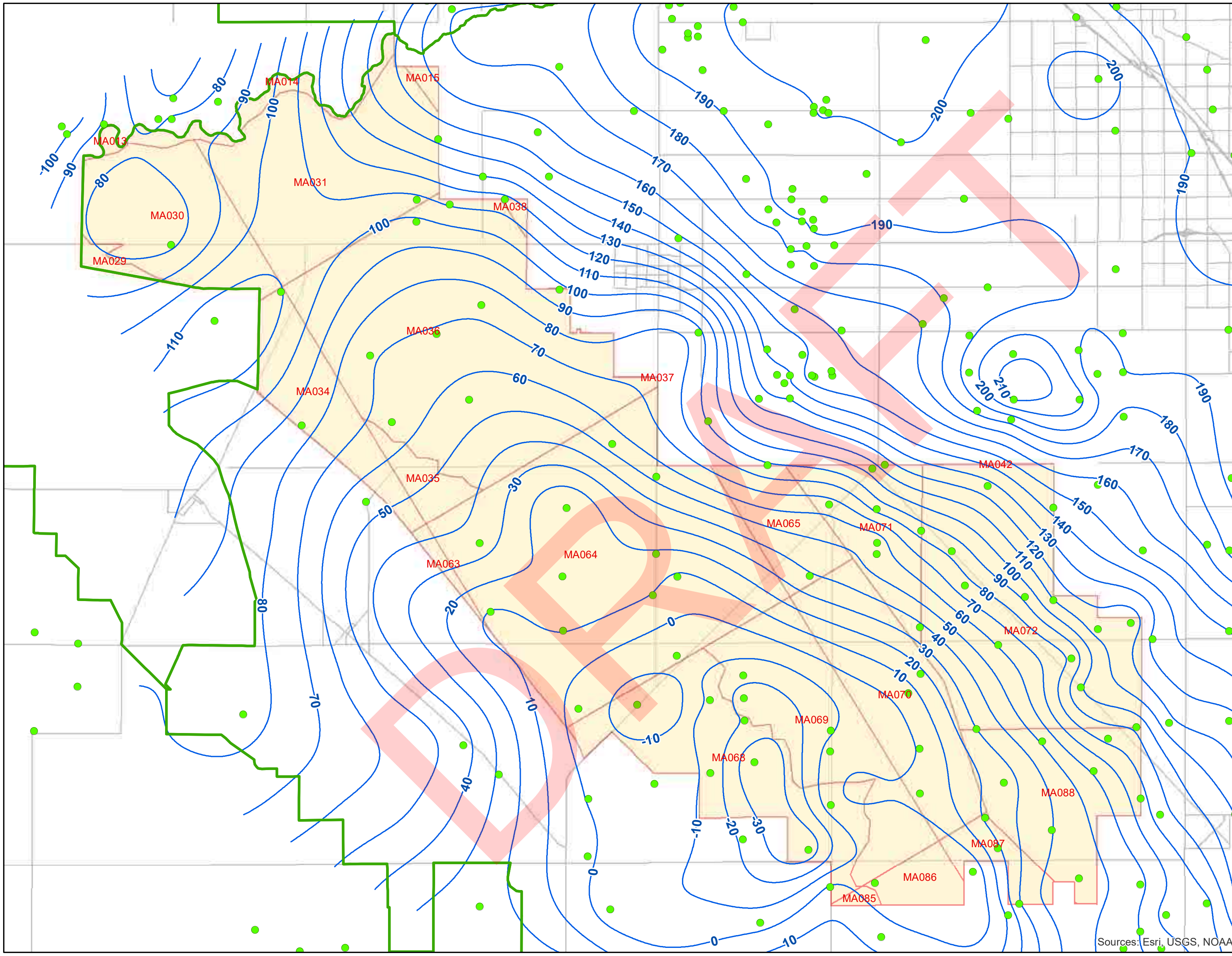
Kings Subbasin
Coordinated Effort

McMullin Area GSA

Spring 2012 - Water Level Elevations
(feet above mean sea level)



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Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

KDSA
Est. 1972

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CONSULTING GROUP
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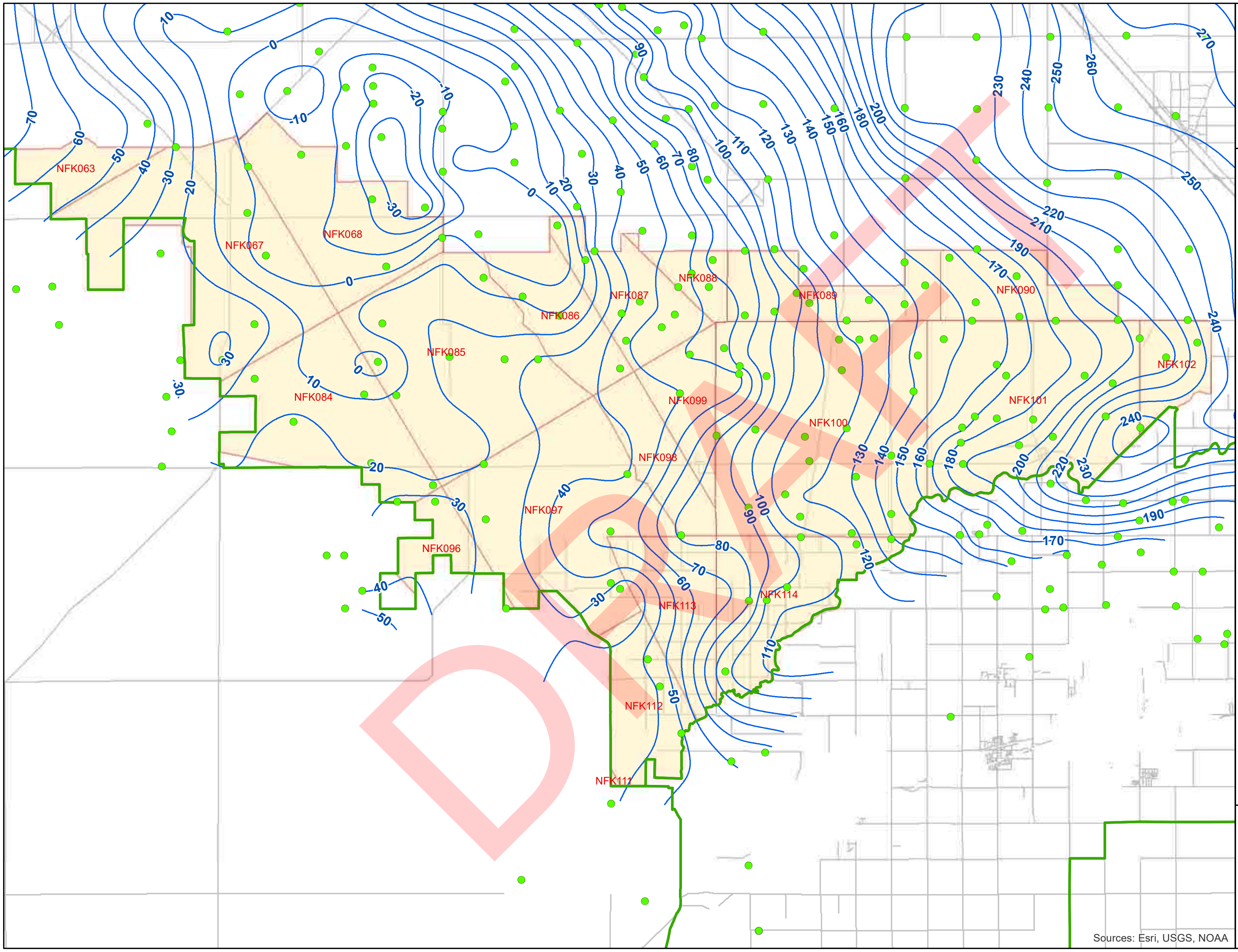

Kings Subbasin
Coordinated Effort

North Fork Kings GSA

Spring 2012 - Water Level Elevations
(feet above mean sea level)

Legend

Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

KDSA Est. 1972

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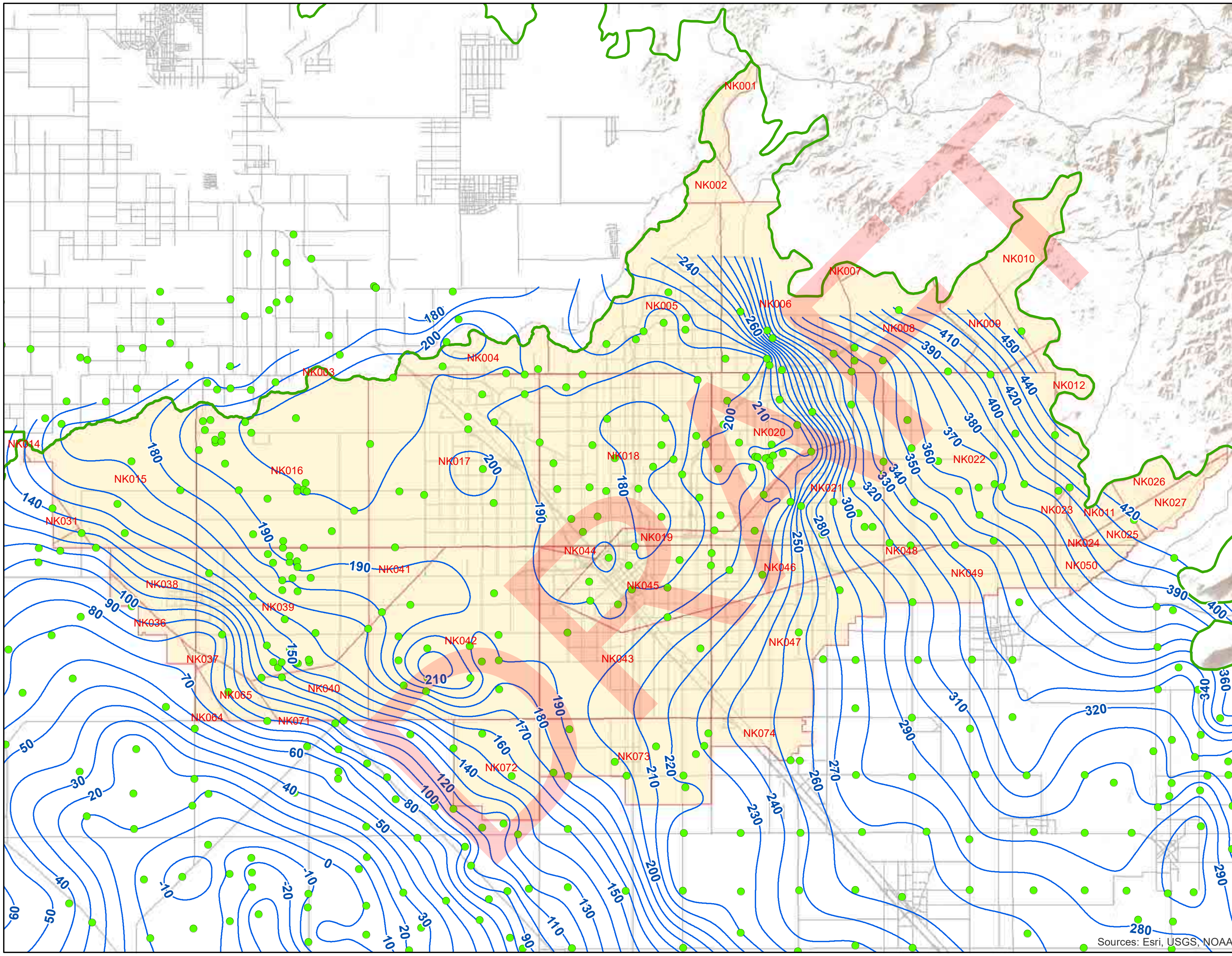

Kings Subbasin
Coordinated Effort

North Kings GSA

Spring 2012 - Water Level Elevations
(feet above mean sea level)

Legend

Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

KDSA
Est. 1972

EST. 1968
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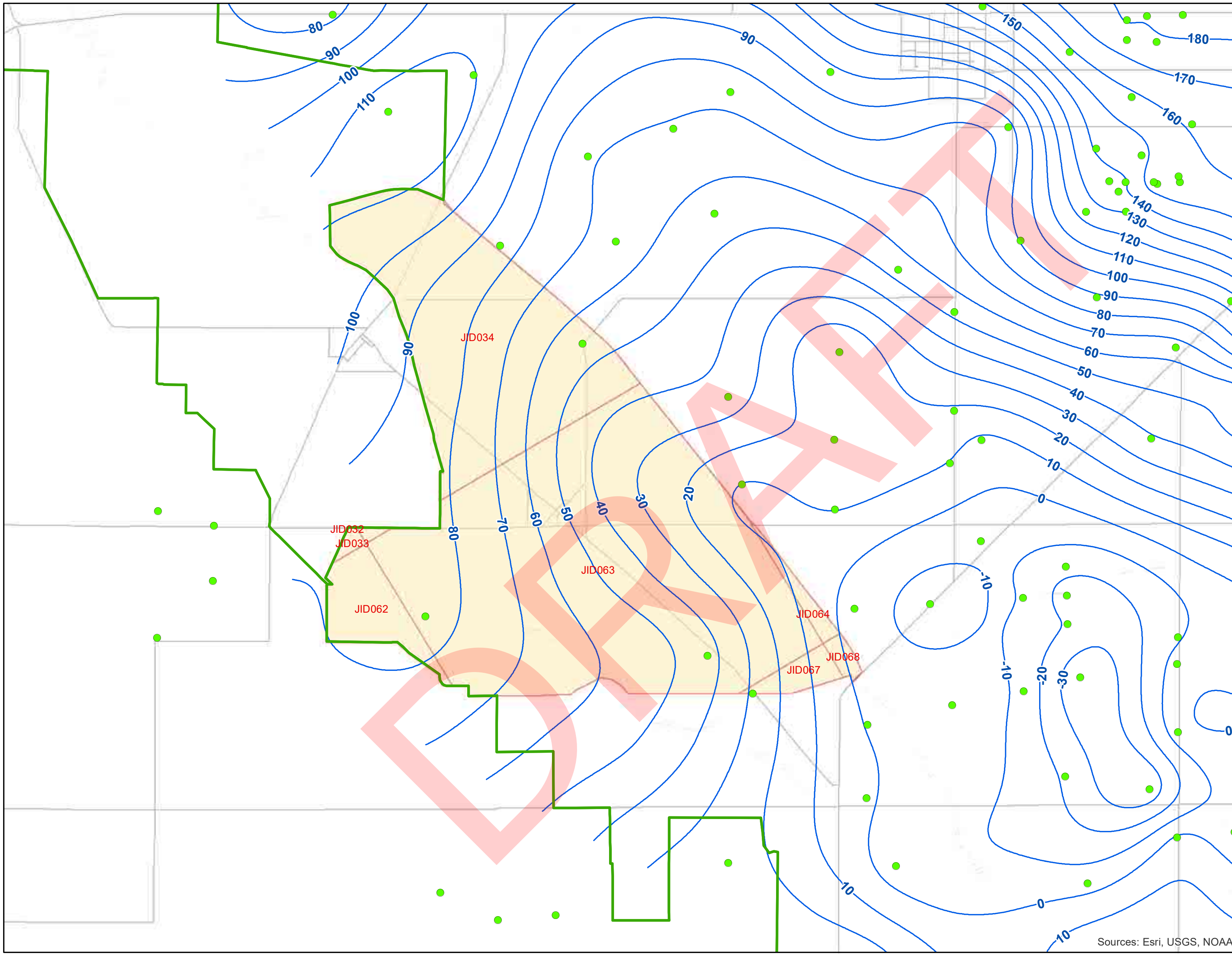

Kings Subbasin
Coordinated Effort

James Irrigation District GSA

Spring 2012 - Water Level Elevations
(feet above mean sea level)

Legend

Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

KDSA
Est. 1972

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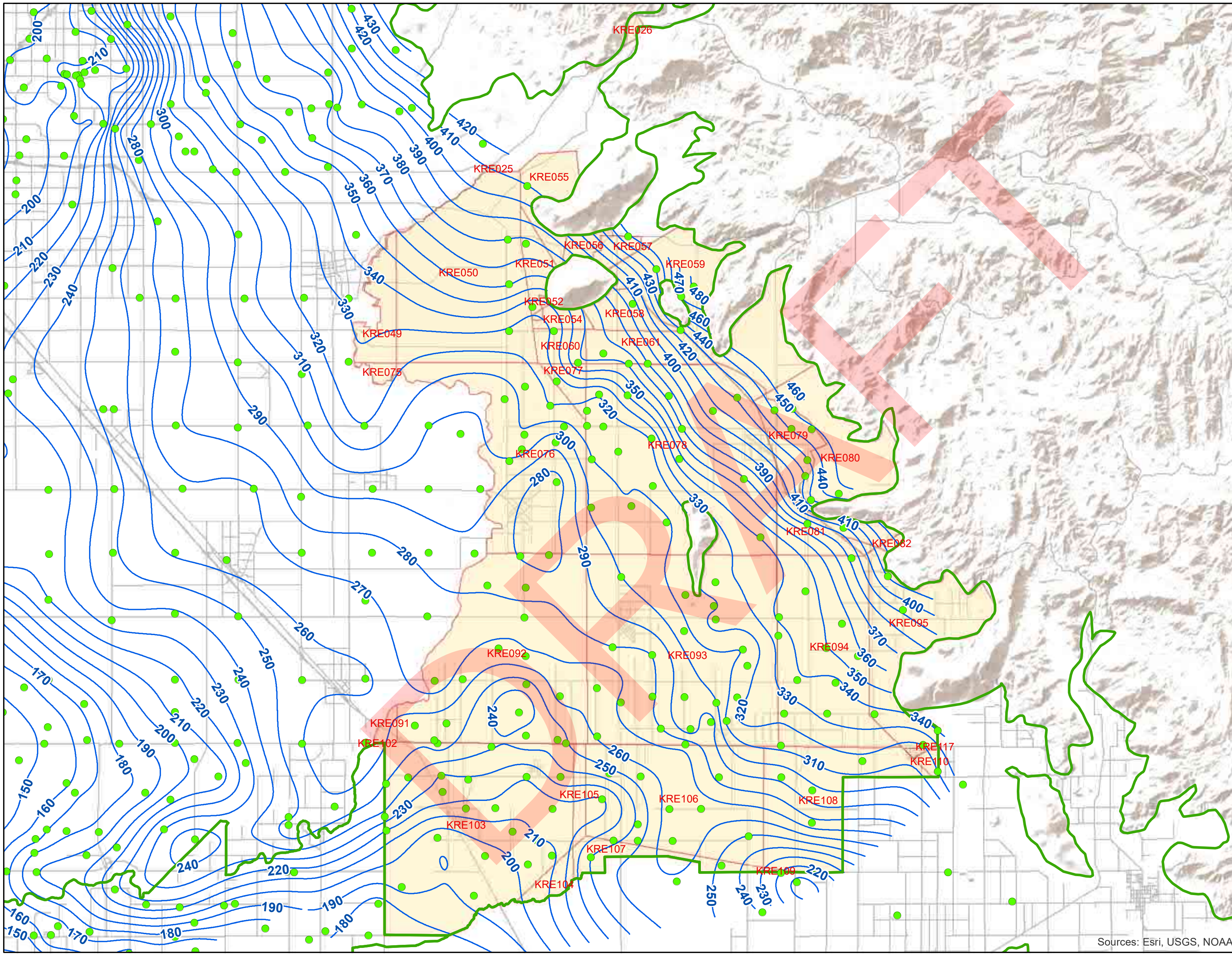

Kings Subbasin
Coordinated Effort

Kings River East GSA

Spring 2012 - Water Level Elevations
(feet above mean sea level)

Legend

Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

KDSA
Est. 1972

EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
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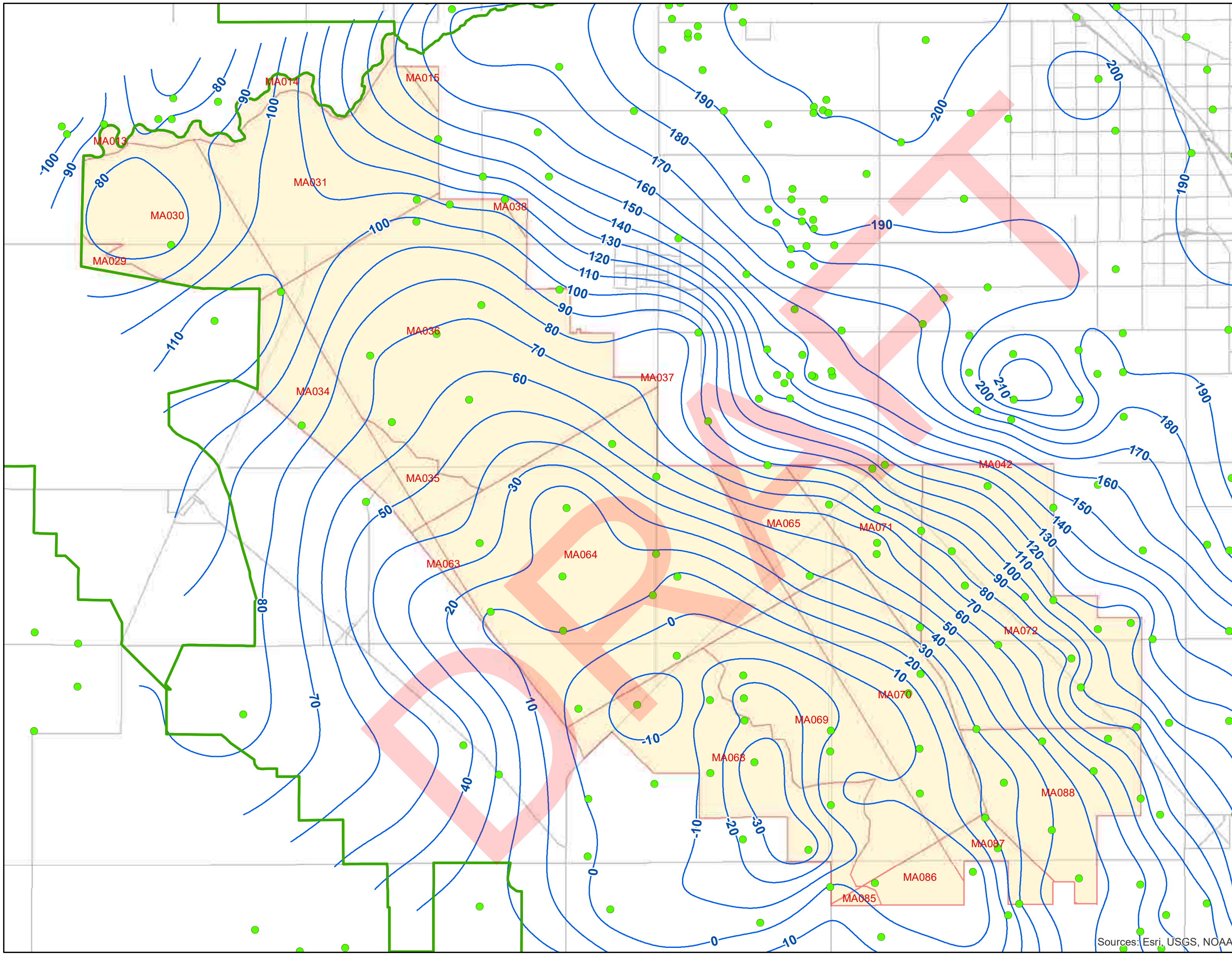
Kings Subbasin
Coordinated Effort

McMullin Area GSA

Spring 2012 - Water Level Elevations
(feet above mean sea level)



Legend

Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

KDSA
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EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
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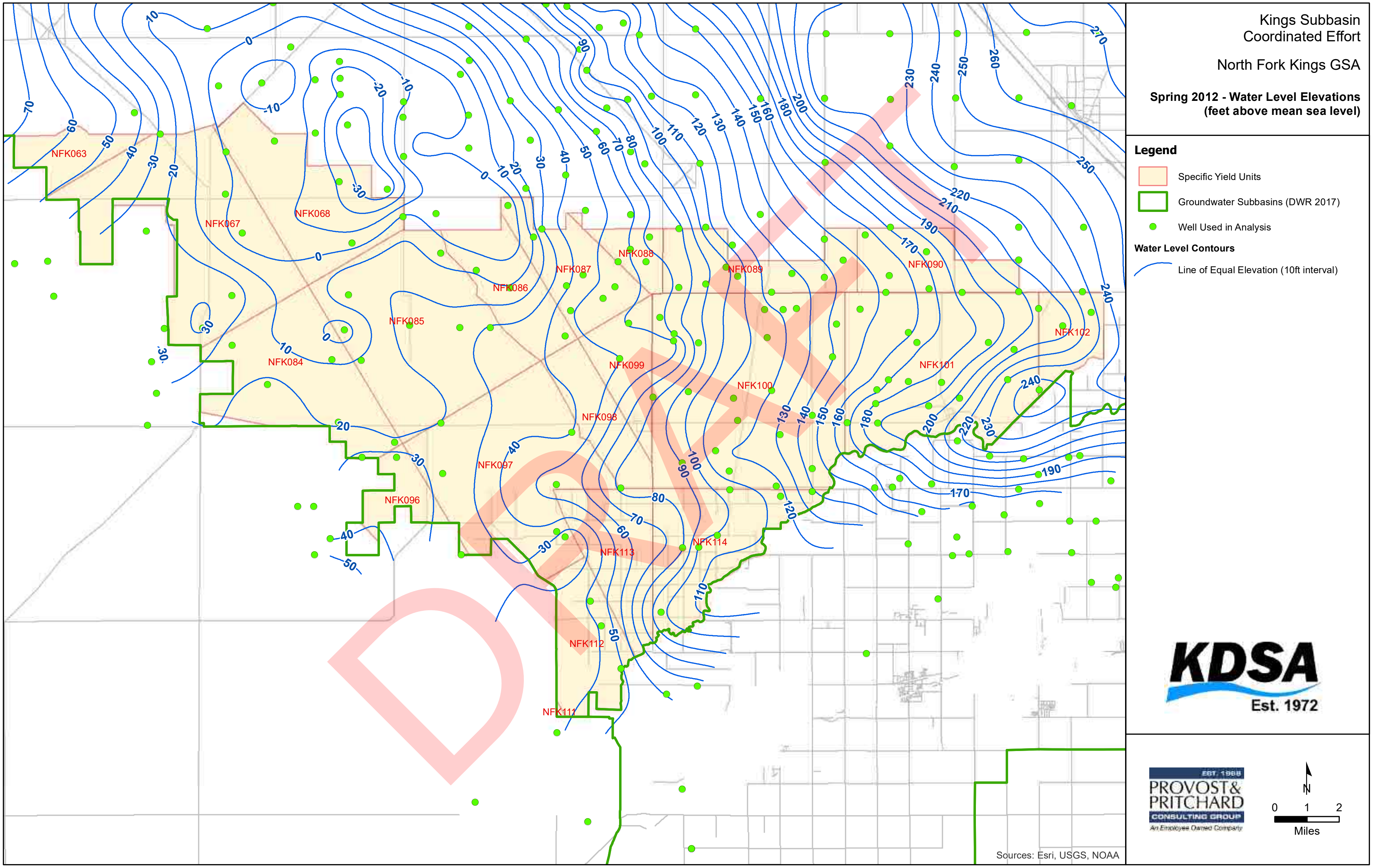

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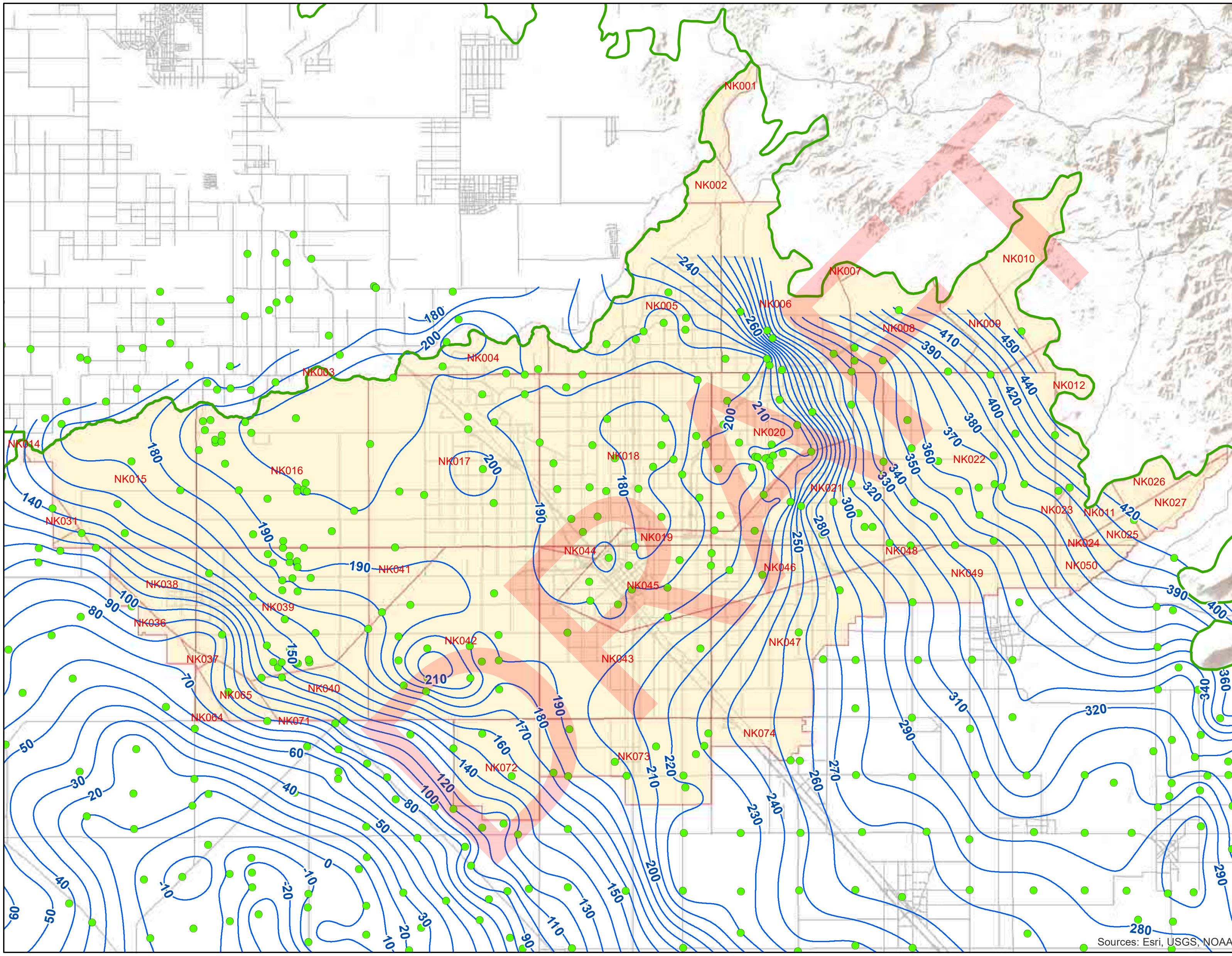
Kings Subbasin
Coordinated Effort

North Kings GSA

Spring 2012 - Water Level Elevations
(feet above mean sea level)



Legend

Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

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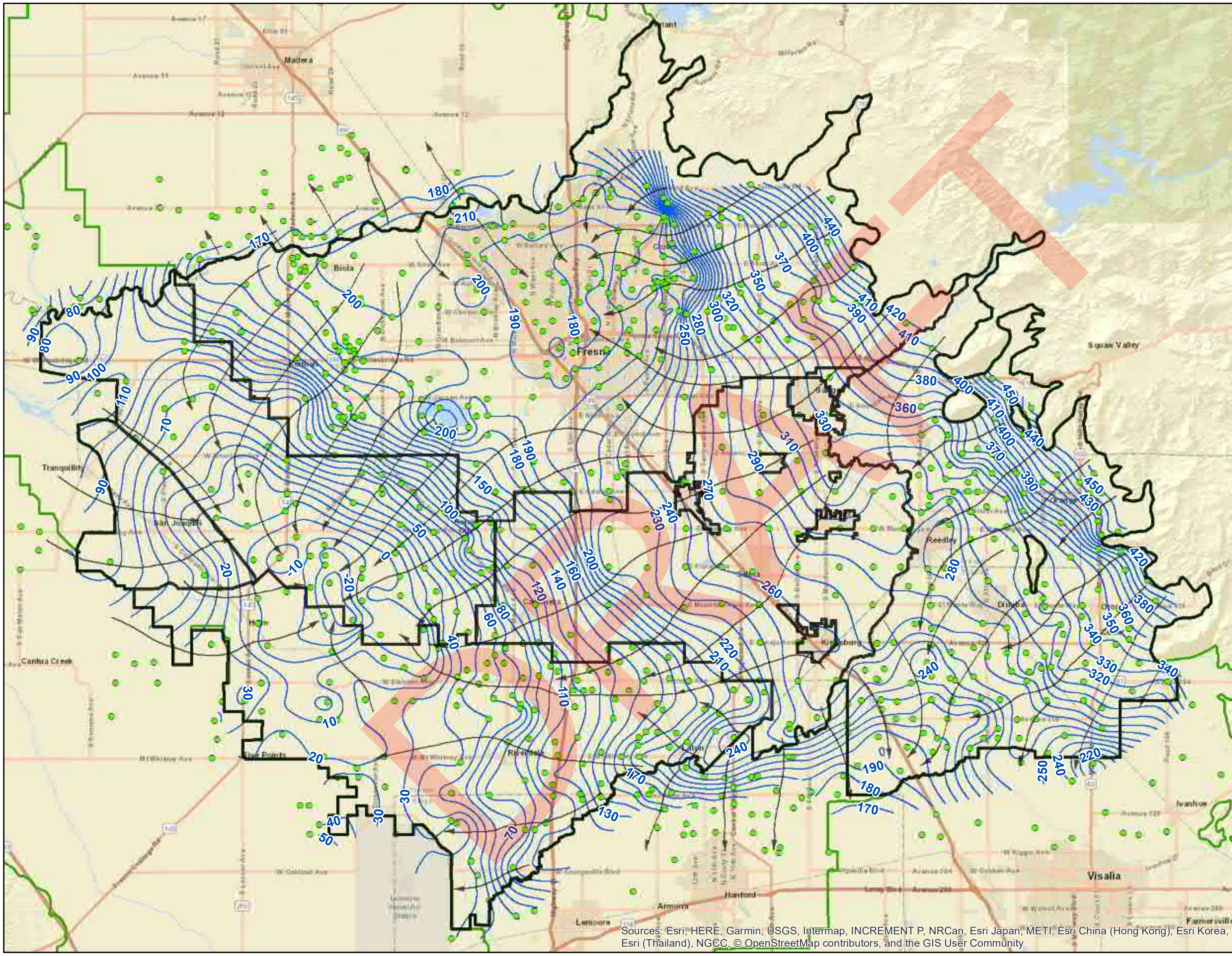

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2012 - Water Level Elevations (feet above mean sea level)

Legend

Kings Coordinated Effort GSAs

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

Direction of Groundwater Flow

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KDSA Est. 1972

PROVOST & PRITCHARD CONSULTING GROUP, EST. 1968, An Employee Owned Company

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Attachment 2

Well Water Level Data used in Contour Maps

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
CK047	CID	Central Kings GSA	CID05	T14S R21E 25	329.4	42.8	53.5	286.6	275.9
CK047	CID	Central Kings GSA	CID04	T14S R21E 27	322.0	46.0	57.3	276.0	264.7
CK047	CID	Central Kings GSA	CID15	T14S R21E 36	326.6		51.5		275.1
CK049	DWR	Central Kings GSA	367211N1195432W001	T14S R22E 14	376.8		28.7		348.1
CK049	CID	Central Kings GSA	CID09	T14S R22E 14	374.4	26.8	29.6	347.6	344.8
CK049	DWR	Central Kings GSA	366922N1196110W001	T14S R22E 29	345.0		36.5		308.5
CK049	CID	Central Kings GSA	CID06	T14S R22E 29	342.4	32.5	36.6	309.9	305.8
CK049	CID	Central Kings GSA	CID13	T15S R22E 02	352.4	24.7	24.7	327.7	327.7
CK072	DWR	Central Kings GSA	366052N1198624W001	T15S R19E 25	248.0		113.5		134.5
CK072	CID	Central Kings GSA	CID71	T15S R19E 25	246.0	117.0	114.5	129.0	131.5
CK072	DWR	Central Kings GSA	365774N1198516W001	T15S R19E 36	245.6	127.0	129.1	118.6	116.5
CK073	CID	Central Kings GSA	CID73	T15S R20E 08	261.5	80.0	80.0	181.5	181.5
CK073	CID	Central Kings GSA	CID74	T15S R20E 20	253.8	70.1	103.7	183.7	150.1
CK073	DWR	Central Kings GSA	366049N1197543W001	T15S R20E 24	277.4		76.3		201.1
CK073	CID	Central Kings GSA	CID78	T15S R20E 25	275.2	47.8	47.8	227.4	227.4
CK073	CID	Central Kings GSA	CID69	T15S R20E 32	248.2		121.8		126.4
CK073	CID	Central Kings GSA	CID67	T16S R20E 01	266.4	42.2	42.2	224.2	224.2
CK074	DWR	Central Kings GSA	366344N1197177W001	T15S R21E 08	294.8	37.5		257.3	
CK074	FID	Central Kings GSA	15S21E10M001MX	T15S R21E 10	305.7	38.9	51.0	266.8	254.7
CK074	CID	Central Kings GSA	CID16	T15S R21E 12	318.8	40.3	40.3	278.5	278.5
CK074	DWR	Central Kings GSA	366053N1196788W001	T15S R21E 22	302.5		53.6		248.9
CK074	CID	Central Kings GSA	CID01	T15S R21E 24	303.0		34.7		268.3
CK074	CID	Central Kings GSA	CID81	T15S R21E 27	301.5	37.5	55.1	264.0	246.4
CK074	CID	Central Kings GSA	CID79	T15S R21E 30	286.4	59.1	62.7	227.3	223.7
CK074	DWR	Central Kings GSA	365761N1197188W001	T15S R21E 31	283.7		55.6		228.1
CK075	CID	Central Kings GSA	CID12	T15S R22E 03	341.0	13.4	34.7	327.6	306.3
CK075	CID	Central Kings GSA	CID14	T15S R22E 06	334.0	31.4	41.0	302.6	293.0
CK075	CID	Central Kings GSA	CID19	T15S R22E 14	347.3	35.7	28.0	311.6	319.3
CK075	CID	Central Kings GSA	CID18	T15S R22E 15	338.3	31.8	37.2	306.6	301.1
CK075	DWR	Central Kings GSA	366339N1196096W001	T15S R22E 17	329.0		44.3		284.7
CK075	CID	Central Kings GSA	CID17	T15S R22E 18	329.7		45.0		284.7
CK075	CID	Central Kings GSA	CID26	T15S R22E 20	309.3		39.3		270.0
CK075	CID	Central Kings GSA	CID25	T15S R22E 28	327.3		41.7		285.6
CK075	DWR	Central Kings GSA	365764N1196104W001	T16S R22E 05	311.6	40.0		271.6	
CK076	DWR	Central Kings GSA	366339N1195027W001	T15S R23E 17	358.7		54.8		303.9
CK076	CID	Central Kings GSA	CID21	T15S R23E 17	359.0		61.2		297.8
CK076	CID	Central Kings GSA	CID20	T15S R23E 18	355.9	53.1	55.6	302.9	300.3
CK076	CID	Central Kings GSA	CID22	T15S R23E 21	346.1	47.2	51.9	298.9	294.2
CK076	DWR	Central Kings GSA	366044N1194732W001	T15S R23E 28	347.1		50.4		296.7
CK076	CID	Central Kings GSA	CID23	T15S R23E 29	341.6	45.7	45.7	295.9	295.9
CK088	CID	Central Kings GSA	CID70	T16S R19E 01	242.5	102.2	138.0	140.3	104.5
CK088	DWR	Central Kings GSA	365471N1198554W001	T16S R19E 13	237.7	129.0	153.0	108.7	84.7
CK088	CID	Central Kings GSA	CID55	T16S R19E 13	234.0	134.0	134.0	100.0	100.0
CK088	CID	Central Kings GSA	CID54	T16S R19E 24	215.7		158.0		57.7
CK089	CID	Central Kings GSA	CID68	T16S R20E 04	260.6	62.1	103.0	198.5	157.6
CK089	CID	Central Kings GSA	CID58	T16S R20E 12	264.8	87.8	89.9	177.1	174.9
CK089	CID	Central Kings GSA	CID56	T16S R20E 17	248.4	132.4	138.0	116.0	110.4
CK089	CID	Central Kings GSA	CID50	T16S R20E 20	240.0		135.1		104.9
CK089	CID	Central Kings GSA	CID49	T16S R20E 21	256.7	94.4	121.8	162.3	134.9
CK089	DWR	Central Kings GSA	365216N1197577W001	T16S R20E 23	257.5	80.1		177.4	
CK089	CID	Central Kings GSA	CID48	T16S R20E 23	237.5	78.5	107.7	159.0	129.8
CK089	DWR	Central Kings GSA	365132N1197554W001	T16S R20E 26	254.7	82.4	107.4	172.3	147.3
CK089	DWR	Central Kings GSA	365105N1198066W001	T16S R20E 28	243.9	102.3	131.5	141.6	112.4
CK090	CID	Central Kings GSA	CID64	T16S R21E 01	307.4	37.5	46.2	269.9	261.2
CK090	CID	Central Kings GSA	CID65	T16S R21E 03	295.2	32.7	46.7	262.5	248.5
CK090	CID	Central Kings GSA	CID66	T16S R21E 05	281.5		56.6		224.9
CK090	CID	Central Kings GSA	CID59	T16S R21E 07	276.9		57.4		219.5
CK090	DWR	Central Kings GSA	365469N1196471W001	T16S R21E 11	291.0		50.0		241.0
CK090	CID	Central Kings GSA	CID63	T16S R21E 12	288.4	48.9	50.0	239.5	238.4
CK090	CID	Central Kings GSA	CID60	T16S R21E 16	295.2	51.1	61.1	244.1	234.1
CK090	DWR	Central Kings GSA	365183N1197185W001	T16S R21E 19	265.5		92.0		173.5
CK090	CID	Central Kings GSA	CID62	T16S R21E 25	279.2	59.1	61.2	220.1	218.0
CK090	CID	Central Kings GSA	CID47	T16S R21E 29	263.4	72.1	92.0	191.2	171.4
CK091	CID	Central Kings GSA	CID29	T16S R22E 01	324.2	43.3	48.5	280.9	275.7
CK091	CID	Central Kings GSA	CID28	T16S R22E 04	317.2	29.8	43.9	287.4	273.3
CK091	CID	Central Kings GSA	CID27	T16S R22E 06	308.0	38.1	45.0	269.9	263.0
CK091	DWR	Central Kings GSA	365500N1195400W001	T16S R22E 11	316.5		43.2		273.3
CK091	CID	Central Kings GSA	CID35	T16S R22E 12	314.2	33.4	45.2	280.7	269.0

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
CK091	CID	Central Kings GSA	CID38	T16S R22E 18	297.2	40.9	47.6	256.3	249.6
CK091	CID	Central Kings GSA	CID34	T16S R22E 24	296.8	31.7	38.0	265.1	258.8
CK091	CID	Central Kings GSA	CID39	T16S R22E 29	285.2	40.2	47.1	245.0	238.1
CK091	CID	Central Kings GSA	CID43	T16S R22E 31	276.7		50.5		226.2
CK092	CID	Central Kings GSA	CID31	T16S R23E 04	326.6	41.7	39.0	284.9	287.6
CK092	CID	Central Kings GSA	CID30	T16S R23E 05	329.2	40.7	45.9	288.5	283.3
CK092	CID	Central Kings GSA	CID32	T16S R23E 18	317.6	34.9	41.0	282.7	276.6
CK102	CID	Central Kings GSA	CID41	T16S R22E 36	290.0	17.6	24.2	272.4	265.8
CK102	CID	Central Kings GSA	CID42	T17S R22E 03	284.6	25.2	25.2	259.4	259.4
CK102	DWR	Central Kings GSA	364600N1195568W001	T17S R22E 11	285.7	23.0	29.2	262.7	256.5
CK102	DWR	Central Kings GSA	364517N1195829W001	T17S R22E 16	278.7	20.5	24.4	258.2	254.3
CK102	DWR	Central Kings GSA	364553N1195829W001	T17S R22E 16	278.7	21.0	30.2	257.7	248.5
JID034	DWR	JID	366685N1202060W001	T14S R16E 35	168.5	62.3		106.2	
JID034	DWR	JID	366502N1201782W001	T15S R16E 01	167.8		113.5		54.3
JID063	DWR	JID	366022N1202260W003	T15S R16E 28	171.1	72.5		98.6	
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JID063	JID	JID	15S17E20C001MX	T15S R17E 20	176.0	105.8	121.0	70.2	55.0
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JID067	KRCD	JID	B02	T16S R17E 09	178.6		150.0		28.6
KRE050	DWR	Kings River East GSA	367144N1194477W001	T14S R23E 15	395.6		9.7		385.9
KRE050	DWR	Kings River East GSA	367186N1194574W001	T14S R23E 15	394.6	9.9		384.7	
KRE050	AID	Kings River East GSA	B014A	T14S R23E 15	394.7		15.0		379.7
KRE050	DWR	Kings River East GSA	367056N1194485W001	T14S R23E 22	382.6	17.4		365.2	
KRE050	AID	Kings River East GSA	B015A	T14S R23E 22	382.5		22.1		360.5
KRE050	DWR	Kings River East GSA	366908N1194568W001	T14S R23E 27	366.0	25.4		340.6	
KRE050	DWR	Kings River East GSA	366664N1195118W001	T14S R23E 31	335.6	14.5		321.1	
KRE050	DWR	Kings River East GSA	366744N1194943W001	T14S R23E 32	337.6	12.5		325.1	
KRE050	DWR	Kings River East GSA	366767N1194568W001	T14S R23E 34	361.6	30.7		330.9	
KRE050	AID	Kings River East GSA	H020A	T14S R23E 34	361.5	30.7	33.1	330.8	328.4
KRE051	AID	Kings River East GSA	B013A	T14S R23E 14	414.7		11.1		403.6
KRE051	AID	Kings River East GSA	B013B	T14S R23E 14	390.7	11.2	14.0	379.5	376.7
KRE051	AID	Kings River East GSA	B018A	T14S R23E 26	364.5		30.1		334.4
KRE054	DWR	Kings River East GSA	366806N1194302W001	T14S R23E 25	397.6	51.8		345.8	
KRE055	AID	Kings River East GSA	B009A	T14S R23E 02	418.6		9.1		409.5
KRE057	OCID	Kings River East GSA	14S24E17C001MX	T14S R24E 17	462.8	2.2	15.2	460.6	447.6
KRE058	OCID	Kings River East GSA	14S24E28R001MX	T14S R24E 28	436.2	5.4	7.2	430.8	429.0
KRE058	OCID	Kings River East GSA	14S24E29C001MX	T14S R24E 29	432.0	41.0	36.5	391.0	395.5
KRE058	OCID	Kings River East GSA	14S24E29K001MX	T14S R24E 29	430.4	28.7	23.1	401.7	407.3
KRE059	OCID	Kings River East GSA	14S24E21D001MX	T14S R24E 21	450.2	0.3	9.2	449.9	441.0
KRE059	OCID	Kings River East GSA	14S24E21H001MX	T14S R24E 21	464.0		45.2		418.8
KRE059	OCID	Kings River East GSA	14S24E22L001MX	T14S R24E 22	486.8	1.0	5.8	485.8	481.0
KRE059	OCID	Kings River East GSA	14S24E22N001MX	T14S R24E 22	487.8	14.1	17.0	473.7	470.8
KRE059	DWR	Kings River East GSA	366763N1193582W002	T14S R24E 28	435.7		5.1		430.6
KRE060	AID	Kings River East GSA	H021A	T14S R23E 35	397.6		65.0		332.6
KRE060	AID	Kings River East GSA	H021B	T14S R23E 35	383.3		64.1		319.2
KRE060	DWR	Kings River East GSA	366625N1194163W001	T14S R23E 36	393.6	49.4		344.2	
KRE060	AID	Kings River East GSA	H026A	T15S R23E 01	393.7	49.4	37.1	344.3	356.6
KRE061	DWR	Kings River East GSA	366636N1194038W001	T14S R24E 31	397.6	41.9		355.7	
KRE061	AID	Kings River East GSA	B024A	T14S R24E 31	409.4		45.0		364.4
KRE061	DWR	Kings River East GSA	366616N1193874W001	T15S R24E 05	400.6	44.9		355.7	
KRE076	AID	Kings River East GSA	H027A	T15S R23E 02	376.6	59.8	62.1	316.8	314.5
KRE076	DWR	Kings River East GSA	366500N1194600W001	T15S R23E 03	370.5		61.7		308.8
KRE076	AID	Kings River East GSA	H029A	T15S R23E 10	366.8		62.1		304.7
KRE076	AID	Kings River East GSA	H030A	T15S R23E 11	376.6		57.1		319.5
KRE076	DWR	Kings River East GSA	366339N1194132W001	T15S R23E 12	373.6	60.7		312.9	
KRE076	AID	Kings River East GSA	H031B	T15S R23E 12	376.6	60.7	60.1	315.9	316.6
KRE076	AID	Kings River East GSA	H032A	T15S R23E 13	371.7		65.0		306.7
KRE076	AID	Kings River East GSA	H033A	T15S R23E 13	360.6		67.1		293.5
KRE076	AID	Kings River East GSA	H034A	T15S R23E 14	366.8		58.0		308.8
KRE076	AID	Kings River East GSA	H034B	T15S R23E 15	360.6		57.1		303.5
KRE076	DWR	Kings River East GSA	366169N1194568W001	T15S R23E 22	356.6	54.9		301.7	

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
KRE076	AID	Kings River East GSA	H035A	T15S R23E 22	356.6		58.1		298.6
KRE076	DWR	Kings River East GSA	366183N1194313W001	T15S R23E 23	360.6	53.9		306.7	
KRE076	DWR	Kings River East GSA	366044N1194304W001	T15S R23E 24	351.7	51.9		299.8	
KRE076	DWR	Kings River East GSA	366075N1194304W001	T15S R23E 24	353.6	55.0		298.6	
KRE076	DWR	Kings River East GSA	366183N1194299W001	T15S R23E 24	359.6	54.5		305.1	
KRE076	AID	Kings River East GSA	I037A	T15S R23E 24	351.7		75.0		276.7
KRE076	DWR	Kings River East GSA	365894N1194132W001	T15S R23E 25	348.6	42.9		305.7	
KRE076	DWR	Kings River East GSA	365864N1194482W001	T15S R23E 35	342.6	43.4		299.2	
KRE076	DWR	Kings River East GSA	365753N1194268W001	T15S R23E 36	337.6	27.0		310.6	
KRE077	DWR	Kings River East GSA	366539N1194302W001	T15S R23E 01	382.6	55.6		327.0	
KRE077	AID	Kings River East GSA	H026B	T15S R23E 01	382.5		57.1		325.5
KRE078	DWR	Kings River East GSA	366613N1193782W002	T15S R24E 05	401.6	16.8		384.8	
KRE078	AID	Kings River East GSA	I045A	T15S R24E 05	402.9	44.9	41.1	358.0	361.8
KRE078	AID	Kings River East GSA	I045B	T15S R24E 05	401.6		22.1		379.5
KRE078	DWR	Kings River East GSA	366489N1194057W001	T15S R24E 06	385.6	58.6		327.0	
KRE078	DWR	Kings River East GSA	366344N1194032W001	T15S R24E 07	375.6	59.7		315.9	
KRE078	DWR	Kings River East GSA	366403N1194129W001	T15S R24E 07	378.6	62.0		316.6	
KRE078	AID	Kings River East GSA	H031A	T15S R24E 07	379.9	63.0	62.0	316.9	317.9
KRE078	AID	Kings River East GSA	I047A	T15S R24E 07	385.5		64.0		321.5
KRE078	AID	Kings River East GSA	I054A	T15S R24E 07	375.7		59.1		316.6
KRE078	AID	Kings River East GSA	I048A	T15S R24E 08	386.5		46.1		340.4
KRE078	DWR	Kings River East GSA	366324N1193588W001	T15S R24E 09	397.6	26.9		370.7	
KRE078	DWR	Kings River East GSA	366468N1193677W001	T15S R24E 09	400.6	14.0		386.6	
KRE078	AID	Kings River East GSA	H049A	T15S R24E 09	400.4	11.8	26.1	388.6	374.3
KRE078	OCID	Kings River East GSA	15S24E10H001MX	T15S R24E 10	415.6	3.5	9.3	412.1	406.3
KRE078	OCID	Kings River East GSA	15S24E11A001MX	T15S R24E 11	429.9	2.6	8.6	427.3	421.3
KRE078	AID	Kings River East GSA	J052A	T15S R24E 15	397.3	27.9	28.1	369.4	369.2
KRE078	DWR	Kings River East GSA	366186N1193721W001	T15S R24E 16	382.6	52.0		330.6	
KRE078	AID	Kings River East GSA	I053A	T15S R24E 16	383.2		61.1		322.1
KRE078	AID	Kings River East GSA	J052B	T15S R24E 16	382.5	53.0	85.0	329.5	297.5
KRE078	DWR	Kings River East GSA	366300N1193800W001	T15S R24E 17	382.8		60.6		322.2
KRE078	AID	Kings River East GSA	I054B	T15S R24E 18	369.2		57.1		312.1
KRE078	DWR	Kings River East GSA	366144N1193952W001	T15S R24E 19	366.6	58.0		308.6	
KRE078	DWR	Kings River East GSA	366175N1194104W001	T15S R24E 19	367.6	55.6		312.0	
KRE078	AID	Kings River East GSA	I055A	T15S R24E 19	365.6	56.6	56.0	309.0	309.6
KRE078	DWR	Kings River East GSA	366044N1193938W001	T15S R24E 20	361.6	52.4		309.2	
KRE078	AID	Kings River East GSA	J057A	T15S R24E 21	390.7		45.0		345.7
KRE078	AID	Kings River East GSA	J057B	T15S R24E 21	372.7	50.5	60.0	322.2	312.7
KRE078	DWR	Kings River East GSA	366113N1193543W001	T15S R24E 22	387.6	44.5		343.1	
KRE078	DWR	Kings River East GSA	366174N1193585W001	T15S R24E 22	390.6	44.9		345.7	
KRE078	OCID	Kings River East GSA	15S24E23C001MX	T15S R24E 23	406.4	35.5		370.9	
KRE078	OCID	Kings River East GSA	15S24E23J001MX	T15S R24E 23	411.3	37.6	42.6	373.7	368.7
KRE078	DWR	Kings River East GSA	366171N1193338W001	T15S R24E 23	405.7	35.5		370.2	
KRE078	OCID	Kings River East GSA	15S24E26B001MX	T15S R24E 26	404.9	48.4		356.5	
KRE078	DWR	Kings River East GSA	365918N1193410W001	T15S R24E 27	398.7	43.0		355.7	
KRE078	AID	Kings River East GSA	H060A	T15S R24E 27	396.7	43.0	46.0	353.7	350.6
KRE078	DWR	Kings River East GSA	366036N1193721W001	T15S R24E 28	372.6	50.5		322.1	
KRE078	AID	Kings River East GSA	J062A	T15S R24E 29	361.5		52.1		309.4
KRE078	DWR	Kings River East GSA	366000N1194100W001	T15S R24E 30	352.6		46.5		306.1
KRE078	DWR	Kings River East GSA	366039N1194079W001	T15S R24E 30	357.6	52.6		305.0	
KRE078	AID	Kings River East GSA	I063A	T15S R24E 30	348.8		47.0		301.8
KRE078	DWR	Kings River East GSA	365817N1193793W001	T15S R24E 32	358.6	40.5		318.1	
KRE078	DWR	Kings River East GSA	365889N1193863W001	T15S R24E 32	362.6	48.0		314.6	
KRE078	AID	Kings River East GSA	M065A	T15S R24E 32	361.2	48.0	47.0	313.2	314.2
KRE078	DWR	Kings River East GSA	365889N1193677W001	T15S R24E 33	366.6	54.2		312.4	
KRE078	AID	Kings River East GSA	M066A	T15S R24E 33	367.8		59.1		308.7
KRE078	DWR	Kings River East GSA	365816N1193299W001	T15S R24E 35	393.7	54.0		339.7	
KRE078	OCID	Kings River East GSA	15S24E36F001MX	T15S R24E 36	406.6	69.6	66.0	337.0	340.6
KRE078	AID	Kings River East GSA	T102A	T16S R24E 02	392.7	56.9	100.0	335.8	292.7
KRE078	AID	Kings River East GSA	M104A	T16S R24E 04	355.6	42.0		313.6	
KRE079	OCID	Kings River East GSA	15S24E12H001MX	T15S R24E 12	444.7		4.0		440.7
KRE079	OCID	Kings River East GSA	15S25E07G001MX	T15S R25E 07	459.4	8.3	8.8	451.1	450.6
KRE079	OCID	Kings River East GSA	15S25E17D001MX	T15S R25E 17	464.5		16.7		447.8
KRE079	DWR	Kings River East GSA	366310N1192843W001	T15S R25E 17	464.7	4.7		460.0	
KRE079	OCID	Kings River East GSA	15S25E18C001MX	T15S R25E 18	447.5		6.6		440.9
KRE079	OCID	Kings River East GSA	15S25E19A001MX	T15S R25E 19	458.7	29.5	29.5	429.2	429.2
KRE079	OCID	Kings River East GSA	15S25E19J001MX	T15S R25E 19	453.6	30.1	32.6	423.5	421.0
KRE080	OCID	Kings River East GSA	15S25E06Q001MX	T15S R25E 06	466.1	11.0	6.7	455.1	459.4

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
KRE080	OCID	Kings River East GSA	15S25E29A001MX	T15S R25E 29	464.0	12.0	19.8	452.0	444.2
KRE080	OCID	Kings River East GSA	15S25E29E001MX	T15S R25E 29	438.8	7.2	10.3	431.6	428.5
KRE080	DWR	Kings River East GSA	365985N1192852W001	T15S R25E 30	438.8		8.8		430.0
KRE080	OCID	Kings River East GSA	15S25E33D001MX	T15S R25E 33	426.6	25.6	28.5	401.0	398.1
KRE080	DWR	Kings River East GSA	365857N1192670W001	T15S R25E 33	427.1	25.6		401.5	
KRE081	OCID	Kings River East GSA	15S25E31A001MX	T15S R25E 31	426.8	36.5	44.1	390.3	382.7
KRE081	OCID	Kings River East GSA	15S25E32F001MX	T15S R25E 32	415.0	34.2		362.8	
KRE081	DWR	Kings River East GSA	365771N1192695W001	T15S R25E 32	410.7	15.6		395.1	
KRE092	DWR	Kings River East GSA	365675N1194135W001	T16S R23E 01	341.6	35.6		306.0	
KRE092	AID	Kings River East GSA	I072A	T16S R23E 02	337.6	27.0	61.1	310.6	276.5
KRE092	AID	Kings River East GSA	I073A	T16S R23E 03	336.6	40.7	57.1	295.9	279.6
KRE092	DWR	Kings River East GSA	365542N1194807W001	T16S R23E 09	312.6	20.9		291.7	
KRE092	AID	Kings River East GSA	K075A	T16S R23E 09	330.4		49.0		281.4
KRE092	AID	Kings River East GSA	K075B	T16S R23E 09	315.0	20.9	90.0	294.1	225.0
KRE092	DWR	Kings River East GSA	365500N1194500W001	T16S R23E 10	323.6		53.9		269.7
KRE092	AID	Kings River East GSA	I077A	T16S R23E 11	330.7		46.0		284.7
KRE092	AID	Kings River East GSA	J079A	T16S R23E 13	323.5		85.0		238.5
KRE092	DWR	Kings River East GSA	365450N1194504W001	T16S R23E 15	324.7	31.8		292.9	
KRE092	AID	Kings River East GSA	K081A	T16S R23E 15	327.8	32.8	55.1	295.0	272.7
KRE092	DWR	Kings River East GSA	365319N1194913W001	T16S R23E 20	312.7	19.0		293.7	
KRE092	AID	Kings River East GSA	K084A	T16S R23E 20	314.6		60.1		254.6
KRE092	DWR	Kings River East GSA	365300N1194688W001	T16S R23E 21	318.7	30.5		288.2	
KRE092	DWR	Kings River East GSA	365319N1194641W002	T16S R23E 22	319.7	33.5		286.2	
KRE092	AID	Kings River East GSA	K086A	T16S R23E 22	319.6		52.1		267.5
KRE092	DWR	Kings River East GSA	365283N1194482W001	T16S R23E 23	316.7	32.8		283.9	
KRE092	AID	Kings River East GSA	K086B	T16S R23E 23	316.6		49.1		267.5
KRE092	DWR	Kings River East GSA	365094N1194302W001	T16S R23E 25	313.7	34.6		279.1	
KRE092	AID	Kings River East GSA	J089A	T16S R23E 25	313.6	34.6	51.1	279.0	262.5
KRE092	AID	Kings River East GSA	I090A	T16S R23E 26	314.6	32.0	68.0	282.6	246.6
KRE092	DWR	Kings River East GSA	365136N1194491W001	T16S R23E 27	311.7	32.0		279.7	
KRE092	DWR	Kings River East GSA	365178N1194846W001	T16S R23E 28	308.3	29.0		279.3	
KRE092	AID	Kings River East GSA	K085A	T16S R23E 28	311.7	29.0	47.0	282.7	264.7
KRE092	AID	Kings River East GSA	K093A	T16S R23E 29	300.5	20.7	25.1	279.8	275.4
KRE092	AID	Kings River East GSA	K095A	T16S R23E 31	297.6		42.1		255.5
KRE092	DWR	Kings River East GSA	364892N1194941W001	T16S R23E 32	298.7	34.6		264.1	
KRE092	DWR	Kings River East GSA	364900N1195000W001	T16S R23E 32	296.7		44.3		252.4
KRE092	DWR	Kings River East GSA	365003N1194935W001	T16S R23E 32	303.7	29.9		273.8	
KRE092	AID	Kings River East GSA	W096A	T16S R23E 32	302.8	29.4	48.0	273.4	254.8
KRE092	DWR	Kings River East GSA	364997N1194682W001	T16S R23E 33	303.7	37.8		265.9	
KRE092	DWR	Kings River East GSA	365031N1194749W001	T16S R23E 33	305.7	29.0		276.7	
KRE092	AID	Kings River East GSA	K097A	T16S R23E 33	298.9		100.0		198.9
KRE092	AID	Kings River East GSA	K098A	T16S R23E 34	308.7		78.0		230.7
KRE092	AID	Kings River East GSA	K098B	T16S R23E 35	304.8		60.0		244.7
KRE092	DWR	Kings River East GSA	364900N1194300W001	T16S R23E 36	304.5		60.3		244.2
KRE092	AID	Kings River East GSA	W100A	T16S R23E 36	304.8	41.6	56.0	263.2	248.8
KRE093	DWR	Kings River East GSA	365600N1193400W001	T16S R24E 02	371.3		44.9		326.4
KRE093	DWR	Kings River East GSA	365631N1193360W001	T16S R24E 02	376.7	41.5		335.2	
KRE093	AID	Kings River East GSA	M103A	T16S R24E 02	372.7	52.9	46.1	319.8	326.6
KRE093	AID	Kings River East GSA	M105A	T16S R24E 05	339.9	31.5	40.1	308.4	299.8
KRE093	DWR	Kings River East GSA	365744N1194121W001	T16S R24E 06	348.6	24.0		324.6	
KRE093	AID	Kings River East GSA	M106A	T16S R24E 06	332.7		70.0		262.7
KRE093	DWR	Kings River East GSA	365500N1194116W001	T16S R24E 07	329.1	40.0		289.1	
KRE093	DWR	Kings River East GSA	365597N1193718W001	T16S R24E 09	350.6	51.5		299.1	
KRE093	DWR	Kings River East GSA	365481N1193499W001	T16S R24E 10	358.2	51.5		306.7	
KRE093	DWR	Kings River East GSA	365525N1193410W001	T16S R24E 10	367.7	50.9		316.8	
KRE093	DWR	Kings River East GSA	365561N1193582W001	T16S R24E 10	357.7	56.9		300.8	
KRE093	AID	Kings River East GSA	J110A	T16S R24E 10	357.6	44.5	43.1	313.1	314.5
KRE093	AID	Kings River East GSA	M110A	T16S R24E 10	367.8	50.9	49.0	316.9	318.7
KRE093	DWR	Kings River East GSA	365592N1193224W001	T16S R24E 12	379.7	51.6		328.1	
KRE093	AID	Kings River East GSA	D112A	T16S R24E 12	378.6	51.6		327.0	
KRE093	DWR	Kings River East GSA	365392N1193074W001	T16S R24E 13	360.2	29.5		330.7	
KRE093	AID	Kings River East GSA	T113B	T16S R24E 13	358.6		24.1		334.5
KRE093	DWR	Kings River East GSA	365314N1193385W001	T16S R24E 14	349.7	29.8		319.9	
KRE093	DWR	Kings River East GSA	365411N1193232W001	T16S R24E 14	362.7	30.5		332.2	
KRE093	DWR	Kings River East GSA	365439N1193227W001	T16S R24E 14	362.7	32.0		330.7	
KRE093	AID	Kings River East GSA	M115A	T16S R24E 14	362.5		39.1		323.5
KRE093	DWR	Kings River East GSA	365386N1193593W001	T16S R24E 16	349.7	40.6		309.1	
KRE093	AID	Kings River East GSA	M116A	T16S R24E 16	349.7		43.1		306.6

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
KRE093	AID	Kings River East GSA	M118A	T16S R24E 18	326.8		47.1		279.7
KRE093	DWR	Kings River East GSA	365239N1194088W001	T16S R24E 19	318.7	27.5		291.2	
KRE093	DWR	Kings River East GSA	365297N1194079W001	T16S R24E 19	320.7	31.8		288.9	
KRE093	AID	Kings River East GSA	M120A	T16S R24E 20	337.6		57.1		280.5
KRE093	DWR	Kings River East GSA	365236N1193591W001	T16S R24E 21	338.7	37.5		301.2	
KRE093	AID	Kings River East GSA	D121A	T16S R24E 21	338.6	37.5		301.1	
KRE093	AID	Kings River East GSA	O123A	T16S R24E 23	352.7	24.2	42.0	328.5	310.7
KRE093	AID	Kings River East GSA	O123B	T16S R24E 23	346.8		31.1		315.7
KRE093	AID	Kings River East GSA	O126A	T16S R24E 26	337.6		22.0		315.6
KRE093	AID	Kings River East GSA	O127A	T16S R24E 26	331.7	19.0	32.0	312.7	299.7
KRE093	AID	Kings River East GSA	O128A	T16S R24E 27	329.7	29.2	34.0	300.5	295.7
KRE093	DWR	Kings River East GSA	365089N1193588W001	T16S R24E 28	327.8		32.5		295.3
KRE093	DWR	Kings River East GSA	365128N1193679W001	T16S R24E 28	327.2	35.0		292.2	
KRE093	DWR	Kings River East GSA	365144N1193777W001	T16S R24E 29	328.7	34.0		294.7	
KRE093	AID	Kings River East GSA	O129A	T16S R24E 29	328.7	34.0	50.1	294.7	278.7
KRE093	DWR	Kings River East GSA	365058N1193952W001	T16S R24E 30	316.7	33.8		282.9	
KRE093	AID	Kings River East GSA	M130A	T16S R24E 30	314.6	29.5	54.1	285.1	260.5
KRE093	AID	Kings River East GSA	M130B	T16S R24E 30	318.6	33.8	47.0	284.8	271.5
KRE093	DWR	Kings River East GSA	365022N1194085W001	T16S R24E 31	309.7	28.0		281.7	
KRE093	AID	Kings River East GSA	M131A	T16S R24E 31	306.8		46.0		260.8
KRE093	DWR	Kings River East GSA	364928N1193724W001	T16S R24E 33	315.7	28.6		287.1	
KRE093	AID	Kings River East GSA	O133A	T16S R24E 33	315.6	28.6	36.1	287.0	279.6
KRE093	AID	Kings River East GSA	O134A	T16S R24E 34	323.8		38.1		285.7
KRE093	AID	Kings River East GSA	O134B	T16S R24E 34	319.6	17.5	25.1	302.1	294.4
KRE093	AID	Kings River East GSA	O135A	T16S R24E 35	327.8		16.0		311.7
KRE093	AID	Kings River East GSA	T136A	T16S R24E 36	338.6	9.2	42.1	329.4	296.5
KRE093	AID	Kings River East GSA	T199A	T17S R24E 01	328.7	12.0		316.7	
KRE093	AID	Kings River East GSA	O201A	T17S R24E 03	309.7		35.1		274.6
KRE094	OCID	Kings River East GSA	16S25E04C001MX	T16S R25E 04	418.5	24.7	35.9	393.8	382.6
KRE094	DWR	Kings River East GSA	365721N1192620W001	T16S R25E 04	418.3		35.4		382.9
KRE094	DWR	Kings River East GSA	365447N1193041W001	T16S R25E 07	371.5		63.3		308.2
KRE094	DWR	Kings River East GSA	365591N1193007W001	T16S R25E 07	383.7	40.2		343.5	
KRE094	AID	Kings River East GSA	T139A	T16S R25E 07	385.3	40.2	60.0	345.1	325.3
KRE094	AID	Kings River East GSA	T139B	T16S R25E 07	385.8		40.0		345.8
KRE094	AID	Kings River East GSA	T139C	T16S R25E 07	369.8		28.1		341.7
KRE094	DWR	Kings River East GSA	365557N1192867W001	T16S R25E 08	385.7	31.5		354.2	
KRE094	DWR	Kings River East GSA	365388N1192692W001	T16S R25E 17	382.7	25.4		357.3	
KRE094	AID	Kings River East GSA	T143A	T16S R25E 17	382.5		27.1		355.5
KRE094	AID	Kings River East GSA	T143B	T16S R25E 17	373.6		24.1		349.5
KRE094	DWR	Kings River East GSA	365231N1192959W001	T16S R25E 19	357.7	18.8		338.9	
KRE094	AID	Kings River East GSA	T145A	T16S R25E 19	356.4	18.8	18.1	337.6	338.3
KRE094	DWR	Kings River East GSA	365153N1192731W001	T16S R25E 20	367.2		29.1		338.1
KRE094	DWR	Kings River East GSA	365160N1192601W001	T16S R25E 21	372.7	29.2		343.5	
KRE094	AID	Kings River East GSA	T147A	T16S R25E 21	383.5		26.0		357.5
KRE094	AID	Kings River East GSA	T147B	T16S R25E 21	375.1		24.1		351.0
KRE094	DWR	Kings River East GSA	365142N1192690W001	T16S R25E 29	364.7	27.0		337.7	
KRE094	AID	Kings River East GSA	T151A	T16S R25E 29	366.8	27.9	29.1	338.9	337.7
KRE094	DWR	Kings River East GSA	364875N1192870W001	T16S R25E 31	341.7	21.0		320.7	
KRE094	DWR	Kings River East GSA	365011N1192976W001	T16S R25E 31	344.7	16.8		327.9	
KRE094	AID	Kings River East GSA	T153A	T16S R25E 31	343.5	16.8	21.0	326.7	322.5
KRE094	DWR	Kings River East GSA	365008N1192801W001	T16S R25E 32	352.7	27.8		324.9	
KRE094	AID	Kings River East GSA	T154A	T16S R25E 32	354.5	28.8	22.0	325.7	332.5
KRE094	DWR	Kings River East GSA	365003N1192545W001	T16S R25E 33	360.7	26.5		334.2	
KRE094	DWR	Kings River East GSA	364881N1192390W001	T16S R25E 34	346.7	22.0		324.7	
KRE094	DWR	Kings River East GSA	364975N1192501W001	T16S R25E 34	356.7	34.0		322.7	
KRE094	AID	Kings River East GSA	X156A	T16S R25E 34	346.8	24.0		322.8	
KRE094	DWR	Kings River East GSA	364861N1192478W001	T17S R25E 03	346.7	25.0		321.7	
KRE094	DWR	Kings River East GSA	364864N1192981W001	T17S R25E 06	335.7	22.9		312.8	
KRE094	AID	Kings River East GSA	X229A	T17S R25E 06	333.7		21.1		312.6
KRE095	OCID	Kings River East GSA	16S25E03K001MX	T16S R25E 03	436.8	21.5	26.2	415.3	410.6
KRE095	DWR	Kings River East GSA	365632N1192417W001	T16S R25E 03	432.7	21.5		411.2	
KRE095	OCID	Kings River East GSA	16S25E10J001MX	T16S R25E 10	422.6	25.7	30.4	396.9	392.2
KRE095	DWR	Kings River East GSA	365513N1192370W001	T16S R25E 10	422.7	25.7		397.0	
KRE095	DWR	Kings River East GSA	365388N1192506W001	T16S R25E 15	397.7	26.5		371.2	
KRE095	OCID	Kings River East GSA	16S25E22E001MX	T16S R25E 22	389.6	15.5		374.1	
KRE095	AID	Kings River East GSA	X155A	T16S R25E 34	361.9		25.1		336.8
KRE095	AID	Kings River East GSA	X157A	T16S R25E 35	357.6		37.1		320.5
KRE095	DWR	Kings River East GSA	364852N1192192W001	T17S R25E 01	357.7	21.3		336.4	

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
KRE103	DWR	Kings River East GSA	364878N1194210W001	T17S R23E 01	304.7	41.6		263.1	
KRE103	DWR	Kings River East GSA	364881N1194399W001	T17S R23E 02	303.7	66.5		237.2	
KRE103	AID	Kings River East GSA	W166A	T17S R23E 03	298.6	41.4	58.0	257.2	240.6
KRE103	AID	Kings River East GSA	W168A	T17S R23E 05	298.6		45.0		253.5
KRE103	DWR	Kings River East GSA	364731N1195149W001	T17S R23E 07	291.7	54.0	49.4	237.7	242.3
KRE103	AID	Kings River East GSA	W159A	T17S R23E 07	292.6		43.1		249.5
KRE103	DWR	Kings River East GSA	364664N1194954W001	T17S R23E 08	290.7	49.0	63.9	241.7	226.8
KRE103	AID	Kings River East GSA	W171A	T17S R23E 08	292.6		63.1		229.6
KRE103	DWR	Kings River East GSA	364594N1194832W001	T17S R23E 09	287.7	73.0		214.7	
KRE103	DWR	Kings River East GSA	364733N1194816W001	T17S R23E 09	294.2	50.3		243.9	
KRE103	AID	Kings River East GSA	W172A	T17S R23E 09	292.6	50.8	64.1	241.8	228.5
KRE103	DWR	Kings River East GSA	364733N1194568W001	T17S R23E 10	294.2	40.2		254.0	
KRE103	AID	Kings River East GSA	K174A	T17S R23E 11	297.6		76.1		221.5
KRE103	AID	Kings River East GSA	W175A	T17S R23E 12	297.6	51.5	62.0	246.1	235.5
KRE103	DWR	Kings River East GSA	364583N1194299W001	T17S R23E 13	290.7	67.0		223.7	
KRE103	AID	Kings River East GSA	X176A	T17S R23E 13	290.7		75.1		215.6
KRE103	DWR	Kings River East GSA	364586N1194646W001	T17S R23E 15	287.7	61.5		226.2	
KRE103	AID	Kings River East GSA	W178A	T17S R23E 15	287.7	61.5	71.1	226.2	216.6
KRE103	AID	Kings River East GSA	W178B	T17S R23E 15	283.6		78.1		205.5
KRE103	AID	Kings River East GSA	W179A	T17S R23E 16	287.7	58.5	72.1	229.2	215.7
KRE103	DWR	Kings River East GSA	364500N1195000W001	T17S R23E 17	283.5		90.8		192.7
KRE103	AID	Kings River East GSA	W180A	T17S R23E 17	285.8		92.0		193.7
KRE103	DWR	Kings River East GSA	364544N1195277W001	T17S R23E 18	286.7	41.5		245.2	
KRE103	DWR	Kings River East GSA	364594N1195241W001	T17S R23E 18	287.7	57.0		230.7	
KRE103	AID	Kings River East GSA	W181A	T17S R23E 18	277.6		58.0		219.5
KRE103	DWR	Kings River East GSA	364442N1194835W001	T17S R23E 21	285.7	64.9		220.8	
KRE103	AID	Kings River East GSA	X184A	T17S R23E 21	277.6	68.0	100.0	209.6	177.6
KRE103	AID	Kings River East GSA	X185A	T17S R23E 22	280.8		84.0		196.8
KRE103	AID	Kings River East GSA	X186A	T17S R23E 23	287.7		78.0		209.7
KRE103	AID	Kings River East GSA	X186B	T17S R23E 23	280.5		78.1		202.4
KRE103	AID	Kings River East GSA	X187A	T17S R23E 24	282.8		75.1		207.7
KRE103	DWR	Kings River East GSA	364225N1194688W001	T17S R23E 27	273.2	68.5		204.7	
KRE103	AID	Kings River East GSA	X191A	T17S R23E 28	272.6		80.0		192.6
KRE103	DWR	Kings River East GSA	364286N1195154W001	T17S R23E 30	278.7	61.9		216.8	
KRE103	DWR	Kings River East GSA	364303N1195146W001	T17S R23E 30	278.7	69.0	83.6	209.7	195.1
KRE103	AID	Kings River East GSA	W193A	T17S R23E 30	278.5		86.0		192.5
KRE103	DWR	Kings River East GSA	364078N1195221W001	T17S R23E 31	272.7	70.0		202.7	
KRE104	AID	Kings River East GSA	X189A	T17S R23E 26	277.6		111.0		166.6
KRE106	AID	Kings River East GSA	X209A	T17S R24E 02	313.6		31.0		282.6
KRE106	AID	Kings River East GSA	O201B	T17S R24E 03	297.6	18.0	42.0	279.6	255.5
KRE106	DWR	Kings River East GSA	364875N1193932W001	T17S R24E 05	306.7	29.2		277.5	
KRE106	AID	Kings River East GSA	M203A	T17S R24E 05	299.5	37.8	53.1	261.7	246.4
KRE106	AID	Kings River East GSA	M205A	T17S R24E 07	294.6		75.1		219.5
KRE106	AID	Kings River East GSA	O202A	T17S R24E 09	300.5		45.1		255.4
KRE106	DWR	Kings River East GSA	364581N1193496W001	T17S R24E 10	304.3		40.7		263.6
KRE106	DWR	Kings River East GSA	364581N1193513W001	T17S R24E 10	304.7	35.0		269.7	
KRE106	AID	Kings River East GSA	X201A	T17S R24E 12	318.5	23.7		294.8	
KRE106	AID	Kings River East GSA	X211A	T17S R24E 13	312.7		63.1		249.6
KRE106	AID	Kings River East GSA	X213A	T17S R24E 14	306.4	6.9	41.0	299.5	265.4
KRE106	DWR	Kings River East GSA	364578N1193502W001	T17S R24E 15	305.7	6.9		298.8	
KRE106	DWR	Kings River East GSA	364575N1193679W001	T17S R24E 16	298.7	19.8		278.9	
KRE106	AID	Kings River East GSA	X214A	T17S R24E 16	299.9	19.8	36.0	280.1	263.8
KRE106	AID	Kings River East GSA	X215A	T17S R24E 16	292.6		50.1		242.5
KRE106	DWR	Kings River East GSA	364583N1193857W001	T17S R24E 17	294.7	30.8		263.9	
KRE106	DWR	Kings River East GSA	364425N1193860W001	T17S R24E 20	292.7	24.0		268.7	
KRE106	AID	Kings River East GSA	X218B	T17S R24E 20	292.7	24.0	45.1	268.7	247.6
KRE106	AID	Kings River East GSA	X220A	T17S R24E 22	297.1		31.1		266.1
KRE107	DWR	Kings River East GSA	364400N1194100W001	T17S R24E 19	285.1		46.2		238.9
KRE107	AID	Kings River East GSA	X217A	T17S R24E 19	286.7		47.1		239.6
KRE107	DWR	Kings River East GSA	364439N1193993W001	T17S R24E 20	289.7	22.7		267.0	
KRE107	AID	Kings River East GSA	X218A	T17S R24E 20	289.7	22.7	52.0	267.0	237.7
KRE107	AID	Kings River East GSA	X221A	T17S R24E 23	307.7		60.0		247.7
KRE108	DWR	Kings River East GSA	364736N1192415W001	T17S R25E 03	340.7	36.0		304.7	
KRE108	AID	Kings River East GSA	X226A	T17S R25E 03	346.8		30.0		316.8
KRE108	AID	Kings River East GSA	X227A	T17S R25E 04	336.6		56.0		280.6
KRE108	AID	Kings River East GSA	X230A	T17S R25E 06	324.8		32.0		292.8
KRE108	DWR	Kings River East GSA	364700N1192900W001	T17S R25E 08	304.3		30.8		273.5
KRE108	AID	Kings River East GSA	X231A	T17S R25E 08	327.8		31.1		296.7

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
KRE108	AID	Kings River East GSA	X234A	T17S R25E 17	323.8		48.1		275.8
KRE108	AID	Kings River East GSA	X234B	T17S R25E 17	327.8		74.1		253.6
KRE108	DWR	Kings River East GSA	364433N1192959W001	T17S R25E 18	323.7	64.0		259.7	
KRE108	DWR	Kings River East GSA	364575N1192967W001	T17S R25E 18	327.7	50.8		276.9	
KRE110	AID	Kings River East GSA	X224A	T17S R25E 01	357.0	18.6	37.0	338.4	319.9
MA015	FID	McMullin Area GSA	13S17E19H001MX	T13S R17E 19	205.3	34.5		170.8	
MA030	DWR	McMullin Area GSA	367646N1202604W001	T13S R16E 30	177.4	55.1		122.3	
MA030	DWR	McMullin Area GSA	367571N1202521W001	T13S R16E 32	177.4	67.6		109.8	
MA030	DWR	McMullin Area GSA	367488N1202374W001	T14S R16E 04	172.9	66.9		106.0	
MA030	DWR	McMullin Area GSA	367413N1202504W001	T14S R16E 05	169.5	58.7		110.8	
MA030	DWR	McMullin Area GSA	367418N1202513W001	T14S R16E 05	169.5	62.1		107.4	
MA030	DWR	McMullin Area GSA	367485N1202516W001	T14S R16E 05	173.4	54.8		118.6	
MA030	DWR	McMullin Area GSA	367485N1202602W001	T14S R16E 06	172.4	45.9		126.5	
MA030	DWR	McMullin Area GSA	367485N1202688W001	T14S R16E 06	172.4	48.6		123.8	
MA030	DWR	McMullin Area GSA	367341N1202654W001	T14S R16E 07	167.5	43.7		123.8	
MA030	DWR	McMullin Area GSA	367341N1202696W001	T14S R16E 07	167.5	41.6		125.9	
MA030	KRCD	McMullin Area GSA	A01	T14S R16E 07	162.6		84.0		78.6
MA030	DWR	McMullin Area GSA	367260N1202418W001	T14S R16E 08	170.5	53.8		116.7	
MA031	DWR	McMullin Area GSA	367707N1201910W001	T13S R16E 26	193.4	81.7		111.7	
MA031	DWR	McMullin Area GSA	367757N1201874W001	T13S R16E 26	193.4	54.5		138.9	
MA031	DWR	McMullin Area GSA	367707N1202141W001	T13S R16E 27	185.9	52.5		133.4	
MA031	DWR	McMullin Area GSA	367782N1202141W001	T13S R16E 27	188.4	46.0		142.4	
MA031	DWR	McMullin Area GSA	367710N1202263W001	T13S R16E 28	182.4	68.6		113.8	
MA031	DWR	McMullin Area GSA	367560N1202232W001	T13S R16E 33	178.4	76.9		101.5	
MA031	DWR	McMullin Area GSA	367596N1202329W001	T13S R16E 33	177.4	79.8		97.6	
MA031	DWR	McMullin Area GSA	367635N1202146W001	T13S R16E 34	184.4	68.1		116.3	
MA031	DWR	McMullin Area GSA	367635N1201868W001	T13S R16E 36	192.4	78.4		114.0	
MA031	FID	McMullin Area GSA	13S17E30J001MX	T13S R17E 29	203.2	63.1	61.2	140.1	142.0
MA031	DWR	McMullin Area GSA	367493N1202171W001	T14S R16E 03	179.4	79.2		100.2	
MA031	DWR	McMullin Area GSA	367457N1202232W001	T14S R16E 04	176.5	66.3		110.2	
MA031	DWR	McMullin Area GSA	367463N1202324W001	T14S R16E 04	172.4	78.6		93.8	
MA031	FID	McMullin Area GSA	14S17E06B001MX	T14S R17E 06	196.5	99.8	89.0	96.7	107.5
MA034	KRCD	McMullin Area GSA	A05	T14S R16E 15	171.4		61.0		110.4
MA034	DWR	McMullin Area GSA	366780N1201882W001	T14S R16E 26	174.5	64.6		109.9	
MA034	DWR	McMullin Area GSA	366900N1202000W001	T14S R16E 26	171.0		67.0		104.0
MA034	KRCD	McMullin Area GSA	A07	T14S R16E 26	170.8		67.0		103.8
MA034	KRCD	McMullin Area GSA	A09	T14S R16E 34	165.3		81.0		84.3
MA035	JID	McMullin Area GSA	14S17E31R001MX	T14S R17E 31	180.0	134.3		45.7	
MA035	KRCD	McMullin Area GSA	A24	T15S R17E 06	175.3		170.0		5.3
MA036	DWR	McMullin Area GSA	367200N1202100W001	T14S R16E 15	171.0		88.0		83.0
MA036	KRCD	McMullin Area GSA	A08	T14S R16E 24	176.7		105.0		71.7
MA036	KRCD	McMullin Area GSA	A10	T14S R16E 36	177.9		112.0		65.9
MA036	FID	McMullin Area GSA	14S17E04R001MX	T14S R17E 04	205.2	100.7		104.5	
MA036	DWR	McMullin Area GSA	367352N1201146W001	T14S R17E 04	207.7	100.7		107.0	
MA036	FID	McMullin Area GSA	14S17E05C001MX	T14S R17E 05	202.9	92.3	92.0	110.6	110.9
MA036	KRCD	McMullin Area GSA	A12	T14S R17E 06	197.4		99.0		98.4
MA036	DWR	McMullin Area GSA	367318N1201466W002	T14S R17E 08	197.5	73.4		124.1	
MA036	DWR	McMullin Area GSA	367200N1201000W001	T14S R17E 15	210.0		113.0		97.0
MA036	KRCD	McMullin Area GSA	A13	T14S R17E 15	210.3		113.0		97.3
MA036	DWR	McMullin Area GSA	367100N1201500W001	T14S R17E 17	188.0		119.0		69.0
MA036	KRCD	McMullin Area GSA	A14	T14S R17E 17	196.7		123.0		73.7
MA036	KRCD	McMullin Area GSA	A15	T14S R17E 19	187.7		119.0		68.7
MA036	DWR	McMullin Area GSA	367052N1201152W001	T14S R17E 21	203.5	145.0		58.5	
MA036	JID	McMullin Area GSA	14S17E28A001MX	T14S R17E 28	195.0	129.3		65.7	
MA036	DWR	McMullin Area GSA	366893N1201171W001	T14S R17E 28	197.5	129.3		68.2	
MA036	KRCD	McMullin Area GSA	A20	T14S R17E 29	187.7		132.0		55.7
MA036	DWR	McMullin Area GSA	366652N1201516W001	T14S R17E 31	182.5	134.3		48.2	
MA036	JID	McMullin Area GSA	14S17E32R001MX	T14S R17E 32	184.5	108.5		76.0	
MA038	KRCD	McMullin Area GSA	A11	T14S R17E 04	208.4		91.0		117.4
MA063	JID	McMullin Area GSA	15S17E07J001MX	T15S R17E 07	175.0	52.8		122.2	
MA063	DWR	McMullin Area GSA	366180N1201457W001	T15S R17E 17	173.6		123.4		50.2
MA064	DWR	McMullin Area GSA	366700N1200800W001	T14S R17E 35	201.0		147.0		54.0
MA064	KRCD	McMullin Area GSA	A21	T14S R17E 35	201.1		147.0		54.1
MA064	JID	McMullin Area GSA	14S17E36A001MX	T14S R17E 36	207.0	144.6		62.4	
MA064	DWR	McMullin Area GSA	366763N1200610W001	T14S R17E 36	209.5	144.6		64.9	
MA064	KRCD	McMullin Area GSA	A22	T15S R17E 01	204.5		152.0		52.5
MA064	DWR	McMullin Area GSA	366500N1201000W001	T15S R17E 03	191.0		179.0		12.0
MA064	KRCD	McMullin Area GSA	A23	T15S R17E 03	191.1		179.0		12.1

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
MA064	KRCD	McMullin Area GSA	A25	T15S R17E 08	178.6		144.0		34.6
MA064	JID	McMullin Area GSA	15S17E11A001MX	T15S R17E 11	195.0	162.3		32.7	
MA064	JID	McMullin Area GSA	15S17E13R001MX	T15S R17E 13	193.0	171.8	183.5	21.2	9.5
MA064	KRCD	McMullin Area GSA	A26	T15S R17E 13	196.7		178.0		18.7
MA064	JID	McMullin Area GSA	15S17E15J001MX	T15S R17E 15	187.0	168.5	168.1	18.5	18.9
MA064	DWR	McMullin Area GSA	366255N1200977W001	T15S R17E 15	189.6	168.5		21.1	
MA064	KRCD	McMullin Area GSA	A28	T15S R17E 21	177.8		168.0		9.8
MA064	JID	McMullin Area GSA	15S17E22J001MX	T15S R17E 22	186.0	160.9	175.8	25.1	10.2
MA064	DWR	McMullin Area GSA	366077N1200982W001	T15S R17E 22	188.6	160.9		27.7	
MA064	DWR	McMullin Area GSA	366032N1200799W001	T15S R17E 26	191.6	198.6		-7.0	
MA064	DWR	McMullin Area GSA	365771N1200971W001	T15S R17E 35	184.7	157.4		27.3	
MA064	DWR	McMullin Area GSA	365800N1200900W001	T15S R17E 35	180.0		184.0		-4.0
MA064	DWR	McMullin Area GSA	365888N1200796W001	T15S R17E 35	190.1	230.3		-40.2	
MA064	KRCD	McMullin Area GSA	A30	T15S R17E 35	180.2		184.0		-3.8
MA064	JID	McMullin Area GSA	15S18E06A001MX	T15S R18E 06	207.0	128.8		78.2	
MA064	DWR	McMullin Area GSA	366596N1200432W001	T15S R18E 06	209.6	128.8		80.8	
MA064	JID	McMullin Area GSA	15S18E07A001MX	T15S R18E 07	204.0	157.8		46.2	
MA064	DWR	McMullin Area GSA	366471N1200435W001	T15S R18E 07	206.6	157.8		48.8	
MA064	JID	McMullin Area GSA	15S18E17C001MX	T15S R18E 17	203.0	208.6		-5.6	
MA064	DWR	McMullin Area GSA	366327N1200360W001	T15S R18E 17	205.6	208.6		-3.0	
MA064	DWR	McMullin Area GSA	366300N1200600W001	T15S R18E 18	197.0		178.0		19.0
MA064	KRCD	McMullin Area GSA	A39	T15S R18E 18	197.6		189.0		8.6
MA064	JID	McMullin Area GSA	15S18E19R001MX	T15S R18E 19	195.5		96.3		99.2
MA064	KRCD	McMullin Area GSA	A42	T15S R18E 30	193.3		201.0		-7.7
MA065	DWR	McMullin Area GSA	366600N1200200W001	T15S R18E 04	216.0		128.0		88.0
MA065	KRCD	McMullin Area GSA	A34	T15S R18E 04	216.3		128.0		88.3
MA065	DWR	McMullin Area GSA	366257N1199943W001	T15S R18E 15	210.7		221.7		-11.0
MA065	DWR	McMullin Area GSA	366299N1199893W001	T15S R18E 15	214.6	157.0		57.6	
MA065	KRCD	McMullin Area GSA	A37	T15S R18E 15	208.8		170.0		38.8
MA068	DWR	McMullin Area GSA	365818N1200707W001	T15S R17E 36	192.6	197.9		-5.3	
MA068	KRCD	McMullin Area GSA	A31	T15S R17E 36	186.4		200.0		-13.6
MA068	DWR	McMullin Area GSA	365849N1200393W001	T15S R18E 32	202.6	196.0	213.6	6.6	-11.0
MA068	DWR	McMullin Area GSA	365782N1200252W001	T15S R18E 33	200.6	196.0	221.7	4.6	-21.1
MA068	DWR	McMullin Area GSA	365677N1200210W001	T16S R18E 04	199.7	181.0	187.3	18.7	12.4
MA068	KRCD	McMullin Area GSA	A54	T16S R18E 04	192.3		229.0		-36.7
MA068	DWR	McMullin Area GSA	365610N1200391W001	T16S R18E 08	193.7	202.0	207.1	-8.3	-13.4
MA068	DWR	McMullin Area GSA	365571N1200163W001	T16S R18E 09	200.7	186.0		14.7	
MA068	DWR	McMullin Area GSA	365505N1199899W001	T16S R18E 10	204.7	182.0	209.9	22.7	-5.2
MA068	KRCD	McMullin Area GSA	A56	T16S R18E 10	196.3		237.0		-40.7
MA068	DWR	McMullin Area GSA	365400N1200000W001	T16S R18E 15	195.0		230.0		-35.0
MA068	KRCD	McMullin Area GSA	A58	T16S R18E 15	194.9		230.0		-35.2
MA069	DWR	McMullin Area GSA	366077N1199982W001	T15S R18E 22	212.6	292.7		-80.1	
MA069	DWR	McMullin Area GSA	365930N1200257W001	T15S R18E 29	202.6	200.0	218.6	2.6	-16.0
MA069	DWR	McMullin Area GSA	365855N1200254W001	T15S R18E 32	202.6	198.0	227.1	4.6	-24.5
MA069	DWR	McMullin Area GSA	365680N1199902W001	T16S R18E 03	208.7	182.5	215.3	26.2	-6.7
MA069	DWR	McMullin Area GSA	365749N1199899W001	T16S R18E 03	208.7	185.0	219.6	23.7	-11.0
MA070	DWR	McMullin Area GSA	366257N1199893W001	T15S R18E 15	212.6	182.4		30.2	
MA070	DWR	McMullin Area GSA	366157N1199754W001	T15S R18E 23	216.6	154.9		61.7	
MA070	KRCD	McMullin Area GSA	A44	T15S R18E 36	215.4		209.0		6.4
MA070	DWR	McMullin Area GSA	365935N1199532W001	T15S R19E 30	222.6	182.0	205.0	40.6	17.6
MA070	DWR	McMullin Area GSA	365682N1199538W001	T16S R18E 01	219.2	182.0		37.2	
MA070	KRCD	McMullin Area GSA	A53	T16S R18E 01	213.0		212.0		1.0
MA070	DWR	McMullin Area GSA	365700N1199500W001	T16S R19E 06	213.0		212.0		1.0
MA070	DWR	McMullin Area GSA	365543N1199535W001	T16S R19E 07	214.7		212.1		2.6
MA071	KRCD	McMullin Area GSA	A32	T15S R18E 01	228.0		113.0		115.1
MA071	FID	McMullin Area GSA	15S18E02A001MX	T15S R18E 02	222.7	114.1	117.8	108.6	104.9
MA071	JID	McMullin Area GSA	15S18E03R001MX	T15S R18E 03	217.0	143.3	151.2	73.7	65.8
MA071	DWR	McMullin Area GSA	366366N1199710W001	T15S R18E 12	222.6	156.0	167.9	66.6	54.7
MA071	DWR	McMullin Area GSA	366477N1199710W001	T15S R18E 12	224.6	127.0	141.8	97.6	82.8
MA071	DWR	McMullin Area GSA	366300N1199700W001	T15S R18E 13	219.0		163.0		56.0
MA071	KRCD	McMullin Area GSA	A36	T15S R18E 13	218.6		163.0		55.6
MA071	DWR	McMullin Area GSA	366088N1199535W001	T15S R18E 24	226.6	168.0	189.1	58.6	37.5
MA071	KRCD	McMullin Area GSA	A35	T15S R19E 07	224.4		140.0		84.4
MA072	KRCD	McMullin Area GSA	A45	T15S R19E 05	232.3		106.0		126.3
MA072	DWR	McMullin Area GSA	366338N1199404W001	T15S R19E 07	225.6	125.0	142.7	100.6	82.9
MA072	KRCD	McMullin Area GSA	A46	T15S R19E 10	240.1		97.0		143.2
MA072	KRCD	McMullin Area GSA	A48	T15S R19E 18	228.0		152.0		76.0
MA072	DWR	McMullin Area GSA	366080N1199521W001	T15S R19E 19	226.6	161.0		65.6	

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
MA072	DWR	McMullin Area GSA	366188N1199104W001	T15S R19E 21	234.6	141.0	142.0	93.6	92.6
MA072	DWR	McMullin Area GSA	366177N1198988W001	T15S R19E 22	237.6	116.0	128.0	121.6	109.6
MA072	DWR	McMullin Area GSA	366082N1198807W001	T15S R19E 23	244.6	130.5	130.5	114.1	114.1
MA072	KRCD	McMullin Area GSA	A49	T15S R19E 23	247.6		133.0		114.6
MA072	KRCD	McMullin Area GSA	A50	T15S R19E 27	238.8		156.0		82.8
MA072	DWR	McMullin Area GSA	366007N1199146W001	T15S R19E 28	232.6	151.0		81.6	
MA072	KRCD	McMullin Area GSA	A51	T15S R19E 29	229.8		169.0		60.8
MA072	DWR	McMullin Area GSA	365782N1199071W001	T15S R19E 33	230.6	168.0		62.6	
MA072	DWR	McMullin Area GSA	365891N1198877W001	T15S R19E 34	237.6	139.0	139.0	98.6	98.6
MA072	KRCD	McMullin Area GSA	A52	T16S R19E 02	242.5		150.0		92.5
MA072	DWR	McMullin Area GSA	365755N1199304W001	T16S R19E 05	225.6	169.0	195.7	56.6	29.9
MA086	KRCD	McMullin Area GSA	A59	T16S R18E 23	203.0		210.0		-7.0
MA087	DWR	McMullin Area GSA	365463N1199268W001	T16S R19E 17	218.0	176.0	199.6	44.7	21.1
MA087	KRCD	McMullin Area GSA	A63	T16S R19E 17	217.4		199.0		18.4
MA087	DWR	McMullin Area GSA	365180N1199129W001	T16S R19E 21	220.0	173.0	194.0	49.7	28.7
MA087	DWR	McMullin Area GSA	365213N1199060W001	T16S R19E 21	220.0		162.2		60.5
MA088	DWR	McMullin Area GSA	365721N1198766W001	T16S R19E 02	242.6		160.0		82.6
MA088	KRCD	McMullin Area GSA	A60	T16S R19E 04	230.5		179.0		51.5
MA088	KRCD	McMullin Area GSA	A61	T16S R19E 08	224.7		199.0		25.7
MA088	DWR	McMullin Area GSA	365577N1199099W001	T16S R19E 09	227.7	168.0		59.7	
MA088	DWR	McMullin Area GSA	365616N1198824W001	T16S R19E 10	232.7	150.0	171.0	82.7	61.7
MA088	KRCD	McMullin Area GSA	A62	T16S R19E 12	238.1		162.0		76.1
MA088	DWR	McMullin Area GSA	365435N1198916W001	T16S R19E 15	230.7	155.0		75.7	
MA088	DWR	McMullin Area GSA	365421N1198996W001	T16S R19E 16	227.7	159.0	188.0	68.7	39.7
MA088	DWR	McMullin Area GSA	365263N1198885W001	T16S R19E 22	225.0	158.0	182.0	69.7	45.7
NFK067	KRCD	North Fork Kings GSA	B03	T16S R17E 11	179.5		180.0		-0.5
NFK067	KRCD	North Fork Kings GSA	B05	T16S R17E 14	182.4		181.0		1.4
NFK067	DWR	North Fork Kings GSA	365388N1201257W001	T16S R17E 16	184.7	173.1		11.6	
NFK067	DWR	North Fork Kings GSA	365391N1201360W001	T16S R17E 17	183.7	156.2		27.5	
NFK067	DWR	North Fork Kings GSA	365300N1200900W001	T16S R17E 23	182.0		181.0		1.0
NFK067	KRCD	North Fork Kings GSA	B09	T16S R17E 26	185.4		190.0		-4.6
NFK067	DWR	North Fork Kings GSA	365000N1201100W001	T16S R17E 34	190.0		129.0		61.0
NFK067	KRCD	North Fork Kings GSA	B11	T16S R17E 34	190.3		129.0		61.3
NFK067	KRCD	North Fork Kings GSA	B12	T16S R17E 35	193.0		168.0		25.0
NFK067	KRCD	North Fork Kings GSA	B21	T17S R17E 02	198.9		168.0		30.9
NFK067	DWR	North Fork Kings GSA	364700N1201000W001	T17S R17E 11	199.0		168.0		31.0
NFK068	KRCD	North Fork Kings GSA	B04	T16S R17E 12	183.9		189.0		-5.1
NFK068	DWR	North Fork Kings GSA	365396N1200077W001	T16S R18E 16	197.7	159.0	219.8	38.7	-22.1
NFK068	KRCD	North Fork Kings GSA	B13	T16S R18E 17	189.3		211.0		-21.7
NFK068	DWR	North Fork Kings GSA	365246N1200349W001	T16S R18E 20	192.7	163.0		29.7	
NFK068	DWR	North Fork Kings GSA	365235N1199902W001	T16S R18E 22	207.7		206.7		1.0
NFK068	KRCD	North Fork Kings GSA	B17	T16S R18E 28	191.3		195.0		-3.7
NFK084	KRCD	North Fork Kings GSA	B22	T17S R17E 11	199.2		186.0		13.2
NFK084	DWR	North Fork Kings GSA	364593N1200299W001	T17S R18E 09	200.8	142.0	192.1	58.8	8.7
NFK084	DWR	North Fork Kings GSA	364449N1200488W001	T17S R18E 17	207.8		113.1		94.7
NFK084	DWR	North Fork Kings GSA	364452N1200485W001	T17S R18E 17	207.8		121.5		86.3
NFK084	DWR	North Fork Kings GSA	364482N1200657W001	T17S R18E 18	206.8		184.8		22.0
NFK084	DWR	North Fork Kings GSA	364313N1200263W001	T17S R18E 21	207.8	143.0	188.8	64.8	19.0
NFK084	KRCD	North Fork Kings GSA	B28	T17S R18E 21	202.3		222.0		-19.7
NFK084	DWR	North Fork Kings GSA	364224N1199949W001	T17S R18E 26	206.8	128.0	184.6	78.8	22.2
NFK084	KRCD	North Fork Kings GSA	B31	T17S R18E 27	208.0		176.0		32.0
NFK085	DWR	North Fork Kings GSA	365071N1199693W001	T16S R18E 25	207.7	172.0	202.1	35.7	5.6
NFK085	DWR	North Fork Kings GSA	364893N1200127W001	T16S R18E 33	198.7	138.0	178.2	60.7	20.5
NFK085	DWR	North Fork Kings GSA	364900N1200200W001	T16S R18E 33	193.0		176.0		17.0
NFK085	KRCD	North Fork Kings GSA	B18	T16S R18E 33	192.6		176.0		16.6
NFK085	DWR	North Fork Kings GSA	364743N1199863W001	T17S R18E 02	201.8	143.0	178.3	58.8	23.5
NFK085	KRCD	North Fork Kings GSA	B23	T17S R18E 02	197.9		174.0		23.9
NFK085	DWR	North Fork Kings GSA	364591N1200135W001	T17S R18E 09	197.8	136.0	186.6	61.8	11.2
NFK085	DWR	North Fork Kings GSA	364727N1200229W001	T17S R18E 09	196.8	140.0	200.0	56.8	-3.2
NFK085	DWR	North Fork Kings GSA	364700N1199600W001	T17S R18E 12	205.0		181.0		24.0
NFK085	DWR	North Fork Kings GSA	364449N1199682W001	T17S R18E 13	204.8	119.0		85.8	
NFK085	DWR	North Fork Kings GSA	364527N1199593W001	T17S R18E 13	204.8	120.0		84.8	
NFK085	DWR	North Fork Kings GSA	364441N1199752W001	T17S R18E 24	203.8		29.4		174.4
NFK085	DWR	North Fork Kings GSA	364735N1199579W001	T17S R19E 07	207.8	140.5	197.7	67.3	10.1
NFK085	DWR	North Fork Kings GSA	364738N1199416W001	T17S R19E 07	207.8	122.0	177.1	85.8	30.7
NFK085	KRCD	North Fork Kings GSA	B33	T17S R19E 07	205.4		181.0		24.4
NFK085	DWR	North Fork Kings GSA	364510N1199321W001	T17S R19E 17	207.8	122.0		85.8	
NFK085	DWR	North Fork Kings GSA	364493N1199460W001	T17S R19E 18	205.8	121.0		84.8	

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NFK085	DWR	North Fork Kings GSA	364432N1199502W001	T17S R19E 19	206.8	115.0		91.8	
NFK086	KRCD	North Fork Kings GSA	B20	T16S R19E 31	209.6		201.0		8.6
NFK086	DWR	North Fork Kings GSA	364916N1199307W001	T16S R19E 32	215.0	168.0	206.5	49.7	11.2
NFK086	DWR	North Fork Kings GSA	364700N1198400W002	T17S R19E 10	212.0		167.0		45.0
NFK087	DWR	North Fork Kings GSA	365285N1199318W001	T16S R19E 20	215.0	176.0	224.0	41.7	-6.3
NFK087	DWR	North Fork Kings GSA	365035N1199127W001	T16S R19E 28	220.0	163.0		59.7	
NFK087	DWR	North Fork Kings GSA	365100N1199200W001	T16S R19E 29	218.0		206.0		12.0
NFK087	KRCD	North Fork Kings GSA	A64	T16S R19E 29	218.2		206.0		12.2
NFK087	DWR	North Fork Kings GSA	364893N1198907W001	T16S R19E 34	220.0	149.0		73.7	
NFK087	DWR	North Fork Kings GSA	364924N1198991W001	T16S R19E 34	222.7	163.0	184.0	59.7	38.7
NFK087	DWR	North Fork Kings GSA	364974N1198899W001	T16S R19E 34	222.7	160.0	177.6	62.7	45.1
NFK087	DWR	North Fork Kings GSA	364921N1198721W001	T16S R19E 35	227.7		175.8		51.9
NFK087	DWR	North Fork Kings GSA	364868N1198788W001	T17S R19E 02	227.7	145.4	174.4	82.3	53.3
NFK087	DWR	North Fork Kings GSA	364813N1198968W001	T17S R19E 03	220.0	140.6	171.5	79.4	48.5
NFK087	DWR	North Fork Kings GSA	364738N1198874W001	T17S R19E 10	222.7	123.9	156.8	98.8	65.9
NFK087	DWR	North Fork Kings GSA	364743N1198877W001	T17S R19E 10	222.7	130.0	161.1	92.7	61.6
NFK088	DWR	North Fork Kings GSA	365088N1198635W001	T16S R19E 25	233.7		173.4		60.3
NFK088	DWR	North Fork Kings GSA	365143N1198529W001	T16S R19E 25	236.7		163.4		73.3
NFK088	DWR	North Fork Kings GSA	365032N1198704W001	T16S R19E 35	228.7	153.8	171.9	74.9	56.8
NFK088	DWR	North Fork Kings GSA	365032N1198549W001	T16S R19E 36	232.7	133.2	167.9	99.5	64.8
NFK089	DWR	North Fork Kings GSA	365180N1198363W001	T16S R20E 30	242.7		164.7		78.0
NFK089	DWR	North Fork Kings GSA	364916N1198366W001	T16S R20E 31	237.7	139.4	165.1	98.3	72.6
NFK089	DWR	North Fork Kings GSA	365035N1198363W001	T16S R20E 31	238.7	146.3		92.4	
NFK089	DWR	North Fork Kings GSA	364932N1198216W001	T16S R20E 32	237.7		149.1		88.6
NFK089	DWR	North Fork Kings GSA	365007N1198102W001	T16S R20E 32	239.7	106.3	141.6	133.4	98.1
NFK089	DWR	North Fork Kings GSA	364966N1198038W001	T16S R20E 33	242.7	105.6	138.0	137.1	104.7
NFK089	DWR	North Fork Kings GSA	364902N1197907W001	T16S R20E 34	238.0		119.9		118.1
NFK089	DWR	North Fork Kings GSA	364977N1197735W001	T16S R20E 34	247.7	91.6	119.0	156.1	128.7
NFK089	CID	North Fork Kings GSA	CID51	T16S R20E 34	243.5	114.4	120.1	129.1	123.4
NFK089	DWR	North Fork Kings GSA	364960N1197554W001	T16S R20E 35	249.7	85.2	113.7	164.5	136.0
NFK089	DWR	North Fork Kings GSA	365036N1197449W001	T16S R20E 36	252.7	82.6	105.5	170.1	147.2
NFK090	KRCD	North Fork Kings GSA	A65	T16S R21E 28	265.7		92.0		173.7
NFK090	DWR	North Fork Kings GSA	365150N1197327W001	T16S R21E 30	257.7	73.7	101.7	184.0	156.0
NFK090	DWR	North Fork Kings GSA	364967N1197193W001	T16S R21E 31	257.7	80.0	104.6	177.7	153.1
NFK090	DWR	North Fork Kings GSA	364908N1196971W001	T16S R21E 33	261.3		94.5		166.8
NFK090	KRCD	North Fork Kings GSA	A67	T16S R21E 35	275.1		63.0		212.2
NFK090	CID	North Fork Kings GSA	CID45	T17S R21E 03	262.0	68.9	68.9	193.1	193.1
NFK096	KRCD	North Fork Kings GSA	B30	T17S R18E 26	201.0		167.0		34.0
NFK096	DWR	North Fork Kings GSA	363719N1199579W001	T18S R19E 07	220.9	143.0	198.0	77.9	22.9
NFK097	KRCD	North Fork Kings GSA	B29	T17S R18E 24	200.2		180.0		20.2
NFK097	KRCD	North Fork Kings GSA	B32	T17S R18E 36	203.8		178.0		25.8
NFK097	DWR	North Fork Kings GSA	364421N1199168W001	T17S R19E 21	212.8	113.0		99.8	
NFK097	DWR	North Fork Kings GSA	364205N1198949W001	T17S R19E 27	216.8	110.0		106.8	
NFK097	DWR	North Fork Kings GSA	364268N1198963W001	T17S R19E 27	217.8		177.6		40.2
NFK097	DWR	North Fork Kings GSA	364299N1199085W001	T17S R19E 28	210.8	108.0		102.8	
NFK097	DWR	North Fork Kings GSA	364199N1199496W001	T17S R19E 30	202.8		122.0		80.8
NFK097	DWR	North Fork Kings GSA	364232N1199449W001	T17S R19E 30	206.8	95.0		111.8	
NFK097	DWR	North Fork Kings GSA	364033N1199049W001	T17S R19E 34	212.8		160.0		52.8
NFK097	DWR	North Fork Kings GSA	364039N1199038W001	T17S R19E 34	212.8	96.0		116.8	
NFK097	DWR	North Fork Kings GSA	363883N1199318W001	T18S R19E 05	212.8	129.0		83.8	
NFK097	DWR	North Fork Kings GSA	363944N1199407W001	T18S R19E 05	206.8	124.0		82.8	
NFK097	DWR	North Fork Kings GSA	363722N1199421W001	T18S R19E 07	217.8	128.0	208.0	89.8	9.8
NFK097	DWR	North Fork Kings GSA	363722N1199504W001	T18S R19E 07	221.8		214.0		7.8
NFK097	DWR	North Fork Kings GSA	363800N1199000W001	T18S R19E 10	203.0		178.6		24.4
NFK097	DWR	North Fork Kings GSA	363800N1199010W001	T18S R19E 10	212.8	4.0	4.9	208.8	207.9
NFK097	LID	North Fork Kings GSA	LID26	T18S R19E 10	213.9		180.0		33.9
NFK097	KRCD	North Fork Kings GSA	B38	TNul Rl> l>	202.4		189.0		13.4
NFK098	DWR	North Fork Kings GSA	364521N1199052W001	T17S R19E 16	212.8	117.0		95.8	
NFK098	DWR	North Fork Kings GSA	364402N1198788W001	T17S R19E 23	220.8	110.0		110.8	
NFK098	DWR	North Fork Kings GSA	364149N1198621W001	T17S R19E 36	221.8	105.0		116.8	
NFK098	LID	North Fork Kings GSA	LID18	T18S R19E 01	221.5		140.0		81.5
NFK099	DWR	North Fork Kings GSA	364757N1198646W001	T17S R19E 01	227.7	129.0	167.2	98.7	60.5
NFK099	KRCD	North Fork Kings GSA	B37	T17S R19E 14	217.1		167.0		50.1
NFK100	DWR	North Fork Kings GSA	364750N1197488W001	T17S R20E 01	247.7	82.4	104.1	165.3	143.6
NFK100	DWR	North Fork Kings GSA	364891N1197549W001	T17S R20E 01	245.7	83.0	85.5	162.7	160.2
NFK100	DWR	North Fork Kings GSA	364782N1197627W001	T17S R20E 02	242.7	80.7		162.0	
NFK100	DWR	North Fork Kings GSA	364816N1197785W001	T17S R20E 02	237.7		116.6		121.1
NFK100	DWR	North Fork Kings GSA	364821N1197710W001	T17S R20E 02	241.7		117.3		124.4

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NFK100	DWR	North Fork Kings GSA	364816N1197888W001	T17S R20E 03	235.7	86.8	117.9	148.9	117.8
NFK100	DWR	North Fork Kings GSA	364857N1198038W001	T17S R20E 04	234.7		171.8		62.9
NFK100	DWR	North Fork Kings GSA	364782N1198210W001	T17S R20E 05	236.7	114.8		121.9	
NFK100	DWR	North Fork Kings GSA	364782N1198471W001	T17S R20E 06	232.7		165.3		67.4
NFK100	DWR	North Fork Kings GSA	364677N1198396W001	T17S R20E 07	227.7		167.5		60.2
NFK100	DWR	North Fork Kings GSA	364700N1198400W001	T17S R20E 07	231.0		160.0		71.0
NFK100	KRCD	North Fork Kings GSA	B40	T17S R20E 07	231.3		160.0		71.3
NFK100	DWR	North Fork Kings GSA	364668N1198257W001	T17S R20E 08	232.7	107.2	148.1	125.5	84.6
NFK100	DWR	North Fork Kings GSA	364688N1197988W001	T17S R20E 09	232.7		104.5		128.2
NFK100	DWR	North Fork Kings GSA	364691N1197874W001	T17S R20E 10	235.7		121.5		114.2
NFK100	DWR	North Fork Kings GSA	364638N1197638W001	T17S R20E 11	242.7	68.8	96.5	173.9	146.2
NFK100	DWR	North Fork Kings GSA	364603N1197510W001	T17S R20E 12	242.7		102.9		139.8
NFK100	LID	North Fork Kings GSA	LID05	T17S R20E 15	233.1		113.0		120.1
NFK100	KRCD	North Fork Kings GSA	B42	T17S R20E 17	228.8		175.0		53.8
NFK100	DWR	North Fork Kings GSA	364424N1198510W001	T17S R20E 19	222.8	109.0	145.3	113.8	77.5
NFK100	DWR	North Fork Kings GSA	364449N1198313W001	T17S R20E 20	225.8	91.8	131.3	134.0	94.5
NFK100	LID	North Fork Kings GSA	LID10	T17S R20E 21	230.9		116.0		114.9
NFK100	LID	North Fork Kings GSA	LID11	T17S R20E 21	232.6		118.0		114.6
NFK100	DWR	North Fork Kings GSA	364313N1197916W001	T17S R20E 22	237.8	78.1	103.0	159.7	134.8
NFK100	DWR	North Fork Kings GSA	364343N1197624W001	T17S R20E 24	235.0	68.7	92.7	169.0	145.0
NFK100	DWR	North Fork Kings GSA	364255N1197804W001	T17S R20E 26	237.8	79.0	106.0	158.8	131.8
NFK100	DWR	North Fork Kings GSA	364185N1198163W001	T17S R20E 28	232.8	91.7	116.0	141.1	116.8
NFK100	DWR	North Fork Kings GSA	364300N1198000W001	T17S R20E 28	229.8		121.3		108.5
NFK100	LID	North Fork Kings GSA	LID16	T17S R20E 31	226.7		136.0		90.7
NFK100	DWR	North Fork Kings GSA	364163N1198007W001	T17S R20E 33	233.8		16.9		216.9
NFK100	LID	North Fork Kings GSA	LID12	T17S R20E 33	233.6		118.0		115.6
NFK100	LID	North Fork Kings GSA	LID09	T17S R20E 34	237.8		121.0		116.8
NFK100	LID	North Fork Kings GSA	LID06	T17S R20E 36	242.8		99.0		143.8
NFK101	KRCD	North Fork Kings GSA	A69	T17S R21E 03	265.0		82.0		183.1
NFK101	CID	North Fork Kings GSA	CID46	T17S R21E 05	252.2	76.1	101.1	176.1	151.1
NFK101	DWR	North Fork Kings GSA	364817N1197357W001	T17S R21E 06	252.7	81.8	104.5	170.9	148.2
NFK101	KRCD	North Fork Kings GSA	A70	T17S R21E 08	255.2		97.0		158.2
NFK101	DWR	North Fork Kings GSA	364667N1197041W001	T17S R21E 09	252.7	67.1	85.6	185.6	167.1
NFK101	DWR	North Fork Kings GSA	364667N1196641W001	T17S R21E 11	259.7	50.3	73.3	209.4	186.4
NFK101	KRCD	North Fork Kings GSA	A72	T17S R21E 12	263.0		57.0		206.0
NFK101	DWR	North Fork Kings GSA	364500N1196535W001	T17S R21E 13	262.7	32.2	33.1	230.5	229.6
NFK101	KRCD	North Fork Kings GSA	A73	T17S R21E 15	252.6		68.0		184.6
NFK101	DWR	North Fork Kings GSA	364481N1197074W002	T17S R21E 16	251.7	54.1		197.6	
NFK101	DWR	North Fork Kings GSA	364492N1197088W001	T17S R21E 17	251.7	53.0	74.0	198.7	177.7
NFK101	DWR	North Fork Kings GSA	364500N1197200W001	T17S R21E 17	245.2		75.8		169.4
NFK101	LID	North Fork Kings GSA	LID02	T17S R21E 17	245.7		78.0		167.7
NFK101	DWR	North Fork Kings GSA	364394N1197271W001	T17S R21E 19	247.7		68.1		179.6
NFK101	DWR	North Fork Kings GSA	364386N1197154W001	T17S R21E 20	250.7	47.5		203.2	
NFK101	DWR	North Fork Kings GSA	364389N1197196W001	T17S R21E 20	249.7	47.4	88.3	202.3	161.4
NFK101	LID	North Fork Kings GSA	LID01	T17S R21E 21	252.6		60.0		192.6
NFK101	DWR	North Fork Kings GSA	364417N1196804W001	T17S R21E 22	255.7		52.6		203.1
NFK101	DWR	North Fork Kings GSA	364428N1196821W001	T17S R21E 22	255.2	36.7		218.5	
NFK101	DWR	North Fork Kings GSA	364306N1197260W001	T17S R21E 29	249.7		60.9		188.8
NFK101	LID	North Fork Kings GSA	LID03	T17S R21E 30	246.7		79.0		167.7
NFK102	KRCD	North Fork Kings GSA	A68	T17S R21E 01	271.4		69.0		202.4
NFK102	KRCD	North Fork Kings GSA	A74	T17S R22E 05	279.5		53.0		226.5
NFK102	DWR	North Fork Kings GSA	364739N1196227W001	T17S R22E 07	272.7	40.5	67.1	232.2	205.6
NFK102	DWR	North Fork Kings GSA	364453N1196360W001	T17S R22E 19	269.7		24.9		244.8
NFK112	LID	North Fork Kings GSA	LID24	T18S R19E 23	212.9		171.0		41.9
NFK112	DWR	North Fork Kings GSA	363400N1198800W001	T18S R19E 26	206.5		164.6		41.9
NFK112	DWR	North Fork Kings GSA	363208N1198691W002	T18S R19E 36	213.8	111.0	165.0	102.8	48.8
NFK112	DWR	North Fork Kings GSA	363133N1199046W001	T19S R19E 03	218.9	94.5		124.4	
NFK113	DWR	North Fork Kings GSA	363981N1198804W001	T18S R19E 02	217.8		9.3		208.5
NFK113	DWR	North Fork Kings GSA	363667N1198832W001	T18S R19E 14	215.8	3.6	5.3	212.2	210.5
NFK114	DWR	North Fork Kings GSA	364002N1197624W001	T18S R20E 01	242.8		109.0		133.8
NFK114	LID	North Fork Kings GSA	LID07	T18S R20E 01	242.8		104.0		138.8
NFK114	LID	North Fork Kings GSA	LID08	T18S R20E 02	240.8		124.0		116.8
NFK114	DWR	North Fork Kings GSA	364000N1198100W001	T18S R20E 04	226.1		130.0		96.1
NFK114	DWR	North Fork Kings GSA	364008N1196907W001	T18S R20E 04	248.6		75.4		175.4
NFK114	LID	North Fork Kings GSA	LID14	T18S R20E 04	235.9		131.0		104.9
NFK114	LID	North Fork Kings GSA	LID23	T18S R20E 07	225.7		146.0		79.7
NFK114	LID	North Fork Kings GSA	LID21	T18S R20E 08	227.7		127.0		100.7
NFK114	DWR	North Fork Kings GSA	363794N1198157W001	T18S R20E 09	230.8		11.1		219.7

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NFK114	LID	North Fork Kings GSA	LID22	T18S R20E 09	235.9		135.0		100.9
NFK114	DWR	North Fork Kings GSA	363700N1198300W001	T18S R20E 17	214.6		144.5		70.1
NFK114	DWR	North Fork Kings GSA	363728N1198296W001	T18S R20E 17	227.3		4.9		222.4
NFK114	DWR	North Fork Kings GSA	363461N1198468W001	T18S R20E 19	219.8	108.0	123.0	111.8	96.8
NK004	DWR	North Kings GSA	368566N1198421W001	T12S R19E 25	257.5	28.9		228.6	
NK004	City of Fresno	North Kings GSA	12S19E33P001MX	T12S R19E 33	300.9	85.5	98.6	215.4	202.3
NK004	City of Fresno	North Kings GSA	12S19E34L001MX	T12S R19E 34	315.4	104.7		210.7	
NK004	FID	North Kings GSA	12S19E34P001MX	T12S R19E 34	317.8	101.1		216.7	
NK004	City of Fresno	North Kings GSA	12S19E35Q001MX	T12S R19E 35	323.1	113.6	124.9	209.5	198.2
NK004	City of Fresno	North Kings GSA	12S19E36J001MX	T12S R19E 36	331.8	123.3	147.9	208.5	183.9
NK004	City of Fresno	North Kings GSA	12S19E36Q001MX	T12S R19E 36	332.1	127.4	140.2	204.7	191.9
NK004	DWR	North Kings GSA	368400N1198400W001	T12S R19E 36	292.0		83.1		208.9
NK005	DWR	North Kings GSA	369188N1197341W001	T12S R20E 01	317.5	48.7		268.8	
NK005	DWR	North Kings GSA	369018N1197560W002	T12S R20E 11	364.5	104.5		260.0	
NK005	DWR	North Kings GSA	368916N1197307W001	T12S R20E 13	389.5	145.3		244.2	
NK005	City of Fresno	North Kings GSA	12S20E15A001MX	T12S R20E 15	361.3	136.6		224.7	
NK005	City of Fresno	North Kings GSA	12S20E23D001MX	T12S R20E 23	364.4	133.5	149.7	230.9	214.7
NK005	City of Fresno	North Kings GSA	12S20E23M001MX	T12S R20E 23	354.2	123.8		230.4	
NK005	DWR	North Kings GSA	368610N1197321W001	T12S R20E 25	368.5	127.4		241.1	
NK005	DWR	North Kings GSA	368610N1197463W001	T12S R20E 25	364.5	131.7		232.8	
NK005	City of Fresno	North Kings GSA	12S20E26A001MX	T12S R20E 26	373.0	144.4	166.3	228.6	206.7
NK005	City of Fresno	North Kings GSA	12S20E26K001MX	T12S R20E 26	360.2	135.5	154.6	224.7	205.6
NK005	DWR	North Kings GSA	368538N1197588W001	T12S R20E 26	355.5	128.4		227.1	
NK005	City of Fresno	North Kings GSA	12S20E27H001MX	T12S R20E 27	367.0	138.0	175.9	229.0	191.1
NK005	City of Fresno	North Kings GSA	12S20E27L001MX	T12S R20E 27	358.0	135.8	158.0	222.2	200.0
NK005	City of Fresno	North Kings GSA	12S20E27N001MX	T12S R20E 27	351.0	132.4	152.8	218.6	198.2
NK005	City of Fresno	North Kings GSA	12S20E32A001MX	T12S R20E 32	346.5		143.0		203.5
NK005	DWR	North Kings GSA	368466N1198071W001	T12S R20E 32	343.5	126.3		217.2	
NK005	City of Fresno	North Kings GSA	12S20E34K001MX	T12S R20E 34	360.1	126.0	151.0	234.1	209.1
NK005	DWR	North Kings GSA	368393N1197810W001	T12S R20E 34	342.5	81.3		261.2	
NK005	DWR	North Kings GSA	368393N1197493W001	T12S R20E 35	352.5	121.0		231.5	
NK005	City of Fresno	North Kings GSA	12S20E36M001MX	T12S R20E 36	349.9	134.6	162.1	215.3	187.8
NK005	DWR	North Kings GSA	368432N1197321W001	T12S R20E 36	362.5		181.7		180.8
NK006	DWR	North Kings GSA	369099N1197113W001	T12S R21E 07	408.0	149.9		258.1	
NK006	DWR	North Kings GSA	12S21E16B001MX	T12S R21E 16	400.0	17.8		382.2	
NK006	DWR	North Kings GSA	368874N1197043W001	T12S R21E 17	390.5	83.1		307.4	
NK006	DWR	North Kings GSA	368893N1197016W001	T12S R21E 17	391.5	72.5		319.0	
NK006	DWR	North Kings GSA	368938N1197091W001	T12S R21E 17	396.5	114.4		282.1	
NK006	DWR	North Kings GSA	368955N1197168W001	T12S R21E 18	394.5	139.3		255.2	
NK006	DWR	North Kings GSA	368682N1197177W001	T12S R21E 19	375.5	92.2	130.1	283.3	245.4
NK006	DWR	North Kings GSA	368716N1197132W001	T12S R21E 19	380.5	81.4		299.1	
NK006	DWR	North Kings GSA	368571N1196546W001	T12S R21E 26	396.3	48.1		348.2	
NK006	DWR	North Kings GSA	368607N1196654W001	T12S R21E 27	398.5	51.0		347.5	
NK006	DWR	North Kings GSA	368613N1196657W001	T12S R21E 27	392.5	48.0		344.5	
NK006	DWR	North Kings GSA	12S21E29K001MX	T12S R21E 29	379.0		90.1		288.9
NK006	DWR	North Kings GSA	368546N1196974W001	T12S R21E 29	379.5		91.5		288.0
NK006	DWR	North Kings GSA	368571N1197002W001	T12S R21E 29	381.5	66.4	89.1	315.1	292.4
NK006	DWR	North Kings GSA	368610N1197132W001	T12S R21E 30	376.5	94.5		282.0	
NK006	City of Clovis	North Kings GSA	12S21E31M001MX	T12S R21E 31	361.5	131.0	167.5	230.5	194.0
NK006	City of Clovis	North Kings GSA	13S21E30Q001MX	T12S R21E 31	370.0	126.3		243.7	
NK006	DWR	North Kings GSA	368463N1197113W001	T12S R21E 31	369.5	95.7		273.8	
NK006	DWR	North Kings GSA	368499N1197227W001	T12S R21E 31	365.5	118.0		247.5	
NK006	City of Clovis	North Kings GSA	12S21E32K001MX	T12S R21E 32	370.1	143.0	165.0	227.1	205.1
NK006	City of Clovis	North Kings GSA	12S21E32Q001MX	T12S R21E 32	370.5	128.0	154.0	242.5	216.5
NK006	DWR	North Kings GSA	368377N1197024W001	T12S R21E 32	368.5	81.7		286.8	
NK006	FID	North Kings GSA	12S21E33P001MX	T12S R21E 33	374.2	93.1		281.1	
NK006	City of Clovis	North Kings GSA	12S21E33P002MX	T12S R21E 33	371.2	113.0	131.8	258.2	239.4
NK006	DWR	North Kings GSA	368377N1196843W001	T12S R21E 33	376.5	93.1		283.4	
NK006	DWR	North Kings GSA	368393N1196871W001	T12S R21E 33	372.5	86.0		286.5	
NK006	DWR	North Kings GSA	368499N1196910W001	T12S R21E 33	378.5	67.3		311.2	
NK006	FID	North Kings GSA	12S21E34D001MX	T12S R21E 34	387.7	70.0		317.7	
NK006	DWR	North Kings GSA	12S21E34H001MX	T12S R21E 34	390.0		61.3		328.7
NK006	DWR	North Kings GSA	368468N1196593W001	T12S R21E 34	392.5	59.7	60.3	332.8	332.2
NK006	DWR	North Kings GSA	368510N1196713W001	T12S R21E 34	390.2	70.0		320.2	
NK008	DWR	North Kings GSA	368552N1196413W001	T12S R21E 26	412.6	47.7		364.9	
NK008	DWR	North Kings GSA	12S21E35Q001MX	T12S R21E 35	419.0		66.9		352.1
NK008	DWR	North Kings GSA	368377N1196479W001	T12S R21E 35	395.1		66.4		328.7
NK008	DWR	North Kings GSA	368432N1196460W001	T12S R21E 35	401.6	60.4	64.1	341.2	337.5

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NK008	DWR	North Kings GSA	368499N1196460W001	T12S R21E 35	404.6	56.7	58.2	347.9	346.3
NK008	DWR	North Kings GSA	368433N1196282W001	T12S R21E 36	411.6	61.9	64.1	349.7	347.5
NK008	DWR	North Kings GSA	368469N1196232W001	T12S R21E 36	421.6	60.2		361.4	
NK008	DWR	North Kings GSA	12S22E19N001MX	T12S R22E 19	438.0		26.6		411.4
NK008	DWR	North Kings GSA	368683N1196185W001	T12S R22E 19	440.6	20.8	25.6	419.8	415.0
NK008	DWR	North Kings GSA	368597N1195846W001	T12S R22E 29	464.6	19.8		444.8	
NK008	DWR	North Kings GSA	12S22E32R001MX	T12S R22E 32	438.0		53.1		384.9
NK008	DWR	North Kings GSA	368378N1195871W001	T12S R22E 32	433.6	46.9	52.6	386.7	381.0
NK009	DWR	North Kings GSA	368750N1195824W001	T12S R22E 21	475.6	11.7		463.9	
NK009	DWR	North Kings GSA	368572N1195413W001	T12S R22E 26	487.6	9.0	21.8	478.6	465.8
NK010	DWR	North Kings GSA	12S22E26L001MX	T12S R22E 26	485.0		21.8		463.2
NK011	DWR	North Kings GSA	368394N1195460W001	T12S R22E 35	447.6	10.0		437.6	
NK011	FID	North Kings GSA	13S23E19N001MX	T13S R23E 19	410.3	11.7		398.6	
NK011	FID	North Kings GSA	13S23E30B001MX	T13S R23E 30	410.8	10.9	5.2	399.9	405.6
NK011	DWR	North Kings GSA	367772N1195179W001	T13S R23E 30	408.6	5.6	13.2	403.0	395.4
NK011	DWR	North Kings GSA	367789N1195107W001	T13S R23E 30	414.0	10.6		403.4	
NK015	FID	North Kings GSA	13S17E12J001MX	T13S R17E 12	244.2	52.5	46.1	191.7	198.1
NK015	FID	North Kings GSA	13S17E13H001MX	T13S R17E 13	242.3		44.0		198.3
NK015	DWR	North Kings GSA	368077N1201163W001	T13S R17E 16	220.4	30.5		189.9	
NK015	DWR	North Kings GSA	367966N1201513W001	T13S R17E 18	199.4	16.3		183.1	
NK015	DWR	North Kings GSA	367977N1201682W001	T13S R17E 18	197.4	8.7		188.7	
NK015	DWR	North Kings GSA	367932N1201510W001	T13S R17E 19	211.4	15.7		195.7	
NK015	FID	North Kings GSA	13S17E20A001MX	T13S R17E 20	209.9	39.2		170.7	
NK015	FID	North Kings GSA	13S17E22B001MX	T13S R17E 22	221.9	42.2	50.5	179.7	171.4
NK015	DWR	North Kings GSA	367785N1200704W001	T13S R17E 24	234.0		52.2		181.8
NK015	DWR	North Kings GSA	367913N1200646W001	T13S R17E 24	242.4	58.2		184.2	
NK015	FID	North Kings GSA	13S17E25C001MX	T13S R17E 25	231.8	52.9	53.1	178.9	178.8
NK015	FID	North Kings GSA	13S17E27L001MX	T13S R17E 27	215.6	53.5	58.6	162.1	157.0
NK015	DWR	North Kings GSA	367691N1200968W001	T13S R17E 27	223.5	59.3		164.2	
NK015	DWR	North Kings GSA	367700N1201100W001	T13S R17E 27	217.0		58.2		158.8
NK015	DWR	North Kings GSA	367732N1201191W001	T13S R17E 28	215.4	58.2		157.2	
NK015	DWR	North Kings GSA	367638N1201279W001	T13S R17E 33	213.5	68.9		144.6	
NK015	FID	North Kings GSA	13S17E34L001MX	T13S R17E 34	214.7	62.8	68.8	151.9	145.9
NK015	DWR	North Kings GSA	367568N1201057W001	T13S R17E 34	217.8	62.7		155.1	
NK015	DWR	North Kings GSA	367563N1200877W001	T13S R17E 35	222.5	71.9		150.6	
NK015	FID	North Kings GSA	13S17E36N001MX	T13S R17E 36	220.6	66.9		153.7	
NK016	DWR	North Kings GSA	368321N1199541W001	T13S R18E 01	284.4	67.7		216.7	
NK016	DWR	North Kings GSA	368227N1199799W001	T13S R18E 02	272.4	59.1		213.3	
NK016	DWR	North Kings GSA	368363N1199802W001	T13S R18E 02	262.4	47.0		215.4	
NK016	DWR	North Kings GSA	368260N1199991W001	T13S R18E 03	267.4	52.6		214.8	
NK016	FID	North Kings GSA	13S18E07K001MX	T13S R18E 07	248.9		54.0		194.9
NK016	FID	North Kings GSA	13S18E07L001MX	T13S R18E 07	245.2		51.0		194.2
NK016	FID	North Kings GSA	13S18E07P002MX	T13S R18E 07	247.4		51.5		195.9
NK016	FID	North Kings GSA	13S18E08K001MX	T13S R18E 08	256.8		55.5		201.3
NK016	DWR	North Kings GSA	368074N1200260W001	T13S R18E 08	255.0		51.0		204.0
NK016	DWR	North Kings GSA	368196N1200160W001	T13S R18E 09	257.4	35.0		222.4	
NK016	FID	North Kings GSA	13S18E10L001MX	T13S R18E 10	261.4	62.9	54.8	198.5	206.6
NK016	DWR	North Kings GSA	368093N1199988W001	T13S R18E 10	260.4	51.4		209.0	
NK016	FID	North Kings GSA	13S18E11J001MX	T13S R18E 11	271.5	67.5		204.0	
NK016	DWR	North Kings GSA	368146N1199716W001	T13S R18E 11	273.9	67.5		206.4	
NK016	DWR	North Kings GSA	368010N1199704W002	T13S R18E 13	268.9	58.8		210.1	
NK016	DWR	North Kings GSA	368002N1199888W001	T13S R18E 15	263.4	57.4		206.0	
NK016	FID	North Kings GSA	13S18E17A001MX	T13S R18E 17	253.2	48.6	51.0	204.6	202.2
NK016	FID	North Kings GSA	13S18E18A001MX	T13S R18E 18	253.7		57.0		196.7
NK016	FID	North Kings GSA	13S18E18A002MX	T13S R18E 18	253.9		58.5		195.4
NK016	FID	North Kings GSA	13S18E18A003MX	T13S R18E 18	250.0		50.0		200.0
NK016	FID	North Kings GSA	13S18E18G002MX	T13S R18E 18	253.6		59.0		194.6
NK016	FID	North Kings GSA	13S18E18G003MX	T13S R18E 18	249.0		53.0		196.0
NK016	FID	North Kings GSA	13S18E18G004MX	T13S R18E 18	244.9		47.0		197.9
NK016	FID	North Kings GSA	13S18E18H002MX	T13S R18E 18	253.2		57.0		196.2
NK016	FID	North Kings GSA	13S18E18M001MX	T13S R18E 18	244.1		47.0		197.1
NK016	FID	North Kings GSA	13S18E18M002MX	T13S R18E 18	245.2		52.0		193.2
NK016	FID	North Kings GSA	13S18E19A001MX	T13S R18E 19	244.6		47.0		197.6
NK016	FID	North Kings GSA	13S18E20D001MX	T13S R18E 20	244.7		51.0		193.7
NK016	DWR	North Kings GSA	367930N1200343W001	T13S R18E 20	247.4	47.9		199.5	
NK016	DWR	North Kings GSA	367813N1200160W001	T13S R18E 21	246.9	49.3		197.6	
NK016	FID	North Kings GSA	13S18E22P002MX	T13S R18E 22	255.4		71.0		184.4
NK016	FID	North Kings GSA	13S18E22Q002MX	T13S R18E 22	254.9		55.0		199.9

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NK016	FID	North Kings GSA	13S18E22R001MX	T13S R18E 22	260.3		63.0		197.3
NK016	FID	North Kings GSA	13S18E22R002MX	T13S R18E 22	260.7		63.0		197.7
NK016	FID	North Kings GSA	13S18E22R003MX	T13S R18E 22	261.5		59.0		202.5
NK016	DWR	North Kings GSA	367857N1199977W001	T13S R18E 22	247.9	53.7		194.2	
NK016	FID	North Kings GSA	13S18E23N001MX	T13S R18E 23	255.1	55.2	49.0	199.9	206.1
NK016	FID	North Kings GSA	13S18E25B001MX	T13S R18E 25	265.9	63.4		202.5	
NK016	FID	North Kings GSA	13S18E25K001MX	T13S R18E 25	261.0		61.0		200.0
NK016	DWR	North Kings GSA	367782N1199585W001	T13S R18E 25	268.4	63.4		205.0	
NK016	FID	North Kings GSA	13S18E27A001MX	T13S R18E 27	257.0		56.0		201.0
NK016	FID	North Kings GSA	13S18E27B001MX	T13S R18E 27	256.7		54.0		202.7
NK016	FID	North Kings GSA	13S18E27B003MX	T13S R18E 27	254.7		56.0		198.7
NK016	FID	North Kings GSA	13S18E28F001MX	T13S R18E 28	243.1	52.1	47.7	191.0	195.4
NK016	DWR	North Kings GSA	367700N1200200W001	T13S R18E 28	245.0		46.0		199.0
NK016	FID	North Kings GSA	13S18E29C001MX	T13S R18E 29	238.5	53.8	48.0	184.7	190.5
NK016	DWR	North Kings GSA	367499N1200410W001	T13S R18E 32	233.8	64.5		169.3	
NK016	FID	North Kings GSA	13S18E33M001MX	T13S R18E 33	237.3	57.5	51.5	179.8	185.8
NK016	FID	North Kings GSA	13S18E34K001MX	T13S R18E 34	242.7		43.1		199.6
NK016	FID	North Kings GSA	13S18E34N001MX	T13S R18E 34	243.1		50.0		193.1
NK016	DWR	North Kings GSA	367638N1200057W001	T13S R18E 34	247.5	58.7		188.8	
NK016	FID	North Kings GSA	13S18E35G001MX	T13S R18E 35	253.2		58.0		195.3
NK016	FID	North Kings GSA	14S18E05D001MX	T14S R18E 05	230.5	64.7		165.8	
NK017	City of Fresno	North Kings GSA	13S19E01C001MX	T13S R19E 01	329.3		129.9		199.4
NK017	City of Fresno	North Kings GSA	13S19E01L001MX	T13S R19E 01	312.8	105.7	123.2	207.1	189.6
NK017	City of Fresno	North Kings GSA	13S19E02M001MX	T13S R19E 02	314.4		120.3		194.1
NK017	FID	North Kings GSA	13S19E06A001MX	T13S R19E 06	291.2	76.8	82.0	214.4	209.2
NK017	FID	North Kings GSA	13S19E07R001MX	T13S R19E 07	279.4	66.0		213.4	
NK017	City of Fresno	North Kings GSA	13S19E10F001MX	T13S R19E 10	304.4	99.1	113.3	205.3	191.1
NK017	City of Fresno	North Kings GSA	13S19E10Q001MX	T13S R19E 10	298.0	90.3	104.2	207.7	193.8
NK017	City of Fresno	North Kings GSA	13S19E11L001MX	T13S R19E 11	304.7	100.4	115.0	204.3	189.7
NK017	DWR	North Kings GSA	367991N1199052W001	T13S R19E 16	292.5	82.4		210.1	
NK017	FID	North Kings GSA	13S19E18E001MX	T13S R19E 18	273.4	65.4		208.0	
NK017	FID	North Kings GSA	13S19E18E002MX	T13S R19E 18	274.2		69.4		204.8
NK017	FID	North Kings GSA	13S19E21D001MX	T13S R19E 21	282.9	75.7		207.2	
NK017	FID	North Kings GSA	13S19E23E001MX	T13S R19E 23	284.6	80.8	81.0	203.8	203.6
NK017	DWR	North Kings GSA	367899N1198799W001	T13S R19E 23	287.0		80.1		207.0
NK017	City of Fresno	North Kings GSA	13S19E26L001MX	T13S R19E 26	279.3	76.6	82.6	202.7	196.7
NK017	FID	North Kings GSA	13S19E27R001MX	T13S R19E 27	390.0	74.2		315.8	
NK017	FID	North Kings GSA	13S19E29A001MX	T13S R19E 29	266.9		71.7		195.2
NK017	FID	North Kings GSA	13S19E29D001MX	T13S R19E 29	268.2		71.3		196.9
NK017	FID	North Kings GSA	13S19E29E001MX	T13S R19E 29	268.0	66.7		201.3	
NK018	City of Fresno	North Kings GSA	13S20E01G001MX	T13S R20E 01	348.4	132.5	158.5	215.9	189.9
NK018	City of Fresno	North Kings GSA	13S20E02G001MX	T13S R20E 02	345.2	127.1		218.1	
NK018	City of Fresno	North Kings GSA	13S20E03H001MX	T13S R20E 03	333.4	123.1		210.4	
NK018	City of Fresno	North Kings GSA	13S20E05B001MX	T13S R20E 05	338.7	126.6	145.6	212.1	193.1
NK018	City of Fresno	North Kings GSA	13S20E06H001MX	T13S R20E 06	329.3	123.4	137.5	205.9	191.8
NK018	City of Fresno	North Kings GSA	13S20E06M001MX	T13S R20E 06	326.5	124.1		202.4	
NK018	City of Fresno	North Kings GSA	13S20E09L001MX	T13S R20E 09	321.6	112.3	142.2	209.3	179.4
NK018	City of Fresno	North Kings GSA	13S20E10Q001MX	T13S R20E 10	327.5	116.0	142.4	211.5	185.1
NK018	City of Fresno	North Kings GSA	13S20E11L001MX	T13S R20E 11	329.2	116.0	150.0	213.2	179.2
NK018	FID	North Kings GSA	13S20E12H001MX	T13S R20E 12	343.4	113.4		230.0	
NK018	DWR	North Kings GSA	368191N1197363W001	T13S R20E 12	345.9	113.4		232.5	
NK018	City of Fresno	North Kings GSA	13S20E13C001MX	T13S R20E 13	335.2	105.1	140.4	230.1	194.8
NK018	City of Fresno	North Kings GSA	13S20E13H001MX	T13S R20E 13	335.6		135.1		200.5
NK018	City of Fresno	North Kings GSA	13S20E14L001MX	T13S R20E 14	312.9		141.3		171.6
NK018	City of Fresno	North Kings GSA	13S20E16Q001MX	T13S R20E 16	312.4		131.3		181.1
NK018	City of Fresno	North Kings GSA	13S20E17A001MX	T13S R20E 17	319.9	113.3		206.6	
NK018	City of Fresno	North Kings GSA	13S20E17J001MX	T13S R20E 17	317.0	114.9	135.7	202.1	181.3
NK018	City of Fresno	North Kings GSA	13S20E17L001MX	T13S R20E 17	319.0	112.6		206.4	
NK018	City of Fresno	North Kings GSA	13S20E18E001MX	T13S R20E 18	304.0	102.2	119.6	201.8	184.4
NK018	City of Fresno	North Kings GSA	13S20E19C001MX	T13S R20E 19	307.6	105.4	124.5	202.2	183.1
NK018	City of Fresno	North Kings GSA	13S20E20J001MX	T13S R20E 20	304.4	104.4	138.3	200.0	166.1
NK018	City of Fresno	North Kings GSA	13S20E20R001MX	T13S R20E 20	300.2	90.8	115.8	209.4	184.4
NK018	City of Fresno	North Kings GSA	13S20E22H001MX	T13S R20E 22	320.6	118.1	141.9	202.6	178.7
NK018	City of Fresno	North Kings GSA	13S20E23B001MX	T13S R20E 23	324.7	114.1	142.9	210.6	181.8
NK018	City of Fresno	North Kings GSA	13S20E23J001MX	T13S R20E 23	322.2	101.0	131.5	221.1	190.7
NK018	City of Fresno	North Kings GSA	13S20E25G001MX	T13S R20E 25	321.9	95.1	130.4	226.8	191.5
NK018	City of Fresno	North Kings GSA	13S20E26P001MX	T13S R20E 26	307.9	104.1	129.8	203.9	178.1
NK018	City of Fresno	North Kings GSA	13S20E27C001MX	T13S R20E 27	310.1	113.0	130.9	197.1	179.2

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NK018	City of Fresno	North Kings GSA	13S20E28C001MX	T13S R20E 28	307.0		125.2		181.8
NK018	City of Fresno	North Kings GSA	13S20E28N001MX	T13S R20E 28	299.5	90.0	112.8	209.5	186.7
NK018	City of Fresno	North Kings GSA	13S20E28R001MX	T13S R20E 28	300.8	105.8		195.0	
NK018	City of Fresno	North Kings GSA	13S20E30B001MX	T13S R20E 30	304.0	106.1	118.1	197.9	185.9
NK018	City of Fresno	North Kings GSA	13S20E31D001MX	T13S R20E 31	292.4		102.5		189.9
NK018	City of Fresno	North Kings GSA	13S20E32D001MX	T13S R20E 32	293.3	91.6	106.9	201.7	186.4
NK018	City of Fresno	North Kings GSA	13S20E32K001MX	T13S R20E 32	292.1		107.3		184.8
NK019	DWR	North Kings GSA	367577N1197868W001	T13S R20E 34	300.7	103.9		196.8	
NK019	City of Fresno	North Kings GSA	13S20E36P001MX	T13S R20E 36	306.5	99.0		207.5	
NK020	DWR	North Kings GSA	368282N1196616W001	T13S R21E 02	384.5	62.2		322.3	
NK020	City of Clovis	North Kings GSA	13S21E09D001MX	T13S R21E 04	359.9	93.5		266.4	
NK020	City of Clovis	North Kings GSA	13S21E05E001MX	T13S R21E 05	364.6	130.0	169.8	234.6	194.9
NK020	City of Clovis	North Kings GSA	13S21E05J001MX	T13S R21E 05	361.3	96.3		265.0	
NK020	City of Clovis	North Kings GSA	13S21E06H001MX	T13S R21E 06	358.0	140.6		217.4	
NK020	City of Clovis	North Kings GSA	13S21E06P001MX	T13S R21E 06	354.8	120.5	155.5	234.3	199.3
NK020	City of Clovis	North Kings GSA	13S21E07G001MX	T13S R21E 07	345.8	111.4		234.4	
NK020	City of Clovis	North Kings GSA	13S21E07P001MX	T13S R21E 07	345.0		146.3		198.8
NK020	City of Clovis	North Kings GSA	13S21E08J001MX	T13S R21E 08	355.0	101.0	146.0	254.0	209.0
NK020	City of Clovis	North Kings GSA	13S21E09C001MX	T13S R21E 09	360.7	107.0	134.0	253.7	226.7
NK020	City of Clovis	North Kings GSA	13S21E09R001MX	T13S R21E 09	365.0	125.5	147.8	239.5	217.3
NK020	City of Clovis	North Kings GSA	13S21E10G001MX	T13S R21E 10	373.1		107.5		265.6
NK020	DWR	North Kings GSA	368211N1196482W001	T13S R21E 11	388.5	57.3	62.8	331.2	325.7
NK020	FID	North Kings GSA	13S21E14D001MX	T13S R21E 14	378.0	58.6		319.4	
NK020	City of Clovis	North Kings GSA	13S21E15L001MX	T13S R21E 15	357.0		137.0		220.0
NK020	City of Clovis	North Kings GSA	13S21E16M001MX	T13S R21E 16	354.8	126.0	150.0	228.8	204.8
NK020	City of Clovis	North Kings GSA	13S21E16N001MX	T13S R21E 16	347.6	93.0	124.8	254.6	222.9
NK020	City of Clovis	North Kings GSA	13S21E16N002MX	T13S R21E 16	347.0	98.0	127.0	249.0	220.0
NK020	City of Clovis	North Kings GSA	13S21E16P001MX	T13S R21E 16	354.7	95.8	128.0	258.9	226.7
NK020	City of Clovis	North Kings GSA	13S21E17J001MX	T13S R21E 17	355.0	96.5		258.5	
NK020	City of Clovis	North Kings GSA	13S21E17Q001MX	T13S R21E 17	345.5	91.0	131.8	254.5	213.8
NK020	City of Clovis	North Kings GSA	13S21E17Q002MX	T13S R21E 17	349.4	97.0	135.5	252.4	213.9
NK020	City of Clovis	North Kings GSA	13S21E18H001MX	T13S R21E 18	343.0	97.7	139.0	245.3	204.0
NK020	City of Fresno	North Kings GSA	13S21E19E001MX	T13S R21E 19	334.8	93.0	129.8	241.8	205.0
NK020	City of Clovis	North Kings GSA	13S21E20A001MX	T13S R21E 20	347.0	94.5	128.5	252.5	218.5
NK020	City of Clovis	North Kings GSA	13S21E20A002MX	T13S R21E 20	347.0	94.0	131.8	253.0	215.3
NK020	City of Clovis	North Kings GSA	13S21E20F001MX	T13S R21E 20	338.0		141.0		197.0
NK020	City of Clovis	North Kings GSA	13S21E21E001MX	T13S R21E 21	347.0	95.5	126.0	251.5	221.0
NK020	City of Clovis	North Kings GSA	13S21E21E002MX	T13S R21E 21	347.0	90.8		256.2	
NK020	City of Fresno	North Kings GSA	13S21E30P001MX	T13S R21E 30	318.9	93.1	124.1	225.8	194.8
NK020	City of Fresno	North Kings GSA	13S21E31E001MX	T13S R21E 31	312.2	95.1	119.4	217.1	192.8
NK021	DWR	North Kings GSA	367958N1196482W001	T13S R21E 14	372.5		45.3		327.2
NK021	City of Fresno	North Kings GSA	13S21E21P001MX	T13S R21E 21	340.0	78.0		261.9	
NK021	FID	North Kings GSA	13S21E23D001MX	T13S R21E 23	362.0	53.8		308.2	
NK021	DWR	North Kings GSA	367811N1196482W001	T13S R21E 23	356.5	32.8	44.9	323.7	311.6
NK021	DWR	North Kings GSA	367936N1196593W001	T13S R21E 23	364.5	53.6		310.9	
NK021	FID	North Kings GSA	13S21E24J001MX	T13S R21E 24	370.8	32.3	40.6	338.5	330.2
NK021	DWR	North Kings GSA	367664N1196438W001	T13S R21E 25	356.5	36.6	53.8	319.9	302.7
NK021	FID	North Kings GSA	13S21E26M001MX	T13S R21E 26	348.1	47.8	58.3	300.3	289.9
NK021	DWR	North Kings GSA	367700N1196799W001	T13S R21E 27	341.5	62.8	82.2	278.7	259.3
NK021	City of Fresno	North Kings GSA	13S21E28G001MX	T13S R21E 28	338.7	96.9	119.2	241.8	219.5
NK021	City of Fresno	North Kings GSA	13S21E29H001MX	T13S R21E 29	335.3	93.1	124.4	242.3	210.9
NK021	City of Fresno	North Kings GSA	13S21E32G001MX	T13S R21E 32	327.7	93.1	122.2	234.7	205.5
NK021	DWR	North Kings GSA	367522N1196754W001	T13S R21E 34	336.5	61.1		275.4	
NK021	DWR	North Kings GSA	367556N1196666W001	T13S R21E 34	340.5		64.3		276.2
NK021	DWR	North Kings GSA	367594N1196349W001	T13S R21E 36	353.5	27.9	47.1	325.6	306.4
NK021	DWR	North Kings GSA	367594N1196399W001	T13S R21E 36	354.5	28.2	46.6	326.3	307.9
NK021	DWR	North Kings GSA	367922N1196279W001	T13S R22E 19	374.5		37.9		336.6
NK022	DWR	North Kings GSA	368244N1195449W001	T13S R22E 02	447.6	23.0	26.3	424.6	421.3
NK022	DWR	North Kings GSA	13S22E03B001MX	T13S R22E 03	434.0		24.9		409.1
NK022	DWR	North Kings GSA	368353N1195627W001	T13S R22E 03	436.6	12.0	23.9	424.6	412.7
NK022	DWR	North Kings GSA	13S22E05A001MX	T13S R22E 05	420.0	51.6		368.4	
NK022	DWR	North Kings GSA	368322N1196127W001	T13S R22E 06	417.6	63.1		354.5	
NK022	FID	North Kings GSA	13S22E07R001MX	T13S R22E 07	391.6	31.5	45.5	360.1	346.1
NK022	DWR	North Kings GSA	368106N1196143W001	T13S R22E 07	394.0		45.0		349.0
NK022	DWR	North Kings GSA	368133N1196127W001	T13S R22E 07	393.6	27.0	39.1	366.6	354.5
NK022	DWR	North Kings GSA	368211N1195946W001	T13S R22E 08	414.6	45.2		369.4	
NK022	DWR	North Kings GSA	368103N1195899W001	T13S R22E 09	405.6	30.6		375.0	
NK022	FID	North Kings GSA	13S22E13A001MX	T13S R22E 13	436.6	3.0		433.6	

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NK022	DWR	North Kings GSA	368053N1195199W001	T13S R22E 13	442.6		8.4		434.2
NK022	DWR	North Kings GSA	368061N1195449W001	T13S R22E 14	436.6	25.3	31.9	411.3	404.7
NK022	DWR	North Kings GSA	367953N1195585W001	T13S R22E 15	415.6	30.5	41.6	385.1	375.0
NK022	DWR	North Kings GSA	367989N1196102W001	T13S R22E 18	392.6		39.9		352.2
NK022	DWR	North Kings GSA	13S22E20A001MX	T13S R22E 20	380.0		16.9		363.1
NK022	DWR	North Kings GSA	367922N1195946W001	T13S R22E 20	382.6	9.5	15.9	373.1	366.7
NK022	DWR	North Kings GSA	13S22E22R001MX	T13S R22E 22	393.0		27.9		365.1
NK022	DWR	North Kings GSA	367811N1195585W001	T13S R22E 22	395.6	15.2	26.9	380.4	368.7
NK022	DWR	North Kings GSA	13S22E23R001MX	T13S R22E 23	405.0	6.5	15.9	398.5	389.1
NK022	DWR	North Kings GSA	367881N1195496W001	T13S R22E 23	407.6	10.3	24.9	397.3	316.6
NK022	DWR	North Kings GSA	367789N1195382W001	T13S R22E 26	406.6		14.9		391.7
NK022	DWR	North Kings GSA	367792N1195535W001	T13S R22E 26	402.6		22.8		379.8
NK022	FID	North Kings GSA	13S22E27R001MX	T13S R22E 27	390.0	11.9		378.1	
NK022	DWR	North Kings GSA	367653N1195677W001	T13S R22E 27	387.6	9.6	27.1	378.0	360.5
NK022	DWR	North Kings GSA	367789N1195682W001	T13S R22E 27	393.6		31.7		361.9
NK022	DWR	North Kings GSA	367772N1195807W001	T13S R22E 28	385.6	15.8	29.9	369.8	355.7
NK022	DWR	North Kings GSA	367703N1196077W001	T13S R22E 29	376.5	20.4	37.4	356.1	339.1
NK022	DWR	North Kings GSA	367717N1196088W001	T13S R22E 29	376.5	19.7	38.8	356.8	337.7
NK022	FID	North Kings GSA	13S22E31N001MX	T13S R22E 31	356.5	31.9	47.5	324.6	309.1
NK022	DWR	North Kings GSA	367522N1196216W001	T13S R22E 31	361.5	28.0	45.4	333.5	316.1
NK022	FID	North Kings GSA	13S22E32A001MX	T13S R22E 32	370.8	15.8	34.7	355.0	336.1
NK022	DWR	North Kings GSA	367644N1195963W001	T13S R22E 32	373.0		33.3		339.7
NK022	DWR	North Kings GSA	367522N1195854W001	T13S R22E 33	378.6	28.7		349.9	
NK022	DWR	North Kings GSA	367522N1195588W001	T13S R22E 34	386.6	28.1	38.9	358.5	347.7
NK022	FID	North Kings GSA	14S22E03C001MX	T14S R22E 03	379.7	27.7		352.0	
NK022	DWR	North Kings GSA	367500N1195832W001	T14S R22E 04	378.6		42.2		336.4
NK025	DWR	North Kings GSA	367606N1194707W001	T13S R23E 33	434.0		12.9		421.1
NK025	DWR	North Kings GSA	367536N1194652W001	T13S R23E 34	428.6	8.7		419.9	
NK027	FID	North Kings GSA	13S23E33B001MX	T13S R23E 33	431.8	7.0	13.9	424.8	417.9
NK036	FID	North Kings GSA	13S17E33M001MX	T13S R17E 33	210.1	72.2	80.4	137.9	129.7
NK038	DWR	North Kings GSA	367474N1201129W001	T14S R17E 03	212.5	75.0		137.5	
NK038	DWR	North Kings GSA	367341N1200788W001	T14S R17E 11	217.5	93.7		123.8	
NK039	FID	North Kings GSA	14S18E02B001MX	T14S R18E 02	249.7	61.8		187.9	
NK039	FID	North Kings GSA	14S18E03B001MX	T14S R18E 03	245.6		49.1		196.5
NK039	FID	North Kings GSA	14S18E03D001MX	T14S R18E 03	241.0		46.0		195.0
NK039	FID	North Kings GSA	14S18E03E001MX	T14S R18E 03	249.5		52.0		197.5
NK039	FID	North Kings GSA	14S18E03E002MX	T14S R18E 03	248.3		69.5		178.8
NK039	FID	North Kings GSA	14S18E03F001MX	T14S R18E 03	250.1		56.0		194.1
NK039	FID	North Kings GSA	14S18E03G001MX	T14S R18E 03	250.1		44.0		206.1
NK039	FID	North Kings GSA	14S18E03G002MX	T14S R18E 03	248.8		67.0		181.8
NK039	FID	North Kings GSA	14S18E03K001MX	T14S R18E 03	249.9		70.0		179.9
NK039	FID	North Kings GSA	14S18E03K002MX	T14S R18E 03	241.7		50.0		191.7
NK039	FID	North Kings GSA	14S18E03L001MX	T14S R18E 03	239.1		50.5		188.6
NK039	FID	North Kings GSA	14S18E04B001MX	T14S R18E 04	239.3	69.0		170.3	
NK039	FID	North Kings GSA	14S18E04G001MX	T14S R18E 04	238.4		51.3		187.1
NK039	FID	North Kings GSA	14S18E04J001MX	T14S R18E 04	237.9		51.0		186.9
NK039	FID	North Kings GSA	14S18E04K001MX	T14S R18E 04	237.4		55.0		182.4
NK039	FID	North Kings GSA	14S18E06P001MX	T14S R18E 06	224.2		76.3		148.0
NK039	FID	North Kings GSA	14S18E09H001MX	T14S R18E 09	236.3	66.3	61.2	170.0	175.1
NK039	FID	North Kings GSA	14S18E09M001MX	T14S R18E 09	226.3	76.2	68.2	150.1	158.2
NK039	FID	North Kings GSA	14S18E10A001MX	T14S R18E 10	243.6		58.0		185.6
NK039	FID	North Kings GSA	14S18E10C001MX	T14S R18E 10	240.3		59.0		181.3
NK039	FID	North Kings GSA	14S18E10D001MX	T14S R18E 10	234.7		54.3		180.4
NK039	FID	North Kings GSA	14S18E10K001MX	T14S R18E 10	240.8		62.5		178.3
NK039	FID	North Kings GSA	14S18E14N001MX	T14S R18E 14	234.2		73.0		161.2
NK039	FID	North Kings GSA	14S18E15M001MX	T14S R18E 15	230.9	65.2	73.0	165.7	157.9
NK039	FID	North Kings GSA	14S18E19A001MX	T14S R18E 19	215.9	91.3	128.7	124.6	87.2
NK039	FID	North Kings GSA	14S18E21F001MX	T14S R18E 21	226.1		85.0		141.1
NK039	FID	North Kings GSA	14S18E21Q001MX	T14S R18E 21	226.2		88.0		138.2
NK039	FID	North Kings GSA	14S18E22N002MX	T14S R18E 21	227.5		75.0		152.5
NK039	FID	North Kings GSA	14S18E22J001MX	T14S R18E 22	229.6		81.0		148.6
NK039	FID	North Kings GSA	14S18E22L001MX	T14S R18E 22	230.4		83.0		147.4
NK039	FID	North Kings GSA	14S18E22P001MX	T14S R18E 22	235.8		93.0		142.8
NK039	FID	North Kings GSA	14S18E22Q001MX	T14S R18E 22			90.0		910.0
NK039	FID	North Kings GSA	14S18E22R001MX	T14S R18E 22	231.2		75.0		156.2
NK039	FID	North Kings GSA	14S18E22R002MX	T14S R18E 22	233.3		77.0		156.3
NK039	FID	North Kings GSA	14S18E26C001MX	T14S R18E 26	228.4		115.0		113.4
NK039	FID	North Kings GSA	14S18E22P002MX	T14S R18E 27	235.3		81.0		154.3

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NK039	FID	North Kings GSA	14S18E27B001MX	T14S R18E 27	228.0		74.0		154.0
NK039	FID	North Kings GSA	14S18E27B002MX	T14S R18E 27	228.1		83.0		145.1
NK039	FID	North Kings GSA	14S18E22N001MX	T14S R18E 28	235.5		96.0		139.5
NK039	FID	North Kings GSA	14S18E28A001MX	T14S R18E 28	227.2		88.0		139.2
NK039	FID	North Kings GSA	14S18E29J001MX	T14S R18E 29	218.7		81.0		137.7
NK040	FID	North Kings GSA	14S18E27M001MX	T14S R18E 28	226.7		96.0		130.7
NK040	FID	North Kings GSA	14S18E28L001MX	T14S R18E 28	222.0		98.0		124.0
NK040	FID	North Kings GSA	14S18E28Q001MX	T14S R18E 33	226.3	108.0		118.3	
NK040	FID	North Kings GSA	14S19E18N001MX	T14S R19E 18	238.8	60.2	68.2	178.6	170.6
NK040	DWR	North Kings GSA	367088N1199521W001	T14S R19E 18	240.7	60.2		180.5	
NK041	FID	North Kings GSA	14S19E06A001MX	T14S R19E 06	254.8	60.1	59.2	194.7	195.6
NK041	FID	North Kings GSA	14S19E07D001MX	T14S R19E 07	248.3	59.9		188.4	
NK041	DWR	North Kings GSA	367346N1199516W001	T14S R19E 07	250.8	60.8		190.0	
NK041	FID	North Kings GSA	14S19E18G001MX	T14S R19E 18	243.6	58.4	63.0	185.2	180.6
NK042	FID	North Kings GSA	14S19E03Q001MX	T14S R19E 03	264.7		96.8		167.9
NK042	DWR	North Kings GSA	367355N1198988W001	T14S R19E 03	264.9	64.2		200.7	
NK042	FID	North Kings GSA	14S19E04R001MX	T14S R19E 04	262.4	64.2		198.2	
NK042	FID	North Kings GSA	14S19E11L001MX	T14S R19E 11	272.7	66.8	80.8	205.9	192.0
NK042	FID	North Kings GSA	14S19E15G001MX	T14S R19E 15	252.6	41.3		211.3	
NK042	FID	North Kings GSA	14S19E17C001MX	T14S R19E 17	249.9	64.7	67.9	185.2	182.0
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E20D001MX	T14S R19E 20	244.1	48.0	56.0	196.1	188.1
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E20N001MX	T14S R19E 20	238.7	38.9	43.8	199.8	194.9
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E21M001MX	T14S R19E 21	249.9	37.2	42.5	212.7	207.4
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E21P001MX	T14S R19E 21	243.7	31.9	49.7	211.8	194.0
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E22G001MX	T14S R19E 22	251.5	52.9	61.0	198.6	190.5
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E23B001MX	T14S R19E 23	258.2	52.5	65.3	205.7	192.9
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E23Q001MX	T14S R19E 23	254.4	58.2	65.0	196.2	189.3
NK042	FID	North Kings GSA	14S19E26D001MX	T14S R19E 26	251.5	49.9	68.0	193.7	183.5
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E26Q001MX	T14S R19E 26	250.1		72.4		177.7
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E27K001MX	T14S R19E 27	250.9	45.4	49.0	205.5	201.8
NK042	Fresno Clovis RWRF	North Kings GSA	14S19E28M001MX	T14S R19E 28	248.9	42.0	38.8	206.9	210.1
NK042	DWR	North Kings GSA	366768N1199160W001	T14S R19E 29	237.0		54.3		182.7
NK042	FID	North Kings GSA	14S19E32D001MX	T14S R19E 32	234.4		108.2		126.2
NK042	FID	North Kings GSA	14S19E33D001MX	T14S R19E 33	239.5	47.7	55.0	191.8	184.5
NK042	FID	North Kings GSA	14S20E31D001MX	T14S R20E 31	258.1	59.4		198.7	
NK043	City of Fresno	North Kings GSA	14S20E13F001MX	T14S R20E 13	291.8	76.6		215.2	
NK043	DWR	North Kings GSA	367063N1198335W001	T14S R20E 18	269.0		76.0		193.0
NK043	FID	North Kings GSA	14S20E19A001MX	T14S R20E 19	267.4	67.1	76.5	200.3	190.9
NK043	City of Fresno	North Kings GSA	14S20E22J001MX	T14S R20E 22	282.5	65.8		216.7	
NK043	City of Fresno	North Kings GSA	14S20E24K001MX	T14S R20E 24	294.7	68.3	77.9	226.4	216.8
NK043	FID	North Kings GSA	14S20E33F001MX	T14S R20E 33	271.1	54.2		216.9	
NK043	FID	North Kings GSA	15S20E03A001MX	T15S R20E 03	0.0	52.2		227.4	
NK043	DWR	North Kings GSA	366635N1197735W001	T15S R20E 03	282.6	52.2		230.4	
NK044	City of Fresno	North Kings GSA	14S20E04E001MX	T14S R20E 04	287.0	111.6	123.1	175.4	163.9
NK045	City of Fresno	North Kings GSA	14S20E01J001MX	T14S R20E 01	312.6	105.1	116.0	207.6	196.6
NK045	DWR	North Kings GSA	367391N1197457W001	T14S R20E 01	313.5	101.0		212.5	
NK045	City of Fresno	North Kings GSA	14S20E02J001MX	T14S R20E 02	302.4	97.1	114.5	205.3	187.9
NK045	City of Fresno	North Kings GSA	14S20E03C001MX	T14S R20E 03	296.5		116.3		180.2
NK045	City of Fresno	North Kings GSA	14S20E03J001MX	T14S R20E 03	295.2	96.8		198.4	
NK045	City of Fresno	North Kings GSA	14S20E03M001MX	T14S R20E 03	293.8	99.0	111.5	194.8	182.3
NK045	City of Fresno	North Kings GSA	14S20E04F001MX	T14S R20E 04	288.0	90.6	94.9	197.4	193.1
NK045	City of Fresno	North Kings GSA	14S20E08H001MX	T14S R20E 08	279.1	79.3	93.2	199.8	185.9
NK045	City of Fresno	North Kings GSA	14S20E08R001MX	T14S R20E 08	279.9	79.2	90.0	200.7	189.9
NK045	City of Fresno	North Kings GSA	14S20E10M001MX	T14S R20E 10	291.4	93.9	100.8	197.5	190.6
NK045	City of Fresno	North Kings GSA	14S20E11F001MX	T14S R20E 11	295.4	93.0	104.3	202.4	191.1
NK045	City of Fresno	North Kings GSA	14S20E14L001MX	T14S R20E 14	288.1	76.1	87.4	212.0	200.7
NK045	City of Fresno	North Kings GSA	14S20E16A001MX	T14S R20E 16	283.4	82.3	95.1	201.1	188.3
NK046	FID	North Kings GSA	14S21E03D001MX	T14S R21E 03	333.0	67.2		265.8	
NK046	City of Fresno	North Kings GSA	14S21E06E001MX	T14S R21E 06	310.1	97.0	116.1	213.1	194.0
NK046	City of Fresno	North Kings GSA	14S21E06Q001MX	T14S R21E 06	309.6	93.4	109.4	216.2	200.2
NK046	City of Fresno	North Kings GSA	14S21E07M001MX	T14S R21E 07	302.8	86.0		216.8	
NK046	City of Fresno	North Kings GSA	14S21E08A001MX	T14S R21E 08	320.5	95.3	104.1	225.2	216.4
NK046	City of Fresno	North Kings GSA	14S21E08J001MX	T14S R21E 08	317.1	82.0		235.1	
NK046	City of Fresno	North Kings GSA	14S21E09C001MX	T14S R21E 09	320.1	88.9		231.2	
NK047	FID	North Kings GSA	14S21E11L001MX	T14S R21E 11	334.2	52.9	62.4	281.3	271.8
NK047	City of Fresno	North Kings GSA	14S21E17E001MX	T14S R21E 17	307.5	88.2		219.3	
NK047	City of Fresno	North Kings GSA	14S21E17N001MX	T14S R21E 17	314.5	66.4		248.1	
NK047	FID	North Kings GSA	14S21E22D001MX	T14S R21E 22	317.8	53.4	61.2	264.4	256.6

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
NK047	FID	North Kings GSA	14S21E29D001MX	T14S R21E 29	302.0		42.1		259.9
NK047	DWR	North Kings GSA	366927N1197171W001	T14S R21E 30	305.0		18.0		287.0
NK047	FID	North Kings GSA	14S21E32H001MX	T14S R21E 32	306.7	45.6		261.1	
NK047	FID	North Kings GSA	15S21E06B001MX	T15S R21E 06	297.1	45.7		251.4	
NK048	FID	North Kings GSA	14S22E06A001MX	T14S R22E 06	362.2	28.9	46.9	333.3	315.3
NK049	FID	North Kings GSA	14S22E08N001MX	T14S R22E 08	349.7	41.7	48.0	308.0	301.7
NK049	CID	North Kings GSA	CID07	T14S R22E 08	348.8	41.1	41.1	307.7	307.7
NK050	FID	North Kings GSA	14S23E06C001MX	T14S R23E 06	409.4	27.1		382.3	
NK065	FID	North Kings GSA	14S18E32D001MX	T14S R18E 32	212.3	115.3	121.7	97.0	90.6
NK072	FID	North Kings GSA	15S19E02M001MX	T15S R19E 02	242.9	73.2	85.3	169.7	157.6
NK072	CID	North Kings GSA	CID72	T15S R19E 12	249.6	104.5	95.8	145.1	153.8
NK072	FID	North Kings GSA	15S19E14M001MX	T15S R19E 14	241.3	100.7		140.6	
NK073	FID	North Kings GSA	15S20E01J001MX	T15S R20E 01	292.7		58.8		233.9
NK073	FID	North Kings GSA	15S20E01R001MX	T15S R20E 01	290.1	45.3	59.0	244.8	231.1
NK073	FID	North Kings GSA	15S20E02N001MX	T15S R20E 02	279.6	49.2	66.2	230.4	213.4
NK073	FID	North Kings GSA	15S20E05E001MX	T15S R20E 05	260.8		68.4		192.4
NK073	FID	North Kings GSA	15S20E07Q001MX	T15S R20E 07	252.2	65.0	80.3	187.2	171.9
NK073	FID	North Kings GSA	15S20E09K001MX	T15S R20E 09	270.9	56.2	73.1	214.7	197.9
NK073	CID	North Kings GSA	CID76	T15S R20E 10	272.8	72.7	74.8	200.1	198.0
NK073	FID	North Kings GSA	15S20E12F001MX	T15S R20E 12	288.9	44.2	62.5	244.7	226.4
NK073	CID	North Kings GSA	CID77	T15S R20E 12	275.2	59.0	59.0	224.4	224.4
NK073	FID	North Kings GSA	15S20E13E001MX	T15S R20E 13	282.1	58.4	65.0	223.7	217.1
NK074	DWR	North Kings GSA	366632N1197271W001	T15S R21E 06	300.2	45.6		254.6	
NK074	CID	North Kings GSA	CID02	T15S R21E 09	303.7		51.6		252.1
SK049	CID	South Kings GSA	CID11	T14S R22E 22	354.6	28.1	32.1	326.5	322.5
SK049	CID	South Kings GSA	CID10	T14S R22E 26	366.2	29.9	34.8	336.3	331.4
SK075	CID	South Kings GSA	CID24	T15S R22E 24	338.7	45.5	45.5	293.2	293.2
SK091	DWR	South Kings GSA	365183N1195754W001	T16S R22E 22	300.7		41.2		259.5
SK091	CID	South Kings GSA	CID40	T16S R22E 27	297.9	33.5	41.2	264.4	256.7
Outside of Study Area	DWR	Outside of Study Area	369260N1199141W001	T11S R19E 32	320.0	139.2	156.2	183.2	166.2
Outside of Study Area	DWR	Outside of Study Area	369302N1198943W001	T11S R19E 33	331.9	194.6		137.3	
Outside of Study Area	DWR	Outside of Study Area	369735N1198307W001	T11S R20E 18	391.4	151.5		239.9	
Outside of Study Area	DWR	Outside of Study Area	369396N1197843W001	T11S R20E 27	405.0	217.8		187.2	
Outside of Study Area	DWR	Outside of Study Area	369235N1198313W001	T11S R20E 31	383.4	262.3		121.1	
Outside of Study Area	DWR	Outside of Study Area	369375N1198168W001	T11S R20E 32	387.0		330.8		54.9
Outside of Study Area	DWR	Outside of Study Area	369307N1197896W001	T11S R20E 33	392.5	249.2		143.3	
Outside of Study Area	DWR	Outside of Study Area	368368N1203291W001	T12S R15E 33	162.4	42.6	52.8	119.8	109.6
Outside of Study Area	DWR	Outside of Study Area	368368N1203099W001	T12S R15E 34	166.4		69.9		96.5
Outside of Study Area	DWR	Outside of Study Area	368732N1201835W001	T12S R16E 23	204.9		113.5		91.4
Outside of Study Area	DWR	Outside of Study Area	368516N1201829W001	T12S R16E 26	202.4		107.1		95.3
Outside of Study Area	DWR	Outside of Study Area	368438N1202621W001	T12S R16E 31	179.9	90.0	119.1	89.9	60.8
Outside of Study Area	DWR	Outside of Study Area	368496N1201649W001	T12S R16E 36	208.4		97.5		110.9
Outside of Study Area	DWR	Outside of Study Area	368874N1200604W001	T12S R17E 13	252.4	98.0		154.4	
Outside of Study Area	MID	Outside of Study Area	12S17E14L001MX	T12S R17E 14	241.0		115.9		125.1
Outside of Study Area	DWR	Outside of Study Area	368896N1200846W001	T12S R17E 14	243.4		115.4		128.0
Outside of Study Area	DWR	Outside of Study Area	368849N1200927W001	T12S R17E 15	238.4		104.0		134.4
Outside of Study Area	DWR	Outside of Study Area	368680N1201377W001	T12S R17E 20	220.4	88.7		131.7	
Outside of Study Area	DWR	Outside of Study Area	368752N1201107W001	T12S R17E 21	230.4	87.3		143.1	
Outside of Study Area	DWR	Outside of Study Area	368785N1200832W001	T12S R17E 23	239.4		115.9		123.5
Outside of Study Area	DWR	Outside of Study Area	368766N1200566W001	T12S R17E 24	248.4	83.4		165.0	
Outside of Study Area	MID	Outside of Study Area	12S17E26B001MX	T12S R17E 26	235.0		87.1		147.9
Outside of Study Area	MID	Outside of Study Area	12S17E26R001MX	T12S R17E 26	233.0		82.8		150.2
Outside of Study Area	DWR	Outside of Study Area	368516N1200888W001	T12S R17E 26	235.4		81.8		153.6
Outside of Study Area	DWR	Outside of Study Area	368649N1200841W001	T12S R17E 26	237.4		86.1		151.3
Outside of Study Area	DWR	Outside of Study Area	368655N1200777W001	T12S R17E 26	239.4		96.6		142.8
Outside of Study Area	DWR	Outside of Study Area	368507N1201468W001	T12S R17E 31	214.4		91.6		122.8
Outside of Study Area	MID	Outside of Study Area	12S17E32G001MX	T12S R17E 32	217.0		97.8		119.2
Outside of Study Area	DWR	Outside of Study Area	368441N1201291W001	T12S R17E 32	219.4		96.8		122.6
Outside of Study Area	MID	Outside of Study Area	12S17E34D001MX	T12S R17E 34	225.0		92.7		132.3
Outside of Study Area	DWR	Outside of Study Area	368502N1200941W001	T12S R17E 34	232.4		90.7		141.7
Outside of Study Area	DWR	Outside of Study Area	368371N1200785W001	T12S R17E 35	241.4	68.2		173.2	
Outside of Study Area	MID	Outside of Study Area	12S17E36K001MX	T12S R17E 36	243.0		79.0		164.0
Outside of Study Area	DWR	Outside of Study Area	368418N1200632W001	T12S R17E 36	245.4		78.5		166.9
Outside of Study Area	DWR	Outside of Study Area	368977N1200282W001	T12S R18E 08	262.4		115.8		146.6
Outside of Study Area	DWR	Outside of Study Area	368980N1200107W001	T12S R18E 09	267.4	95.8	113.5	171.6	153.9
Outside of Study Area	DWR	Outside of Study Area	369074N1199993W001	T12S R18E 10	267.4		121.0		146.4
Outside of Study Area	DWR	Outside of Study Area	368960N1199629W001	T12S R18E 12	282.4	101.8	152.6	180.6	129.8
Outside of Study Area	MID	Outside of Study Area	12S18E13R001MX	T12S R18E 13	288.0		115.7		172.3

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
Outside of Study Area	DWR	Outside of Study Area	368952N1199879W001	T12S R18E 15	275.4		130.9		144.5
Outside of Study Area	MID	Outside of Study Area	12S18E16A001MX	T12S R18E 16	268.0		108.9		159.1
Outside of Study Area	DWR	Outside of Study Area	368913N1200018W001	T12S R18E 16	270.4		107.9		162.5
Outside of Study Area	MID	Outside of Study Area	12S18E19H001MX	T12S R18E 19	251.0		98.3		152.7
Outside of Study Area	DWR	Outside of Study Area	368752N1200377W001	T12S R18E 19	253.4		97.8		155.6
Outside of Study Area	DWR	Outside of Study Area	368663N1200299W001	T12S R18E 20	258.4		92.7		165.7
Outside of Study Area	MID	Outside of Study Area	12S18E21P001MX	T12S R18E 21	267.0		102.4		164.6
Outside of Study Area	DWR	Outside of Study Area	368732N1200099W001	T12S R18E 21	267.4	85.5	100.4	181.9	167.0
Outside of Study Area	DWR	Outside of Study Area	368747N1200019W001	T12S R18E 21	269.4		101.4		168.0
Outside of Study Area	DWR	Outside of Study Area	368805N1199474W001	T12S R18E 24	290.4		115.2		175.2
Outside of Study Area	DWR	Outside of Study Area	368805N1199474W002	T12S R18E 24	290.4		119.1		171.3
Outside of Study Area	DWR	Outside of Study Area	368582N1199563W001	T12S R18E 25	284.4	88.1		196.3	
Outside of Study Area	MID	Outside of Study Area	12S18E26L001MX	T12S R18E 26	276.0		98.0		178.0
Outside of Study Area	DWR	Outside of Study Area	368582N1199752W001	T12S R18E 26	278.4		97.5		180.9
Outside of Study Area	DWR	Outside of Study Area	368621N1199788W001	T12S R18E 26	277.4	89.5		187.9	
Outside of Study Area	MID	Outside of Study Area	12S18E31J001MX	T12S R18E 31	254.0		84.7		169.3
Outside of Study Area	DWR	Outside of Study Area	368427N1200377W001	T12S R18E 31	256.4	83.6		172.8	
Outside of Study Area	MID	Outside of Study Area	12S18E35G001MX	T12S R18E 35	278.0		86.0		192.0
Outside of Study Area	DWR	Outside of Study Area	368471N1199696W001	T12S R18E 35	280.4		85.0		195.4
Outside of Study Area	DWR	Outside of Study Area	369110N1198816W001	T12S R19E 03	332.9	195.0		137.9	
Outside of Study Area	DWR	Outside of Study Area	369082N1198641W001	T12S R19E 11	340.4	199.8		140.6	
Outside of Study Area	DWR	Outside of Study Area	368910N1198577W001	T12S R19E 14	339.4	180.8		158.6	
Outside of Study Area	DWR	Outside of Study Area	368810N1199385W001	T12S R19E 18	295.9		118.2		177.7
Outside of Study Area	MID	Outside of Study Area	12S19E20D001MX	T12S R19E 20	293.0		133.3		159.7
Outside of Study Area	DWR	Outside of Study Area	368788N1199121W001	T12S R19E 20	304.4	105.4		199.0	
Outside of Study Area	DWR	Outside of Study Area	368793N1199252W001	T12S R19E 20	295.4		132.3		163.1
Outside of Study Area	MID	Outside of Study Area	12S19E21B001MX	T12S R19E 21	300.0		127.8		172.2
Outside of Study Area	DWR	Outside of Study Area	368788N1198977W001	T12S R19E 21	302.4	96.8		205.6	
Outside of Study Area	DWR	Outside of Study Area	368799N1198646W001	T12S R19E 23	330.0	134.3		195.7	
Outside of Study Area	DWR	Outside of Study Area	368652N1198671W001	T12S R19E 26	326.5	127.0		199.5	
Outside of Study Area	MID	Outside of Study Area	12S19E28A001MX	T12S R19E 28	307.5		102.5		205.0
Outside of Study Area	DWR	Outside of Study Area	368532N1199029W001	T12S R19E 28	307.5		93.7		213.8
Outside of Study Area	DWR	Outside of Study Area	368657N1198971W001	T12S R19E 28	309.9		100.0		209.9
Outside of Study Area	MID	Outside of Study Area	12S19E29A001MX	T12S R19E 29	301.0		120.7		180.3
Outside of Study Area	DWR	Outside of Study Area	368638N1199129W001	T12S R19E 29	303.4		120.2		183.2
Outside of Study Area	DWR	Outside of Study Area	368418N1199427W001	T12S R19E 31	288.4	84.4		204.0	
Outside of Study Area	DWR	Outside of Study Area	369107N1198121W001	T12S R20E 05	363.6		267.7		95.9
Outside of Study Area	DWR	Outside of Study Area	368899N1198079W001	T12S R20E 17	365.5	164.9		200.6	
Outside of Study Area	DWR	Outside of Study Area	368935N1198035W001	T12S R20E 17	367.5	174.2		193.3	
Outside of Study Area	DWR	Outside of Study Area	368946N1198296W001	T12S R20E 18	355.0	191.2		163.8	
Outside of Study Area	DWR	Outside of Study Area	368805N1198346W001	T12S R20E 19	348.0	164.0		184.0	
Outside of Study Area	DWR	Outside of Study Area	368291N1203016W001	T13S R15E 02	166.9		69.2		97.7
Outside of Study Area	DWR	Outside of Study Area	368213N1203027W001	T13S R15E 11	166.4		71.7		94.7
Outside of Study Area	DWR	Outside of Study Area	367985N1203102W001	T13S R15E 14	166.4	43.4		123.0	
Outside of Study Area	DWR	Outside of Study Area	367796N1203729W001	T13S R15E 19	130.0		38.4		91.6
Outside of Study Area	DWR	Outside of Study Area	367805N1203718W001	T13S R15E 19	157.4	9.3		148.1	
Outside of Study Area	DWR	Outside of Study Area	367807N1203722W001	T13S R15E 19	153.3		109.7		38.3
Outside of Study Area	DWR	Outside of Study Area	367807N1203722W002	T13S R15E 19	153.3		65.3		82.7
Outside of Study Area	DWR	Outside of Study Area	367807N1203722W003	T13S R15E 19	153.3		22.8		125.2
Outside of Study Area	DWR	Outside of Study Area	367813N1203736W001	T13S R15E 19	129.6		25.3		104.3
Outside of Study Area	DWR	Outside of Study Area	367882N1203566W001	T13S R15E 20	162.4	26.0	40.6	136.4	121.8
Outside of Study Area	DWR	Outside of Study Area	367882N1203579W001	T13S R15E 20	162.4		61.0		101.4
Outside of Study Area	DWR	Outside of Study Area	367824N1203377W001	T13S R15E 21	163.4	18.3		145.1	
Outside of Study Area	DWR	Outside of Study Area	367702N1202910W001	T13S R15E 25	172.4	38.8		133.6	
Outside of Study Area	DWR	Outside of Study Area	367738N1202877W001	T13S R15E 25	172.4	43.6	83.6	128.8	88.8
Outside of Study Area	DWR	Outside of Study Area	367705N1203029W001	T13S R15E 26	172.4	36.0	71.4	136.4	101.0
Outside of Study Area	DWR	Outside of Study Area	367730N1203049W001	T13S R15E 26	172.4	35.9	62.1	136.5	110.3
Outside of Study Area	DWR	Outside of Study Area	368268N1202735W001	T13S R16E 06	173.4	96.2		77.2	
Outside of Study Area	DWR	Outside of Study Area	368013N1202052W001	T13S R16E 15	191.4	62.3		129.1	
Outside of Study Area	DWR	Outside of Study Area	368068N1202368W001	T13S R16E 16	180.4	88.9		91.5	
Outside of Study Area	DWR	Outside of Study Area	367813N1202713W001	T13S R16E 19	172.4	59.4		113.0	
Outside of Study Area	DWR	Outside of Study Area	367827N1202666W001	T13S R16E 19	163.0	66.2		109.2	
Outside of Study Area	DWR	Outside of Study Area	367824N1202593W001	T13S R16E 20	177.4	65.7	106.4	111.7	71.0
Outside of Study Area	DWR	Outside of Study Area	367813N1202410W001	T13S R16E 21	182.4	67.4	99.0	115.0	83.4
Outside of Study Area	DWR	Outside of Study Area	367910N1201821W001	T13S R16E 24	192.4	27.8		164.6	
Outside of Study Area	DWR	Outside of Study Area	367755N1202599W001	T13S R16E 30	177.4		96.0		81.4
Outside of Study Area	DWR	Outside of Study Area	367755N1202654W001	T13S R16E 30	177.4	61.3	99.6	116.1	77.8
Outside of Study Area	MID	Outside of Study Area	13S17E03J001MX	T13S R17E 03	232.0		70.0		162.0

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
Outside of Study Area	DWR	Outside of Study Area	368310N1200974W001	T13S R17E 03	234.4	55.0	70.0	179.4	164.4
Outside of Study Area	MID	Outside of Study Area	13S17E04R001MX	T13S R17E 04	222.0		60.3		161.7
Outside of Study Area	DWR	Outside of Study Area	368257N1201154W001	T13S R17E 04	224.4		59.8		164.6
Outside of Study Area	DWR	Outside of Study Area	368232N1201421W001	T13S R17E 05	214.4	53.6	63.8	160.8	150.6
Outside of Study Area	DWR	Outside of Study Area	368146N1201554W001	T13S R17E 07	208.4		53.7		154.7
Outside of Study Area	DWR	Outside of Study Area	368205N1201513W001	T13S R17E 07	211.4	48.0		163.4	
Outside of Study Area	DWR	Outside of Study Area	368118N1201452W001	T13S R17E 08	209.4		41.3		168.1
Outside of Study Area	DWR	Outside of Study Area	368355N1200016W001	T13S R18E 03	267.4	60.6		206.8	
Outside of Study Area	MID	Outside of Study Area	13S18E04H001MX	T13S R18E 04	261.0		72.1		188.9
Outside of Study Area	DWR	Outside of Study Area	368341N1200113W001	T13S R18E 04	264.4	62.6	72.3	201.8	192.1
Outside of Study Area	MID	Outside of Study Area	13S18E05J001MX	T13S R18E 05	259.0		75.7		183.3
Outside of Study Area	DWR	Outside of Study Area	368280N1200260W001	T13S R18E 05	261.4	63.5		197.9	
Outside of Study Area	DWR	Outside of Study Area	368299N1200388W001	T13S R18E 05	254.9	60.4	74.7	194.5	180.2
Outside of Study Area	MID	Outside of Study Area	13S18E06F001MX	T13S R18E 06	246.0		62.5		183.5
Outside of Study Area	DWR	Outside of Study Area	368293N1200474W001	T13S R18E 06	252.4	58.5	70.8	193.9	181.6
Outside of Study Area	DWR	Outside of Study Area	368332N1200546W001	T13S R18E 06	248.4	58.7	61.0	189.7	187.4
Outside of Study Area	DWR	Outside of Study Area	366857N1202799W003	T14S R15E 25	162.5	8.7		153.8	
Outside of Study Area	DWR	Outside of Study Area	367100N1202400W001	T14S R16E 16	162.0		46.0		116.0
Outside of Study Area	KRCD	Outside of Study Area	A06	T14S R16E 17	161.9		46.0		115.9
Outside of Study Area	DWR	Outside of Study Area	367193N1193882W001	T14S R24E 08	462.8		13.9		448.9
Outside of Study Area	DWR	Outside of Study Area	366022N1203168W001	T15S R15E 22	177.6		74.0		103.6
Outside of Study Area	DWR	Outside of Study Area	366072N1203154W001	T15S R15E 23	175.6		57.0		118.6
Outside of Study Area	DWR	Outside of Study Area	366032N1202976W001	T15S R15E 24	171.6		71.0		100.6
Outside of Study Area	DWR	Outside of Study Area	365883N1202888W001	T15S R15E 25	180.6		179.0		1.6
Outside of Study Area	DWR	Outside of Study Area	365883N1202893W001	T15S R15E 25	182.6		98.0		84.6
Outside of Study Area	DWR	Outside of Study Area	365889N1203238W001	T15S R15E 27	190.6		100.0		90.6
Outside of Study Area	DWR	Outside of Study Area	365739N1203252W001	T15S R15E 34	207.6		133.0		74.6
Outside of Study Area	DWR	Outside of Study Area	365741N1203017W001	T15S R15E 35	198.0		262.0		-64.0
Outside of Study Area	DWR	Outside of Study Area	365742N1203077W001	T15S R15E 35	201.6		130.0		71.6
Outside of Study Area	DWR	Outside of Study Area	365742N1203157W001	T15S R15E 35	204.6		95.5		109.1
Outside of Study Area	DWR	Outside of Study Area	365742N1202785W001	T15S R16E 31	189.6		114.2		75.4
Outside of Study Area	DWR	Outside of Study Area	365739N1202791W001	T16S R16E 06	189.6		263.1		-73.5
Outside of Study Area	DWR	Outside of Study Area	365039N1201882W001	T16S R16E 25	197.8		161.0		36.8
Outside of Study Area	DWR	Outside of Study Area	365094N1202249W001	T16S R16E 28	212.8		161.0		51.8
Outside of Study Area	DWR	Outside of Study Area	364875N1202246W001	T16S R16E 34	227.8		184.0		43.8
Outside of Study Area	DWR	Outside of Study Area	365022N1202066W001	T16S R16E 35	204.8		160.0		44.8
Outside of Study Area	DWR	Outside of Study Area	364877N1201848W001	T16S R16E 36	206.8		183.0		23.8
Outside of Study Area	KRCD	Outside of Study Area	B08	T16S R17E 28	186.4		162.0		24.4
Outside of Study Area	CID	Outside of Study Area	CID44	T16S R21E 36	268.7	57.2	69.6	211.5	199.1
Outside of Study Area	DWR	Outside of Study Area	364930N1192142W001	T16S R25E 36	370.7	12.5	30.3	358.2	340.4
Outside of Study Area	DWR	Outside of Study Area	364617N1202291W001	T17S R16E 10	243.9		207.0		36.9
Outside of Study Area	DWR	Outside of Study Area	364734N1201382W001	T17S R17E 04	203.8		152.0		51.8
Outside of Study Area	DWR	Outside of Study Area	364814N1201249W001	T17S R17E 04	202.8		179.0		23.8
Outside of Study Area	DWR	Outside of Study Area	364732N1201569W001	T17S R17E 05	206.8		142.0		64.8
Outside of Study Area	DWR	Outside of Study Area	364439N1201277W001	T17S R17E 16	204.9		186.0		18.9
Outside of Study Area	DWR	Outside of Study Area	364583N1201304W001	T17S R17E 16	210.9		177.0		33.9
Outside of Study Area	DWR	Outside of Study Area	364300N1201221W001	T17S R17E 21	225.9		255.0		-29.1
Outside of Study Area	DWR	Outside of Study Area	364439N1201277W002	T17S R17E 21	227.9		195.0		32.9
Outside of Study Area	DWR	Outside of Study Area	364158N1200485W001	T17S R18E 29	220.9		179.6		41.3
Outside of Study Area	DWR	Outside of Study Area	364014N1197460W002	T17S R20E 36	245.8	16.2		229.6	
Outside of Study Area	DWR	Outside of Study Area	364225N1196816W001	T17S R21E 27	257.7	22.0	40.6	235.7	217.1
Outside of Study Area	DWR	Outside of Study Area	364017N1197277W001	T17S R21E 31	246.8	69.4	92.9	177.4	153.9
Outside of Study Area	DWR	Outside of Study Area	364019N1197179W001	T17S R21E 32	247.8	51.5	79.9	196.3	167.9
Outside of Study Area	DWR	Outside of Study Area	364058N1197138W001	T17S R21E 32	248.7		81.5		167.2
Outside of Study Area	DWR	Outside of Study Area	364033N1196960W001	T17S R21E 33	249.7	50.5	73.4	199.3	176.3
Outside of Study Area	DWR	Outside of Study Area	364131N1196957W001	T17S R21E 33	253.7	47.0		206.7	
Outside of Study Area	DWR	Outside of Study Area	364156N1196638W001	T17S R21E 35	260.7	25.0	44.7	235.7	216.0
Outside of Study Area	DWR	Outside of Study Area	364144N1196449W001	T17S R21E 36	265.7	37.6	54.7	228.1	211.0
Outside of Study Area	AID	Outside of Study Area	W160A	T17S R22E 13	287.4		52.1		235.3
Outside of Study Area	DWR	Outside of Study Area	364378N1195324W001	T17S R22E 24	280.7	83.0		197.7	
Outside of Study Area	DWR	Outside of Study Area	364411N1195424W001	T17S R22E 24	280.2	41.6		238.6	
Outside of Study Area	DWR	Outside of Study Area	364306N1195299W001	T17S R22E 25	277.7	40.5		237.2	
Outside of Study Area	DWR	Outside of Study Area	364300N1195800W001	T17S R22E 27	272.5		57.2		215.3
Outside of Study Area	DWR	Outside of Study Area	364303N1195841W001	T17S R22E 28	275.7		59.5		216.2
Outside of Study Area	DWR	Outside of Study Area	364269N1196232W001	T17S R22E 30	267.7	18.5		249.2	
Outside of Study Area	DWR	Outside of Study Area	364072N1196366W001	T17S R22E 31	261.7		73.6		188.1
Outside of Study Area	DWR	Outside of Study Area	364150N1196196W001	T17S R22E 31	264.7	48.0	68.2	216.7	196.5
Outside of Study Area	DWR	Outside of Study Area	364158N1196135W001	T17S R22E 32	265.2		70.4		194.8

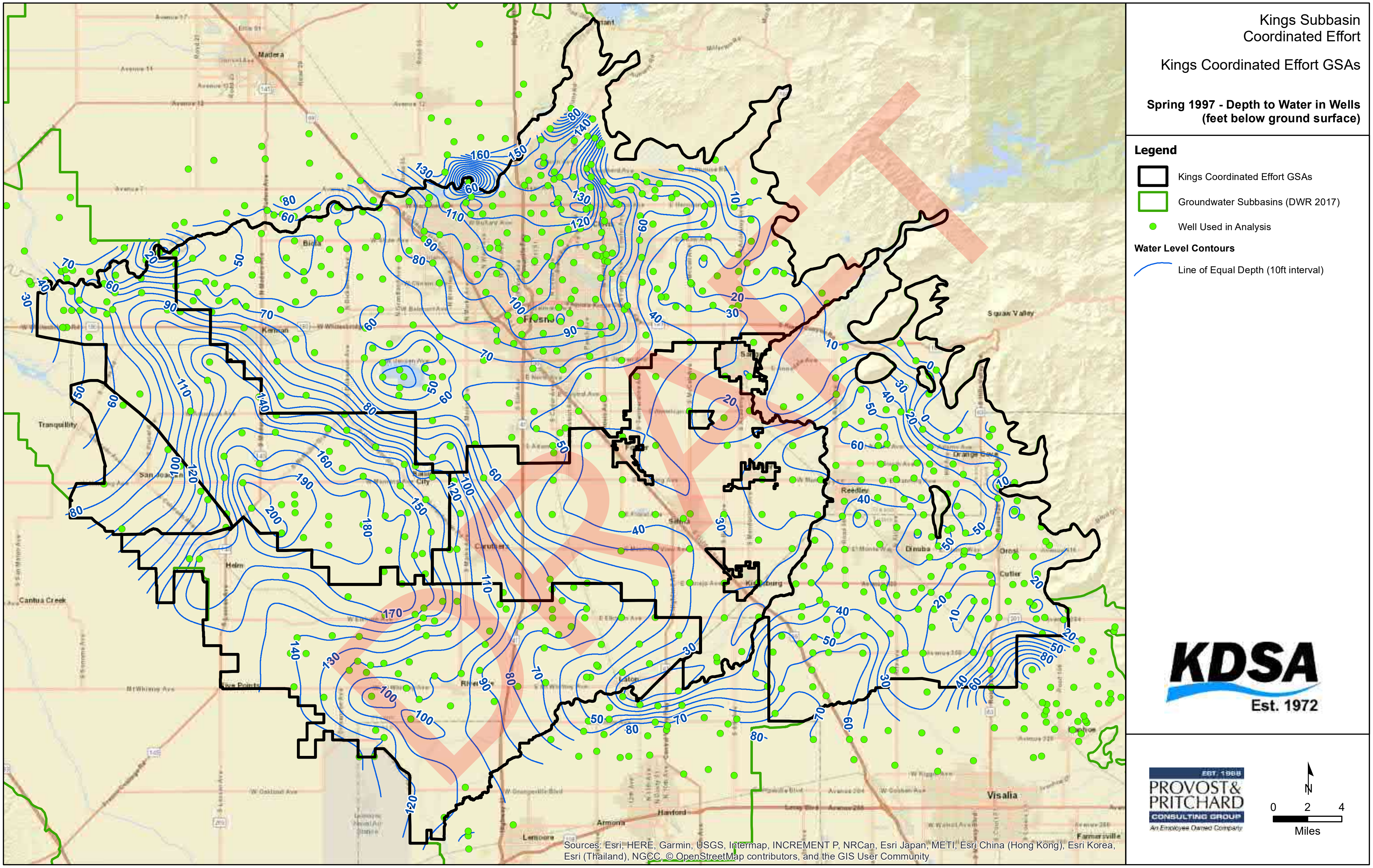
SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
Outside of Study Area	DWR	Outside of Study Area	364044N1195963W001	T17S R22E 33	268.7	81.5	94.0	187.2	174.7
Outside of Study Area	DWR	Outside of Study Area	364031N1195624W001	T17S R22E 35	268.7	67.5	86.4	201.2	182.3
Outside of Study Area	DWR	Outside of Study Area	364158N1195516W001	T17S R22E 35	272.7	95.5		177.2	
Outside of Study Area	DWR	Outside of Study Area	364064N1195293W001	T17S R22E 36	270.7	99.0		171.7	
Outside of Study Area	AID	Outside of Study Area	W163A	T17S R22E 36	272.6		96.1		176.5
Outside of Study Area	DWR	Outside of Study Area	364049N1194573W001	T17S R23E 34	276.2		30.0		241.0
Outside of Study Area	DWR	Outside of Study Area	364339N1193952W001	T17S R24E 20	287.7		14.5		273.2
Outside of Study Area	DWR	Outside of Study Area	364250N1193629W001	T17S R24E 27	296.7	23.7	38.2	273.0	258.5
Outside of Study Area	DWR	Outside of Study Area	364125N1193588W001	T17S R24E 34	299.7		33.5		266.7
Outside of Study Area	DWR	Outside of Study Area	364106N1193145W001	T17S R24E 36	314.5		76.5		238.2
Outside of Study Area	DWR	Outside of Study Area	364718N1192151W001	T17S R25E 01	355.9	18.6		337.3	
Outside of Study Area	DWR	Outside of Study Area	364717N1192506W001	T17S R25E 10	337.7	42.0		295.7	
Outside of Study Area	AID	Outside of Study Area	X225A	T17S R25E 11	347.1		75.1		272.1
Outside of Study Area	DWR	Outside of Study Area	364605N1192059W001	T17S R25E 12	356.7	38.0		318.7	
Outside of Study Area	DWR	Outside of Study Area	364433N1192523W001	T17S R25E 15	342.7	118.0		224.7	
Outside of Study Area	DWR	Outside of Study Area	364292N1192606W001	T17S R25E 21	339.2	98.0		241.2	
Outside of Study Area	DWR	Outside of Study Area	364281N1192092W001	T17S R25E 25	367.7	70.7	84.6	297.0	283.1
Outside of Study Area	DWR	Outside of Study Area	364144N1192276W001	T17S R25E 26	358.7	83.7		275.0	
Outside of Study Area	DWR	Outside of Study Area	364153N1192420W001	T17S R25E 26	352.7	93.0		259.7	
Outside of Study Area	DWR	Outside of Study Area	364283N1192334W001	T17S R25E 26	353.7	89.2		264.5	
Outside of Study Area	DWR	Outside of Study Area	364156N1192798W001	T17S R25E 29	327.7	87.5		240.2	
Outside of Study Area	DWR	Outside of Study Area	364242N1192948W001	T17S R25E 29	320.7		110.0		208.0
Outside of Study Area	DWR	Outside of Study Area	364283N1192953W001	T17S R25E 29	323.7	88.4		235.3	
Outside of Study Area	AID	Outside of Study Area	X236A	T17S R25E 30	323.8		104.1		219.7
Outside of Study Area	DWR	Outside of Study Area	364047N1192606W001	T17S R25E 33	341.7	88.0		253.7	
Outside of Study Area	DWR	Outside of Study Area	364050N1192401W001	T17S R25E 35	351.7	87.0		264.7	
Outside of Study Area	DWR	Outside of Study Area	364086N1192381W001	T17S R25E 35	353.2	87.9	111.1	265.3	242.1
Outside of Study Area	DWR	Outside of Study Area	364139N1192376W001	T17S R25E 35	357.7	87.6		270.1	
Outside of Study Area	DWR	Outside of Study Area	364047N1192237W001	T17S R25E 36	362.7	75.3		287.4	
Outside of Study Area	DWR	Outside of Study Area	364069N1192151W001	T17S R25E 36	367.7	78.0		289.7	
Outside of Study Area	DWR	Outside of Study Area	364752N1191662W001	T17S R26E 04	410.7	5.5		405.2	
Outside of Study Area	DWR	Outside of Study Area	364788N1191653W001	T17S R26E 04	405.6	8.0		397.6	
Outside of Study Area	DWR	Outside of Study Area	364682N1192001W001	T17S R26E 07	362.7	18.0	29.6	344.7	333.1
Outside of Study Area	DWR	Outside of Study Area	364577N1191884W001	T17S R26E 08	366.7	23.5		343.2	
Outside of Study Area	DWR	Outside of Study Area	364502N1191909W001	T17S R26E 18	371.7	39.0		332.7	
Outside of Study Area	DWR	Outside of Study Area	364288N1191842W001	T17S R26E 20	387.7	39.6		348.1	
Outside of Study Area	DWR	Outside of Study Area	364388N1191703W001	T17S R26E 21	396.7	19.2		377.5	
Outside of Study Area	DWR	Outside of Study Area	364396N1191703W001	T17S R26E 21	396.7		27.1		369.6
Outside of Study Area	DWR	Outside of Study Area	364174N1191703W001	T17S R26E 28	403.7	40.8		362.9	
Outside of Study Area	DWR	Outside of Study Area	364193N1191595W001	T17S R26E 28	414.7	42.3		372.4	
Outside of Study Area	DWR	Outside of Study Area	364227N1191706W001	T17S R26E 28	402.7	32.3		370.4	
Outside of Study Area	DWR	Outside of Study Area	364141N1191831W001	T17S R26E 29	388.7	61.2		327.5	
Outside of Study Area	DWR	Outside of Study Area	364146N1191728W001	T17S R26E 29	399.7	33.7	41.5	366.0	358.2
Outside of Study Area	DWR	Outside of Study Area	364000N1191973W001	T17S R26E 31	378.7	73.2		305.5	
Outside of Study Area	DWR	Outside of Study Area	364039N1191987W001	T17S R26E 31	377.7	74.3		303.4	
Outside of Study Area	DWR	Outside of Study Area	363865N1200377W001	T18S R18E 05	237.9		167.0		70.9
Outside of Study Area	DWR	Outside of Study Area	363936N1200399W001	T18S R18E 05	233.9		205.0		28.9
Outside of Study Area	DWR	Outside of Study Area	363936N1200488W001	T18S R18E 05	231.9		206.0		25.9
Outside of Study Area	DWR	Outside of Study Area	363717N1200393W001	T18S R18E 08	243.9		191.4		52.5
Outside of Study Area	DWR	Outside of Study Area	363794N1200307W001	T18S R18E 09	237.9		198.1		39.8
Outside of Study Area	DWR	Outside of Study Area	363575N1199766W001	T18S R18E 13	231.9		161.0		71.9
Outside of Study Area	DWR	Outside of Study Area	363400N1199210W001	T18S R19E 28	219.4	3.3	10.2	216.1	209.2
Outside of Study Area	DWR	Outside of Study Area	363927N1197477W001	T18S R20E 01	242.8		19.8		223.0
Outside of Study Area	DWR	Outside of Study Area	363863N1197571W001	T18S R20E 12	241.8	77.9		163.9	
Outside of Study Area	DWR	Outside of Study Area	363481N1197810W001	T18S R20E 22	235.8		13.8		222.0
Outside of Study Area	DWR	Outside of Study Area	363500N1197800W001	T18S R20E 23	220.8		152.4		68.4
Outside of Study Area	DWR	Outside of Study Area	363500N1197800W002	T18S R20E 23	220.8		151.9		68.9
Outside of Study Area	DWR	Outside of Study Area	363500N1197800W003	T18S R20E 23	220.8		13.9		206.9
Outside of Study Area	DWR	Outside of Study Area	363342N1197629W001	T18S R20E 26	238.8		18.8		220.0
Outside of Study Area	DWR	Outside of Study Area	363425N1197785W001	T18S R20E 26	237.8		14.4		223.4
Outside of Study Area	DWR	Outside of Study Area	363300N1198510W001	T18S R20E 30	216.8	2.9	5.0	213.9	211.8
Outside of Study Area	DWR	Outside of Study Area	363144N1197968W001	T18S R20E 34	227.8	99.2	109.0	128.6	118.8
Outside of Study Area	DWR	Outside of Study Area	363194N1197610W001	T18S R20E 36	235.8		17.4		218.4
Outside of Study Area	DWR	Outside of Study Area	364008N1196477W001	T18S R21E 01	263.2	71.5	88.4	191.7	174.8
Outside of Study Area	DWR	Outside of Study Area	363894N1196557W001	T18S R21E 02	262.2	86.0	101.9	176.2	160.3
Outside of Study Area	DWR	Outside of Study Area	363933N1196735W001	T18S R21E 03	258.7	86.0	101.7	172.8	157.0
Outside of Study Area	DWR	Outside of Study Area	363908N1197016W001	T18S R21E 04	248.8	65.5	94.1	183.3	154.7
Outside of Study Area	DWR	Outside of Study Area	363931N1197227W001	T18S R21E 05	245.8	60.0		185.8	

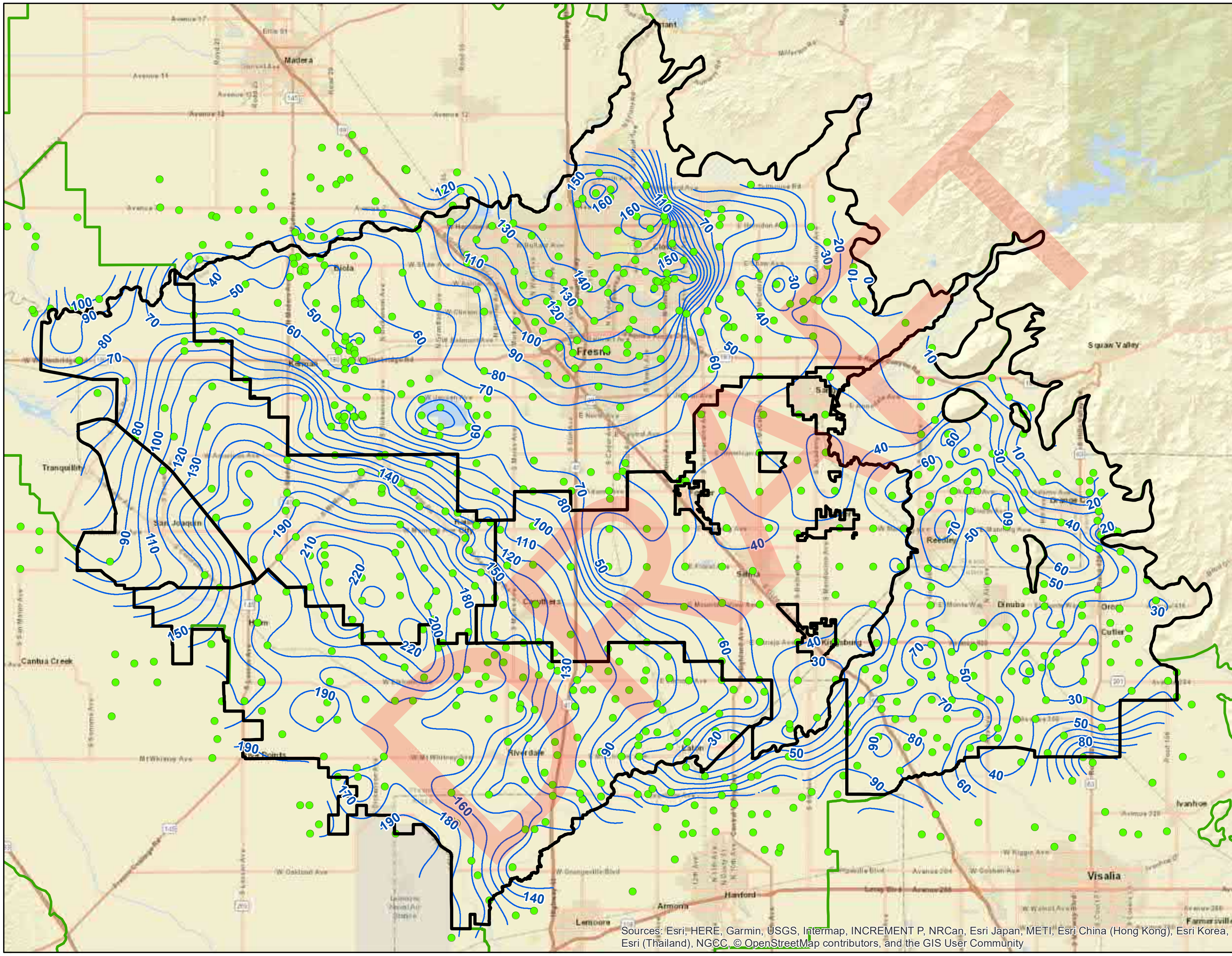
SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
Outside of Study Area	DWR	Outside of Study Area	363722N1197282W001	T18S R21E 07	242.8	81.0	24.4	161.8	218.4
Outside of Study Area	DWR	Outside of Study Area	363764N1197093W001	T18S R21E 08	246.8	75.0	123.8	171.8	123.0
Outside of Study Area	DWR	Outside of Study Area	363719N1196754W001	T18S R21E 10	256.8	91.0	108.5	165.8	148.3
Outside of Study Area	DWR	Outside of Study Area	363794N1196821W001	T18S R21E 10	253.8	93.0	98.6	160.8	155.2
Outside of Study Area	DWR	Outside of Study Area	363728N1196538W001	T18S R21E 12	255.7	93.0	106.7	162.8	149.0
Outside of Study Area	DWR	Outside of Study Area	363711N1196846W001	T18S R21E 15	254.8	86.5	102.8	168.3	152.0
Outside of Study Area	DWR	Outside of Study Area	363675N1197041W001	T18S R21E 16	247.8	23.0	30.7	224.8	217.1
Outside of Study Area	DWR	Outside of Study Area	363603N1197266W001	T18S R21E 17	240.8		19.6		221.2
Outside of Study Area	DWR	Outside of Study Area	363675N1197188W001	T18S R21E 17	247.8	19.0	23.5	228.8	224.3
Outside of Study Area	DWR	Outside of Study Area	363681N1197127W001	T18S R21E 17	247.8	26.0	29.9	221.8	217.9
Outside of Study Area	DWR	Outside of Study Area	363519N1197279W001	T18S R21E 19	242.8	17.5	19.5	225.3	223.3
Outside of Study Area	DWR	Outside of Study Area	363431N1197163W001	T18S R21E 20	246.8		28.4		218.4
Outside of Study Area	DWR	Outside of Study Area	363517N1196927W001	T18S R21E 21	252.8		135.5		117.3
Outside of Study Area	DWR	Outside of Study Area	363417N1196979W001	T18S R21E 28	230.2		30.6		215.2
Outside of Study Area	DWR	Outside of Study Area	363388N1197438W001	T18S R21E 30	239.8		16.0		223.8
Outside of Study Area	DWR	Outside of Study Area	363274N1197327W001	T18S R21E 31	241.8	109.0	135.2	132.8	106.6
Outside of Study Area	DWR	Outside of Study Area	364011N1195379W001	T18S R22E 01	268.7		95.6		173.1
Outside of Study Area	DWR	Outside of Study Area	363911N1195799W001	T18S R22E 03	267.7	92.7	96.8	175.0	170.9
Outside of Study Area	DWR	Outside of Study Area	363992N1195716W001	T18S R22E 03	268.7	73.0	88.2	195.7	180.5
Outside of Study Area	DWR	Outside of Study Area	363942N1196360W002	T18S R22E 06	262.7	89.0	103.0	173.7	159.7
Outside of Study Area	DWR	Outside of Study Area	363978N1196349W001	T18S R22E 06	263.2	76.0		187.2	
Outside of Study Area	DWR	Outside of Study Area	363864N1196193W001	T18S R22E 07	262.7		102.5		160.2
Outside of Study Area	DWR	Outside of Study Area	363722N1196182W001	T18S R22E 08	262.7		115.0		147.7
Outside of Study Area	DWR	Outside of Study Area	363864N1196046W001	T18S R22E 08	261.7	106.0	105.2	155.7	156.5
Outside of Study Area	DWR	Outside of Study Area	363608N1195924W001	T18S R22E 16	260.7	105.0	127.0	155.7	133.7
Outside of Study Area	DWR	Outside of Study Area	363589N1196074W001	T18S R22E 17	257.7		127.9		129.8
Outside of Study Area	DWR	Outside of Study Area	363569N1196182W001	T18S R22E 20	257.8	107.5		150.3	
Outside of Study Area	DWR	Outside of Study Area	363567N1195938W001	T18S R22E 21	259.7		126.8		132.9
Outside of Study Area	DWR	Outside of Study Area	363556N1195654W001	T18S R22E 22	259.7	104.0		155.7	
Outside of Study Area	DWR	Outside of Study Area	363572N1195468W001	T18S R22E 24	258.0	78.0	101.5	180.0	156.5
Outside of Study Area	DWR	Outside of Study Area	363386N1195563W001	T18S R22E 26	256.7		97.4		159.3
Outside of Study Area	DWR	Outside of Study Area	363856N1194443W001	T18S R23E 02	278.5	64.5	89.5	214.2	186.5
Outside of Study Area	DWR	Outside of Study Area	363856N1194824W001	T18S R23E 09	266.7	70.0	132.0	196.7	134.7
Outside of Study Area	DWR	Outside of Study Area	363853N1194291W001	T18S R23E 12	282.7	53.0		229.7	
Outside of Study Area	DWR	Outside of Study Area	363683N1194399W001	T18S R23E 14	280.7	83.5	108.0	197.2	170.0
Outside of Study Area	DWR	Outside of Study Area	363703N1194577W001	T18S R23E 15	274.3	95.0	112.4	179.3	161.9
Outside of Study Area	DWR	Outside of Study Area	363464N1194760W001	T18S R23E 21	266.7		140.9		125.8
Outside of Study Area	DWR	Outside of Study Area	363486N1194269W001	T18S R23E 24	285.7		110.7		172.3
Outside of Study Area	DWR	Outside of Study Area	363417N1194818W001	T18S R23E 28	263.0		106.0		157.0
Outside of Study Area	DWR	Outside of Study Area	363414N1195068W001	T18S R23E 29	258.7		84.8		173.9
Outside of Study Area	DWR	Outside of Study Area	363426N1195264W001	T18S R23E 30	256.0		182.0		70.0
Outside of Study Area	DWR	Outside of Study Area	363928N1193326W001	T18S R24E 02	313.7	49.0		264.7	
Outside of Study Area	DWR	Outside of Study Area	363906N1193685W001	T18S R24E 04	303.7	39.5		264.2	
Outside of Study Area	DWR	Outside of Study Area	363928N1194038W001	T18S R24E 06	290.7	47.5		243.2	
Outside of Study Area	DWR	Outside of Study Area	363789N1194041W001	T18S R24E 07	292.2		77.5		212.0
Outside of Study Area	DWR	Outside of Study Area	363750N1193502W001	T18S R24E 10	312.2	49.5	62.5	262.7	247.0
Outside of Study Area	DWR	Outside of Study Area	363601N1193320W001	T18S R24E 13	316.9		65.0		254.0
Outside of Study Area	DWR	Outside of Study Area	363667N1193148W001	T18S R24E 13	324.4	47.0	51.0	275.7	269.0
Outside of Study Area	DWR	Outside of Study Area	363581N1193521W001	T18S R24E 15	312.7	68.0		244.7	
Outside of Study Area	DWR	Outside of Study Area	363633N1193971W001	T18S R24E 17	295.7	62.5		233.2	
Outside of Study Area	DWR	Outside of Study Area	363922N1192106W001	T18S R25E 01	369.7	79.9		289.8	
Outside of Study Area	DWR	Outside of Study Area	363928N1192295W001	T18S R25E 02	357.7	77.4		280.3	
Outside of Study Area	DWR	Outside of Study Area	363989N1192381W001	T18S R25E 02	357.7	86.1		271.6	
Outside of Study Area	DWR	Outside of Study Area	363933N1192615W001	T18S R25E 04	342.7	81.0		261.7	
Outside of Study Area	DWR	Outside of Study Area	363864N1192834W001	T18S R25E 05	333.3		81.0		249.5
Outside of Study Area	DWR	Outside of Study Area	363944N1192926W001	T18S R25E 05	327.7	71.0		256.7	
Outside of Study Area	DWR	Outside of Study Area	363711N1192250W001	T18S R25E 12	397.7		60.0		335.0
Outside of Study Area	DWR	Outside of Study Area	363692N1192520W001	T18S R25E 15	348.1	58.0	64.0	290.7	282.0
Outside of Study Area	DWR	Outside of Study Area	363703N1192434W001	T18S R25E 15	351.7	61.0		290.7	
Outside of Study Area	DWR	Outside of Study Area	363706N1192665W001	T18S R25E 16	343.1		77.0		264.0
Outside of Study Area	DWR	Outside of Study Area	363889N1192017W001	T18S R26E 06	371.7	70.7		301.0	
Outside of Study Area	DWR	Outside of Study Area	363981N1191956W001	T18S R26E 06	382.7	78.0		304.7	
Outside of Study Area	DWR	Outside of Study Area	363992N1192051W001	T18S R26E 06	373.7	75.9		297.8	
Outside of Study Area	DWR	Outside of Study Area	363822N1192045W001	T18S R26E 07	367.7	63.4		304.3	
Outside of Study Area	DWR	Outside of Study Area	362925N1199046W001	T19S R19E 10	224.8		184.0		38.9
Outside of Study Area	DWR	Outside of Study Area	362611N1199496W001	T19S R19E 19	248.9		215.7		33.2
Outside of Study Area	DWR	Outside of Study Area	362522N1198877W001	T19S R19E 27	220.9		173.4		47.5
Outside of Study Area	DWR	Outside of Study Area	363128N1198266W001	T19S R20E 05	217.8		151.5		66.3

SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
Outside of Study Area	DWR	Outside of Study Area	363053N1198438W001	T19S R20E 06	214.8	97.8	110.6	117.0	104.2
Outside of Study Area	DWR	Outside of Study Area	363092N1198438W001	T19S R20E 06	215.8	101.9	155.4	113.9	60.4
Outside of Study Area	DWR	Outside of Study Area	362942N1198432W001	T19S R20E 07	212.8	97.7		115.1	
Outside of Study Area	DWR	Outside of Study Area	362667N1198352W001	T19S R20E 19	212.9		156.0		56.9
Outside of Study Area	DWR	Outside of Study Area	362692N1197932W001	T19S R20E 22	222.8		14.9		207.9
Outside of Study Area	DWR	Outside of Study Area	362400N1198300W001	T19S R20E 32	198.6		187.8		10.8
Outside of Study Area	DWR	Outside of Study Area	362400N1198300W002	T19S R20E 32	198.6		187.2		11.4

Attachment 3

Depth to Water Contour Maps


Kings Subbasin
Coordinated Effort
Kings Coordinated Effort GSAs
Spring 1997 - Depth to Water in Wells
(feet below ground surface)
Legend
Kings Coordinated Effort GSAs
Groundwater Subbasins (DWR 2017)
Well Used in Analysis
Water Level Contours
Line of Equal Depth (10ft interval)
KDSA
Est. 1972
EST. 1968
PROVOST&
PRITCHARD
CONSULTING GROUP
An Employee Owned Company
0 2 4
Miles
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
DRAFT



Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2012 - Depth to Water in Wells (feet below ground surface)

Legend

- Kings Coordinated Effort GSAs
- Groundwater Subbasins (DWR 2017)
- Well Used in Analysis

Water Level Contours

- Line of Equal Depth (10ft interval)

KDSA Est. 1972

PROVOST & PRITCHARD CONSULTING GROUP, EST. 1968, An Employee Owned Company

0 2 4 Miles

10/18/2018 : G:\Kings River East GSA-2664\266417001-Kings Basin SGMA Coordination\GIS\Map\Wells\DTW\2012\spr12_dtw_all_11x17.mxd

Attachment 4

Storage Change Estimation Tables

Central Kings GSA										
SY Unit	SY Source	SY10to50	SY50to100	SY100to200	SY200to300	Acres	SPR 1997 DTW AVE	1997 GW STORAGE (AF)	SPR 2012 DTW AVE	2012 GW STORAGE (AF)
CK047	USGS WSP 1469	0.159	0.127	0.085	0.141	4,747	42	143,269	53	135,675
CK049	USGS WSP 1469	0.178	0.158	0.104	0.147	10,333	30	377,428	37	365,539
CK050	USGS WSP 1469	0.178	0.158	0.104	0.159	115	25	4,448	24	4,469
CK072	USGS WSP 1469	0.130	0.109	0.139	0.117	1,598	118	36,828	119	36,685
CK073	USGS WSP 1469	0.138	0.134	0.134	0.142	13,442	62	438,946	82	403,341
CK074	USGS WSP 1469	0.138	0.134	0.134	0.145	19,177	38	694,167	51	662,143
CK075	USGS WSP 1469	0.173	0.131	0.121	0.157	20,186	35	745,232	40	729,729
CK076	USGS WSP 1469	0.127	0.138	0.094	0.134	9,895	47	297,769	50	294,019
CK088	USGS WSP 1469	0.155	0.139	0.157	0.120	3,844	135	85,493	157	72,182
CK089	USGS WSP 1469	0.122	0.138	0.148	0.000	17,282	86	289,935	113	223,728
CK090	USGS WSP 1469	0.155	0.135	0.128	0.143	17,929	52	601,268	61	579,657
CK091	USGS WSP 1469	0.156	0.137	0.141	0.148	20,442	35	779,805	43	754,025
CK092	USGS WSP 1469	0.147	0.126	0.141	0.131	4,850	32	174,998	40	169,924
CK102	USGS WSP 1469	0.104	0.085	0.133	0.111	7,060	23	222,369	32	215,450
						150,902		4,891,955		4,646,566

Notes: 1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.

Total Change in Storage (AF) =

James ID GSA											
SY Unit	SY Source	SY10to50	SY50to100	SY100to200	SY200to300	Acres	SPR 1997 DTW AVE	1997 GW STORAGE (AF)	SPR 2012 DTW AVE	2012 GW STORAGE (AF)	SPR 1997 to SPR 2012 Change (AF)
JID032	USGS PP 1401-D	0.100	0.100	0.100	0.100	1	70	32	84	30	-2
JID033	USGS PP 1401-D	0.100	0.100	0.100	0.100	103	70	2,354	84	2,214	-140
JID034	KDSA	0.110	0.110	0.110	0.110	8,971	64	233,029	84	213,102	-19,927
JID062	KDSA	0.100	0.100	0.100	0.100	1,425	80	31,377	92	29,610	-1,767
JID063	KDSA	0.120	0.120	0.120	0.120	17,595	100	421,564	122	376,585	-44,978
JID064	KDSA	0.126	0.126	0.126	0.126	303	146	5,882	172	4,898	-984
JID067	KDSA	0.125	0.125	0.125	0.125	481	150	9,014	165	8,117	-897
JID068	USGS PP 1401-D	0.130	0.130	0.130	0.130	180	156	3,364	179	2,838	-526
						29,058		706,615		637,394	-69,221

Notes: 1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.

Total Change in Storage (AF) = -69,221

Kings River East GSA											
SY Unit	SY Source	SY10to50	SY50to100	SY100to200	SY200to300	Acres	SPR 1997 DTW AVE	1997 GW STORAGE (AF)	SPR 2012 DTW AVE	2012 GW STORAGE (AF)	SPR 1997 to SPR 2012 Change (AF)
KRE025	USGS PP 1401-D	0.180	0.180	0.180	0.000	40	9	1,357	14	1,325	-32
KRE049	USGS WSP 1469	0.178	0.158	0.104	0.147	2,275	23	85,980	31	82,697	-3,283
KRE050	USGS WSP 1469	0.178	0.158	0.104	0.000	13,801	17	332,429	26	311,591	-20,839
KRE051	USGS PP 1401-D	0.180	0.180	0.180	0.000	1,181	21	38,137	20	38,328	191
KRE052	Page and LeBlanc 1969	0.061	0.061	0.061	0.000	53	40	517	35	535	17
KRE053	USGS PP 1401-D	0.130	0.130	0.130	0.000	55	43	1,111	41	1,128	17
KRE054	Page and LeBlanc 1969	0.061	0.061	0.061	0.000	660	48	6,131	53	5,913	-217
KRE055	AID	0.125	0.125	0.125	0.000	2,155	10	51,193	12	50,640	-553
KRE056	AID	0.115	0.115	0.115	0.000	542	13	11,634	19	11,263	-371
KRE057	OCID	0.078	0.078	0.080	0.000	668	9	10,103	20	9,519	-584
KRE058	Page and LeBlanc 1969	0.065	0.065	0.065	0.000	2,001	24	22,938	31	22,039	-899
KRE059	USGS PP 1401-D	0.070	0.000	0.000	0.000	7,583	5	23,828	11	20,687	-3,141
KRE060	USGS WSP 1469	0.069	0.090	0.066	0.102	1,124	50	23,917	54	23,522	-396
KRE061	USGS WSP 1469	0.069	0.090	0.066	0.000	2,431	23	31,594	27	30,877	-716
KRE075	USGS WSP 1469	0.173	0.131	0.121	0.157	331	24	12,861	31	12,460	-401
KRE076	USGS WSP 1469	0.127	0.138	0.094	0.134	12,213	50	363,388	60	346,335	-17,053
KRE077	USGS WSP 1469	0.069	0.090	0.066	0.095	856	56	17,163	53	17,378	215
KRE078	USGS WSP 1469	0.069	0.090	0.066	0.000	20,839	39	246,887	43	240,898	-5,989
KRE079	Page and LeBlanc 1969	0.074	0.074	0.074	0.000	2,497	19	33,374	19	33,533	159
KRE080	USGS PP 1401-D	0.060	0.000	0.000	0.000	6,010	16	12,154	21	10,636	-1,519
KRE081	USGS WSP 1469	0.069	0.090	0.066	0.000	2,020	35	24,571	46	22,984	-1,587
KRE082	USGS PP 1401-D	0.060	0.060	0.060	0.000	236	24	2,493	29	2,419	-74
KRE091	USGS WSP 1469	0.156	0.137	0.141	0.148	360	23	14,385	33	13,838	-547
KRE092	USGS WSP 1469	0.147	0.126	0.141	0.000	18,236	32	421,242	51	368,978	-52,265
KRE093	USGS WSP 1469	0.068	0.080	0.055	0.000	22,806	33	242,748	41	231,109	-11,639
KRE094	USGS WSP 1469	0.056	0.080	0.055	0.000	11,499	27	124,254	28	123,128	-1,127
KRE095	Page and LeBlanc 1969	0.074	0.074	0.074	0.000	7,285	23	95,461	29	92,341	-3,121
KRE102	USGS WSP 1469	0.104	0.085	0.133	0.111	3	23	79	29	77	-2
KRE103	USGS WSP 1469	0.104	0.085	0.120	0.000	19,983	58	310,297	74	284,717	-25,580
KRE104	USGS WSP 1469	0.096	0.086	0.077	0.000	857	56	9,819	68	8,979	-841
KRE105	USGS WSP 1469	0.104	0.085	0.120	0.000	737	49	12,056	65	11,037	-1,019
KRE106	USGS WSP 1469	0.068	0.080	0.055	0.000	12,058	24	135,598	45	118,350	-17,247
KRE107	USGS WSP 1469	0.086	0.102	0.065	0.000	1,741	32	22,894	51	20,072	-2,823
KRE108	USGS WSP 1469	0.068	0.080	0.055	0.000	7,691	50	72,763	48	74,266	1,504
KRE109	USGS WSP 1469	0.097	0.104	0.079	0.000	57	73	607	99	454	-153
KRE110	USGS PP 1401-D	0.074	0.074	0.074	0.000	295	21	3,905	38	3,541	-364
KRE117	Page and LeBlanc 1969	0.074	0.074	0.074	0.000	14	18	192	35	175	-18
						183,192		2,820,061		2,647,765	-172,296

Notes: 1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.

Total Change in Storage (AF) = -172,296

McMullin Area GSA											
SY Unit	SY Source	SY10to50	SY50to100	SY100to200	SY200to300	Acres	SPR 1997 DTW AVE	1997 GW STORAGE (AF)	SPR 2012 DTW AVE	2012 GW STORAGE (AF)	SPR 1997 to SPR 2012 Change (AF)
MA013	USGS WSP 1469	0.155	0.119	0.158	0.133	171	42	6,216	87	5,232	-984
MA014	USGS WSP 1469	0.100	0.078	0.081	0.133	1,166	50	29,464	83	26,529	-2,935
MA015	USGS WSP 1469	0.103	0.069	0.088	0.106	253	29	6,326	46	5,883	-442
MA029	USGS PP 1401-D	0.160	0.160	0.160	0.160	414	36	17,474	79	14,660	-2,814
MA030	Page and LeBlanc 1969	0.134	0.134	0.134	0.134	6,568	50	220,031	82	191,800	-28,231
MA031	Page and LeBlanc 1969	0.128	0.128	0.128	0.128	10,065	72	293,461	73	291,850	-1,611
MA034	KDSA	0.110	0.110	0.110	0.110	4,151	66	106,993	84	98,412	-8,581
MA035	USGS PP 1401-D	0.110	0.110	0.110	0.110	1,290	88	30,080	125	24,854	-5,226
MA036	Page and LeBlanc 1969	0.115	0.115	0.115	0.115	19,957	110	435,002	118	418,523	-16,480
MA037	Page and LeBlanc 1969	0.116	0.116	0.116	0.116	0	0	0	0	0	0
MA038	USGS WSP 1469	0.096	0.157	0.160	0.112	170	81	5,137	93	4,811	-326
MA042	USGS WSP 1469	0.130	0.109	0.139	0.119	19	0	0	0	0	0
MA063	KDSA	0.120	0.120	0.120	0.120	373	101	8,902	142	7,069	-1,833
MA064	KDSA	0.126	0.126	0.126	0.126	21,269	159	378,784	170	347,085	-31,699
MA065	Page and LeBlanc 1969	0.104	0.104	0.104	0.104	2,997	150	46,676	156	44,976	-1,700
MA068	USGS PP 1401-D	0.130	0.130	0.130	0.130	8,576	190	122,708	211	99,308	-23,400
MA069	Page and LeBlanc 1969	0.109	0.109	0.109	0.109	7,629	186	94,483	214	71,294	-23,188
MA070	Page and LeBlanc 1969	0.116	0.116	0.116	0.116	7,181	175	104,063	202	82,017	-22,047
MA071	USGS WSP 1469	0.130	0.109	0.139	0.102	4,233	138	79,407	149	73,190	-6,217
MA072	USGS WSP 1469	0.130	0.109	0.139	0.117	14,476	133	305,046	145	279,719	-25,328
MA085	USGS PP 1401-D	0.110	0.110	0.110	0.110	198	175	2,715	205	2,058	-657
MA086	Page and LeBlanc 1969	0.116	0.116	0.116	0.116	1,326	178	18,702	219	12,399	-6,303
MA087	Page and LeBlanc 1969	0.116	0.116	0.116	0.116	1,467	173	21,616	201	16,878	-4,738
MA088	USGS WSP 1469	0.155	0.139	0.157	0.120	6,629	159	122,463	182	98,437	-24,026
						120,577		2,455,747		2,216,980	-238,767

North Fork Kings GSA

SY Unit	SY Source	SY10to50	SY50to100	SY100to200	SY200to300	Acres	SPR 1997 DTW AVE	1997 GW STORAGE (AF)	SPR 2012 DTW AVE	2012 GW STORAGE (AF)	SPR 1997 to SPR 2012 Change (AF)
NFK063	KDSA	0.120	0.120	0.120	0.120	2,773	120	59,988	132	55,896	-4,092
NFK067	KDSA	0.125	0.125	0.125	0.125	16,262	161	282,547	169	265,641	-16,906
NFK068	USGS PP 1401-D	0.130	0.130	0.130	0.130	9,547	170	161,625	197	128,227	-33,399
NFK084	USGS PP 1401-D	0.120	0.120	0.120	0.120	11,019	147	202,970	188	148,076	-54,894
NFK085	USGS PP 1401-D	0.110	0.110	0.110	0.110	16,075	141	280,525	183	207,347	-73,178
NFK086	Page and LeBlanc 1969	0.116	0.116	0.116	0.116	5,237	161	84,621	197	62,787	-21,834
NFK087	Page and LeBlanc 1969	0.116	0.116	0.116	0.116	5,523	159	90,612	185	73,632	-16,980
NFK088	USGS WSP 1469	0.155	0.139	0.157	0.120	1,891	141	40,262	170	31,592	-8,670
NFK089	USGS WSP 1469	0.122	0.138	0.148	0.139	5,778	101	165,286	133	137,458	-27,828
NFK090	USGS WSP 1469	0.155	0.135	0.128	0.143	5,117	73	157,549	91	144,924	-12,625
NFK096	USGS PP 1401-D	0.130	0.130	0.130	0.130	2,376	137	50,451	174	38,981	-11,470
NFK097	USGS PP 1401-D	0.120	0.120	0.120	0.120	15,060	112	340,403	176	223,752	-116,650
NFK098	Page and LeBlanc 1969	0.133	0.133	0.133	0.133	4,082	111	102,754	160	76,144	-26,610
NFK099	Page and LeBlanc 1969	0.114	0.114	0.114	0.114	3,876	118	80,377	162	61,138	-19,238
NFK100	USGS WSP 1469	0.183	0.119	0.133	0.113	22,931	87	599,625	122	497,606	-102,019
NFK101	USGS WSP 1469	0.173	0.162	0.133	0.135	17,049	52	589,422	71	537,519	-51,903
NFK102	USGS WSP 1469	0.104	0.085	0.133	0.111	3,195	36	96,207	54	90,422	-5,785
NFK111	USGS PP 1401-D	0.080	0.080	0.080	0.080	46	116	679	183	432	-248
NFK112	USGS PP 1401-D	0.120	0.120	0.120	0.120	5,393	115	119,406	173	81,904	-37,503
NFK113	USGS WSP 1469	0.150	0.096	0.150	0.133	6,112	105	168,090	154	123,894	-44,196
NFK114	USGS WSP 1469	0.150	0.096	0.150	0.133	8,485	96	243,046	132	199,309	-43,737
						167,824		3,916,445		3,186,680	-729,765

Notes:
1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.
2) NFK063 Spring 2012 DTW Average estimated from 2011 and 2013 values

Total Change in Storage (AF) = -729,765
Years in Range = 15

North Kings GSA											
SY Unit	SY Source	SY10to50	SY50to100	SY100to200	SY200to300	Acres	SPR 1997 DTW AVE	1997 GW STORAGE (AF)	SPR 2012 DTW AVE	2012 GW STORAGE (AF)	SPR 1997 to SPR 2012 Change (AF)
NK003	USGS WSP 1469	0.103	0.108	0.130	0.105	99	50	2,860	76	2,575	-285
NK004	USGS WSP 1469	0.156	0.151	0.103	0.155	3,613	97	94,730	115	87,604	-7,125
NK005	USGS WSP 1469	0.135	0.117	0.153	0.145	13,847	129	351,516	149	308,775	-42,740
NK006	USGS WSP 1469	0.112	0.131	0.139	0.000	12,544	91	189,440	101	172,744	-16,697
NK008	Page and LeBlanc 1969	0.076	0.076	0.076	0.000	7,640	41	92,336	47	88,775	-3,560
NK009	USGS PP 1401-D	0.060	0.000	0.000	0.000	4,122	11	9,591	26	5,881	-3,710
NK011	USGS PP 1401-D	0.090	0.000	0.000	0.000	3,268	10	11,712	10	11,891	179
NK015	USGS WSP 1469	0.103	0.069	0.088	0.106	13,899	52	315,911	54	313,597	-2,315
NK016	USGS WSP 1469	0.118	0.102	0.126	0.117	20,498	56	589,516	57	587,879	-1,637
NK017	USGS WSP 1469	0.145	0.135	0.143	0.143	22,802	81	710,869	88	688,586	-22,283
NK018	USGS WSP 1469	0.106	0.122	0.109	0.134	21,788	109	507,237	133	452,167	-55,071
NK019	USGS WSP 1469	0.084	0.070	0.064	0.069	1,220	100	16,224	120	14,697	-1,527
NK020	USGS WSP 1469	0.106	0.122	0.109	0.100	11,846	92	259,758	129	210,704	-49,054
NK021	USGS WSP 1469	0.084	0.070	0.064	0.000	11,243	57	106,067	77	89,929	-16,138
NK022	USGS WSP 1469	0.074	0.075	0.044	0.000	23,051	24	232,630	33	217,386	-15,244
NK023	Page and LeBlanc 1969	0.143	0.143	0.143	0.000	656	20	16,865	19	17,024	159
NK024	Page and LeBlanc 1969	0.122	0.122	0.122	0.000	57	24	1,225	20	1,252	27
NK025	USGS PP 1401-D	0.180	0.180	0.180	0.000	894	13	30,086	15	29,687	-399
NK026	USGS PP 1401-D	0.060	0.000	0.000	0.000	1,542	0	0	0	0	0
NK027	PandP	0.060	0.060	0.060	0.000	2,078	0	0	0	0	0
NK031	Page and LeBlanc 1969	0.128	0.128	0.128	0.128	557	69	16,501	69	16,443	-58
NK036	Page and LeBlanc 1969	0.115	0.115	0.115	0.115	1,750	115	37,153	114	37,440	287
NK037	Page and LeBlanc 1969	0.116	0.116	0.116	0.116	204	120	4,260	136	3,870	-390
NK038	USGS WSP 1469	0.096	0.157	0.160	0.112	4,346	95	121,423	97	120,217	-1,207
NK039	USGS WSP 1469	0.096	0.157	0.160	0.115	15,591	74	493,550	77	485,425	-8,124
NK040	USGS WSP 1469	0.130	0.109	0.139	0.115	4,754	94	124,015	92	124,845	830
NK041	USGS WSP 1469	0.145	0.135	0.143	0.118	2,350	62	73,401	63	73,131	-270
NK042	USGS WSP 1469	0.130	0.109	0.139	0.119	20,571	57	626,495	67	604,696	-21,800
NK043	USGS WSP 1469	0.159	0.127	0.085	0.125	14,993	63	384,675	75	362,623	-22,052
NK044	USGS WSP 1469	0.106	0.122	0.109	0.134	359	86	9,349	98	8,815	-534
NK045	USGS WSP 1469	0.084	0.070	0.064	0.083	7,694	88	119,356	101	112,520	-6,836
NK046	USGS WSP 1469	0.084	0.070	0.064	0.104	5,190	77	95,628	90	90,812	-4,816
NK047	USGS WSP 1469	0.159	0.127	0.085	0.141	13,232	53	378,421	66	356,300	-22,121
NK048	USGS WSP 1469	0.074	0.075	0.044	0.105	315	32	6,302	48	5,937	-365
NK049	USGS WSP 1469	0.178	0.158	0.104	0.147	6,571	33	236,782	42	226,470	-10,312
NK050	USGS WSP 1469	0.178	0.158	0.104	0.000	1,863	24	42,812	21	43,691	879
NK064	KDSA	0.126	0.126	0.126	0.126	753	133	15,823	137	15,497	-326
NK065	Page and LeBlanc 1969	0.104	0.104	0.104	0.104	1,981	116	37,815	123	36,433	-1,382
NK071	USGS WSP 1469	0.130	0.109	0.139	0.102	9	127	175	126	177	2
NK072	USGS WSP 1469	0.130	0.109	0.139	0.117	6,406	90	170,630	97	165,810	-4,820
NK073	USGS WSP 1469	0.138	0.134	0.134	0.142	9,589	55	323,029	68	305,824	-17,204
NK074	USGS WSP 1469	0.138	0.134	0.134	0.145	2,386	43	84,986	55	81,005	-3,981
						298,168		6,941,155		6,579,133	-362,022

Notes: 1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.

Total Change in Storage (AF) = -362,022

South Kings GSA

SY Unit	SY Source	SY10to50	SY50to100	SY100to200	SY200to300	Acres	SPR 1997 DTW AVE	1997 GW STORAGE (AF)	SPR 2012 DTW AVE	2012 GW STORAGE (AF)	SPR 1997 to SPR 2012 Change (AF)
SK049	USGS WSP 1469	0.178	0.158	0.104	0.147	3,561	29	130,580	34	127,660	-2,920
SK074	USGS WSP 1469	0.138	0.134	0.134	0.145	1,603	39	57,940	49	55,747	-2,193
SK075	USGS WSP 1469	0.173	0.131	0.121	0.157	2,412	36	88,598	41	86,702	-1,896
SK076	USGS WSP 1469	0.127	0.138	0.094	0.134	48	47	1,455	45	1,465	10
SK091	USGS WSP 1469	0.156	0.137	0.141	0.148	2,245	32	86,530	40	83,768	-2,762
						9,870		365,104		355,343	-9,761

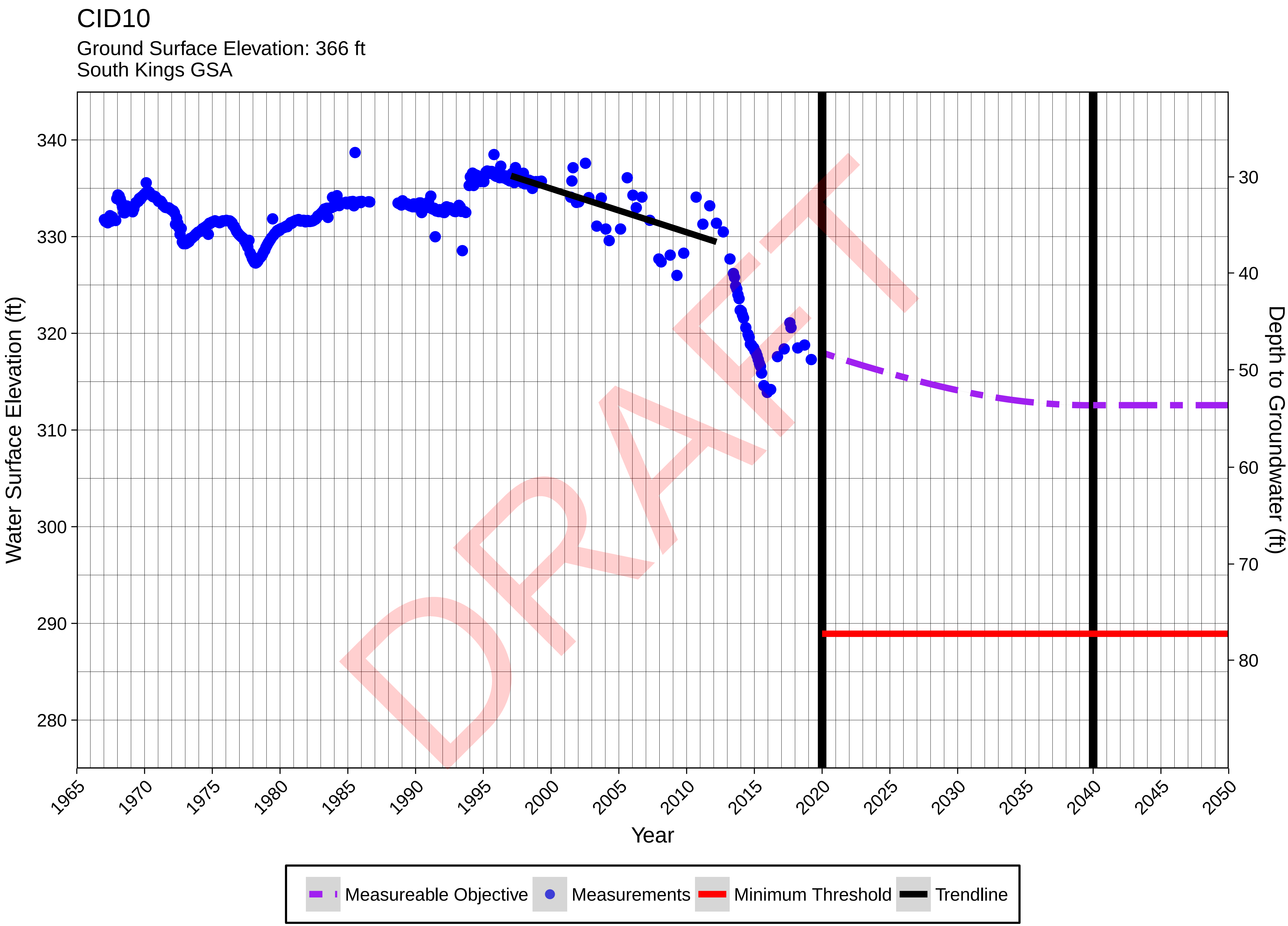
Notes: 1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.

Total Change in Storage (AF) = -9,761

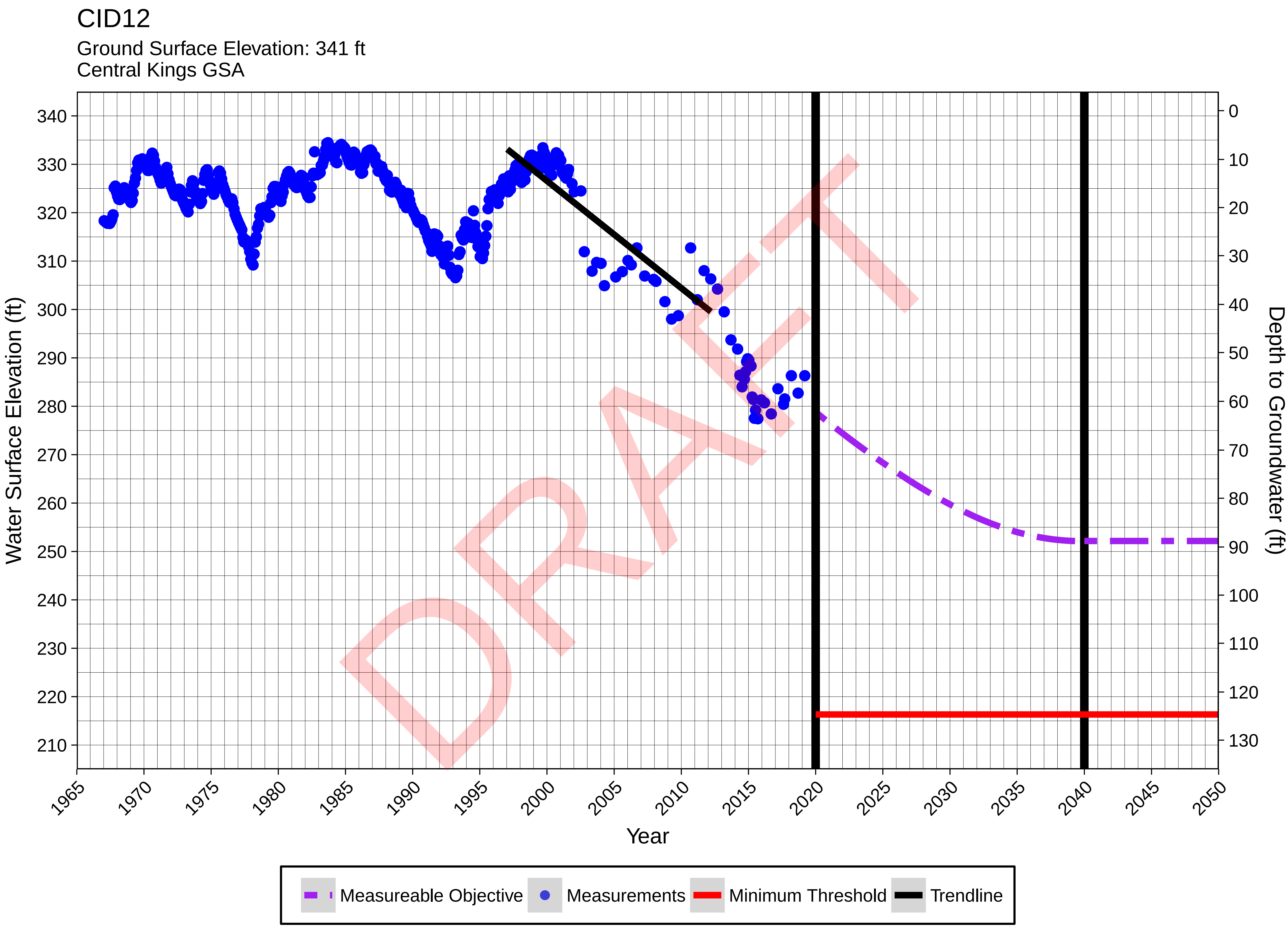
Years in Range = 15

Appendix F

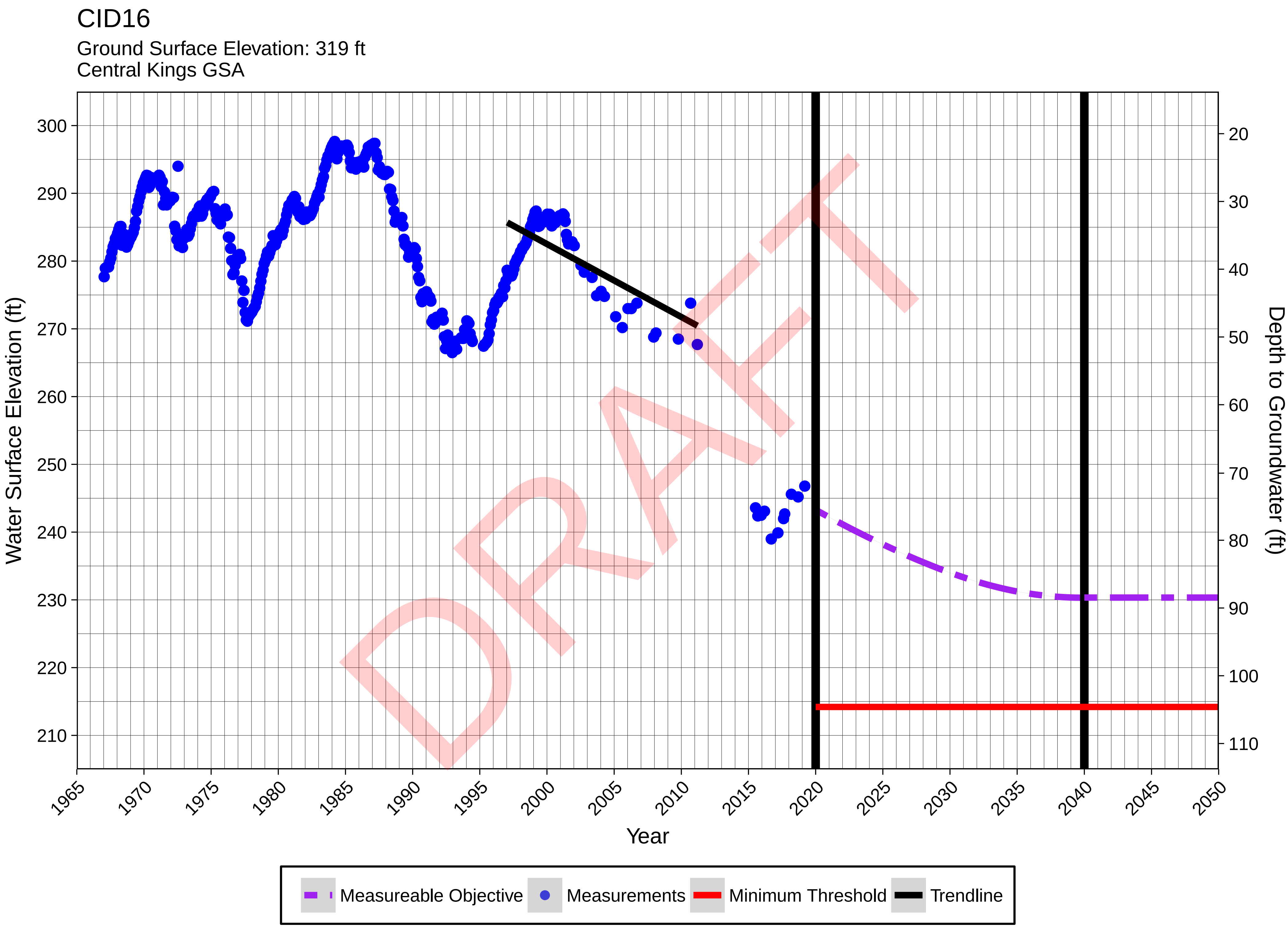
Representative Well Hydrographs

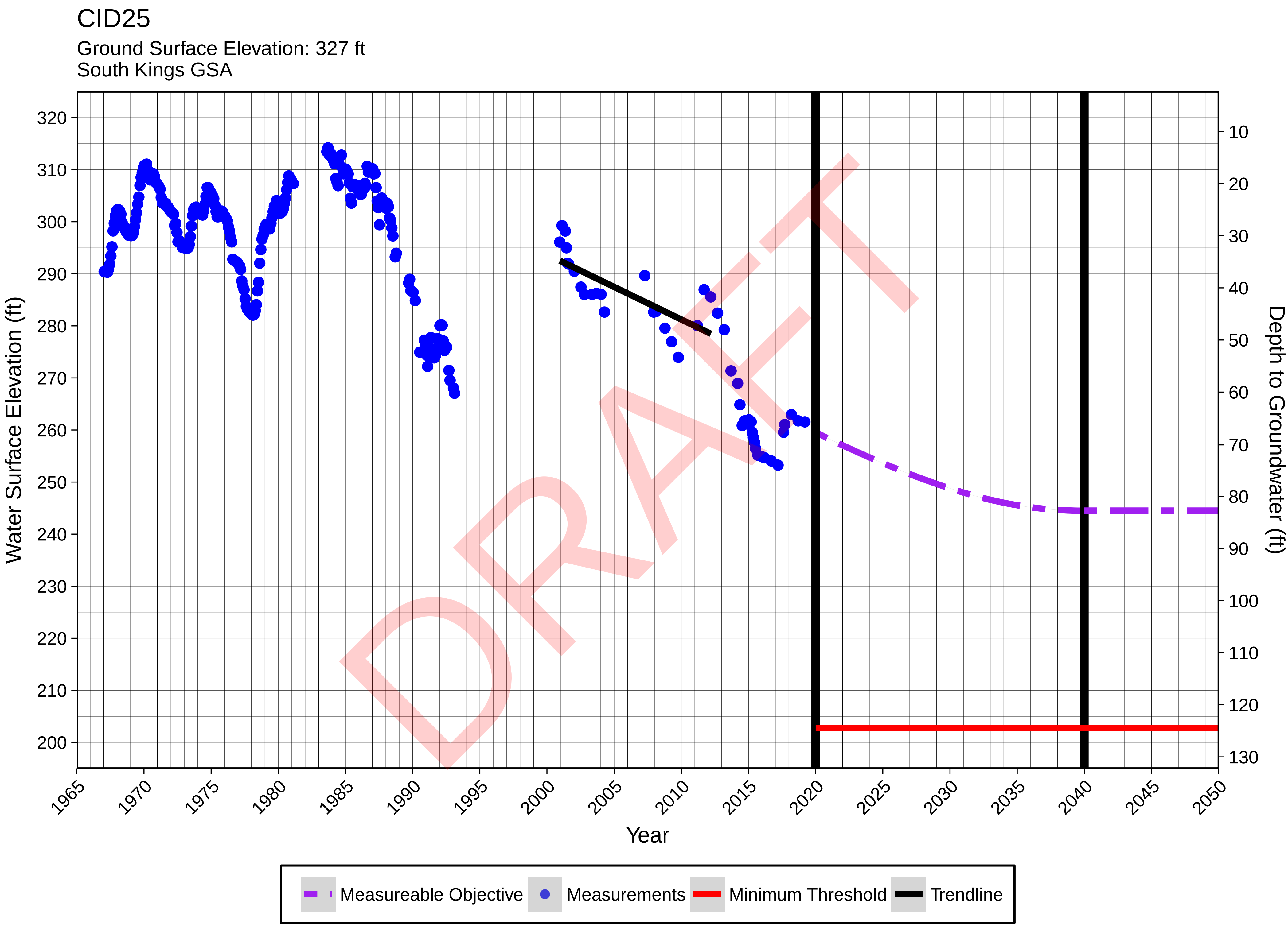


CID10
Ground Surface Elevation: 366 ft
South Kings GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
340
330
320
310
300
290
280
30
40
50
60
70
80
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
DRAFT
Measureable Objective
Measurements
Minimum Threshold
Trendline

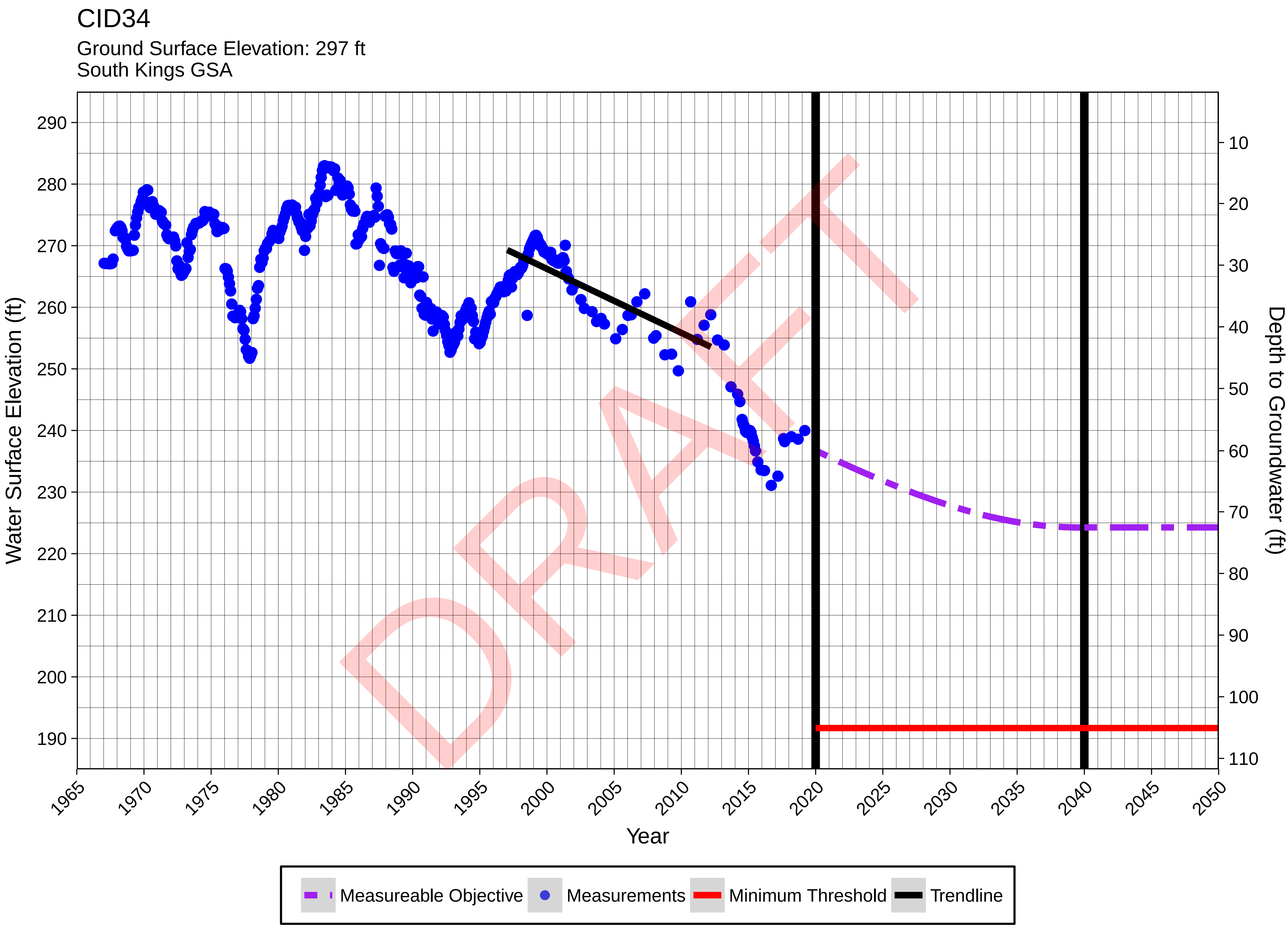


CID12
Ground Surface Elevation: 341 ft
Central Kings GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
340
330
320
310
300
290
280
270
260
250
240
230
220
210
0
10
20
30
40
50
60
70
80
90
100
110
120
130
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Measureable Objective
Measurements
Minimum Threshold
Trendline
DRAFT


CID16
Ground Surface Elevation: 319 ft
Central Kings GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
DRAFT
Measureable Objective
Measurements
Minimum Threshold
Trendline



CID25
Ground Surface Elevation: 327 ft
South Kings GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
DRAFT
Measureable Objective
Measurements
Minimum Threshold
Trendline



CID34
Ground Surface Elevation: 297 ft
South Kings GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
DRAFT
Measureable Objective
Measurements
Minimum Threshold
Trendline

Appendix G

Groundwater Storage Calculations

(Not Included at this Time)

Appendix H

Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans

ARTICLE 3. Technical and Reporting Standards

§ 352. Introduction to Technical and Reporting Standards

This Article describes the monitoring protocols, standards for monitoring sites, and other technical elements related to the development or implementation of a Plan.

Note: Authority cited: Section 10733.2, Water Code.

Reference: Section 10733.2, Water Code.

§ 352.2. Monitoring Protocols

Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows:

(a) Monitoring protocols shall be developed according to best management practices.

(b) The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department, or may adopt similar monitoring protocols that will yield comparable data.

(c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.

Note: Authority cited: Section 10733.2, Water Code.

Reference: Sections 10727.2, 10728.2, 10729, and 10733.2, Water Code.

§ 352.4. Data and Reporting Standards

(a) The following reporting standards apply to all categories of information required of a Plan, unless otherwise indicated:

(1) Water volumes shall be reported in acre-feet.

(2) Surface water flow shall be reported in cubic feet per second and groundwater flow shall be reported in acre-feet per year.

(3) Field measurements of elevations of groundwater, surface water, and land surface shall be measured and reported in feet to an accuracy of at least 0.1 feet relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.

(4) Reference point elevations shall be measured and reported in feet to an accuracy of at least 0.5 feet, or the best available information, relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.

(5) Geographic locations shall be reported in GPS coordinates by latitude and longitude in decimal degree to five decimal places, to a minimum accuracy of 30 feet, relative to NAD83, or another national standard that is convertible to NAD83.

(b) Monitoring sites shall include the following information:

(1) A unique site identification number and narrative description of the site location.

(2) A description of the type of monitoring, type of measurement taken, and monitoring frequency.

(3) Location, elevation of the ground surface, and identification and description of the reference point.

(4) A description of the standards used to install the monitoring site. Sites that do not conform to best management practices shall be identified and the nature of the divergence from best management practices described.

(c) The following standards apply to wells:

(1) Wells used to monitor groundwater conditions shall be constructed according to applicable construction standards, and shall provide the following information in both tabular and geodatabase-compatible shapefile form:

(A) CASGEM well identification number. If a CASGEM well identification number has not been issued, appropriate well information shall be entered on forms made available by the Department, as described in Section 353.2.

(B) Well location, elevation of the ground surface and reference point, including a description of the reference point.

(C) A description of the well use, such as public supply, irrigation, domestic, monitoring, or other type of well, whether the well is active or inactive, and whether the well is a single, clustered, nested, or other type of well.

(D) Casing perforations, borehole depth, and total well depth.

(E) Well completion reports, if available, from which the names of private owners have been redacted.

(F) Geophysical logs, well construction diagrams, or other relevant information, if available.

(G) Identification of principal aquifers monitored.

(H) Other relevant well construction information, such as well capacity, casing diameter, or casing modifications, as available.

(2) 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.

(3) Well information used to develop the basin setting shall be maintained in the Agency's data management system.

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

(1) Data layers, shapefiles, geodatabases, and other information provided with each map, shall be submitted electronically to the Department in accordance with the procedures described in Article 4.

(2) Maps shall be clearly labeled and contain a level of detail to ensure that the map is informative and useful.

(3) The datum shall be clearly identified on the maps or in an associated legend.

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

(1) Hydrographs shall be submitted electronically to the Department in accordance with the procedures described in Article 4.

(2) Hydrographs shall include a unique site identification number and the ground surface elevation for each site.

(3) Hydrographs shall use the same datum and scaling to the greatest extent practical.

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

(1) The model shall include publicly available supporting documentation.

(2) The model shall be based on field or laboratory measurements, or equivalent methods that justify the selected values, and calibrated against site-specific field data.

(3) Groundwater and surface water models developed in support of a Plan after the effective date of these regulations shall consist of public domain open-source software.

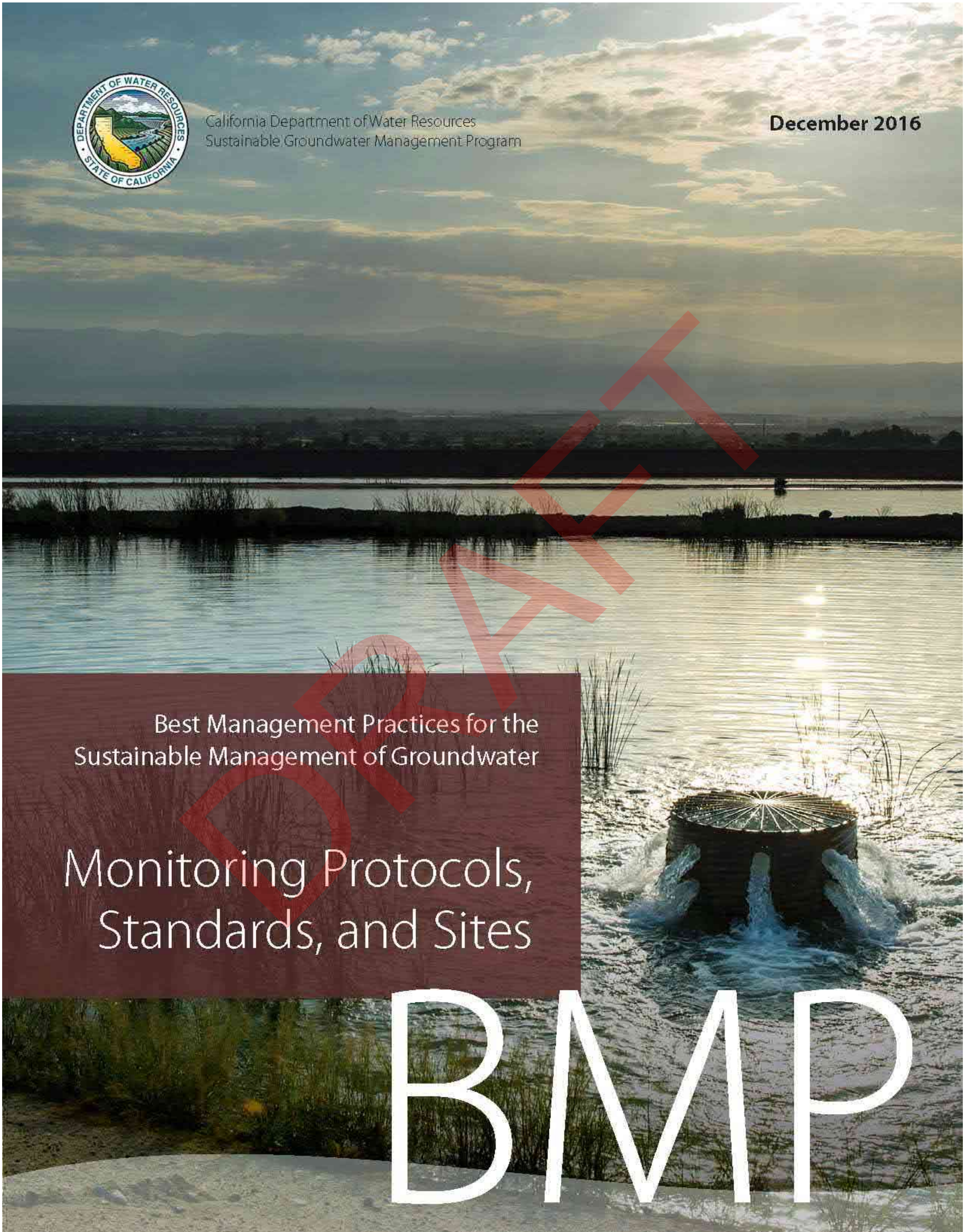
(g) The Department may request data input and output files used by the Agency, as necessary. The Department may independently evaluate the appropriateness of model results relied upon by the Agency, and use that evaluation in the Department's assessment of the Plan.

Note: Authority cited: Section 10733.2, Water Code.

Reference: Sections 10727.2, 10727.6, and 10733.2, Water Code.

Appendix I

Monitoring Protocols, Standards and Sites BMP



California Department of Water Resources
Sustainable Groundwater Management Program

December 2016

Best Management Practices for the Sustainable Management of Groundwater

Monitoring Protocols, Standards, and Sites

BMP

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California Natural Resources Agency
John Laird, Secretary for Natural Resources

Department of Water Resources
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Groundwater Monitoring Protocols, Standards, and Sites Best Management Practice

1. OBJECTIVE

The objective of this *Best Management Practice* (BMP) is to assist in the development of Monitoring Protocols. The California Department of Water Resources (the Department or DWR) has developed this document as part of the obligation in the Technical Assistance chapter (Chapter 7) of the Sustainable Groundwater Management Act (SGMA) to support the long-term sustainability of California's groundwater *basins*. Information provided in this BMP provides technical assistance to Groundwater Sustainability Agencies (GSAs) and other stakeholders to aid in the establishment of consistent data collection processes and procedures. In addition, this BMP can be used by GSAs to adopt a set of sampling and measuring procedures that will yield similar data regardless of the monitoring personnel. Finally, this BMP identifies available resources to support the development of monitoring protocols.

This BMP includes the following sections:

1. Objective. A brief description of how and where monitoring protocols are required under SGMA and the overall objective of this BMP.
2. Use and Limitations. A brief description of the use and limitations of this BMP.
3. Monitoring Protocol Fundamentals. A description of the general approach and background of groundwater monitoring protocols.
4. Relationship of Monitoring Protocols to other BMPs. A description of how this BMP is connected with other BMPS.
5. Technical Assistance. Technical content providing guidance for regulatory sections.
6. Key Definitions. Descriptions of definitions identified in the GSP Regulations or SGMA.
7. Related Materials. References and other materials that provide supporting information related to the development of Groundwater Monitoring Protocols.

2. USE AND LIMITATIONS

BMPs developed by the Department provide technical guidance to GSAs and other stakeholders. Practices described in these BMPs do not replace the GSP Regulations, nor do they create new requirements or obligations for GSAs or other stakeholders. In addition, using this BMP to develop a GSP does not equate to an approval determination by the Department. All references to GSP Regulations relate to Title 23 of the California Code of Regulations (CCR), Division 2, Chapter 1.5, and Subchapter 2. All references to SGMA relate to California Water Code sections in Division 6, Part 2.74.

3. MONITORING PROTOCOL FUNDAMENTALS

Establishing data collection protocols that are based on best available scientific methods is essential. Protocols that can be applied consistently across all basins will likely yield comparable data. Consistency of data collection methods reduces uncertainty in the comparison of data and facilitates more accurate communication within basins as well as between basins.

Basic minimum technical standards of accuracy lead to quality data that will better support implementation of GSPs.

4. RELATIONSHIP OF MONITORING PROTOCOL TO OTHER BMPS

Groundwater monitoring is a fundamental component of SGMA, as each GSP must include a sufficient network of data that demonstrates measured progress toward the achievement of the sustainability goal for each basin. For this reason, a standard set of protocols need to be developed and utilized.

It is important that data is developed in a manner consistent with the basin setting, planning, and projects/management actions steps identified on **Figure 1** and the GSP Regulations. The inclusion of monitoring protocols in the GSP Regulations also emphasizes the importance of quality empirical data to support GSPs and provide comparable information from basin to basin.

Figure 1 provides a logical progression for the development of a GSP and illustrates how monitoring protocols are linked to other related BMPs. This figure also shows the context of the BMPs as they relate to various steps to sustainability as outlined in the GSP Regulations. The monitoring protocol BMP is part of the Monitoring step identified in **Figure 1**.

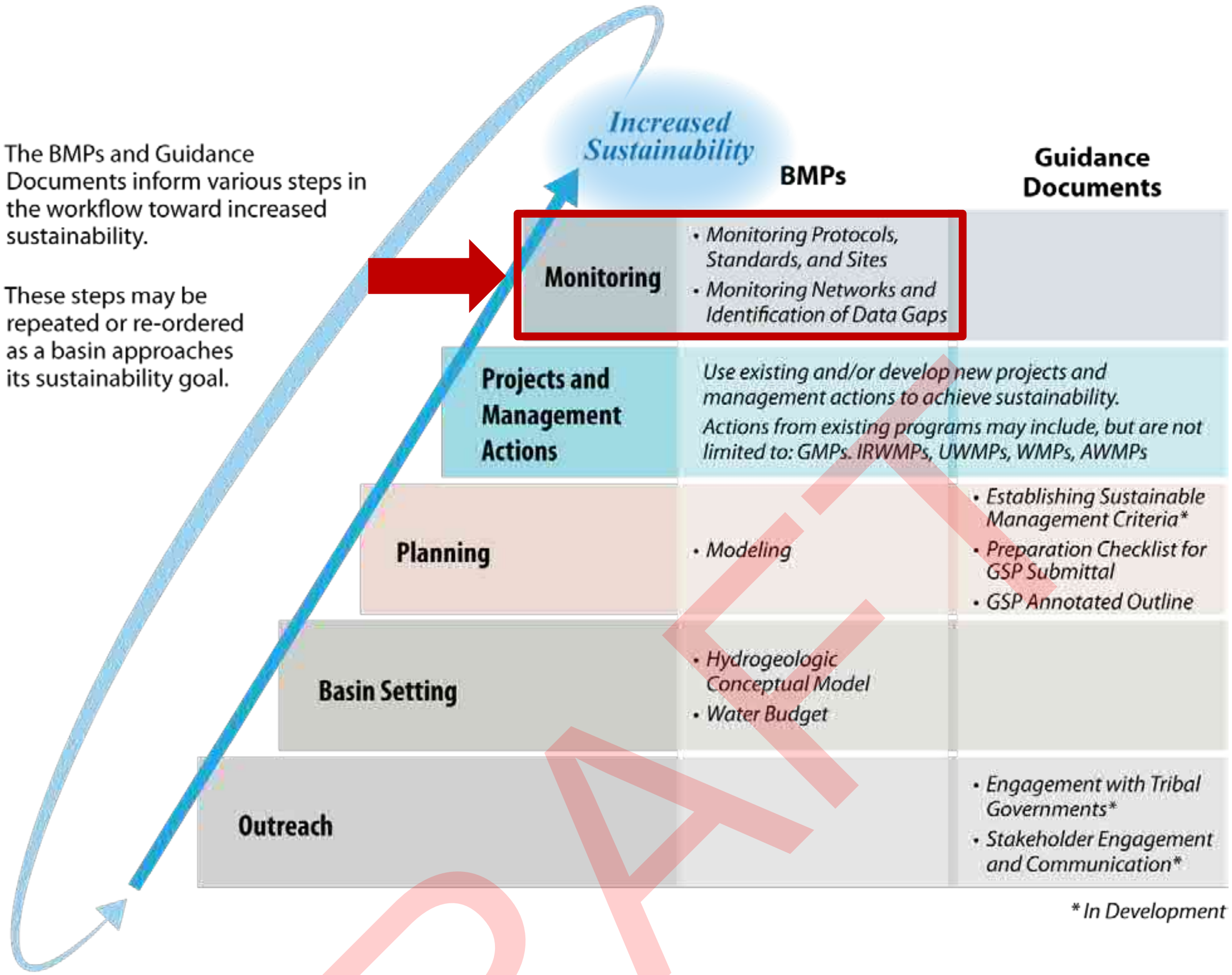

Figure 1 – Logical Progression of Basin Activities Needed to Increase Basin Sustainability

5. TECHNICAL ASSISTANCE

23 CCR §352.2. Monitoring Protocols. Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows:
(a) Monitoring protocols shall be developed according to best management practices.
(b) The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department, or may adopt similar monitoring protocols that will yield comparable data.
(c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.

The GSP Regulations specifically call out the need to utilize protocols identified in this BMP, or develop similar protocols. The following technical protocols provide guidance based upon existing professional standards and are commonly adopted in various groundwater-related programs. They provide clear techniques that yield quality data for use in the various components of the GSP. They can be further elaborated on by individual GSAs in the form of standard operating procedures which reflect specific local requirements and conditions. While many methodologies are suggested in this BMP, it should be understood that qualified professional judgment should be used to meet the specific monitoring needs.

The following BMPs may be incorporated into a GSP's monitoring protocols section for collecting groundwater elevation data. A GSP that adopts protocols that deviate from these BMPs must demonstrate that they will yield comparable data.

PROTOCOLS FOR ESTABLISHING A MONITORING PROGRAM

The protocol for establishment of a monitoring program should be evaluated in conjunction with the *Monitoring Network and Identification of Data Gaps* BMP and other BMPs. Monitoring protocols must take into consideration the *Hydrogeologic Conceptual Model, Water Budget, and Modeling* BMPs when considering the data needs to meet GSP objectives and the sustainability goal.

It is suggested that each GSP incorporate the Data Quality Objective (DQO) process following the U.S. EPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006). Although strict adherence to this method is not required, it does provide a robust approach to consider and assures that data is collected with a specific purpose in mind, and efforts for monitoring are as efficient as possible to achieve the objectives of the GSP and compliance with the GSP Regulations.

The DQO process presents a method that can be applied directly to the sustainability criteria quantitative requirements through the following steps.

1. State the problem – Define sustainability indicators and planning considerations of the GSP and sustainability goal.
2. Identify the goal – Describe the quantitative measurable objectives and minimum thresholds for each of the sustainability indicators.
3. Identify the inputs – Describe the data necessary to evaluate the sustainability indicators and other GSP requirements (i.e. water budget).
4. Define the boundaries of the study – This is commonly the extent of the Bulletin 118 groundwater basin or subbasin, unless multiple GSPs are prepared for a given basin. In that case, evaluation of the coordination plan and specifically how the monitoring will be comparable and meet the sustainability goals for the entire basin.
5. Develop an analytical approach – Determine how the quantitative sustainability indicators will be evaluated (i.e. are special analytical methods required that have specific data needs).
6. Specify performance or acceptance criteria – Determine what quality the data must have to achieve the objective and provide some assurance that the analysis is accurate and reliable.
7. Develop a plan for obtaining data – Once the objectives are known determine how these data should be collected. Existing data sources should be used to the greatest extent possible.

These steps of the DQO process should be used to guide GSAs to develop the most efficient monitoring process to meet the measurable objectives of the GSP and the sustainability goal. The DQO process is an iterative process and should be evaluated regularly to improve monitoring efficiencies and meet changing planning and project needs. Following the DQO process, GSAs should also include a data quality control and quality assurance plan to guide the collection of data.

Many monitoring programs already exist as part of ongoing groundwater management or other programs. To the extent possible, the use of existing monitoring data and programs should be utilized to meet the needs for characterization, historical record documentation, and continued monitoring for the SGMA program. However, an evaluation of the existing monitoring data should be performed to assure the data being collected meets the DQOs, regulatory requirements, and data collection protocol described in this BMP. While this BMP provides guidance for collection of various regulatory based requirements, there is flexibility among the various methodologies available to meet the DQOs based upon professional judgment (local conditions or project needs).

At a minimum, for each monitoring site, the following information or procedure should be collected and documented:

- Long-term access agreements. Access agreements should include year-round site access to allow for increased monitoring frequency.
- A unique identifier that includes a general written description of the site location, date established, access instructions and point of contact (if necessary), type of information to be collected, latitude, longitude, and elevation. Each monitoring location should also track all modifications to the site in a modification log.

PROTOCOLS FOR MEASURING GROUNDWATER LEVELS

This section presents considerations for the methodology of collection of groundwater level data such that it meets the requirements of the GSP Regulations and the DQOs of the specific GSP. Groundwater levels are a fundamental measure of the status of groundwater conditions within a basin. In many cases, relationships of the sustainability indicators may be able to be correlated with groundwater levels. The quality of this data must consider the specific aquifer being monitored and the methodology for collecting these levels.

The following considerations for groundwater level measuring protocols should ensure the following:

- Groundwater level data are taken from the correct location, well ID, and screen interval depth
- Groundwater level data are accurate and reproducible
- Groundwater level data represent conditions that inform appropriate basin management DQOs
- All salient information is recorded to correct, if necessary, and compare data
- Data are handled in a way that ensures data integrity

General Well Monitoring Information

The following presents considerations for collection of water level data that include regulatory required components as well as those which are recommended.

- Groundwater elevation data will form the basis of basin-wide water-table and piezometric maps, and should approximate conditions at a discrete period in time. Therefore, all groundwater levels in a basin should be collected within as short a time as possible, preferably within a 1 to 2 week period.
- Depth to groundwater must be measured relative to an established Reference Point (RP) on the well casing. The RP is usually 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 reference point 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 elevation of the RP of each well must be surveyed to the North American Vertical Datum of 1988 (NAVD88), or a local datum that can be converted to NAVD88. The elevation of the RP must be accurate to within 0.5 foot. It is preferable for the RP elevation to be accurate to 0.1 foot or less. Survey grade global navigation satellite system (GNSS) global positioning system (GPS) equipment can achieve similar vertical accuracy when corrected. Guidance for use of GPS can be found at USGS http://water.usgs.gov/osw/gps/. Hand-held GPS units likely will not produce reliable vertical elevation measurement accurate enough for the casing elevation consistent with the DQOs and regulatory requirements.
- The sampler should remove the appropriate cap, lid, or plug that covers the monitoring access point listening for pressure release. If a release is observed, the measurement should follow a period of time to allow the water level to equilibrate.
- Depth to groundwater must be measured to an accuracy of 0.1 foot below the RP. It is preferable to measure depth to groundwater to an accuracy of 0.01 foot. Air lines and acoustic sounders may not provide the required accuracy of 0.1 foot.
- The water level meter should be decontaminated after measuring each well.

Where existing wells do not meet the base standard as described in the GSP Regulations or the considerations provided above, new monitoring wells may need to be constructed to meet the DQOs of the GSP. The design, installation, and documentation of new monitoring wells must consider the following:

- Construction consistent with California Well Standards as described in Bulletins 74-81 and 74-90, and local permitting agency standards of practice.
- Logging of borehole cuttings under the supervision of a California Professional Geologist and described consistent with the Unified Soil Classification System methods according to ASTM standard D2487-11.
- Written criteria for logging of borehole cuttings for comparison to known geologic formations, principal aquifers and aquitards/aquicludes, or specific marker beds to aid in consistent stratigraphic correlation within and across basins.
- Geophysical surveys of boreholes to aid in consistency of logging practices. Methodologies should include resistivity, spontaneous potential, spectral gamma, or other methods as appropriate for the conditions. Selection of geophysical methods should be based upon the opinion of a professional geologist or professional engineer, and address the DQOs for the specific borehole and characterization needs.
- Prepare and submit State well completion reports according to the requirements of §13752. Well completion report documentation should include geophysical logs, detailed geologic log, and formation identification as attachments. An example well completion as-built log is illustrated in **Figure 2.** DWR well completion reports can be filed directly at the Online System for Well Completion Reports (OSWCR) http://water.ca.gov/oswcr/index.cfm.

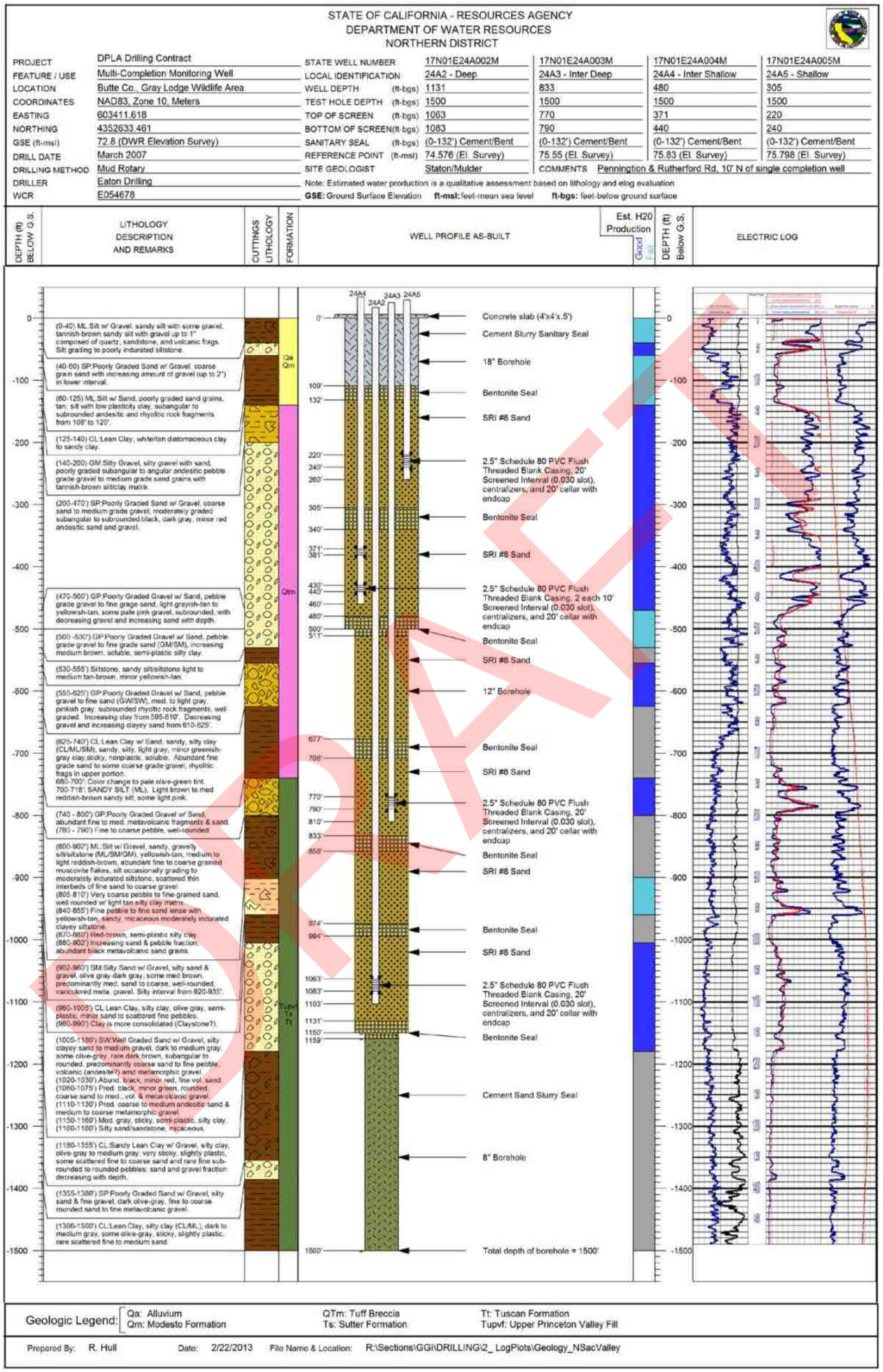

Figure 2 – Example As-Built Multi-Completion Monitoring Well Log

Measuring Groundwater Levels

Well construction, anticipated groundwater level, groundwater level measuring equipment, field conditions, and well operations should be considered prior collection of the groundwater level measurement. The USGS *Groundwater Technical Procedures* (Cunningham and Schalk, 2011) provide a thorough set of procedures which can be used to establish specific Standard Operating Procedures (SOPs) for a local agency. **Figure 3** illustrates a typical groundwater level measuring event and simultaneous pressure transducer download.

Figure 3 – Collection of Water Level Measurement and Pressure Transducer Download

The following points provide a general approach for collecting groundwater level measurements:

- Measure depth to water in the well using procedures appropriate for the measuring device. Equipment must be operated and maintained in accordance with manufacturer's instructions. Groundwater levels should be measured to the nearest 0.01 foot relative to the RP.
- For measuring wells that are under pressure, allow a period of time for the groundwater levels to stabilize. In these cases, multiple measurements should be collected to ensure the well has reached equilibrium such that no significant changes in water level are observed. Every effort should be made to ensure that a representative stable depth to groundwater is recorded. If a well does not stabilize, the quality of the value should be appropriately qualified as a

questionable measurement. In the event that a well is artesian, site specific procedures should be developed to collect accurate information and be protective of safety conditions associated with a pressurized well. In many cases, an extension pipe may be adequate to stabilize head in the well. Record the dimension of the extension and document measurements and configuration.

- The sampler should calculate the groundwater elevation as:

$$GWE = RPE - DTW$$

Where:

GWE = Groundwater Elevation
RPE = Reference Point Elevation
DTW = Depth to Water

The sampler must ensure that all measurements are in consistent units of feet, tenths of feet, and hundredths of feet. Measurements and RPEs should not be recorded in feet and inches.

<u>**Recording Groundwater Levels**</u>

- The sampler should record the well identifier, date, time (24-hour format), RPE, height of RP above or below ground surface, DTW, GWE, and comments regarding any factors that may influence the depth to water readings such as weather, nearby irrigation, flooding, potential for tidal influence, or well condition. If there is a questionable measurement or the measurement cannot be obtained, it should be noted. An example of a field sheet with the required information is shown in **Figure 4**. It includes questionable measurement and no measurement codes that should be noted. This field sheet is provided as an example. Standardized field forms should be used for all data collection. The aforementioned USGS *Groundwater Technical Procedures* offers a number of example forms.
- The sampler should replace any well caps or plugs, and lock any well buildings or covers.
- All data should be entered into the GSA data management system (DMS) as soon as possible. Care should be taken to avoid data entry mistakes and the entries should be checked by a second person for compliance with the DQOs.

STATE OF CALIFORNA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WELL DATA

STATE WELL NUMBER	COUNTY	REFERENCE POINT ELEV.	MEASURING AGENCY
			DWR

NO MEASUREMENT	QUESTIONABLE MEASUREMENT
0. Measurement discontinued	0. Caved or deepened
1. Pumping	1. Pumping
2. Pump house locked	2. Nearby pump operating
3. Tape hung up	3. Casing leaky or wet
4. Can't get tape in casing	4. Pumped recently
5. Unable to locate well	5. Air or pressure gauge measurement
6. Well has been destroyed	6. Other
7. Special	7. Recharge operation at or nearby well
8. Casing leaky or wet	8. Oil in casing
9. Temporarily inaccessible	

DATE	N M	Q M	TAPE AT RP	TAPE AT WS	RP to WS	OBSR VR	COMMENTS

DWR 1213

Figure 4 – Example of Water Level Well Data Field Collection Form

Pressure Transducers

Groundwater levels and/or calculated groundwater elevations may be recorded using pressure transducers equipped with data loggers installed in monitoring wells. When installing pressure transducers, care must be exercised to ensure that the data recorded by the transducers is confirmed with hand measurements.

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

- The sampler must use an electronic sounder or chalked steel tape and follow the protocols listed above to measure the groundwater level and calculate the groundwater elevation in the monitoring well to properly program and reference the installation. It is recommended that transducers record measured groundwater level to conserve data capacity; groundwater elevations can be calculated at a later time after downloading.
- The sampler must note the well identifier, the associated transducer serial number, transducer range, transducer accuracy, and cable serial number.
- Transducers must be able to record groundwater levels with an accuracy of at least 0.1 foot. Professional judgment should be exercised to ensure that the data being collected is meeting the DQO and that the instrument is capable. Consideration of the battery life, data storage capacity, range of groundwater level fluctuations, and natural pressure drift of the transducers should be included in the evaluation.
- The sampler must note whether the pressure transducer uses a vented or non-vented cable for barometric compensation. Vented cables are preferred, but non-vented units provide accurate data if properly corrected for natural barometric pressure changes. This requires the consistent logging of barometric pressures to coincide with measurement intervals.
- Follow manufacturer specifications for installation, calibration, data logging intervals, battery life, correction procedure (if non-vented cables used), and anticipated life expectancy to assure that DQOs are being met for the GSP.
- Secure the cable to the well head with a well dock or another reliable method. Mark the cable at the elevation of the reference point with tape or an indelible marker. This will allow estimates of future cable slippage.
- The transducer data should periodically be checked against hand measured groundwater levels to monitor electronic drift or cable movement. This should happen during routine site visits, at least annually or as necessary to maintain data integrity.

- The data should be downloaded as necessary to ensure no data is lost and entered into the basin's DMS following the QA/QC program established for the GSP. Data collected with non-vented data logger cables should be corrected for atmospheric barometric pressure changes, as appropriate. After the sampler is confident that the transducer data have been safely downloaded and stored, the data should be deleted from the data logger to ensure that adequate data logger memory remains.

PROTOCOLS FOR SAMPLING GROUNDWATER QUALITY

The following protocols can be incorporated into a GSP's monitoring protocols for collecting groundwater quality data. More detailed sampling procedures and protocols are included in the standards and guidance documents listed at the end of this BMP. A GSP that adopts protocols that deviate from these BMPs must demonstrate that the adopted protocols will yield comparable data.

In general, the use of existing water quality data within the basin should be done to the greatest extent possible if it achieves the DQOs for the GSP. In some cases it may be necessary to collect additional water quality data to support monitoring programs or evaluate specific projects. The USGS *National Field Manual for the Collection of Water Quality Data* (Wilde, 2005) should be used to guide the collection of reliable data. **Figure 5** illustrates a typical groundwater quality sampling setup.

Figure 5 – Typical Groundwater Quality Sampling Event

All analyses should be performed by a laboratory certified under the State Environmental Laboratory Accreditation Program. The specific analytical methods are beyond the scope of this BMP, but should be commiserate with other programs evaluating water quality within the basin for comparative purposes.

Groundwater quality sampling protocols should ensure that:

- Groundwater quality data are taken from the correct location
- Groundwater quality data are accurate and reproducible
- Groundwater quality data represent conditions that inform appropriate basin management and are consistent with the DQOs
- All salient information is recorded to normalize, if necessary, and compare data
- Data are handled in a way that ensures data integrity

The following points are general guidance in addition to the techniques presented in the previously mentioned USGS *National Field Manual for the Collection of Water Quality Data.*

Standardized protocols include the following:

- Prior to sampling, the sampler must contact the laboratory to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements.
- Each well used for groundwater quality monitoring must have a unique identifier. This identifier must appear on the well housing or the well casing to avoid confusion.
- In the case of wells with dedicated pumps, samples should be collected at or near the wellhead. Samples should not be collected from storage tanks, at the end of long pipe runs, or after any water treatment.
- The sampler should clean the sampling port and/or sampling equipment and the sampling port and/or sampling equipment must be free of any contaminants. The sampler must decontaminate sampling equipment between sampling locations or wells to avoid cross-contamination between samples.
- The groundwater elevation in the well should be measured following appropriate protocols described above in the groundwater level measuring protocols.
- For any well not equipped with low-flow or passive sampling equipment, an adequate volume of water should be purged from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. Purging three well casing volumes is generally

considered adequate. Professional judgment should be used to determine the proper configuration of the sampling equipment with respect to well construction such that a representative ambient groundwater sample is collected. If pumping causes a well to be evacuated (go dry), document the condition and allow well to recover to within 90% of original level prior to sampling. Professional judgment should be exercised as to whether the sample will meet the DQOs and adjusted as necessary.

- Field parameters of pH, electrical conductivity, and temperature should be collected for each sample. Field parameters should be evaluated during the purging of the well and should stabilize prior to sampling. Measurements of pH should only be measured in the field, lab pH analysis are typically unachievable due to short hold times. Other parameters, such as oxidation-reduction potential (ORP), dissolved oxygen (DO) (in situ measurements preferable), or turbidity, may also be useful for meeting DQOs of GSP and assessing purge conditions. All field instruments should be calibrated daily and evaluated for drift throughout the day.
- Sample containers should be labeled prior to sample collection. The sample label must include: sample ID (often well ID), sample date and time, sample personnel, sample location, preservative used, and analytes and analytical method.
- Samples should be collected under laminar flow conditions. This may require reducing pumping rates prior to sample collection.
- Samples should be collected according to appropriate standards such as those listed in the *Standard Methods for the Examination of Water and Wastewater*, USGS *National Field Manual for the Collection of Water Quality Data,* or other appropriate guidance. The specific sample collection procedure should reflect the type of analysis to be performed and DQOs.
- All samples requiring preservation must be preserved as soon as practically possible, ideally at the time of sample collection. Ensure that samples are appropriately filtered as recommended for the specific analyte. Entrained solids can be dissolved by preservative leading to inconsistent results of dissolve analytes. Specifically, samples to be analyzed for metals should be field-filtered prior to preservation; do not collect an unfiltered sample in a preserved container.
- Samples should be chilled and maintained at 4 °C to prevent degradation of the sample. The laboratory's Quality Assurance Management Plan should detail appropriate chilling and shipping requirements.

- Samples must be shipped under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.
- Instruct the laboratory to use reporting limits that are equal to or less than the applicable DQOs or regional water quality objectives/screening levels.

Special protocols for low-flow sampling equipment

In addition to the protocols listed above, sampling using low-flow sample equipment should adopt the following protocols derived from EPA's *Low-flow (minimal drawdown) ground-water sampling procedures* (Puls and Barcelona, 1996). These protocols apply to low-flow sampling equipment that generally pumps between 0.1 and 0.5 liters per minute. These protocols are not intended for bailers.

Special protocols for passive sampling equipment

In addition to the protocols listed above, passive diffusion samplers should follow protocols set forth in USGS Fact Sheet 088-00.

PROTOCOLS FOR MONITORING SEAWATER INTRUSION

Monitoring seawater intrusion requires analysis of the chloride concentrations within groundwater of each principal aquifer subject to seawater intrusion. While no significant standardized approach exists, the methodologies described above for degraded water quality can be applied for the collection of groundwater samples. In addition to the protocol described above, the following protocols should be followed:

- Water quality samples should be collected and analyzed at least semi-annually. Samples will be analyzed for dissolved chloride at a minimum. It may be beneficial to include analyses of iodide and bromide to aid in determination of salinity source. More frequent sampling may be necessary to meet DQOs of GSP. The development of surrogate measures of chloride concentration may facilitate cost-effective means to monitor more frequently to observe the range of conditions and variability of the flow dynamics controlling seawater intrusion.
- Groundwater levels will be collected at a frequency adequate to characterize changes in head in the vicinity of the leading edge of degraded water quality in each principal aquifer. Frequency may need to be increased in areas of known preferential pathways, groundwater pumping, or efficacy evaluation of mitigation projects.
- The use of geophysical surveys, electrical resistivity, or other methods may provide for identification of preferential pathways and optimize monitoring well placement and evaluation of the seawater intrusion front. Professional judgment

should be exercised to determine the appropriate methodology and whether the DQOs for the GSP would be met.

PROTOCOLS FOR MEASURING STREAMFLOW

Monitoring of streamflow is necessary for incorporation into water budget analysis and for use in evaluation of stream depletions associated with groundwater extractions. The use of existing monitoring locations should be incorporated to the greatest extent possible. Many of these streamflow monitoring locations currently follow the protocol described below.

Establishment of new streamflow discharge sites should consider the existing network and the objectives of the new location. Professional judgment should be used to determine the appropriate permitting that may be necessary for the installation of any monitoring locations along surface water bodies. Regular frequent access will be necessary to these sites for the development of ratings curves and maintenance of equipment.

To establish a new streamflow monitoring station special consideration must be made in the field to select an appropriate location for measuring discharge. Once a site is selected, development of a relationship of stream stage to discharge will be necessary to provide continuous estimates of streamflow. Several measurements of discharge at a variety of stream stages will be necessary to develop the ratings curve correlating stage to discharge. The use of Acoustic Doppler Current Profilers (ADCPs) can provide accurate estimates of discharge in the correct settings. Professional judgment must be exercised to determine the appropriate methodology. Following development of the ratings curve a simple stilling well and pressure transducer with data logger can be used to evaluate stage on a frequent basis. A simple stilling well and staff gage is illustrated in **Figure 6**.

Streamflow measurements should be collected, analyzed, and reported in accordance with the procedures outlined in USGS Water Supply Paper 2175, *Volume 1. – Measurement of Stage Discharge* and *Volume 2. – Computation of Discharge.* This methodology is currently being used by both the USGS and DWR for existing streamflow monitoring throughout the State.

Figure 6 – Simple Stilling Well and Staff Gage Setup

PROTOCOLS FOR MEASURING SUBSIDENCE

Evaluating and monitoring inelastic land subsidence can utilize multiple data sources to evaluate the specific conditions and associated causes. To the extent possible, the use of existing data should be utilized. Subsidence can be estimated from numerous techniques, they include: level surveying tied to known stable benchmarks or benchmarks located outside the area being studied for possible subsidence; installing and tracking changes in borehole extensometers; obtaining data from continuous GPS (CGPS) locations, static GPS surveys or Real-Time-Kinematic (RTK) surveys; or analyzing Interferometric Synthetic Aperture Radar (InSAR) data. No standard procedures exist for collecting data from the potential subsidence monitoring approaches. However, an approach may include:

- Identification of land subsidence conditions.
    - Evaluate existing regional long-term leveling surveys of regional infrastructure, i.e. roadways, railroads, canals, and levees.
    - Inspect existing county and State well records where collapse has been noted for well repairs or replacement.
    - Determine if significant fine-grained layers are present such that the potential for collapse of the units could occur should there be significant depressurization of the aquifer system.

  - Inspect geologic logs and the hydrogeologic conceptual model to aid in identification of specific units of concern.
  - Collect regional remote-sensing information such as InSAR, commonly provided by USGS and NASA. Data availability is currently limited, but future resources are being developed.
- Monitor regions of suspected subsidence where potential exists.
  - Establish CGPS network to evaluate changes in land surface elevation.
  - Establish leveling surveys transects to observe changes in land surface elevation.
  - Establish extensometer network to observe land subsidence. An example of a typical extensometer design is illustrated in **Figure 7**. There are a variety of extensometer designs and they should be selected based on the specific DQOs.

Various standards and guidance documents for collecting data include:

- Leveling surveys must follow surveying standards set out in the California Department of Transportation's Caltrans Surveys Manual.
- GPS surveys must follow surveying standards set out in the California Department of Transportation's Caltrans Surveys Manual.
- USGS has been performing subsidence surveys within several areas of California. These studies are sound examples for appropriate methods and should be utilized to the extent possible and where available:
  - http://ca.water.usgs.gov/land_subsidence/california-subsidence-measuring.html
- Instruments installed in borehole extensometers must follow the manufacturer's instructions for installation, care, and calibration.
- Availability of InSAR data is improving and will increase as programs are developed. This method requires expertise in analysis of the raw data and will likely be made available as an interpretative report for specific regions.

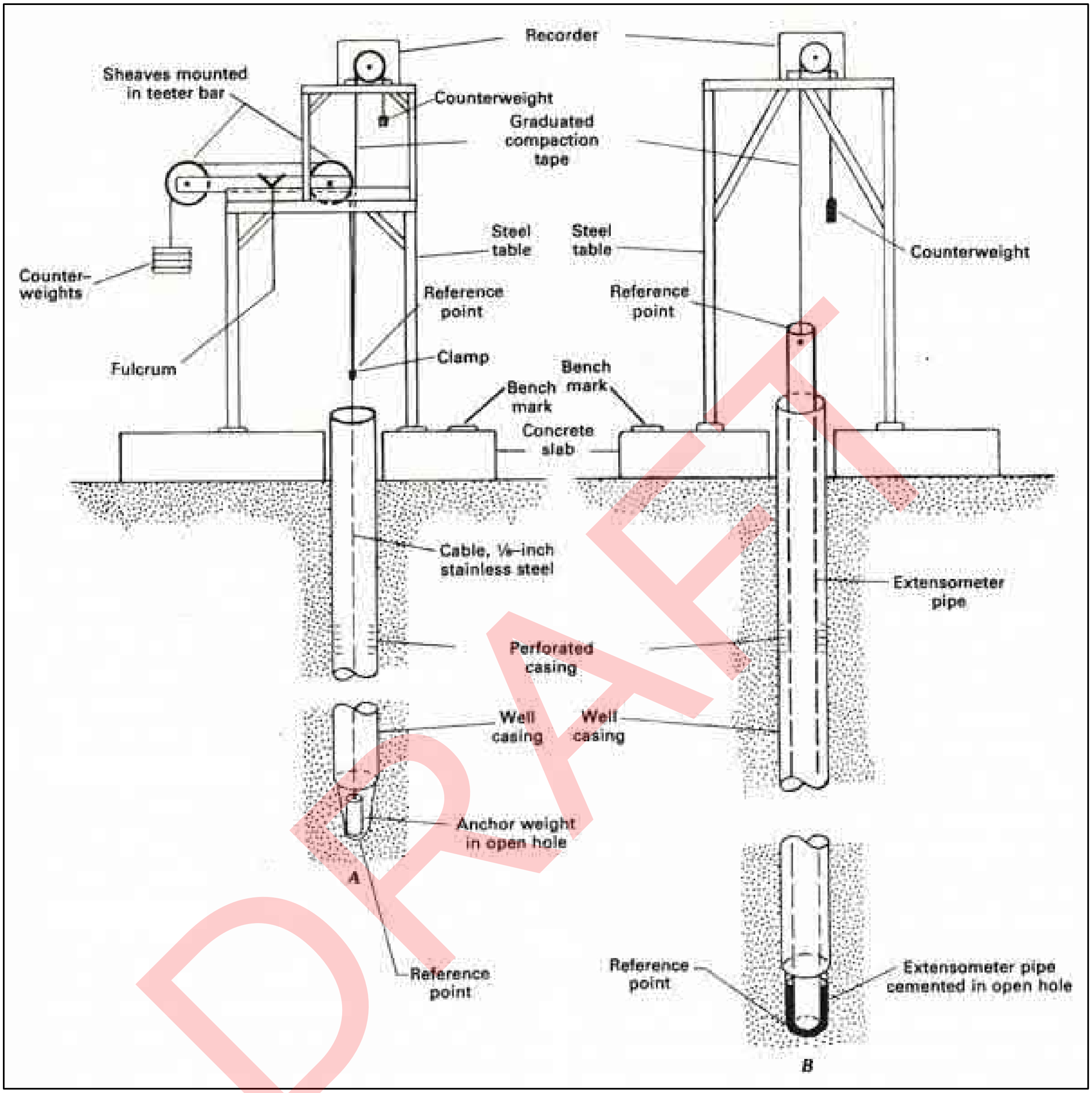

Figure 7 – Simplified Extensometer Diagram

6. KEY DEFINITIONS

The key definitions and sections related to Groundwater Monitoring Protocols, Standards, and Sites outlined in applicable SGMA code and regulations are provided below for reference.

Groundwater Sustainability Plan Regulations (California Code of Regulations §351)

- §351(h) "Best available science" refers to 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.
- §351(i) "Best management practice" refers to 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.

Monitoring Protocols Reference

§352.2. Monitoring Protocols

Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows:

(a) Monitoring protocols shall be developed according to best management practices.

(b) The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department, or may adopt similar monitoring protocols that will yield comparable data.

(c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.

SGMA Reference

§10727.2. Required Plan Elements

(f) Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin. The monitoring protocols shall be designed to generate information that promotes efficient and effective groundwater management.

7. Related Materials

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