JAMES GROUNDWATER SUSTAINABILITY AGENCY

Groundwater Sustainability Plan

in compliance with the

Sustainable Groundwater Management Act

Adopted

December 12, 2019

Acknowledgements

The James Groundwater Sustainability Agency would like to thank the landowners and growers, past and present, within the James Irrigation District and Reclamation District No. 1606 for their hard work, dedication, and financial commitment to developing and managing water resources for the region. The James Groundwater Sustainability Agency would also like to thank the following individuals who made significant contributions to this Groundwater Sustainability Plan:

James Irrigation District

- Riley Chaney, President
- Micah Combs, Vice-President
- Robert Barcellos, Director
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Reclamation District No. 1606

- Gerald Kinnunen, President
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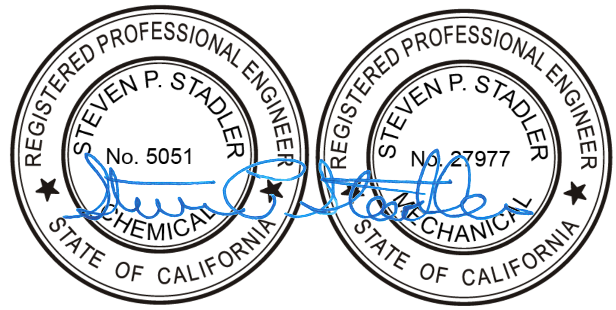
LIMITATION

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.

Section 3 of this Plan, Basin Setting, was prepared in general conformance with section 354.12 of the water code either by and /or under the direct supervision of the appropriate professional as indicated herein.

Per 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. Note: Authority cited: Section 10733.2, Water Code. Reference: Section 10733.2, Water Code.



DATE SIGNED 12/12/19 DATE SIGNED 12/12/19

This Plan is a work product of the James Groundwater Sustainability Agency members and associated stakeholders. 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 MAGSA 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 James GSA or that other conditions may exist which could have a significant effect on groundwater availability.

In developing methods, conclusions, and recommendations this Plan has relied on information that was prepared or provided by others. It is 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
AF/YR....Acre-Foot Per Year
AS....Arsenic
BGS....Below Ground Surface
BPA....Basin Plan Amendment
Caltrans....California Department of Transportation
CASGEM....California Statewide Groundwater Elevation Monitoring
CDFW....California Department of Fish and Wildlife
CEQA....California Environmental Quality Act
CERCLA....Comprehensive Environmental Response, Compensation and Liability Act
CFS....Cubic Feet Per Second
CGPS....Continuous Global Positioning System
CID....Consolidated Irrigation District
City....City of Fresno
Cl....Chloride
Coalition....Kings River Water Quality Coalition
COC....Constituents of Concern
CVHM....Central Valley Hydrologic Model
CVP....Central Valley Project
CVPDMC....Central Valley Project Delta Mendota Canal
CV-SALTS....Central Valley Salinity Alternatives for Long-term Sustainability
CWC....California Water Code
DBCP....1, 2-Dibromo-3-chloropropane
DDW....Division of Drinking Water
DHS....Department of Health Services
District....Consolidated Irrigation District
DTSC....Department of Toxic Substance Control
DWR....Department of Water Resources
DWSAP....Drinking Water Source Assessment and Protection
E-Clay....Corcoran Clay
EDB....Ethylene-Dibromide
EO....Education and Outreach
EPA....Environmental Protection Agency
ET....Evapotranspiration

FCEHD	Fresno County Environmental Health Department
FI	Fees and Incentives
FID	Fresno Irrigation District
FWUA	Friant Water Users Authority
GA	Groundwater Allocations
GAMA	Groundwater Ambient Monitoring and Assessment
GAR	Groundwater Assessment Report
GDE	Groundwater Dependent Ecosystem
GMT	Groundwater Marketing and Trading
GP	Groundwater Pumping
GPS	Global Positioning System
GPD/FT	Gallons Per Day Per Foot
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HCM	Hydrogeological Conceptual Model
HS	Health and Safety
ICM	Initial Conceptual Model
ILRP	Irrigated Lands Regulatory Program
InSAR	Interferometric Synthetic Aperture Radar
ITF	Interagency Task Force
JID	James Irrigation District
JPA	Joint Powers Agreement
KDSA	Kenneth D. Schmidt and Associates
KRCD	Kings River Conservation District
KRWA	Kings River Water Association
KRWQC	Kings River Water Quality Coalition
LAFCO	Local Agency Formation Commission
LDC	Lower Dry Creek
LDCE	Lower Dry Creek Extension
LU	Land Use
James GSA	McMullin Area Groundwater Sustainability Agency
MCL	Maximum Contaminant Level
Mn	Manganese
MPG	Mendota Pool Group
MSL	Mean Sea Level

MT .... Minimum Threshold
MVWD .... Mid-Valley Water District
Na .... Sodium
NASA .... National Aeronautics and Space Administration
NGS .... National Geodetic Survey
NO_3 .... Nitrate
NO_3-N .... Nitrogen
NRCS .... Natural Resource Conservation Service
NRDC .... Natural Resources Defense Council
PAC .... Public Advisory Committee
PAH .... Polynuclear Aromatic Hydrocarbons
PG&E .... Pacific Gas & Electric Company
Qb .... Flood-basin Deposits
Qoao .... Quaternary Older Alluvium
Qsd .... Quaternary Sand Dunes
Qya .... Quaternary Younger Alluvium
RC .... Resource Conservation
RCPP .... Regional Conservation Partnership Program
RCRA .... Resource Conservation and Recovery Act
RCWD .... Raisin City Water District
RWQCB .... Regional Water Quality Control Board
RWTF .... Regional Wastewater Treatment Facility
SAGBI .... Soil Agricultural Groundwater Banking Index
SGMA .... Sustainable Groundwater Management
SJR .... San Joaquin River
SJRRP .... San Joaquin River Restoration Project
SJVAPCD .... San Joaquin Valley Air Pollution Control District
SLDMWA .... San Luis Delta Mendota Water Authority
SNMP .... Salt and Nutrient Management Plan
SOI .... Sphere of Influence
SWP .... State Water Project
SWPPP .... Stormwater Pollution Prevention Plan
SWRCB .... State of California Water Resources Control Board
....
TCP .... 1, 2, 3 -Trichloropropane

TDS .... Total Dissolved Solids
U .... Uranium
USACE .... US Army Corps of Engineers
USBR .... United States Burau of Reclamation
USDA .... United States Department of Agriculture
USGS .... United States Geological Survey
VOC .... Volatile Organic Compound
WARMF .... Watershed Analysis Risk Management Framework
WDR .... Waste Discharge Requirements
WH .... Well Head
WHPA .... Wellhead Protection Area
WSE .... Water Surface Elevation
WRIME .... Water Resources and Information Management Engineering
WWTP .... Wastewater Treatment Plant

Executive Summary

Chapter 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 must be achieved during the planning and implementation horizon from 2020 to 2040 and sustained into the future without causing undesirable results. SGMA requires that the following six sustainability indicators must be considered:

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable seawater intrusion
- Significant and unreasonable degraded water quality
- Significant and unreasonable land subsidence
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

The James GSA was formed under a Memorandum of Understanding (MOU) made effective December 17, 2015 between the James Irrigation District (James ID) and Reclamation District No. 1606 (RD 1606). The City of San Joaquin (City), located in the center of the James GSA area, is not a party to the MOU but the City is included in the GSA area because the boundaries of Reclamation District No. 1606 also includes lands within the City limits. The City of San Joaquin is not in the James Irrigation District (JID) service area. The City of San Joaquin was invited to participate in the MOU but declined.

Under the terms of the MOU, the James GSA is governed by a board comprised of five directors. Four directors are appointed by James ID and one director is appointed by RD 1606. The directors may be elected officials, appointed officials, agency employees, landowners, or residents of the respective appointing agencies. James ID serves as the coordinator for the parties acting jointly under the MOU. Also, the James GSA Board of Directors has appointed an Executive Director and had delegated the management authority to implement the Plan to the Executive Director.

The sustainability goal of the Kings Subbasin 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. This goal will be met by balancing water demand with available water supply and stabilizing the long-term trend of declining groundwater levels without significantly or unreasonably impacting groundwater storage, water quality, land subsidence, or interconnected surface water.

Chapter 2 - Plan Area

The James GSA area (Plan Area) is located in western Fresno County and consists primarily of agricultural land but contains one municipal area. The Plan Area is dominated by agricultural lands. The predominant crops grown on agricultural lands include, in descending order of acreage for 2018 production, almonds, cotton, seed alfalfa, pistachios, grapes, onions, and tomatoes. Lands with native and riparian vegetation comprise the next highest land use and are located primarily in floodways. Urban lands within the

Plan Area are primarily within the City of San Joaquin. A significant percentage of the land use within the Plan Area also includes lands utilized for groundwater recharge. There are no state, federal, or tribal lands within the Plan Area.

Agricultural water demands are met through a combination of available surface water and groundwater. The source of surface water for agricultural use are the Kings River, the San Joaquin River, and the Central Valley Project via the Delta-Mendota Canal and Mendota Pool. James ID and RD 1606 have water rights on the Kings River and San Joaquin Rivers. Landowners within James ID and RD 1606 also have riparian rights to both the Kings River and San Joaquin River but receive water from those sources under contractual arrangements through either James ID or RD 1606. James ID also imports groundwater from lands to the east of the Plan Area. Municipal, industrial, and rural domestic water demands are met solely by groundwater.

Chapter 3 - Basin Setting

Hydrogeologic Conceptual Model

The Hydrogeologic Conceptual Model (HCM) provides a description of the general physical characteristics of the regional hydrology, geology, geologic structure, water quality, principal aquifers, and principal aquitards in the basin setting. The HCM is a written description accompanied by graphical representations of the hydrologic and hydrogeologic conditions that lay the foundation for development of water budgets, monitoring networks, and identification of data gaps. The narrative HCM description provided in Chapter 3 describes the Kings Subbasin, followed in each section by description applicable specifically to the James GSA. The HCM has been prepared utilizing published studies and existing 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, the Sierra Nevada mountains on the northeast, and the Westside and Delta-Mendota Subbasins to the west-southwest. The aquifer system is comprised of unconfined and confined groundwater in the western parts of the subbasin where lacustrine clay beds exist. East of the lacustrine clays, locally significant clay beds separate shallower unconfined groundwater from deeper confined groundwater. The Kings Subbasin is dominated by six major geomorphic features including the alluvial fans of the Kings and San Joaquin Rivers, dune sands, compound fans of intermittent streams between the Kings and San Joaquin Rivers, a compound fan south of the Kings River, and an area termed overflow lands near the topographic axis of the valley. The major geomorphic features are closely related to the surficial deposits, which in turn relate to soil types. **Figure ES-1** is a soil map of the James GSA area based on the Natural Resource Conservation Service (NRCS) textural classification of soils. In general, coarser materials exist in the eastern half of the GSA and finer grained soils are found in the western parts of the GSA area.

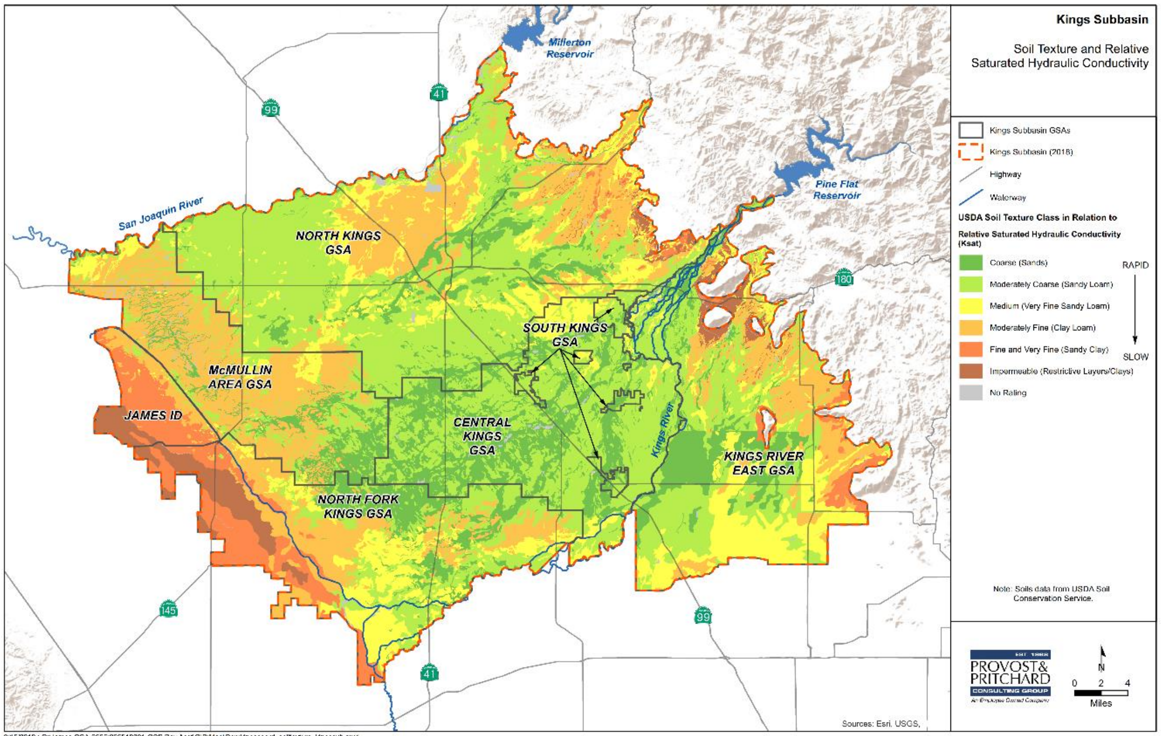


Figure ES-1 James GSA Soil Texture and Saturated Hydraulic Conductivity

The Plan Area aquifer has a series of semi-confining and confining clay formations that vary in depth and lateral extent throughout the aquifer. Various United States Geological Survey (USGS) reports have mapped the general extent of the clay layers in the area, as shown in **Figure ES-2**, as well as the depth of the clay layers. The three most prevalent subsurface clay formations that have historically been studied and delineated in the James GSA area within the San Joaquin Valley are known as the A-Clay (generally at a depth of 50-70 feet), C-Clay (generally at a depth of 210-260 feet), and E-Clay or Corcoran Clay (generally at a depth of 400-550 feet). The A-Clay is no longer a confining layer but does impact vertical movement of water. The C-Clay is considered semi-confining through most of the area with water levels fluctuating above and below the C-Clay at various times and locations. The Corcoran Clay is a confining layer throughout the entire Plan Area. The Corcoran Clay divides the unconfined and confined aquifer within the GSA.

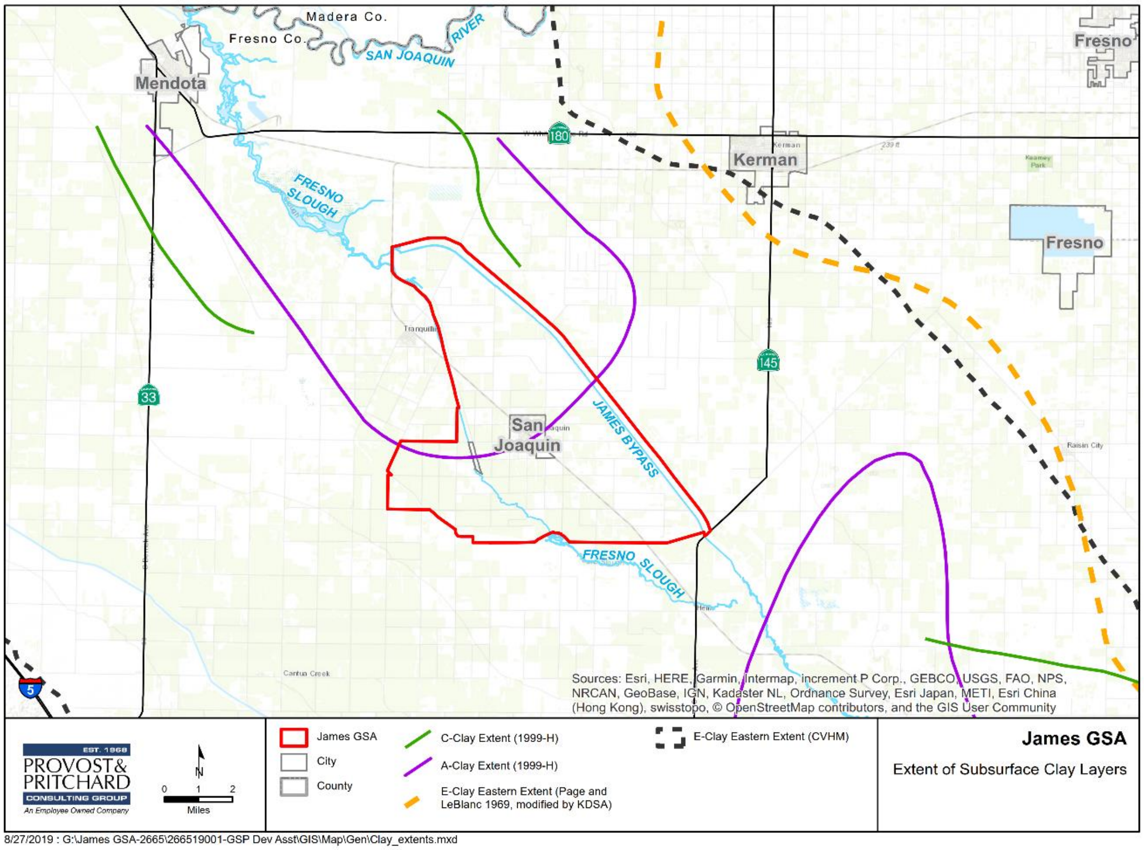


Figure ES-2 Extent of Subsurface Clay Layers

Groundwater Conditions

The natural direction of groundwater flow generally follows the topography from northeast to southwest, sloping from the Sierra Nevada Mountains on the east to the trough of the Valley at the western edge of the Kings Subbasin. 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. Unconfined groundwater conditions extend across essentially the entire Kings Subbasin. Insufficient available surface water supplies have led to heavy agricultural pumping in the region, which has influenced the natural groundwater flow.

Insufficient available surface water supplies in the McMullin Area GSA and the North Fork Kings GSA have caused agricultural users in those area to rely heavily on groundwater pumping. This pumping has created a groundwater elevation depression and has caused groundwater to flow away from the trough of the valley towards the depression. On groundwater elevation maps, the center of the depression appears in various locations between Raisin City and Helm within either the MAGSA or NFKGSA plan areas.

Groundwater in the northern and eastern areas of the James GSA generally travels from northwest to southeast as shown in **Figure ES-3.** Groundwater flows in the western portion of the James GSA appear to flow slowly in an easterly direction. In the southern area of the James GSA, groundwater appears to flow in an easterly direction. The groundwater flows in the easterly direction are substantial.

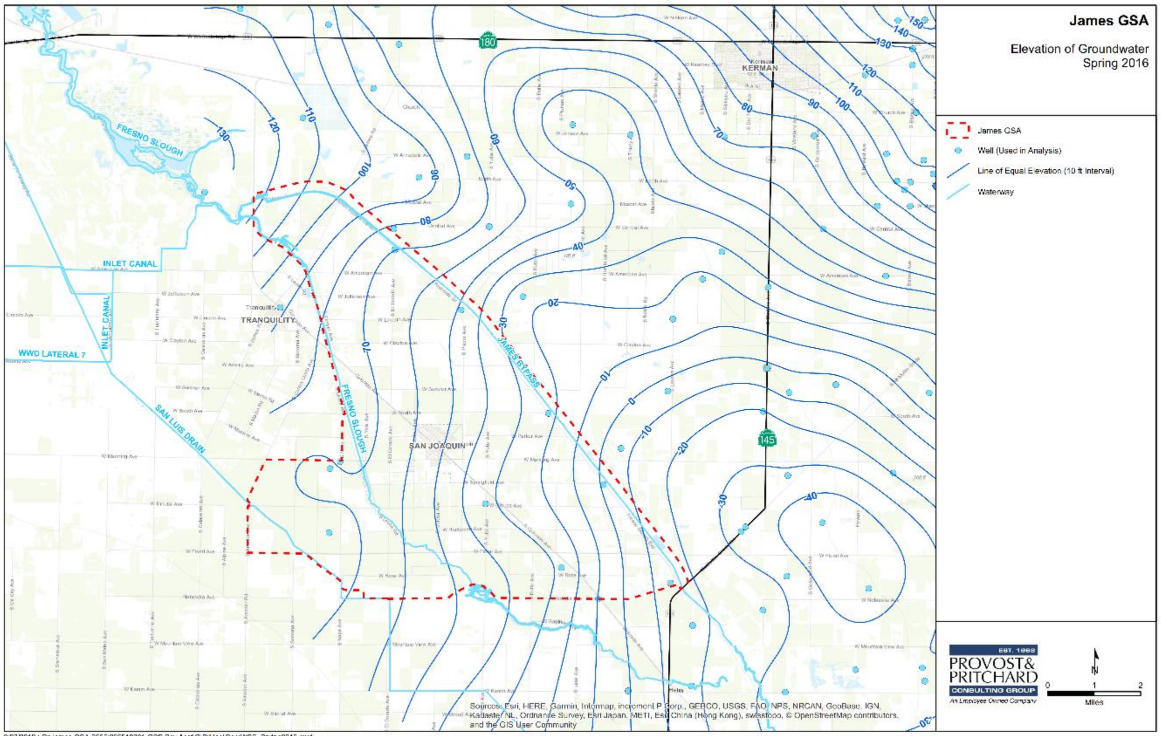


Figure ES-3 Elevation of Groundwater Spring 2016

<u>Groundwater Levels</u>

Groundwater levels in the James GSA saw a considerable decline from 1929 to 1963 as agricultural land development progressed in the Kings Subbasin and the Westside Subbasin. There was a noticeable reversal in the trend in 1963 which is attributed to the delivery of Central Valley Supplies. The period from 1963 to 1990 experienced a continual increase in groundwater elevations. This trend of increasing groundwater levels stopped in 1990 and a period of decline ensued. The decline is attributed to a substantial reduction in Central Valley Project water supply allocations. There is a current declining trend in groundwater levels but occasional increases are noted after wet hydrologic periods. A typical well hydrograph is shown in **Figure ES-4.**

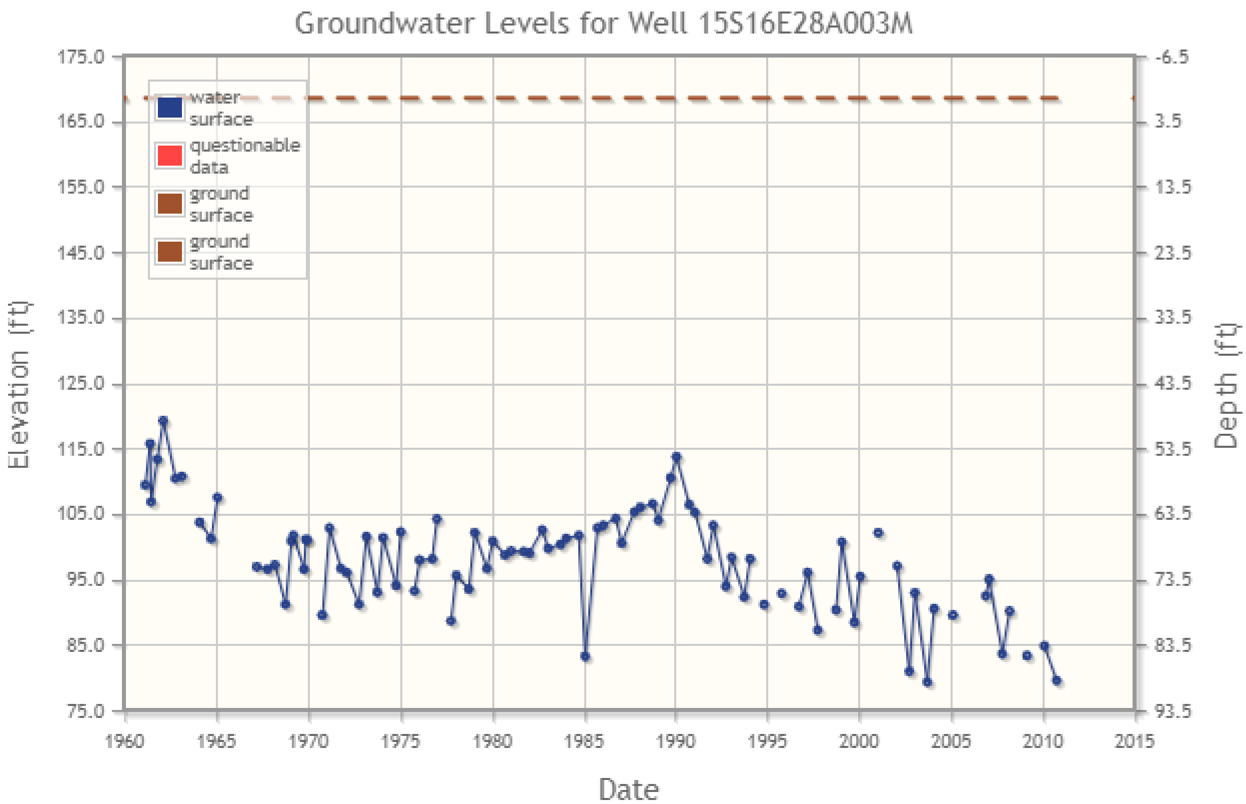


Figure ES-4 Typical James GSA Well Hydrograph

<u>Groundwater Quality</u>

Groundwater within the James GSA area is used to meet agricultural and domestic demands. The groundwater quality assessment for the James GSA Plan Area has been prepared using the available information obtained from the California Groundwater Ambient Monitoring and Assessment (GAMA) Program database, which includes water quality information collected by the California Department of Water Resources (DWR), State Water Resources Control Board, Division of Drinking Water (SWRCB & DDW), and the USGS.

Water quality constituents of concern within the Plan Area is shown in **Table ES-1**. For the area containing municipal drinking water wells, only manganese has incidences of exceeding the United States Environmental Protection Agency (USEPA) public water system quality maximum contaminant levels (MCLs) or Health Advisory Levels. In other areas where rural domestic users rely on groundwater, gross alpha and uranium exceed MCLs. Total dissolved solids and boron do not pose concerns for municipal or rural domestic water users but occur at levels that may impact certain agricultural uses.

Table ES-1 Chemicals of Concern and California MCLs

Chemical of Concern	California Primary MCL	California Secondary MCL	Lifetime Health Advisory Level
Arsenic	10 µg/L	-	-
Chromium (Total)	50 µg/L	-	-
Fluoride	2,000 µg/L	-	-
Gross Alpha	15 pCi/L	-	
Lead *	15 µg/L	-	-
Nitrate	10 mg/L (as N)	-	-
1,2,3-Trichloropropane	0.005 µg/L	-	-
Uranium	20 pCi/L		
Manganese	-	50 µg/L	-
Total Dissolved Solids	-	500 mg/L to 1,000 mg/L	
Boron **	-	-	6,000 µg/L

* The USEPA regulates the concentration of lead in drinking water by an Action Level, which is similar to an MCL but requires additional testing at customer services.

** The State of California has adopted a Notification Level of 1,000 µg/L.

Land Subsidence

Land subsidence was first monitored in the 1920s, then occasionally through the 1970s during periods when there was less access to surface water in portions of the San Joaquin Valley. The frequency of subsidence monitoring decreased after the 1970s, by which time access to surface water had increased due to the canals and water storage projects built in California, allowing less reliance on groundwater in the 1970s and 1980s to meet water demands in areas outside the James GSA. Subsidence monitoring increased again in the 2000s due to more-frequent drought conditions, environmental regulations that resulted in lower surface water allocations to State Water Project (SWP) and Central Valley Project (CVP) contractors, and local farmers and cities increasing reliance on groundwater. Recent monitoring has indicated increased subsidence in portions of the James GSA as a result of the recent drought and heavy reliance on groundwater pumping, as indicated by NASA InSAR (satellite) data showing the change in land surface elevation from May 2015 through April 2017 (**Figure ES-5**).

Generally, there appears to be minimal subsidence occurring in the Plan Area with the exception of the northwestern portion of the Plan Area near Tranquillity. From May 2015 through April 2017, subsidence in the northwestern corner of the Plan Area was measured using NASA InSAR data from 10 to 15 inches (or 5 to 7.5 inches per year) while other areas of the Plan Area only subsided 2 to 3 inches (1.0 to 1.5 inches per year). Subsidence rates increase along the eastern boundary of the Plan Area adjacent to areas that rely exclusively on groundwater. There are no wells that extract groundwater from the confined aquifer within the Plan Area and subsidence rates within the Plan Area are almost exclusively influenced by groundwater pumping in adjacent GSAs or subbasins.

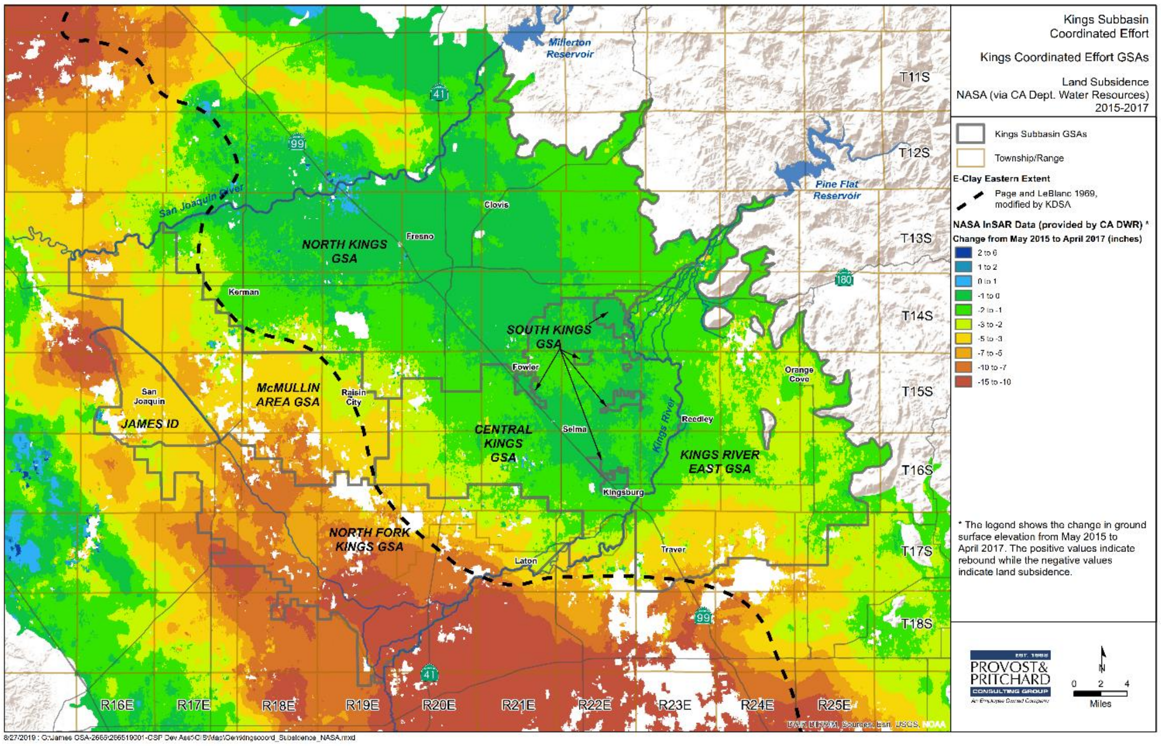


Figure ES-5 Land Subsidence in James GSA and Surrounding Area

Water Budgets

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 James GSA.

Water budgets were prepared for a historical period (1997-2011), current period (2016-2017), and future periods (2040 and 2070). The historical water budget covers a hydrologically average period based on Kings River diversions and was developed to help calibrate the water budget process. The future water budgets are based on numerous assumptions related to climate change, population growth, and water use. These assumptions will likely change over time resulting in different conclusions. There is uncertainty in several aspects of the water budget; the results should be viewed as guidelines rather than precise values.

The estimated annual decline in groundwater storage for the aquifer underlying the James GSA during the historic period was approximately 4,700 acre-feet. The estimated annual decline under current conditions assuming that no managed groundwater recharge activities are implemented is 5,600 acre-feet. In the early-future (2040) scenario, the James GSA will have to implement projects and management actions to generate 6,800 acre-feet annually of managed recharge. In the late-future (2070) scenario, this amount increases to 7,800 acre-feet annually due to impacts of growth and climate change on water supplies and demands. The amounts are considered conservative as actions taken by other Kings Subbasin GSAs will halt and reverse declining groundwater levels and reduce groundwater flows leaving the James GSA.

Chapter 4 - Sustainable Management Criteria

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. Development of these Sustainable Management Criteria is dependent on basin information developed and presented in **Chapter 3**.

The goal of the Kings Subbasin and this GSA 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 when the basin and this GSA will be considered sustainable are:

- 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 Subbasin have been coordinating for several years on how to reach and maintain sustainability. As described in the **Chapter 3** - Basin Setting, the Kings Subbasin includes significantly varied geologic conditions, water supplies, and land uses that lead to different conditions and obligations within each GSA. The Kings Subbasin setting describes the trend of declining groundwater levels within the Kings Subbasin 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 water supplies, groundwater flows, land use, and other information were used to establish the water budgets, estimates of storage change within each GSA, and sustainable yield. Coordination efforts between the GSAs have resulted in concurrence of the initial quantities of storage change responsibility for each GSA to correct in order to achieve sustainability. These quantities and each GSAs respective obligation will continue to be monitored and evaluated as additional information is gathered.

Each GSA in the Kings Subbasin is responsible for implementing the projects and management actions necessary to reach sustainability and meet its initial mitigation requirements for storage change. Each GSA has identified measures that will be implemented to ensure the Kings Subbasin will be managed within the sustainable yield, as identified in **Chapter 6**– Projects and Management Actions to Achieve Sustainability. Collectively, these projects and programs have been identified to ensure the Kings Subbasin reaches sustainability by 2040. The projects and programs include technical data and estimates of project benefit; the total of these benefits meet the initial estimates for reaching sustainability within the Kings Subbasin.

The Kings Subbasin has agreed to a phased approach of increasing mitigation to achieve sustainability. The basin has set incremental targets for correcting the overdraft of 10% by 2025, 30% by 2030, 60% by 2035, and 100% by 2040. Each GSA in the Kings Subbasin 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.

Groundwater Levels

The GSAs within the Kings Subbasin 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 the water level has declined to a depth that water quality cannot be treated for beneficial use. **Figure ES-6** shows a typical well hydrograph and incremental overdraft mitigation to reach the measurable objective and sustainability in 2040. The measurable objective will include an extension of a current hydrograph gradually stabilizing, and a minimum threshold defined as the depth of groundwater predicted if a historic 5-year drought occurred.

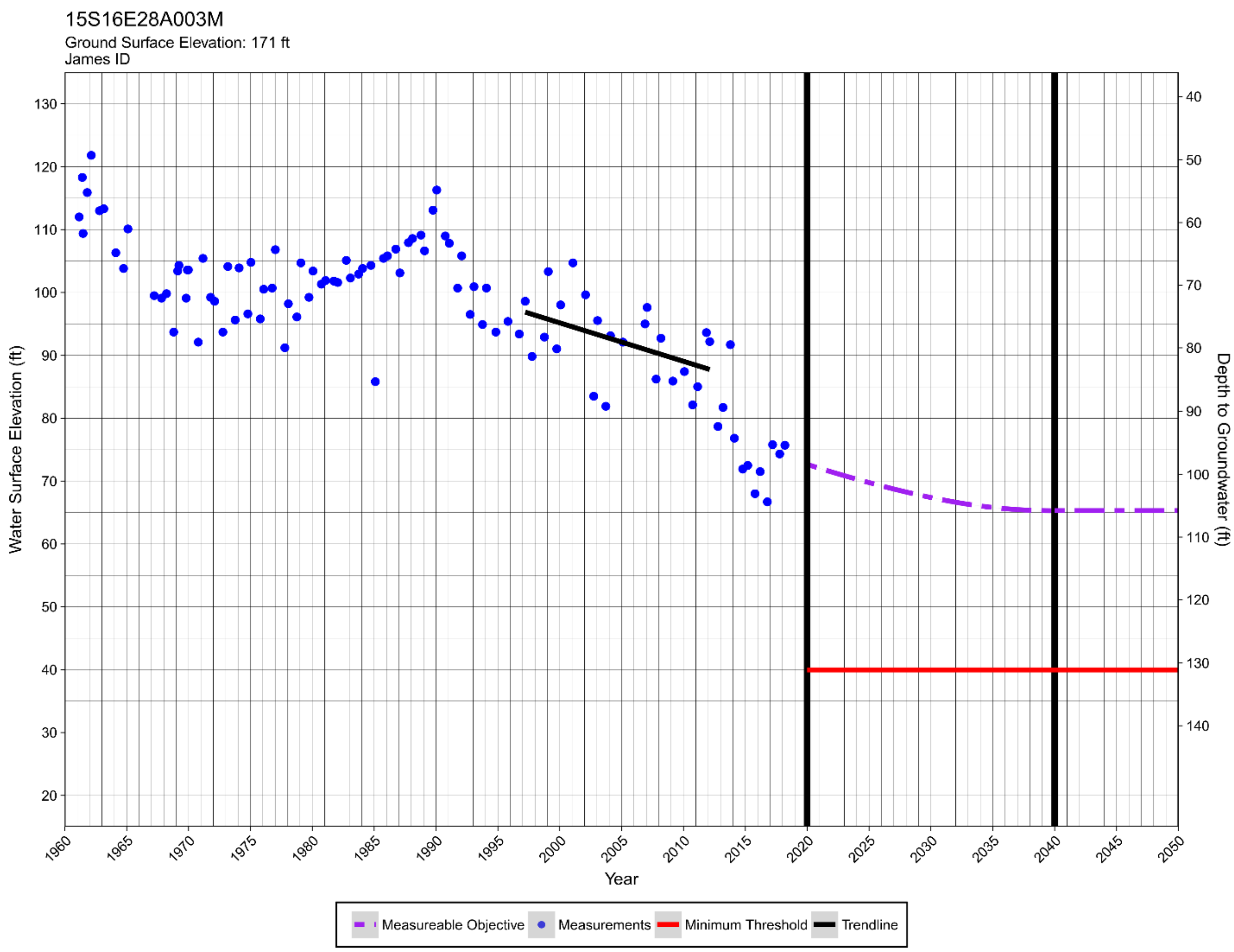


Figure ES-6 Typical James GSA Well Hydrograph with Phased Mitigation to Reach Sustainability

Storage Change

As part of the coordination of GSAs within the Kings Subbasin, a common method was used to estimate the change in groundwater storage for the entire subbasin and within each GSA during the hydrologic average base period, identified as the 15-year period from October 1996 to September 2011 based on Kings River surface water diversion into the area. The calculation of estimated groundwater storage change within the Kings Subbasin upper unconfined aquifer zone was approximately -1.8 MAF during the hydrologic average base period from spring 1997 to spring 2012, or an average of about -122,000 AF/year. Estimating storage change in the lower confined aquifer zone is not possible at this time due to limited or absent data from confined wells in the area. In addition, groundwater pumped from the confined portions of the aquifer is captured as storage change in the unconfined aquifer due to downward leakage through wells and aquitards. The 2040 goal is to stabilize, over the long-term, changes in groundwater storage. The goal will be to prevent groundwater storage from falling below the overall storage represented by groundwater level measurable objectives, and to never allow groundwater storage to fluctuate below the storage value represented by the groundwater level minimum thresholds.

Water Quality

Groundwater quality monitoring and reporting by community water systems is a requirement of California Title 22 Code of Regulations. With the powers provided by SGMA, a GSA can only regulate and manage groundwater pumping and recharge efforts. Groundwater pollution characterization and mitigation are typically enforced by local agencies and state level programs. The MCL values, which are protective of human health, will be relied upon as the primary criteria for defining minimum thresholds and undesirable results when related to groundwater pumping policies and recharge projects for the constituents of concern in the area. These constituents of concern will be the focus of the SGMA monitoring effort. Groundwater monitoring results from representative community and non-community wells within the James GSA monitoring network will be reviewed annually for compliance with State MCL values and changes from historical values, especially tracking trends in water quality. The measurable objective is to maintain water quality at potable water standards, below MCLs for the constituents of concern. In situations where monitoring network wells (either existing or future wells) have a history of being above MCLs for constituents of concern, the measurable objective is for the wells to maintain stable or improving groundwater quality trends so there is no degraded water quality from groundwater management activities.

Land Subsidence

The Minimum Threshold for the annual land subsidence rate in the Plan Area has been established as 6 inches per year over an area of 4 square miles with a maximum cumulative land subsidence of 36 inches over 20 years. The Measurable Objective was established as 3 inches per year over an area of 4 square miles with a maximum cumulative land subsidence of 24 inches over 20 years.

Surface Water and Groundwater Interaction

This sustainability indicator applies to portions of the Kings Subbasin. It does not apply to the area within James GSA because the waterways in the Plan Area, specifically the James Bypass and Fresno Slough, are either disconnected from their water source or flow only occasionally and are disconnected from groundwater through an unsaturated zone. Portions of these waterways that are inundated year-round are inundated artificially by the Mendota Dam. However, the James GSA has proposed establishing a shallow groundwater monitoring network along inundated reaches of the Fresno Slough and James Bypass to monitor for impacts and changes in near-river gradients and potential impacts to other water users.

Seawater Intrusion

This sustainability indicator does not apply to the Kings Subbasin.

Chapter 5 - Monitoring Network

This chapter describes the monitoring networks being developed by the James GSA that will collect data to determine short-term, seasonal, and long-term trends in groundwater and related surface conditions. This information will yield information necessary to support: 1) the implementation of this Plan, 2) evaluation of the effectiveness of this Plan, and 3) decision making by the James GSA management. The results and data from historical monitoring efforts are discussed in **Section 3.2**. The Monitoring Network chapter describes the current and proposed monitoring programs, identifies data gaps, and describes the plans to fill data gaps for each sustainability indicator.

The GSAs within the Kings Subbasin have established three monitoring networks within each GSA for groundwater level, groundwater quality, and land subsidence. The objectives of the various monitoring programs include:

1. Establish a baseline for future monitoring.
2. Provide warning of potential future problems.
3. Use data gathered to generate information for water resources evaluation.
4. Help to quantify annual changes in water budget components.
5. Develop meaningful long-term trends in groundwater characteristics.
6. Provide comparable data from various locales within 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.

The primary challenge in developing the water level monitoring network was utilizing available data and navigating through the obstacles and limitations of the three general data gap types: temporal, spatial, and insufficient quality of data. Because of the unique geology and multiple primary clay layers within the James GA, well construction information including perforated intervals is required to identify which aquifer zone is being monitored. Publicly available groundwater level data is limited in terms of high quality monitoring points. These ideal monitoring points must have known construction information, not be composite, have adequate measurement history and frequency, and provide sufficient spatial coverage across the Plan Area.

The James GSA intends to expand its groundwater level network as additional well construction information is obtained for existing wells and as new dedicated monitoring wells are installed. The groundwater elevation measurements will be collected every March and October to provide data on the seasonal high and low groundwater conditions. The groundwater level data will be provided to the Kings Subbasin Plan Manager for inclusion in the Data Management System and annual reports. These wells along with additional future wells will be used for groundwater storage calculations.

The groundwater quality monitoring network will rely on the publicly available groundwater quality data from selected representative wells that will be obtained annually and evaluated against sustainable management criteria. 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 as needed.

Land subsidence will be primarily monitored using KRCD's land subsidence monitoring program. The monitoring network includes benchmark surveying on an approximate seven-mile grid network with records dating back to 2010. This spatial and temporal network is adequate and designed with the flexibility to increase or decrease measurement frequency and/or benchmark spacing if more or less data is warranted. NASA InSAR remote sensing data will be used to verify any observed subsidence and fill in gaps between the surveyed benchmarks.

Chapter 6 - Projects and Management Actions

Each GSA within the Kings Subbasin has identified projects and management actions that may be used in order to achieve groundwater sustainability within the basin. The James GSA has identified twenty-one projects, three programs (or programmatic management actions), and four management actions. Projects identified include 10 projects within the GSP plan area and 11 projects outside of the GSP plan are but within the subbasin. The projects and management actions are listed in **Table ES-2**.

Each of the projects, programs, and management actions were analyzed. The expected benefits from all of the projects listed was determined to be far more than is necessary to meet the needs of the James GSA in achieving groundwater sustainability within the Kings Subbasin.

Figure ES-7 shows the planned James GSA phased mitigation of overdraft to reduction to achieve groundwater sustainability.

Various aspects of the projects were reviewed to assess whether entities within the James GSA have an adequate water supply to implement the planned projects, programs, and management actions. All of the projects except three are demonstrably feasible. The three projects that are not demonstrably feasible are conceptually feasible but are not required to achieve sustainability.

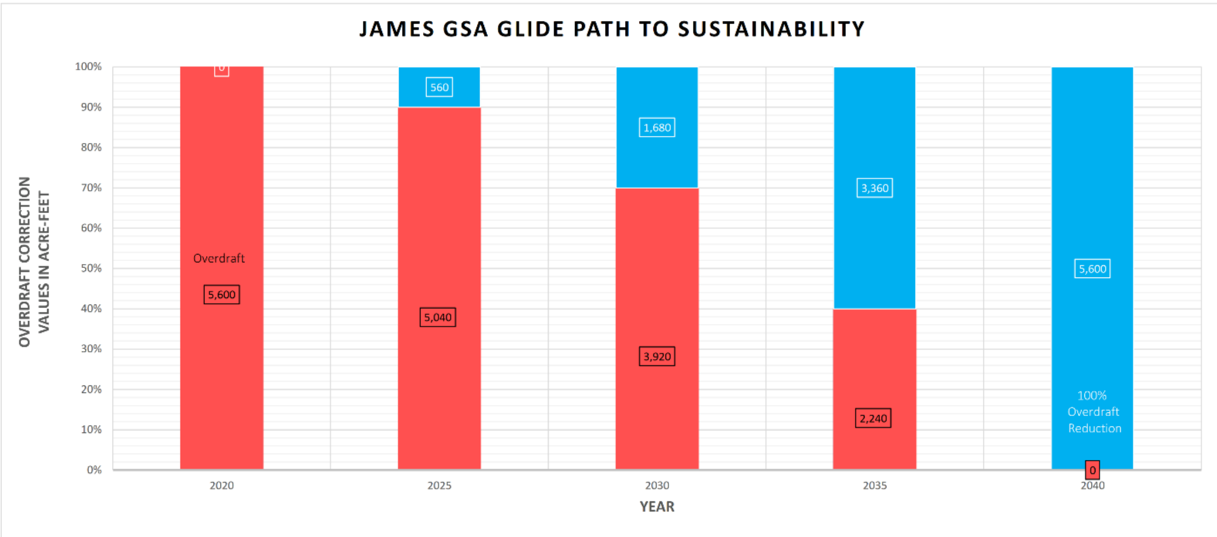


Figure ES-7 James GSA Phased Mitigation of Overdraft Reduction to Reach Sustainability

Table ES-2 Projects, Programs, and Management Actions

Projects	
1	K-Basin Groundwater Recharge
2	Basins 1 and 2 Storage and Recharge
3	Basin 3 Floodwater Capture and Recharge
4	Floodway Recharge and Spreading
5	Distribution System Recharge
6	City of San Joaquin Storm Water Pond Recharge
7	McMullin On-Farm Flood Capture and Recharge
8	Southwest Groundwater Banking
9	Carmichael Slough Recharge
10	James Main Canal Spreading
11	Fresno Slough Recharge
12	Mud Dam Spreading and Recharge
13	James Bypass Floodwater Utilization
14	Lassen Avenue Floodwater Utilization
15	McMullin Grade Floodwater Utilization
16	Distributed Recharge Basin
17	McMullin Master Plan
18	James Ranch Recharge Basin
19	Wildlife Habitat Restoration
20	Mendota Pool Water Quality Monitoring
21	Lake Avenue Canal
Programs	
1	Fallow Land Recharge
2	Flood and Excess Water
3	Central Valley Project Water Banking
Management Actions	
1	Water Management Planning
2	Metered Agricultural Water Deliveries
3	Metered Groundwater Extractions
4	Mendota Pool Water Quality Engagement

Chapter 7 - Plan Implementation

The adoption of the GSP will be the official start of the Plan Implementation for James GSA. After GSP adoption, the GSA will continue its efforts to engage the public and secure the necessary funding to successfully monitor and manage groundwater resources within the area in a sustainable manner. While the GSP is being reviewed by DWR, the GSA will coordinate with various stakeholders and beneficial users to improve the monitoring network, fill data gaps, and begin the implementation of both projects and management actions.

The James GSA will implement projects, programs, and management actions based on subbasin and Plan Area conditions as well as monitoring of the sustainability indicators established by this plan and other plans covering the subbasin. Each project, program, or management action will influence sustainability differently. In general, projects, programs, and management actions will be selected for implementation based on a number of factors including capital cost, operating cost, water supply considerations, and benefits. An implementation schedule was prepared and used as an initial roadmap to determine costs associated with implemented projects, programs, and management actions.

Costs to implement needed projects, programs, and management actions to achieve groundwater sustainability were estimated. The total cost in 2020 dollars to implement the Plan are estimated to be TBD.

Funding alternatives for this cost were reviewed and the James GSA Board of Directors, through consultation and agreement with the James ID Board of Directors and the RD 1606 Board of Trustees, determined that it will fund the James Groundwater Sustainability Agency through direct contributions by underlying districts. The schedules and estimates presented in the GSP are initial estimates and will likely change as the plan is implement and periodically evaluated.

Successful implementation of this GSP over the planning and implementation horizon (2020-2040) will require ongoing efforts to engage stakeholders and the general public in the sustainability process, communicating the statutory requirement, the objectives of the GSP, and progress toward each identified measurable objective. The James GSA will report the result of the Kings Subbasin and Plan Area operations including current groundwater levels, extraction volume, surface water use, total water use, groundwater storage change, and progress of GSP implementation to the public and DWR on an annual basis, in cooperation with the other GSAs in the Subbasin. The Kings Subbasin has developed a Data Management System to help store and evaluate groundwater related data. In addition, the James GSA will provide updated information and amend the GSP at least every five years. The update will include the results of the Kings Subbasin operations and 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 networks, summary of enforcement or legal actions, and agency coordination efforts to the public and DWR.

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.

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.

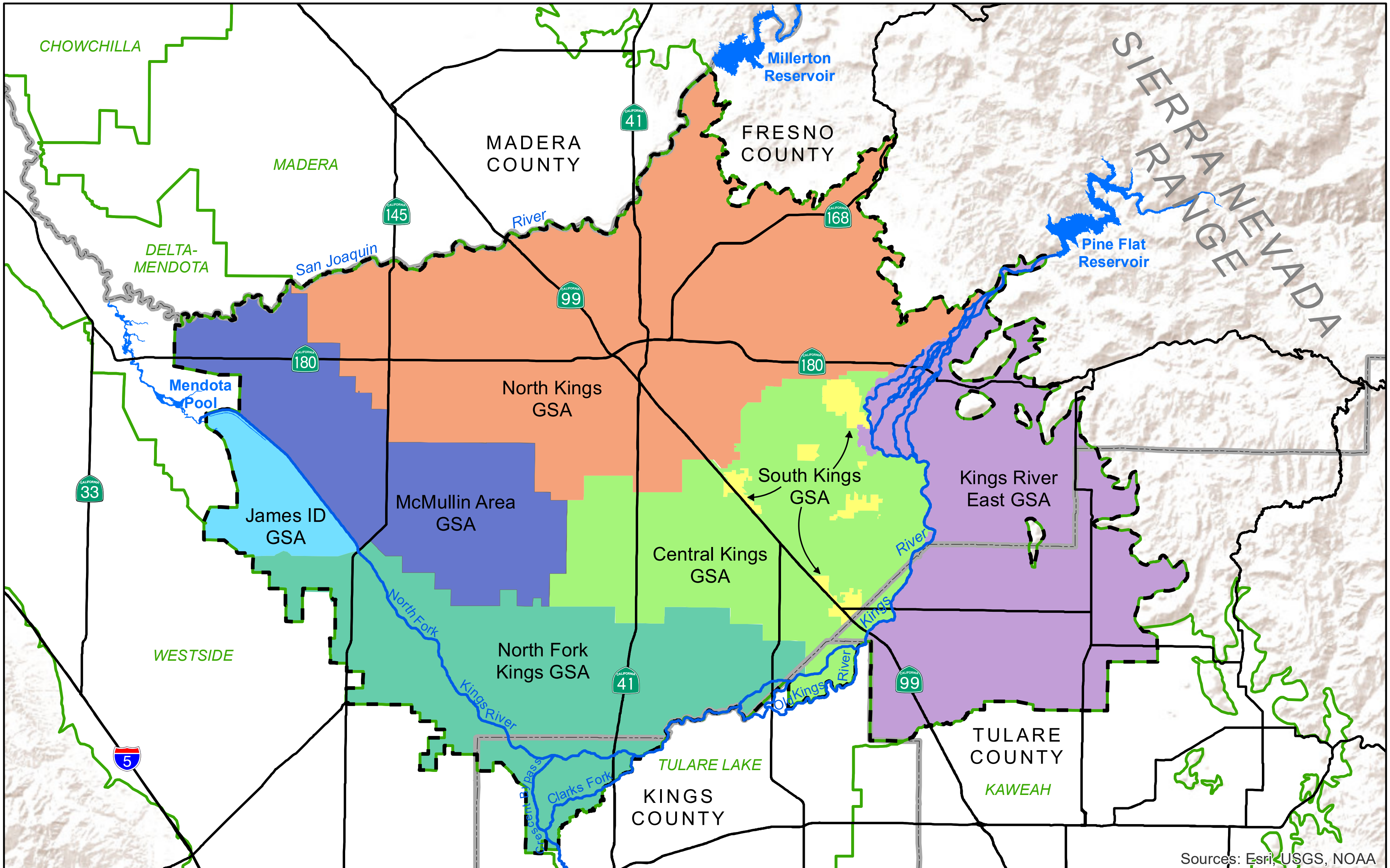
In his signing statement, Governor Brown emphasized that “groundwater management in California is best accomplished locally.” The GSAs within the Kings Subbasin are working to achieve basin-wide sustainability through local efforts and cooperation.

1.2 Sustainability Goal

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. A more detailed description of the Sustainability Goal for the subbasin and Sustainable Management Criteria for the subbasin and this GSA, are included in **Chapter 4**

1.3 Coordination Agreements

The Kings Subbasin has seven Groundwater Sustainability Agencies (GSAs), all of whom are preparing individual GSPs (see **Figure 1-1).** The seven GSAs have worked cooperatively since 2016 to coordinate the formation of the GSAs and developed other coordination elements of the GSPs. The GSAs have entered into a cooperative Memorandum of Understanding for development of the GSPs and grant funding. The GSAs also have developed a Coordination Agreement to facilitate future coordination efforts 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 similar 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, and data management system. Appendix 1-A includes a copy of the Kings Subbasin Coordination Agreement.



Kings Groundwater Subbasin (DWR 2018)

Other Groundwater Subbasins (DWR 2018)

County

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James GSA

Kings Groundwater Subbasin
Groundwater Sustainability Agencies

Figure 1-1

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1.4 Inter-basin Agreements

There are currently 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. GSA discussions with neighboring agencies have been reported back to the other GSAs within the Kings Subbasin.

As shown in **Figure 2-1,** the James GSA borders the Madera Subbasin and the Delta-Mendota Subbasin.

1.5 Agency Information

Legal Requirements:

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

The name and mailing address of the GSA is as follows:

James Groundwater Sustainability Agency
8749 Ninth Street, P.O. Box 757
San Joaquin, CA 93660-0757

1.5.1 Organization and Management Structure of the GSA

Legal 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 James GSA was formed under a Memorandum of Understanding (MOU) made effective December 17, 2015 between the James Irrigation District (JID) and Reclamation District No. 1606 (RD 1606) (Appendix A). The City of San Joaquin (City), located in the center of the James GSA area, is not a party to the MOU but the City is included in the GSA area because the boundaries of Reclamation District No. 1606 also includes lands within the City limits. The City of San Joaquin is not in the James Irrigation District (JID) service area. The City of San Joaquin was invited to participate in the MOU but declined due to issues involving the County of Fresno.

Under the terms of the MOU, the James GSA is governed by a board comprised of five directors. Four directors are appointed by James ID and one director is appointed by RD 1606. The directors may be elected officials, appointed officials, agency employees, landowners, or residents of the respective appointing agencies. James ID serves as the coordinator for the parties acting jointly under the MOU.

The James GSA Board of Directors has appointed an Executive Director and had delegated the management authority to implement the Plan to the Executive Director. Accordingly, the name and contact information of the plan manager is as follows:

Steven P. Stadler, P.E.
Executive Director
James Groundwater Sustainability Agency
8749 Ninth Street, P.O. Box 757
San Joaquin, CA 93660-0757
(559) 693-4356 phone
(559) 693-4257 facsimile
sstadler@jamesid.org

1.5.2 Legal Authority of the GSA

Legal Requirements:

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

As mentioned previously, the James was formed under a MOU by James ID and RD 1606. James ID is an Irrigation District formed on February 16, 1920 and is governed sections 20500 *et seq.* (Division 11) of the Water Code. The powers and purposes of James ID are provided in sections 22075 et. seq. RD 1606 was formed on May 9, 1914 and is governed sections 50000 *et seq.* (Division 15) of the Water Code. The powers and duties of RD 1606 are provided in sections 50900 et. seq. Both the James ID and RD 1606 are local agencies with the authority to form a groundwater sustainability agency through a MOU under Water Code section 10723.6 subdivision (a)(2).

In December of 2015, the RD 1606 Board of Directors adopted RD 1606 Resolution 2015-02 to form the GSA. The James ID Board of Directors took similar action and adopted James ID Resolution No. 2016-04. A properly noticed public hearing was held on January 11 and 12, 2016 to determine whether to become a GSA.

As required by Water Code section 10723.8, a notification to become a Groundwater Sustainability Agency was filed with the DWR on January 29, 2016. The notification covered the portion of the Kings Subbasin that lies within the boundaries of James ID and RD 1606 as shown in **Figure 1-1**. The notification included all the required information including a boundary map of the GSA, a list of interested parties. After the 90-day review period, James GSA became an exclusive groundwater sustainability agency on or about March 29, 2016.

Upon adoption and submittal of the Plan to DWR, the James GSA will possess the powers and authorities provided in Water Code sections 10725 *et seq.* and will have complete legal authority to implement the Plan.

<u>Implementation Cost Estimate and Funding</u>

The James GSA projects that it will cost $778,800 annually to implement the Plan. Because the projects and management actions in this plan will be implemented as needed to achieve groundwater sustainability, this estimated cost may vary considerably. Initially, funding for implementation of the Plan will be provided by the James ID with the costs being passed along to growers and landowners through tax assessments and water rates. While this funding arrangement is contemplated for the foreseeable future, it is possible that Plan implementation may be funded from other sources at a later date.

The GSPs within the King Subbasin have agreed to utilize the same GSP outline structure and format, with only minor differences in some lower-level subheadings. This GSP is organized in a manner consistent with the GSP Emergency Regulations (i.e. California Code of Regulations section on Groundwater Sustainability Plans) in a format similar to that of the outline provided by DWR. Following is a brief summary of each GSP section. The complete checklist is included in Appendix 1-B.

- **Executive Summary** provides a summary of what will be included in the GSP.
- **Section 1 - Introduction** describes the Introduction, including the purpose of the GSP, sustainability goal, agency information, and GSP organization.
- **Section 2 - Plan Area** describes the 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 – Basin Setting** 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 – Sustainable Management Criteria** 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 – Monitoring Network** 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 – Projects and Management Actions to Achieve Sustainability** 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 – Plan Implementation** 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 – References and Technical Studies** summarizes the references and sources used to prepare and document this Plan.

2 Plan Area

Regulation Requirements:

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

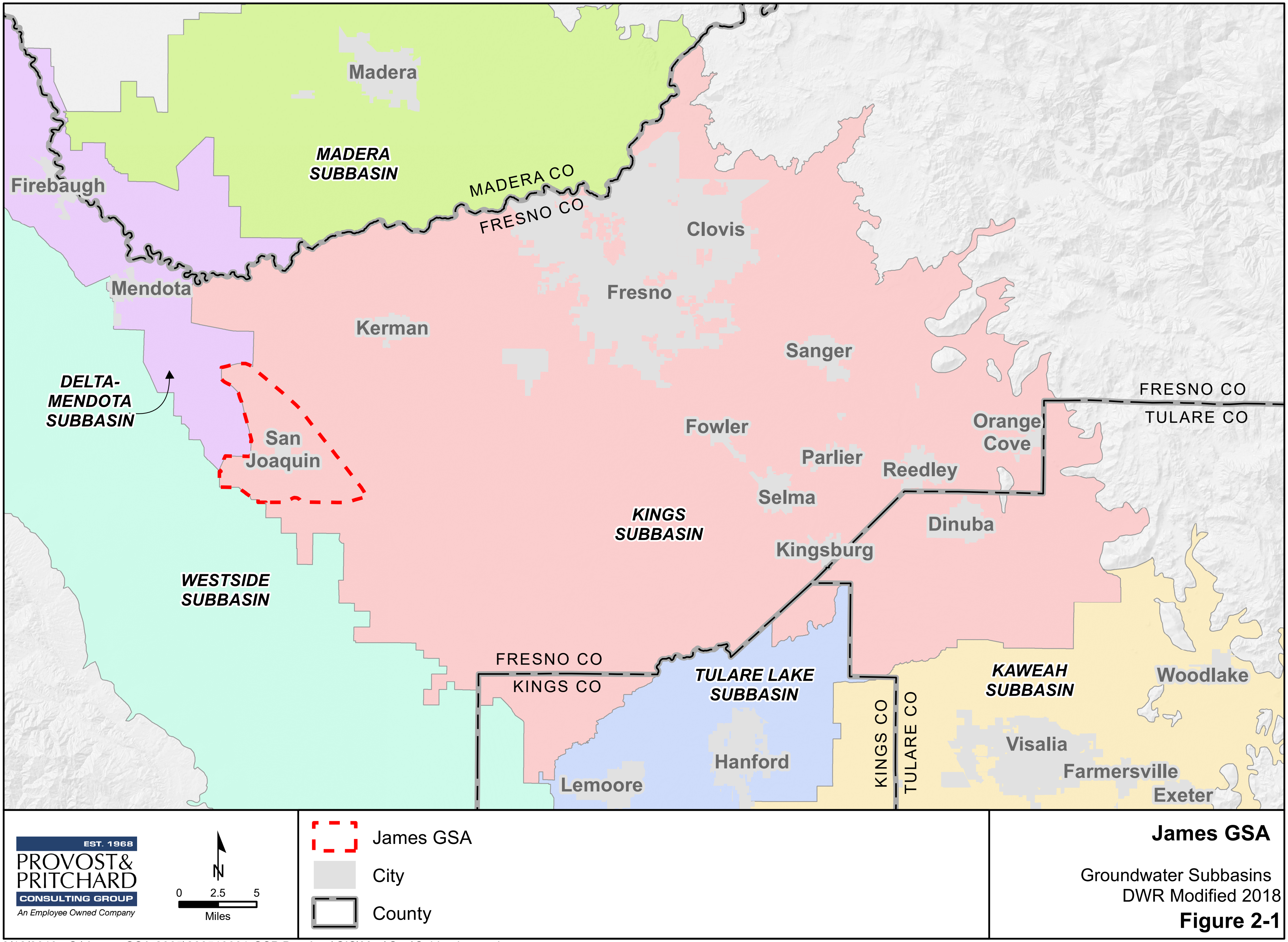
(a) One or more maps of the basin that depict the following, as applicable:

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 part of the San Joaquin Valley Groundwater Basin. It is bordered by five groundwater subbasins including the Madera, Kaweah, Tulare Lake, Westside, and Delta-Mendota Subbasins, shown in **Figure 2-1.** The San Joaquin and Kings Rivers are the two principal rivers within or bordering the subbasin. The Fresno Slough and James Bypass are along the western edge of the subbasin and connect the Kings River with the San Joaquin River.

The James Groundwater Sustainability Agency (James GSA) is one of seven Groundwater Sustainability Agencies (GSAs) within the Kings Subbasin, shown in **Figure 2-2**. There is no overlap among the GSAs and there are no adjudicated areas in the groundwater subbasin.

There are no state, federal, or tribal lands within the Plan Area. The entire Plan Area is within the County of Fresno and the City of San Joaquin is located in the center of the Plan Area. James ID and RD 1606 are special districts within the Plan Area and their boundaries are shown in Figure 2-3. Other special districts covering some or all of the Plan Area include the James Resource Conservation District, Consolidated Mosquito Abatement District, Fresno County Fire Protection District, and the Kings River Conservation District.



James GSA

Groundwater Subbasins
DWR Modified 2018

Figure 2-1

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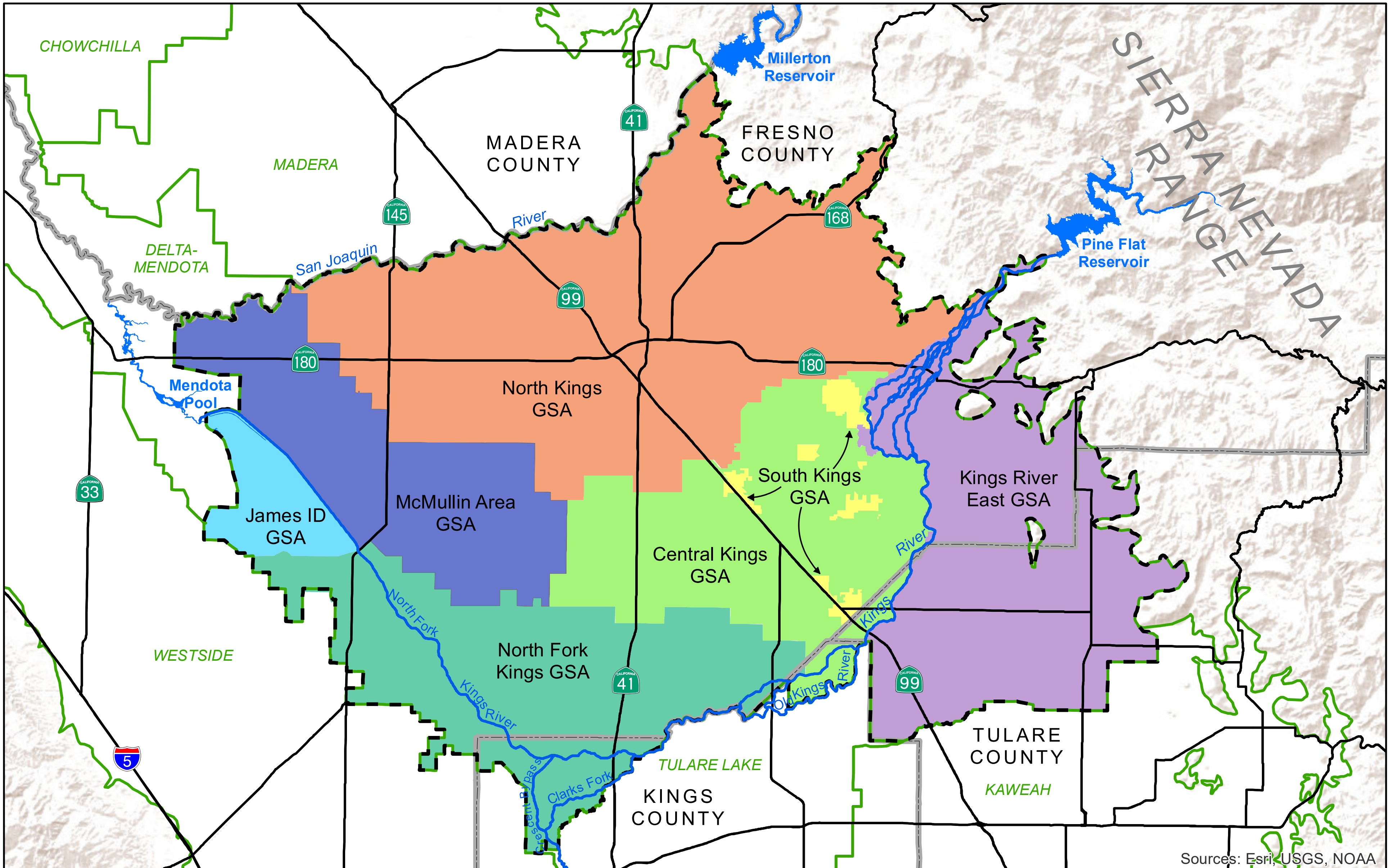

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James GSA

Kings Groundwater Subbasin
Groundwater Sustainability Agencies

Figure 2-2

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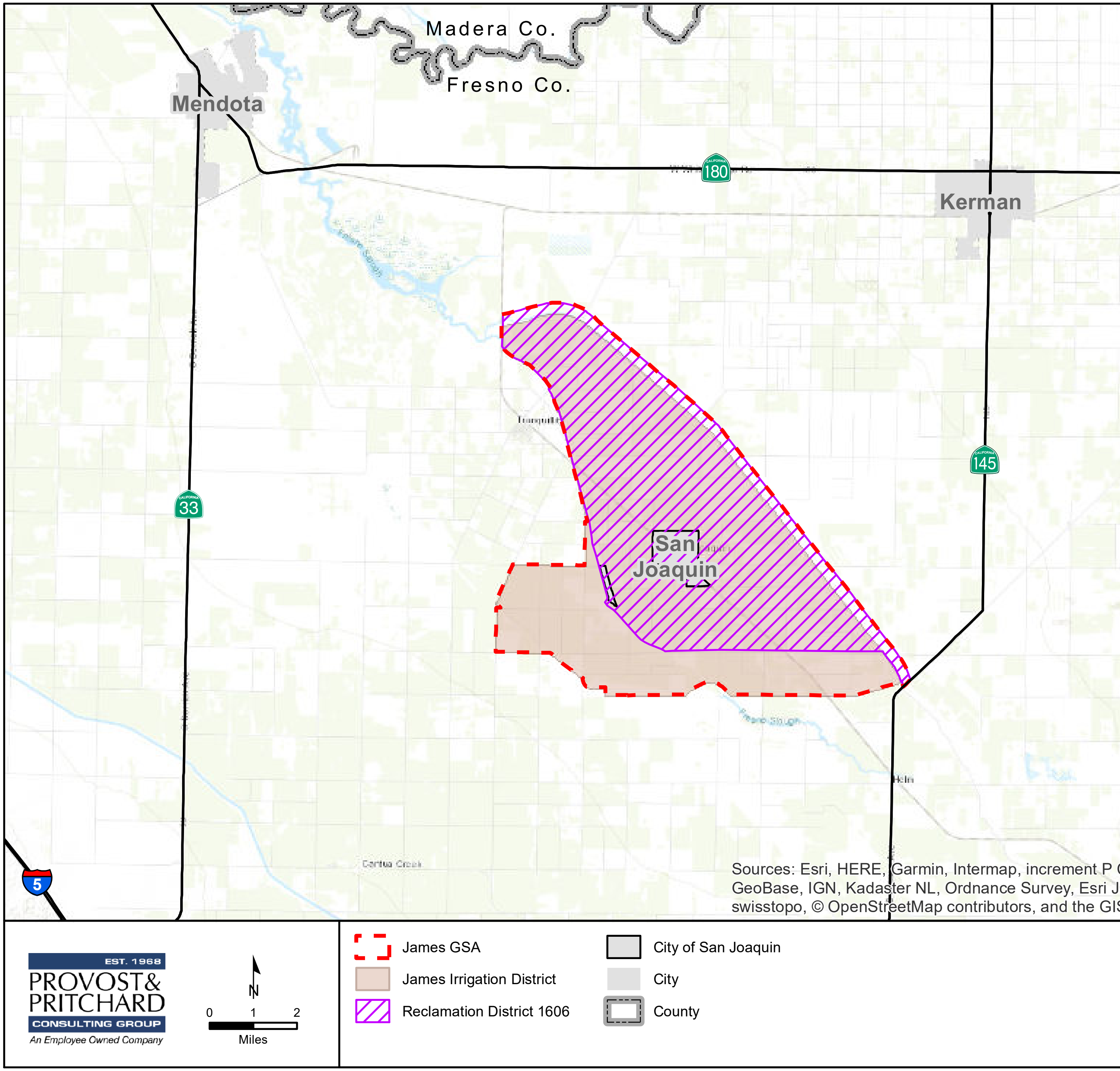

James GSA

Agencies

Figure 2-3

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The area consists of a combination of large and small farming operations that generally host permanent crops and annual row crops. Farmed agricultural land represents a large majority of the total area. The California Department of Water Resources (DWR) has updated statewide land use cropping maps in 2014 using Land IQ satellite imagery. **Figure 2-4** displays land use for James GSA. **Table 2-1**, below, summarizes the land-use data based on percentage of total area within the GSA.

Table 2-1 Land-Use in James GSA

Land-Use Classification	Percent of Total Area
Agricultural Lands	**90%**
Agricultural: Grains, Pasture and Field Crops	36%
Agricultural: Truck Crops	18%
Agricultural: Permanent Crops	30%
Agricultural: Idle Land	3%
Agricultural: Farmsteads and Others	1%
Native and Riparian vegetation	**6%**
Water Features	**2%**
Residential	**<1%**
Urban Lands	**1%**
Industrial	**<1%**

The Plan Area is dominated by agricultural lands. The predominant crops grown on agricultural lands include, in descending order of acreage for 2018 production, almonds, cotton, seed alfalfa, pistachios, grapes, onions, and tomatoes. Lands with native and riparian vegetation comprise the next highest land use and are located primarily in floodways. Urban lands within the Plan Area are primarily within the City of San Joaquin. A significant percentage of the land use within the Plan Area also includes lands utilized for groundwater recharge.

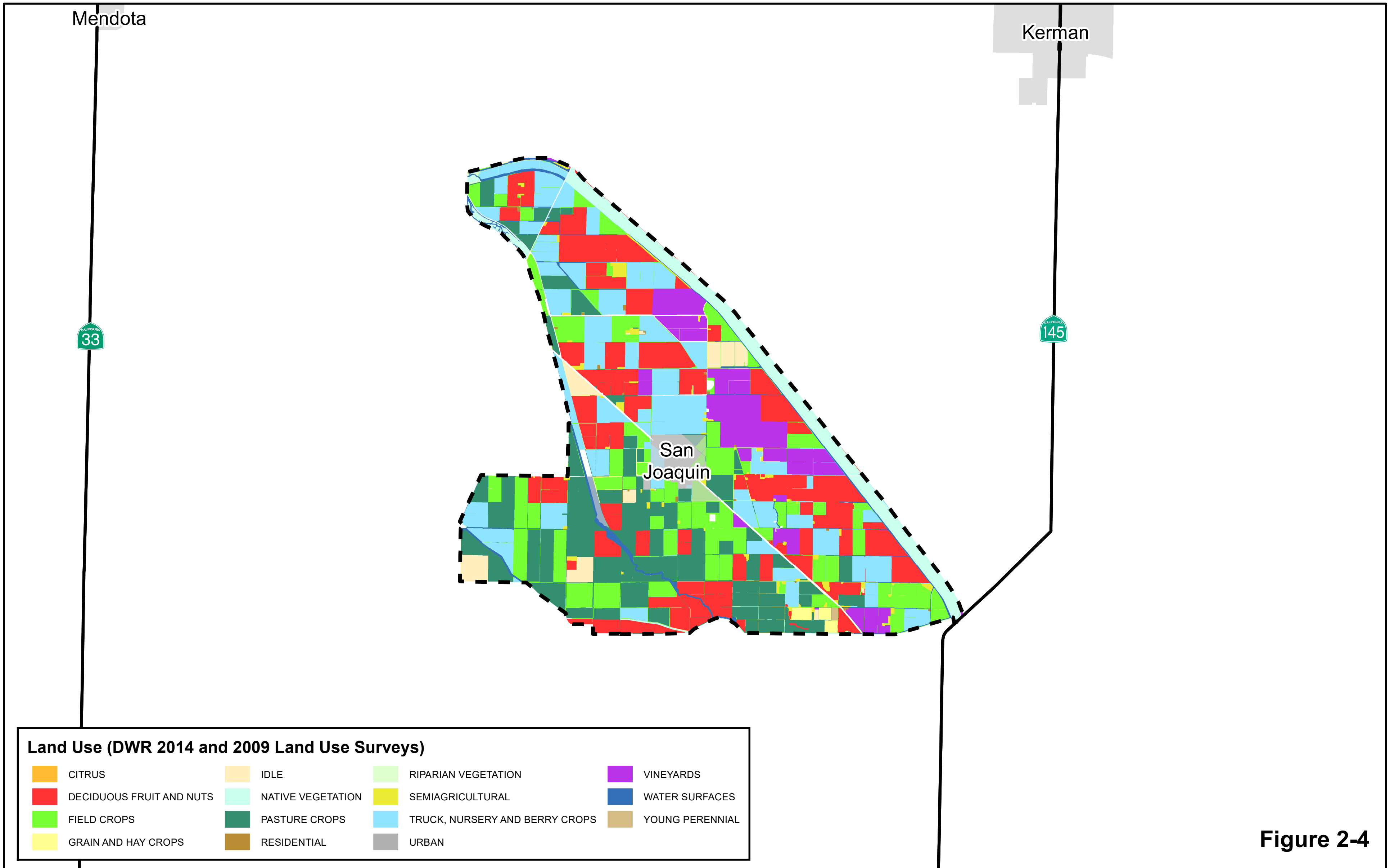

Figure 2-4

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James GSA

City

James GSA

DWR Land Use
Fresno County (2009)
Statewide (2014)

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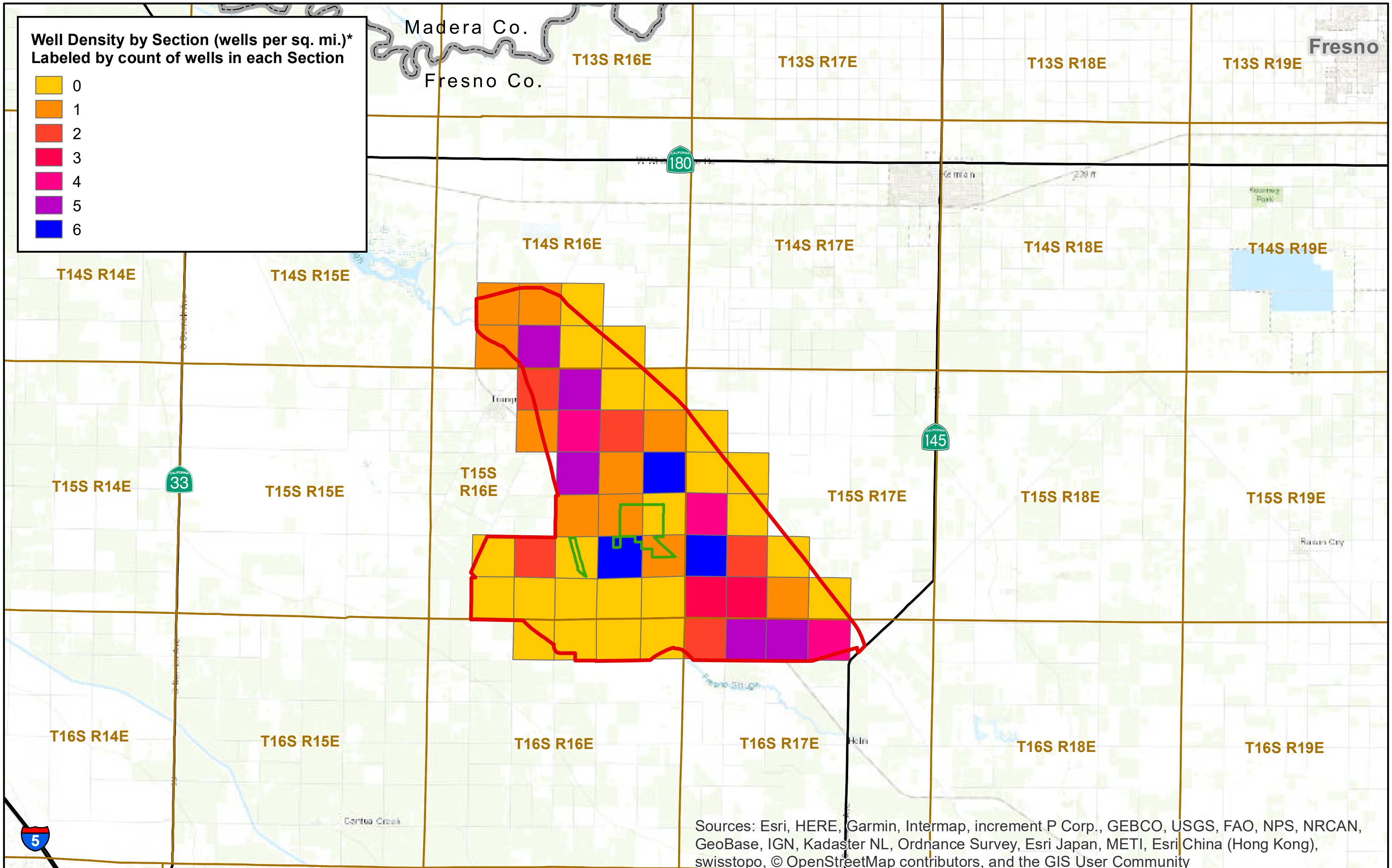
Water use and water source type for each of the plan's participants are shown in **Table 2-2.** Aside from individual rural residences and farming operations, the City of San Joaquin is the only community that is dependent on groundwater. The City of San Joaquin relies exclusively on groundwater for the service it provides to its residential, commercial and industrial customers. There are no other public or community water systems located within the Plan Area.

Table 2-2 Water Uses and Water Sources

Agency / Water Company	Water Use	Water Source
City of San Joaquin	Municipal Commercial Industrial	Groundwater
James Irrigation District	Agricultural	Surface (Kings River) Surface (San Joaquin River) Surface (Central Valley Project) Surface (Fresno ID) Surface (Tranquillity ID) Groundwater (within James ID) Groundwater (outside of James ID)
Reclamation District No. 1606	Agricultural	Surface (Kings River) Surface (San Joaquin River) Surface (Central Valley Project)

Figure 2-5, Figure 2-6, and **Figure 2-7** are maps of well densities by section within the Plan Area for irrigation, rural domestic, and municipal wells, respectively. There are (placeholder) irrigation wells, three municipal wells, and an estimated (placeholder) rural domestic wells. The location of irrigation and municipal wells are known and based on public records or agency staff knowledge. The locations of active rural domestic wells were determined or inferred by an inspection of aerial imagery, roadside canvass, and staff knowledge. The well densities only include active wells for the extraction of groundwater. Inactive wells, abandoned wells, monitoring wells, and test wells were not included in the figures.



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Miles

James GSA
City of San Joaquin
County
Township/Range

*Well data provided by James Irrigation District.

James GSA
Irrigation Well
Density by Section
Figure 2-5

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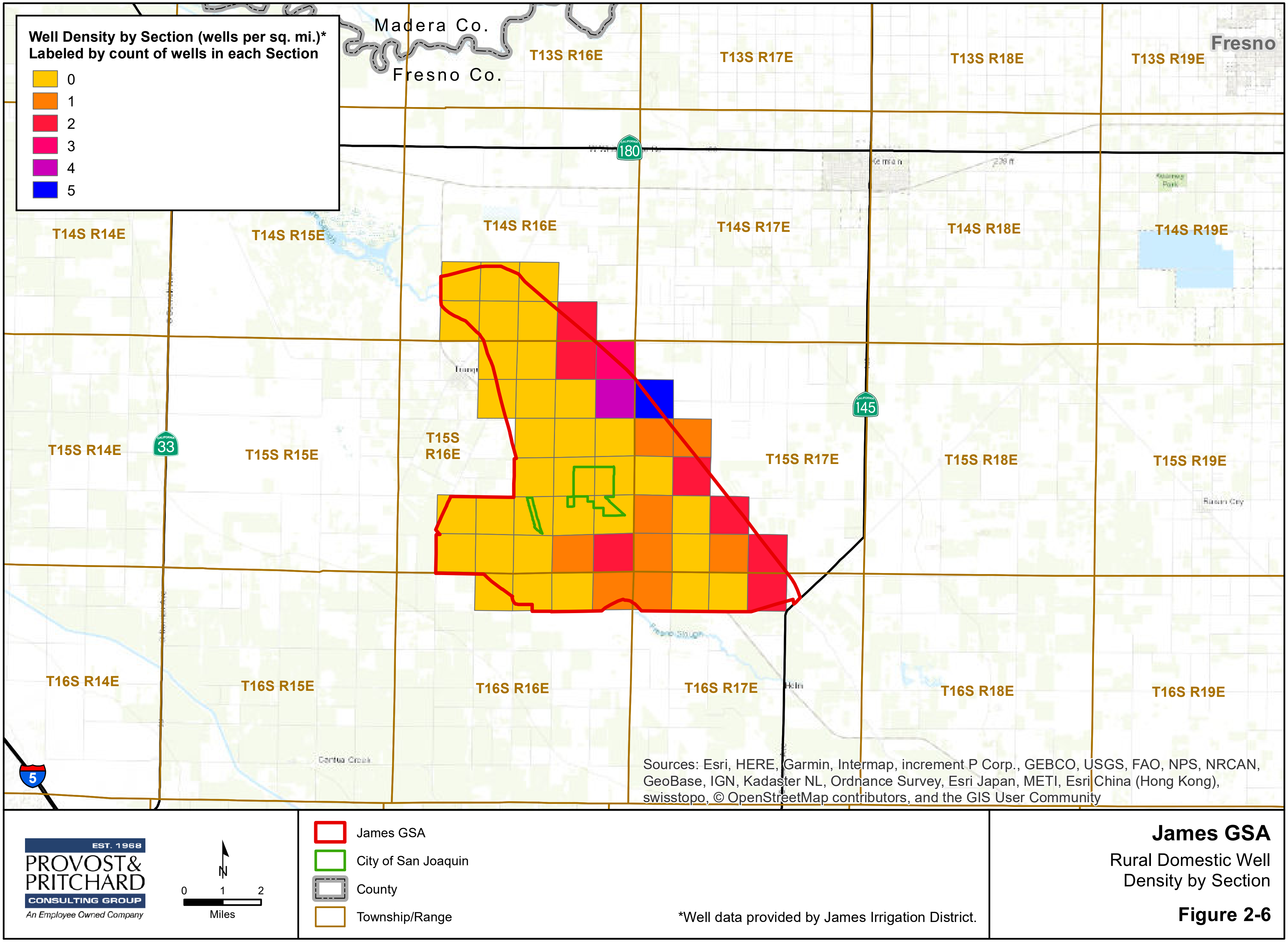

James GSA

Rural Domestic Well Density by Section

Figure 2-6

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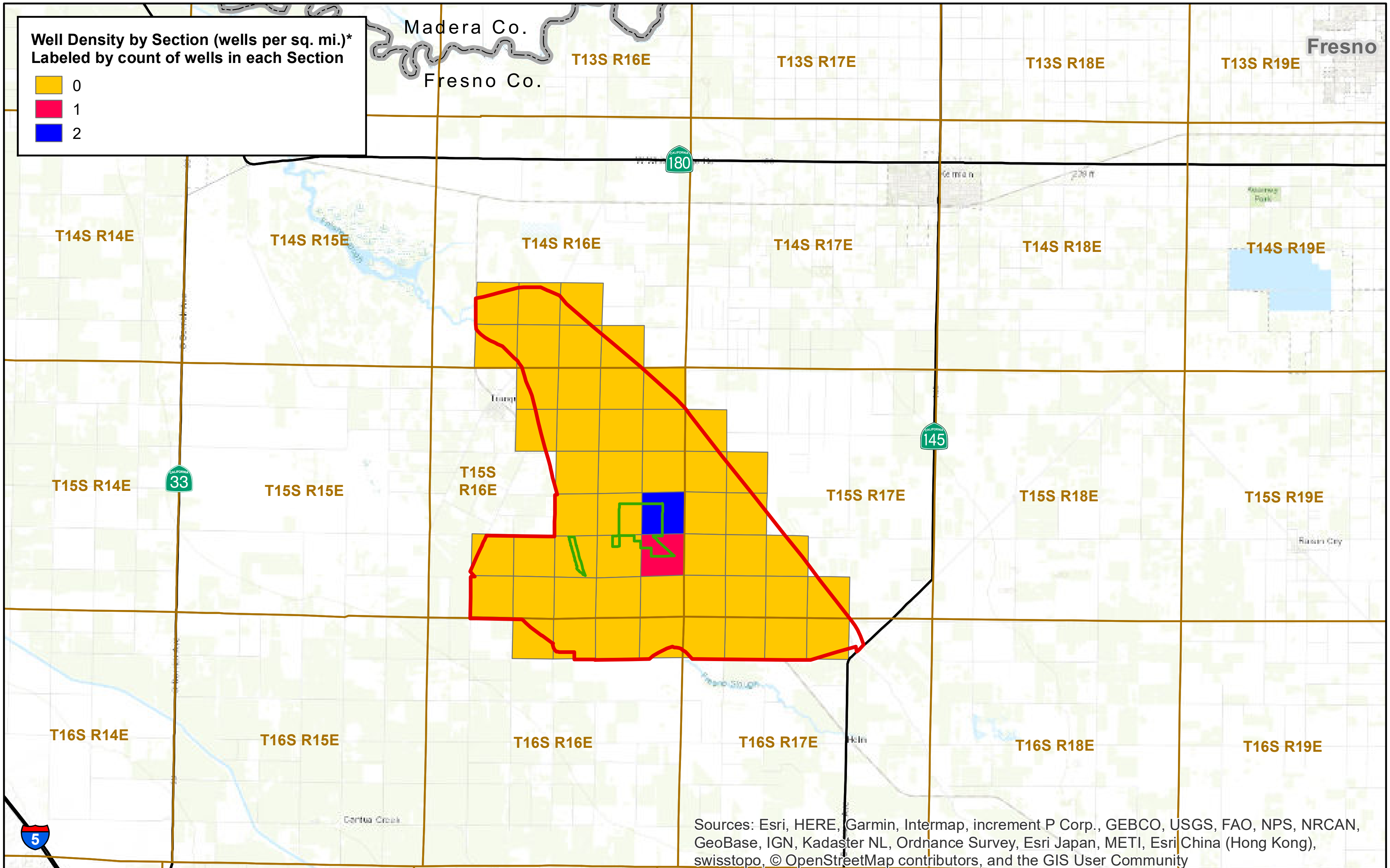

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Miles

James GSA
City of San Joaquin
County
Township/Range

*Well data provided by James Irrigation District.

James GSA

Municipal Well Density by Section

Figure 2-7

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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.

2.1.1 Groundwater Basin Boundaries

The Kings Subbasin is located within the southern part of the San Joaquin Valley Basin in the Central Valley of California. The groundwater subbasin boundary as defined in the DWR Bulletin 118 (2003) is shown in **Figure 2-1**. The groundwater basin covers an area of 1,530 square miles. DWR estimates 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. The Upper Kings Subbasin has a total groundwater storage capacity of 35 million AF to an average depth of about 500 feet. The groundwater storage in the Lower Kings Subbasin is estimated to be about 44 million AF to an average depth of about 1,000 feet. The Upper Kings Subbasin refers to approximately the northeastern two-thirds of the subbasin, and the Lower Kings Subbasin refers to the southwestern one-third which includes James GSA .

2.1.2 Groundwater Sustainability Plan Area

The James GSA Groundwater Sustainability Plan Area, referred to as Plan Area throughout this Plan, is identified in Figure 2-3. The Plan Area encompasses (placeholder) acres or about 42 square miles and is mostly highly developed agriculture on prime farmland. The Plan Area is in the westernmost portion of the Kings Subbasin (California Department of Water Resources (DWR) basin 5-022.08) (Figure 1-1). The Kings Subbasin is one of 16 subbasins in the San Joaquin Valley Groundwater Basin (DWR basin 5-022) that spans California's Central Valley.

As shown on **Figure 2-1**, five groundwater subbasins are adjacent to the Kings Subbasin:

- Delta Mendota Subbasin (DWR Basin 5-022.07)
- Westside Subbasin (DWR Basin 5-022.09)
- Tulare Lake Subbasin (DWR Basin 5-022.12)
- Madera Subbasin (DWR Basin 5-022.06), and
- Kaweah Subbasin (DWR Basin 5-022.11).

Seven GSAs have formed to encompass the Kings Subbasin. These are listed below and shown on **Figure 2-2.**

- James GSA
- McMullin Area GSA
- North Fork Kings GSA
- North Kings GSA
- Central Kings GSA
- South Kings GSA, and
- Kings River East GSA.

Three GSAs border the Plan Area to the west and north outside of the Kings Subbasin. The Westlands Water District GSA, located in the Westside Groundwater Subbasin, lies to the west of the Plan Area and the Central Delta-Mendota Region and Fresno County GSAs, both located in the Delta-Mendota Groundwater Subbasin, lie to the west and northwest of the Plan Area.

Geographically, the Plan Area is bordered to the east by the James Bypass, a designated floodway owned and maintained by RD 1606. The Fresno Slough borders the Plan Area along the northern portion of the western boundary. Private conservation lands lie along a portion of the southern boundary of the Plan Area.

2.1.3 Jurisdictional Agencies

The James GSA is the exclusive GSA within its GSA boundaries and the Plan Area. No adjudicated areas exist in the Kings Subbasin and no Alternative Plans have been submitted.

The James Irrigation District and the Reclamation District No 1606 manage the James ID GSA. The City of San Joaquin (City) also lies within the James ID GSA. These are described briefly below.

JAMES IRRIGATION DISTRICT.

The JID was formed in 1920 under the California Water Code to supply irrigation water. The District covers 26,392 acres wholly within Fresno County, California and is approximately thirty miles southwest of the City of Fresno. The San Joaquin Valley Farmlands Company, successor to the James Ranch, granted James ID a perpetual right to pump groundwater from beneath lands east of the District, up to 200 cubic feet per second (cfs), and to import that water into the James ID service area.

Groundwater is JID's main source of supply. Other supplies include Central Valley Project (CVP) water, operational spills from the Fresno Irrigation District, and surface water from the Kings River via the Fresno Slough. Water is allocated to growers based on irrigated acreage (Woodard & Curran, 2019).

Currently, the JID serves water to 60 farms on 23,874 irrigated acres of agricultural land. Urban encroachment is slowly reducing JID's agricultural lands. The primary crops include cotton, alfalfa seed/hay, pistachios, almonds, tomatoes, grapes, and onions with a trend in conversion from annual to permanent crops, averaging about 1,000 acres per year (Woodard & Curran, 2019).

RECLAMATION DISTRICT NO. 1606.

RD 1606 was formed in 1914 and encompasses approximately 18,520 acres and includes the City of San Joaquin and surrounding lands. It obtains and provides water for agricultural uses to about 170 acres and one agricultural tenant. It owns and maintains the Fresno Slough and Fresno Slough Bypass to convey Kings River floodwater and local storm water. RD 1606 contracts with the JID for flood control operations and maintenance and shares JID's office and staff. Its facilities are also used by JID for regulating reservoirs and groundwater recharge. A three-member Board of Directors is elected at large (Braitman & Associates, 2007).

CITY OF SAN JOAQUIN.

The City was incorporated in 1920, covers about one square mile and is located in the center of the Plan Area. It has a city manager form of government with five council members, a city manager, and about 10 full-time staff members for its population of about 4,000 people (KBWA, 2012). The City relies solely on groundwater for its water supply. It has three wells and produces just under 800 acre-feet per year (AFY) (P&P, 2010).

COUNTY OF FRESNO

Fresno County was formed in 1856. The county has a total area of 6,011 square miles of which 5,958 square miles is land and 53 square miles (0.9%) is water. Major watercourses are the San Joaquin River, Kings River, Delta-Mendota Canal, Big Creek, and Friant-Kern Canal. It is bordered on the west by the Coast Range and on the east by the Sierra Nevada. It is the center of a large agricultural area. The Coast Range, which forms the county's western boundary, reaches a height of over 4,000 feet west of Coalinga while some peaks along the crest of the Sierra Nevada, the county's eastern boundary, exceed 14,000 feet. The San Joaquin Valley floor, between the two ranges, is fifty to sixty miles wide and has an elevation near the City of Fresno of about 325 feet above mean sea level. The current boundaries of the County were established in 1909. Fresno County is one of the largest, fastest growing, and most diverse counties in the state of California. The 2010 United States Census reported that Fresno County had a population of 930,450. Fresno County is home to 15 incorporated communities, all located on the Valley floor. Over 60% of the County's total population resides in the Fresno and Clovis metropolitan area. Through the Fresno County Public Works and Planning Department, Fresno County has jurisdiction for land use planning for unincorporated areas. The County also has responsibility for well permitting through its Public Health Department.

KINGS RIVER CONSERVATION DISTRICT.

KRCD is a legislatively defined special district that supports local interests in water planning and management, develops projects, collects groundwater data, and prepares an annual report of groundwater conditions; however, KRCD does not have the legislative authority to manage groundwater. There are six divisions within KRCD. James GSA is located within KRCD Division 4 and it is part of the Lower King's Subbasin planning area.

ADJACENT JURISDICTIONS.

The James ID GSA is bounded by the following water agencies

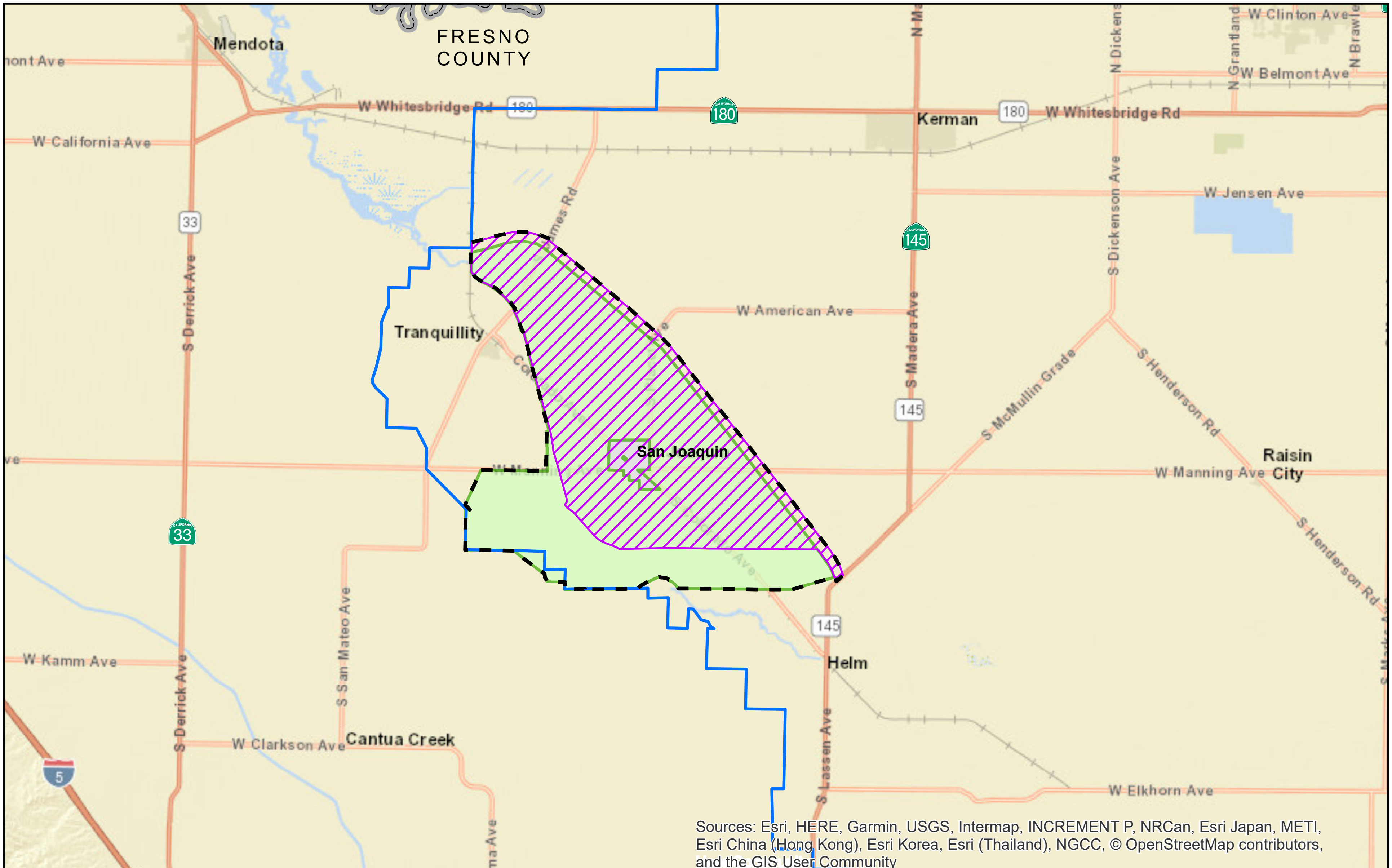
- Westlands Water District (WWD) to the southwest
- Tranquility Irrigation District (TID) to the west
- Tranquility Public Utility District to the west
- Fresno Slough Water District to the northwest
- Mid-Valley Water District to the northeast, and
- Stinson Water District to the south.

NEARBY JURISDICTIONS.

Other nearby water agencies include Raisin City Water District and the Fresno Irrigation District which are located to the east and northeast of the Plan Area, respectively.

STATE, FEDERAL, AND TRIBAL JURISDICTIONS.

No other state or federal agencies are known to administer land in the Plan Area, such as military installations, United States Forest Service lands or other federal lands, or state parks. No tribal lands are documented in the DWR Water Management Planning Tool or are known to exist in the Plan Area.



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- James Irrigation District
- City of San Joaquin
- Reclamation District 1606
- Kings River Conservation District
- Fresno County

James GSA

Jurisdiction Map

Figure 2-8

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2.2 Water Resources 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.
§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.

Water resources management have a long history in the James GSA. The James ID has been the sole source of irrigation water for its landowners and growers for a century. Effective water management by James ID allowed agricultural lands within the Plan Area to develop well ahead of most lands in western Fresno County. These water management activities have been incorporated into the agricultural water management and groundwater management plans developed by James ID. During the past couple of decades, other plans and program that interact with water management in the Plan Area have been put into place by state and local agencies. These plans and programs are summarized below.

2.2.1 Agricultural Water Management Plans

James Irrigation District Agricultural Water Management Plan, 2016. The James Irrigation District Water Management Plan (AWMP) (P&P, 2016) involves planning and operations to provide an adequate, reliable and acceptable agricultural water supply for the landowners within JID's service area. JID's water supplies are defined as water which is delivered to JID water management facilities for the purposes of agricultural, groundwater recharge, transfer and exchange, or irrigation water uses. Agricultural water supply, primarily for crop irrigation, includes water delivered to JID's service area from both surface water and groundwater sources. The AWMP describes JID's history, its service area, water management facilities and operations, and its drought management plan. It also documents water supplies and use, describes water quality monitoring, and addresses Best Management Practices (BMPs).

The James GSA has incorporated appropriate elements of the AWMP into the Plan and will continue to coordinate implementation of the Plan with the AWMP.

2.2.2 Groundwater Management Plans

JID and City of San Joaquin Groundwater Management Plan, 2010. JID first prepared a Groundwater Management Plan (GMP) in 2001 and updated the plan in November 2010 (P&P, 2010). The updated GMP was a joint effort between the City of San Joaquin and JID. The two agencies prepared the integrated GMP to better coordinate efforts, share data, and improve regional management of groundwater resources. The GMP describes the management goals and objectives of the GMP, provides background on the geology and hydrogeology and documents water supply and groundwater conditions. The GMP also documents monitoring programs and protocols for groundwater, surface water, and subsidence monitoring.

The James GSA has incorporated appropriate elements of the GMP into the Plan and will continue to coordinate implementation of the Plan with the AWMP.

2.2.3 Urban Water Management Plans

While land use in the James ID GSA is predominantly agricultural, it contains the water supply service area of the City of San Joaquin. The City has not prepared an Urban Water Management Plan (UWMP) since it is below the threshold of providing over 3,000 AFY or serving more than 3,000 urban connections. The City provides about 800 AFY to approximately 4,000 residents.

Presently, there is no UWMP. Should an UWMP be prepared for the City of San Joaquin in the future, it is anticipated that the James GSA will incorporate appropriate elements of the UWMP into the Plan and will continue to coordinate implementation of the Plan with the UWMP.

2.2.4 Regional Water Management Plans

A few regional water management programs include the Plan Area and are briefly summarized below.

Kings Basin Integrated Regional Water Management Plan, 2018. The Kings Basin Integrated Regional Water Management is a collaborative effort between 57 public, private and non-governmental agencies to manage water resources in the Kings Subbasin and small portions of the Delta-Mendota, Kaweah and Tulare Lake Subbasins that started in 2006. The James ID GSA is located on the western edge of this IRWMP area. The Kings Basin Integrated Regional Water Management Plan (KB IRWMP) (KBWA, 2018) is an update to the initial 2007 Upper Kings Basin IRWMP and the 2012 Kings Basin IRWMP. The IRWMP process provides a framework for regional coordination of groundwater and surface water management activities and for implementation of the measures necessary to meet those objectives. The overdraft of groundwater was identified as the primary issue to be addressed. The KB IRWMP (KBWA, 2018) describes the region, provides goals and objectives, and identifies and evaluates projects and programs, including assessment of climate change. The 2018 IRWMP includes the following components:

- Governance
- Goals and objectives
- Planning area description
- Resources management strategies
- Impacts and benefits
- Performance and monitoring
- Data management
- Financing
- Technical analyses
- Relation to local planning
- Coordination, and
- Planning for climate change impacts.

The following regional goals were established:

- Halt, and ultimately reverse, the current overdraft and provide for sustainable management of surface and groundwater
- Increase the water supply reliability, enhance operational flexibility, and reduce system constraints
- Improve and protect water quality
- Provide additional flood protection
- Protect and enhance aquatic ecosystems and wildlife habitat.

The Kings Basin Integrated Groundwater and Surface Water Model (IGSM) was developed during the IRWMP process to simulate surface water and groundwater systems in the Kings Subbasin.

Westside-San Joaquin Integrated Water Resources Plan, 2019. The James ID GSA is also located on the eastern edge of the planning area of the Westside-San Joaquin IRWMP. The WSJ IRWMP extends from the City of Tracy in San Joaquin County in the north, to Highway 41 and Kettleman City in Kings County to the south and includes portions of San Joaquin, Stanislaus, Merced, Madera, Fresno, and Kings counties. The San

Luis & Delta-Mendota Water Authority (SLDMWA) is the regional water management group for the Westside-San Joaquin IRWMP. It was established as a Joint Powers Authority in January 1992 and consists of 28-member agencies, including the JID.

A main purpose of the SLDMWA is the operation and maintenance of certain USBR CVP facilities, with the goal of increasing reliability of the facilities in a cost-effective manner. SLDMWA also provides information and representation needs of its members.

The IRWMP's goal is to provide a more reliable water supply, protect agricultural, municipal, and environmental water uses, and meet community needs, including those of disadvantaged communities, by improving water supply sustainability, water quality, and drainage.

The James GSA has incorporated appropriate elements of the Kings Basin IRWMP and the Westside-San Joaquin IRWMP into the Plan. Some projects developed under this Plan have been included in the project list for the Kings basin IRWMP. It is expected that all major projects will eventually be submitted to one or both IRWMP planning groups for approval and adoption.

2.2.5 California Statewide Groundwater Elevation Monitoring Program

The Kings River Conservation District (KRCD) is a special district and was formed by the California Legislature with the passage of the Kings River Conservation Act in 1951. KRCD supports local interests in the management of water, power, and environmental resources and providing flood control along the Kings River. One of KRCD's historical programs is to coordinate monitoring of groundwater elevations.

KRCD represents the Kings Subbasin as the Responsible Entity for the California Statewide Groundwater Elevation Monitoring (CASGEM) Program. Since 2009, the CASGEM Program has tracked seasonal and long-term groundwater elevation trends in groundwater basins statewide. James ID has provided groundwater elevation data to KRCD for the past decade or so. In turn, James ID has utilized the CASGEM data to assess groundwater elevations within its boundaries and on adjacent lands. The James GSA expects to utilize CASGEM Program data in its monitoring efforts and will continue to provide data to KRCD for eventual submission to the CASGEM Program for the foreseeable future.

2.2.6 Groundwater Ambient Monitoring and Assessment Program

The Groundwater Ambient Monitoring and Assessment (GAMA) Program is California's comprehensive groundwater quality monitoring program that was designed to help better understand and identify risks to groundwater resources. GAMA was created by the State Water Resources Control Board in 2000. It was later expanded by Assembly Bill 599 - the Groundwater Quality Monitoring Act of 2001. AB 599 required that the State Water Resources Control Board, in coordination with an Interagency Task Force (ITF) and Public Advisory Committee (PAC) proceed towards integrating existing monitoring programs and designing new program elements as deemed necessary, which would result in a publicly accepted plan to monitor and assess groundwater quality in basins that account for 95% of the state's groundwater use. The GAMA Program is based on interagency collaboration with the State and Regional Water Boards, Department of Water Resources, Department of Pesticide Regulations, U.S. Geological Survey, and Lawrence Livermore National Laboratory, and cooperation with local water agencies and well owners.

The main goals of GAMA are to:

- Improve statewide comprehensive groundwater monitoring.
- Increase the availability to the public of groundwater quality and contamination information.
- Establish ambient groundwater quality on a basin-wide scale.

- Continue periodic groundwater sampling and groundwater quality studies in order to characterize various chemicals of concern and identify trends in groundwater quality.
- Centralize the availability of groundwater information to the public and decision makers to better protect our groundwater resources.

James ID provides access to two sites for monitoring under the GAMA program. The James GSA will utilize data obtained through participation in the GAMA Program for the foreseeable future.

2.2.7 Irrigated Lands Regulatory Program

The Irrigated Lands Regulatory Program (ILRP) addresses discharge of wastes (e.g., sediments, pesticides, nitrates) from commercial irrigated lands. These wastes can harm aquatic life or make water unusable for drinking water or agricultural uses. The goal of the ILRP is to protect surface water and groundwater quality and to reduce impacts of irrigated agricultural discharges to waters of the State. In 1999, the California Legislature passed Senate Bill 390, which eliminated a blanket waiver for agricultural waste discharges. The Bill required the Water Boards to develop a program to regulate agricultural lands under the Porter-Cologne Water Quality Control Act. In 2003, the Central Valley Water Board adopted a conditional Waiver of Waste Discharge Requirements (WDRs) to regulate agricultural discharges to surface waters. In December 2012, the Central Valley Water Board started adopting WDRs that address discharges to both surface water and groundwater, thus requiring ILRP enrollment for all commercially irrigated agricultural operations. Surface water quality has been monitored for several years and, in the future, groundwater quality will be monitored. Based on information in the workplan documents and additional information provided by KRWQC, annual groundwater monitoring under the IRLP program is anticipated to commence during the Fall of 2018; however, at the time of writing, discussions are underway to adapt annual groundwater monitoring to a spring schedule due to several factors related to the fall harvest season.

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 properties within James GSA also 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.

As one of the mandatory requirements under the ILRP WDRs, the Kings Coalition prepared a Groundwater Assessment Report (GAR), which is an analysis of the risks to groundwater from salts and nitrates as the primary constituents of concern (COCs) that may originate from irrigated agriculture within that coalition area. Both the vadose zone and aquifer have nitrates and salts in storage that are the result of past land use practices, representing a reservoir of impacts that will continue to migrate over time Landowners and growers participate in the ILRP Program directly and agencies typically have no direct role in the program unless they serve as the coordinator for a coalition. The James GSA will coordinate its efforts with the Kings Basin Water Quality Coalition and expects to use any data or reports that are available to the public for monitoring groundwater quality.

2.2.8 Salt and Nutrient Management Plan

The Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS) began in 2006 and is a collaborative, stakeholder driven and managed program to develop sustainable salinity and nitrate management planning for the Central Valley. The State Water Resources Control Board (SWRCB) requires the CV-SALTS program so that scientific and regulatory tools may be developed and implemented in order to address salinity levels and manage various nutrient concerns. CV-SALTS will then use these tools to prepare a Basin Plan Amendment (BPA) with the RWQCB changing the objectives and implementation program for salt and nutrient management. To date, six technical project areas have been developed and can be reviewed at https://www.cvsalinity.org/technical-projects-index.html

Each of these project areas has provided information for the Salt and Nutrient Management Plan (SNMP) for the entire Central Valley which was submitted to the RWQCB in December 2016 and subsequently released for comment. Once finalized, the SNMP will be utilized to prepare the BPA. Moving forward, future expansion will include additional management practice development, the BPA, implementation, monitoring and reporting, and a Phase II SNMP.

It is expected that the BPA will create different compliance options. Depending on local conditions and the desire to pursue various compliance options such as creating management zones, the degree of interaction the James GSA will have with the SNMP and the BPA is unknown. Some degree of interaction and coordination is expected.

2.2.9 California State Water Resources Control Board Site Cleanup Program

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 State of California Department of Toxic Substance Control (DTSC) also 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.

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 the data into a publicly accessible online database. The online database can be accessed at http://geotracker.waterboards.ca.gov/gama/.

The James GSA has utilized data obtained from the DTSC or the SWRCP as a part of the Plan and will continue to utilize any information available to the public for Plan implementation.

2.2.10 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.

Existing water management plans and programs do not appear to create a constraint that will impact operational flexibility and water operations for agencies within the James GSA. In fact, it is expected that operational flexibility will increase and the Kings Subbasin will move towards sustainability as other agencies within the Kings Subbasin adopt water management practices similar to those adopted in the Plan Area (such as metering of water agricultural, municipal, and industrial water deliveries, volumetric billing, and metering of groundwater extractions).

2.3 Relation to General Plans

2.3.1 Summary of General Plans/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 is a comprehensive, long-term framework for the enhanced protection of agricultural, natural, and cultural resources and for development within the county or city. Designed to meet state general plan requirements, it outlines policies, standards, and programs and sets out plan proposals to guide day-to-day decisions concerning county's or city's future. Each general plan must include the vision, goals, and objectives of the city or county in terms of planning and development within eight different "elements" defined by the state as: land use, housing, circulation, conservation, noise, safety, open space, and environmental justice. 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. Fresno County and the City of San Joaquin have adopted general plans that govern the Plan Area.

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.

The Fresno County General Plan and the San Joaquin General Plan were adopted prior to the development of the GSA and this Plan, and the General Plans did not consider the impacts of Plan' implementation. This Plan uses the same land use change assumptions identified in the general plan for forecasting the anticipated water budget, described later in this GSP in **Section 3.3**

In the near term, existing land use plans are not expected to change water demands within the Plan Area significantly nor are the expected to affect the ability of the James GSA to achieve sustainable groundwater management because common assumptions have been used between the various plans. This is not expected to change over the planning and implementation horizon because the general plans are required to incorporate this Plan thus ensuring future consistency.

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 above, the two General Plans within the Plan Area were developed prior to the development of the GSP. The General Plan sections that cover water supply are summarized below.

Fresno County General Plan - Fresno County development is dependent on a complex network of public facilities and services. Each type of service has a unique set of constraints and issues and must adapt to growth and change differently. The General Plan sets out policies and implementation programs to respond to this variety of issues and constraints. The Public Facilities and Services Element is organized accordingly into 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.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 decline 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.23 - The County shall regulate the transfer of groundwater for use outside of Fresno County. The regulation shall extend to the substitution of groundwater for transferred surface water.
- Policy PF-C.26- The County shall encourage the use of reclaimed water where economically, environmentally, and technically feasible.

San Joaquin General Plan – The San Joaquin General Plan is similar to the Fresno County General Plan in format and objectives. The San Joaquin General Plan addresses land within the boundaries and the sphere of influence of the City of San Joaquin. The relevant policies in the general plan are listed below:

- Policy PFS 2.1.1 - The City shall condition approval of new development projects on the availability of adequate water supply and infrastructure to serve the new development.
- Policy PFS 2.1.4 - Growth inducing projects will be reviewed for environmental impacts that such development may have upon the existing water sources and distribution facilities.
- Policy PFS 2.1.9 - The City shall monitor its water consumption and manage supply and infrastructure to meet anticipated demand.
- Program PFS 2.1.9a - City staff shall produce annual public reports of recorded water consumption, demand projections, and the state of infrastructure improvements in progress.

Implementation of the Plan is not expected to affect the water supply assumptions of the Fresno County General Plan or the San Joaquin General Plan. The Fresno County General Plan does not allow for land use types that will increase water consumption in areas outside of the sphere of influence of the City of San Joaquin. Increased demand on water sources through growth and land use changes provided in the San Joaquin General Plan will be offset by a corresponding reduction in agricultural water demand. Further, the San Joaquin General Plan addresses water supply assumptions adaptively as it provides for the environmental review of growth inducing impacts. Water supply effects by Plan implementation for areas within the basin but outside of the Plan Area are addressed in other GSPs for the basin.

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.

Within the Plan Area, well permitting and approval is managed by Fresno County Environmental Health Division (FCEHD). The FCEHD issues permits to construct new water wells; reconstruct, repair or deepen existing wells; and destroy abandoned wells to properly licensed water well drilling contractors in unincorporated Fresno County. Fresno County Department of Public Health, Environmental Health Division enforces the provisions of the California Well Standards Ordinance and the construction standards set forth in the California Well Standards, Bulletins 74-81 and 74-90. Only persons who possess an active C-57 Water Well Contractors License may perform construction, reconstruction, or destruction work on wells. In order to obtain a permit to drill a well, properly licensed contractors submit a completed Water Well Permit Form, along with applicable permit fees, to the FCEHD office. The over-the-counter permit is a ministerial process, not requiring discretionary action or CEQA. The application is reviewed, and if found acceptable, will usually be approved within two working days. Once the permit application is approved, a well permit number is assigned, and drilling may commence. The permit is valid for 180 days.

The California Well Standards Ordinance requires contractors, as part of the well construction process, to install an annular seal of at least twenty (20) feet in depth (fifty [50] feet for public water system wells or industrial wells) to help protect the well from contamination. The California Well Standards Ordinance also requires contractors to notify the FCEHD office at least twenty-four (24) hours in advance of the scheduled time to install the annular seal so that Environmental Health staff can arrange to inspect the seal installation process. This inspection helps to ensure that the seal is installed in an approved manner to help prevent contamination of the well water.

More information can be found at the FCEHD Water Well Permitting Program website https://www.co.fresno.ca.us/departments/public-health/environmental-health/water-surveillance-program/water-well-permitting-program

Information requested on well permit applications as required by the State are as follows:

1. A map of the desired well location (distance from streets, global positioning coordinates, ground elevation)
2. Depth of well
3. Estimated pumping rate, schedule, and annual extraction volume
4. Water table depth, location to flood plain
5. Distance from potential pollution sources onsite or on adjacent properties
6. Distance from ponds, lakes, or streams
7. Any existing wells on the property including use, depth, and estimated extraction volume
8. The size in acres to be served by the well
9. Planned category use, such as irrigation, stock, domestic, municipal, or industrial

Existing well permitting programs may need to be expanded and adequately funded to ensure that location, well depth, water quality, and production information is collected, and well construction specifications and well abandonment standards are enforced.

New well permits could be conditioned upon receiving a water availability determination. New development projects could be required to secure "will serve" letters from local water agencies, and larger projects could be subject to water availability determinations to show that sufficient water is available as part of the land-use approval process. These requirements could also be expanded. Land-use agencies could be required to consider protection of prime groundwater recharge areas and consult groundwater management agencies regarding any significant groundwater-dependent development, including new permanent crop plantings to obtain "will serve" letters and water availability determinations.

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.

Other than the Fresno County General Plan and the San Joaquin General Plan previously mentioned, the James GSA does not anticipate that there are any land use plans outside the basin that could affect the ability of the James GSA to achieve groundwater sustainability.

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

Saltwater intrusion is a major concern commonly found in coastal aquifers around the world. Saltwater intrusion is the induced flow of seawater into freshwater aquifers primarily caused by groundwater development near the coast. Where groundwater is being pumped from aquifers that are in hydraulic connection with the sea, induced gradients may cause the migration of saltwater from the sea toward a well, making the freshwater well unusable. Given the distance separating the James GSA area from the Pacific Ocean, saltwater intrusion from the ocean into the freshwater aquifer is not a concern for the area. However, groundwater with naturally occurring elevated concentrations of salts exist at depth in the local aquifers. The interface between the freshwater zone and the saline water zone represents a flow divide and defines the bottom of the fresh groundwater flow system. Below this depth, driving forces are not strong enough to counteract buoyancy and viscosity forces such that there is little mixing of modern groundwater recharge with formation waters. By determining the depth of this mixing zone throughout the study area, a physically based bottom boundary can be represented (base of freshwater system). 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 – Hydrogeologic Conceptual Model. As wells are drilled deeper, pumping can cause upcoming (i.e., upward vertical migration) of saline water thus increasing salinity in the freshwater aquifer. The James GSA plan participants strive to prevent the importation of saline surface waters that could ultimately degrade the groundwater. When alternative water sources are available for importation, the plan participants consider not only the cost but also the quality, including salinity, of the water. James GSA 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.

The 1996 federal Safe Drinking Water Act amendments require each state to develop and implement a Source Water Assessment Program. Section 11672.60 of the California Health and Safety Code requires the Department of Health Services (DHS, the precursor to CDPH) to develop and implement a program to protect sources of drinking water, specifying that the program must include both a source water assessment program and a wellhead protection program. In response to both legal mandates, DHS developed the Drinking Water Source Assessment and Protection (DWSAP) Program. California's DWSAP Program addresses both groundwater and surface water sources. The groundwater portion of the DWSAP Program serves as the state's wellhead protection program. DHS submitted the DWSAP Program in January 1999. US EPA approved the DWSAP as California's wellhead protection program in January 1999. In November 1999, US EPA gave final approval of the DWSAP Program as California's source water assessment and protection program. DHS was responsible for the completion of all assessments by May 2003. 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 also the direct supply source to the customer, and such contaminants entering the well could then be pumped out and discharged directly into the distribution system. Therefore, essential elements 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. 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 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 can become contaminated from natural sources or numerous types of human activities. Residential, municipal, commercial, industrial, and agricultural activities can all affect groundwater quality. Contaminants may reach groundwater from activities on the land surface, such as releases or spills from stored industrial wastes; from sources below the land surface but above the water table, such as septic systems or leaking underground petroleum storage systems; from structures beneath the water table, such as wells; or from contaminated recharge water. Depending on its physical, chemical, and biological properties, a contaminant that has been released into the environment may move within an aquifer in the same manner that groundwater moves. (Some contaminants, because of their physical or chemical properties, do not always follow groundwater flow.) It is possible to predict, to some degree, the transport within an aquifer of those substances that move along with groundwater flow. For example, both water and certain contaminants flow in the direction of the topography from recharge areas to discharge areas. Soils that are porous and permeable tend to transmit water and certain types of contaminants with relative ease to an aquifer below.

Just as groundwater generally moves slowly, so do contaminants in groundwater. Because of this slow movement, contaminants tend to remain concentrated in the form of a plume that flows along the same path as the groundwater. The size and speed of the plume depends on the amount and type of contaminant, its solubility and density, and the velocity of the surrounding groundwater. Contaminants can also move into the groundwater system through macro-pores—root systems, animal burrows, abandoned wells, and other systems of holes and cracks that supply pathways for contaminants. In areas surrounding pumping wells, the potential for contamination increases because water from the zone of contribution, a land area larger than the original recharge area, is drawn into the well and the surrounding aquifer. Under certain conditions, pumping can also cause the groundwater (and associated contaminants) from another aquifer to enter the initial water source being pumped. This phenomenon is called inter-aquifer leakage. Thus, properly identifying and protecting the areas affected by well pumping is an important strategy to maintaining groundwater quality.

Groundwater within the GSA Area is generally of good quality for agricultural use. However, serious water quality problems in certain areas exist due to high concentrations of certain constituents. Information on existing contaminant plumes is limited. Therefore, specific information on the plumes is not provided here. However, some of the main constituents of concern include nitrate, Dibromo-Chloropropane (DBCP), Ethylene-Dibromide (EDB), 1,2,3-Trichloropropane (TCP) and petroleum hydrocarbons. Contamination of groundwater can result in poor drinking water quality, loss of water supply, degraded surface water systems, high cleanup costs, high costs for alternative water supplies, and/or potential health problems. Several federal laws help protect groundwater quality. The Safe Drinking Water Act (SDWA) established three drinking water source protection programs:

- The Wellhead Protection Program, Sole Source Aquifer Program, and the Source Water Assessment Program also calls for regulation of the use of underground injection wells for waste disposal and provided EPA and the states with the authority to ensure that drinking water supplied by public water systems meets minimum health standards.
- The Clean Water Act regulates groundwater that is shown to have a connection with surface water. It sets standards for allowable pollutant discharges to surface water.
- The Resource Conservation and Recovery Act (RCRA) regulates treatment, storage, and disposal of hazardous and nonhazardous wastes.
- The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund) authorizes the government to clean up contamination or sources of potential contamination from hazardous waste sites or chemical spills, including those that threaten drinking water supplies. CERCLA includes a “community right-to know” provision.
- The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulates pesticide use. The Toxic Substances Control Act (TSCA) regulates manufactured chemicals.

In addition, several State of California online databases provide information and data regarding 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 Substance 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 DTSCs 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 GAMA (Groundwater Ambient Monitoring and Assessment) program collects data by testing untreated raw water for naturally occurring and man-made chemicals and compiles all 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 the proper capping and locking of 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. Due to staff and funding limitations, enforcement of the well abandonment policies is limited. Enforcement is the responsibility of local authorities.

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

2.4.5 Replenishment of Groundwater Extractions

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

In the James GSA area, the primary local water sources for groundwater replenishment include precipitation and San Joaquin and Kings River flood flows. The neighboring agencies with surface water infrastructure or access to surface water include James Irrigation District, Consolidated Irrigation District, Fresno Irrigation District, Laguna Irrigation District, Mutual Water Companies, KRCD, and KRWA. As noted earlier, there is no significant groundwater recharge activity in the James GSA. For more information, refer to the Conjunctive Use Programs section. Refer to Water Budget Information section in the Basin Setting section for discussions on how groundwater recharge is credited to different agencies.

2.4.6 Well Construction Policies

Proper well construction is important to ensure reliability, longevity, and protection of groundwater resources from contamination. All the member agencies follow State standards (DWR Bulletins 74-81 and 74-90) when constructing municipal and agricultural wells. Fresno County has adopted a well construction permitting program consistent with State Well Standards to help ensure proper construction of private wells. The County maintains records of all wells drilled in the Plan area. As of 2017, there were no limits on well construction, which may be revisited in the future. Private domestic or agricultural wells can be drilled with a county permit. 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 on State law. The GSA may decide to enforce more stringent well construction policies for keeping track of construction and water level measurement data. They would need to enter into an agreement with the County of Fresno to make any changes to permitting operations.

2.4.7 Groundwater Projects

All 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 continue to develop additional future projects to meet sustainability. Developing more groundwater recharge and water banking projects is considered key in stabilizing groundwater levels. **Section 6** provides descriptions, estimated costs, and estimated yield for numerous proposed projects.

The role of the James GSA is to promote cooperation and sharing of information and ideas between the agencies. The James 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 areas conducive to recharge and areas where recharge provides the most benefits, thereby reducing the burden on certain agencies from having to recharge in their boundaries if they do not have suitable land or soils.

There are several proposed recharge projects to improve groundwater conditions in the area, which are generally favorable for artificial recharge. For more detailed information on potential projects, refer to **Section 6**.

2.4.8 Efficient Water Management Practices

Water management is an important element of irrigated crop production. Efficient irrigation systems and water management practices can help maintain farm profitability in an era of limited, higher-cost water supplies. Efficient water management may also reduce the impact of irrigated production on offsite water quantity and quality. As is often the case, technology is not the whole solution anywhere, but part of the solution almost everywhere. Water conservation has been, and will continue to be, an important tool in local water management, as well as a key strategy in achieving sustainable groundwater management. Since groundwater is currently the only source of water for the farmers and other users within James GSA , there is a clear awareness of the importance of water conservation and a renewed focus on developing recharge and surface water deliveries projects. Four components are being considered. These are direct groundwater recharge, dormant flooding, in-lieu surface water deliveries, and groundwater banking. The intent of these options is to capture floodwater from the Kings and San Joaquin Rivers, when available, and to provide the facilities with which the water districts could participate in transfers or exchanges that would net water for the growers – either groundwater or surface water – and help move the plan area towards sustainability. Continuing some of these conservation efforts will be necessary to achieve groundwater sustainability. Recycled water use is considered an important beneficial use of water but is unavailable in this area. There may be future purchases of recycled water from other agencies outside of James GSA with potential projects discussed in **Section 6.2**. Future efforts will include an increased focusing on elevating awareness on groundwater overdraft and land subsidence and explaining the requirements of SGMA.

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. Relationships unique to the region are briefly summarized below.

<u>Kings River Water</u>. The Kings River provides a significant amount of the surface water used in the Plan Area. Kings River water is impounded by Pine Flat Dam, which is owned and operated by the US Army Corps of Engineers (USACE). The water rights permits were obtained from the SWRCB, although allocation and management of water is largely handled by the Kings River Water Association. As needed, the member agencies work with the USACE and SWRCB to oversee and manage their Kings River water. The member

agencies also developed and continue to implement the Kings River Fisheries Program in partnership with the California Department of Fish and Wildlife.

Central Valley Project Water. The Central Valley Project provides a substantial amount of surface water used in the Plan Area. The water is provided to James ID and RD 1606 under a Central Valley Project (CVP) Water Service Contract with the U.S Bureau of Reclamation (USBR). James ID and RD 1606 are water service contractors within the USBR Delta Division and Mendota Pool Unit. The CVP water is conveyed to the Plan Area thorough project facilities that are owned by the federal government and operated and maintained by the San Luis and Delta-Mendota Water Authority (SLDMWA). James ID and RD 1606 are members of the SLDMWA. James ID and RD 1606 works cooperatively with USBR and SLDMWA to administer and manage the contractual water supply.

San Joaquin River Water. The Friant Division of the Central Valley Project utilizes the San Joaquin River as their main source of supply. James ID and RD 1606 have rights to the San Joaquin River predating the construction of the CVP. Under the terms of the contract, USBR has certain obligations to James ID and RD 1606 with regards to the settlement contract water. These obligations are similar to those owed by the federal government to contractors within the San Joaquin River Exchange Contractors Water Authority (SJRECWA).

James GSA members are also eligible to receive grants from various agencies for water-related projects. Grants are obtained from DWR, SWRCB, USGS, USDA, 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

Apart from the Ecologic Reserves land that is owned and managed by the CDFW, Fresno County is the only member agency with direct land-use planning authority. However, all the member agencies have an interest in land-use planning policies and how it will impact their continued development and water supplies **Figure 2-4** is a map showing land use in the James 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. Some smaller communities have no formal land-use policies or rely on county policies. These smaller communities will need to develop new policies and long-term plans as part of the SGMA process.

2.4.11 Impacts on Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDE) are not prevalent in James GSA due to heavy historical pumping causing groundwater levels to fall dramatically combined with a lack of surface water inflow. The impact of this GSP on GDEs will be further discussed in **Section 3.2.8.** - conform to basin2ide language. Refer to Section 3.2.8

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.

Pursuant to California Water Code Section 10723.2, the GSA shall consider the interests of the beneficial uses and users of groundwater, as well as those responsible for implementing a GSP. As a part of the notification James GSA provided to DWR, the James GSA developed a list of interested parties. The list explained how their interests will be considered in the development and operation of the groundwater sustainability agency and the development of the agency's groundwater sustainability plan. Since the initial notification, the list has been updated and is provided below. The listing includes 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.

Holders of Overlying Groundwater Rights: Agricultural Users
The agricultural users that hold groundwater rights within the GSA area include James ID, RD 1606, and individual landowners. Other than wells owned and operated by the James Irrigation District, there are very few agricultural wells owned by individual landowners within the GSA area. All of the individual landowners are also landowners within the James ID.

The GSA was formed under a Memorandum of Understanding which included James ID and RD 1606. The GSA shall consider the interests of these parties through their representation in the GSA. The GSA shall consider the interests of individual landowners through their representation by James ID or their direct participation in the GSA. The GSA will also reach out to individual landowners with agricultural wells through direct communications.

Holders of Overlying Groundwater Rights: Domestic Well Users
Rural residents within the GSA boundaries and outside to the City of San Joaquin service area rely on groundwater to meet their domestic needs. Each of these rural residences is within the James ID.

The GSA shall consider the interests of rural residents through landowner representation by James ID or their direct participation in the GSA. The GSA will reach out to rural residents through direct communications. The GSA will afford rural residents every opportunity to engage in groundwater planning and management efforts that may have an impact on their domestic wells.

Municipal Well Operators
The City of San Joaquin ("City") is the only municipal well operator within the boundaries of the GSA. The City and the District entered into a Memorandum of Understanding in 2010 to improve coordination of water management activities. RD 1606 encompasses the City and its geographic area is represented within the GSA by the RD 1606 appointed director. The GSA will afford the City of San Joaquin every opportunity to engage in groundwater planning and management through participation on its Advisory Committee, direct communications, and coordination with City officials.

The GSA shall consider the interests of the City through the representation of the RD 1606 appointed director and direct participation in the GSA.

Public Water Systems
The only public water system within the boundaries of the GSA is operated by the City of San Joaquin see Municipal Well Operators above.

Local Land Use Planning Agencies
The City of San Joaquin is the only municipality within the boundaries of the GSA. The boundaries of the GSA are entirely within the County of Fresno ("County"). The District started working with the City and County shortly after passage of the Sustainable Groundwater Management Act and continue to work with both entities.

The GSA shall consider the interests of the City through the RD 1606 representative in the GSA and their direct participation in the GSA. The GSA is a participant with the County in various workgroups involving SGMA implementation within Fresno County and the Kings Sub-basin. The GSA shall consider the interest of the County through its participation in these venues and through direct communication and coordination with County officials.

Environmental Users of Groundwater
The State of California owns land adjacent to the GSA boundary. The lands are managed by the California Department of Fish and Wildlife ("CDFW"). The lands are within the Delta-Mendota Sub-basin and outside of the Kings Sub-basin.

The District will consult with CDFW on any groundwater management efforts that may have an impact on their environmental uses.

Surface Water Right Holders
Certain entities and landowners owning lands within the GSA boundaries hold per-1914 surface water rights, post-1914 surface water rights, and riparian water rights for Kings River and San Joaquin River waters. The entities holding riparian water rights are the James ID and RD 1606.

The GSA was formed under a MOU which included James ID and RD 1606. The GSA shall consider the interests of these parties through their representation in the GSA. The GSA shall consider the interests of individual landowners through their representation by James ID or their direct participation in the GSA. The GSA will also reach out to individual landowners through direct communications.

Surface Water Users
Lands within the GSA boundaries receive surface water deliveries from either the James ID or RD 1606. James ID and neighboring surface water users receive surface water deliveries from the Central Valley Project, the San Joaquin River, and the Kings River. James ID is a member of the San Luis and Delta-Mendota Water Authority ("SLDMWA") and the Kings River Water Association. RD 1606 is a member of the SLDMWA.

As stated previously, the GSA will consider the interests of James ID and RD 1606 through their representation in the GSA.

Federal Government
There are no known federal government lands within the GSA area. There are no military facilities in the vicinity of the GSA area. There may be Waters of the United States within or adjoining the GSA area. The federal government, through U.S. Bureau of Reclamation ("USBR"), delivers surface water to the James ID, RD 1606, and parties neighboring the GSA area.

The GSA will coordinate its efforts with the USBR and engage, and if appropriate consult with, other appropriate federal agencies where federal government interests are involved.

California Native American Tribes
A request was made by the James ID to the Native American Heritage Commission advising the NAHC of the possible formation of a GSA. The NAHC has advised James ID in correspondence dated October 7, 2015 that a record search of the sacred land file has failed to indicate the presence of Native American cultural resources in the immediate GSA area. The NAHC has provided a listing of Native American individuals and organizations that may have knowledge of cultural resources in the project area.

At this time, there are no known Native American Tribal interests in the GSA area. The GSA will continue to investigate any possible Native American Tribal interests and will coordinate its activities with any identified interests.

Disadvantaged Communities
The District has made an effort to locate disadvantaged communities, including, but not limited to, those served by private domestic wells or small community water systems. The nearest disadvantaged community, as identified in the Disadvantaged Community Water Study for the Tulare Lake Basin, August 2014, is the town of Tranquillity. The town lies one-half mile from the boundaries of the GSA and is outside of the Kings Sub-basin. The Tranquillity Public Utilities District and the Tranquillity Irrigation District provide water-related services to Tranquillity.

The GSA will coordinate its efforts with TID and TPUD.

Entities listed in Water Code section 10927 that are monitoring and reporting groundwater elevations in all or a part of a groundwater basin managed by the GSA
The Kings River Conservation District ("KRCD") serves as the California Statewide Groundwater Elevation Monitoring ("CASGEM") entity monitoring groundwater elevations in the Kings Sub-basin. The James Irrigation District submits groundwater elevations to KRCD on a semi-annual basis.

The GSA shall continue to coordinate its groundwater monitoring activities with the KRCD and James ID and will support KRCD its role as the CASGEM entity monitoring groundwater elevations in the Kings Sub-basin.

Nearby landowners and other entities outside of the James GSA
Nearby landowners and other entities outside of the James GSA may be affected by projects, management actions, or other plans or actions undertaken or being considered by the James GSA. The James GSA has formed an Advisory Committee and includes nearby landowners and representatives of other entities outside of the James GSA in the planning and decision-making process.

The GSA shall consider the interests of nearby landowners and other entities outside of the James GSA through their direct participation in the GSA.

Other Interests of All Beneficial Uses and Users of Groundwater
At this time, the GSA is not aware of any interests of all beneficial uses and users of groundwater other than those listed above. The GSA will consider any other interests as it is made aware of those interests.

Public Meetings

> **§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.

A list of public meetings where the GSP was discussed or considered is shown below:

Table 2-3 List of Public Meetings

Date	Type of Meeting/Location
01/12/2016	James Irrigation District - Special Meeting of the Board of Directors and Public Hearing
02/11/2016	James Irrigation District - Regular Meeting of the Board of Directors
03/08/2016	James Irrigation District - Regular Meeting of the Board of Directors
03/18/2016	James Irrigation District - Annual Meeting
04/12/2016	James Irrigation District - Regular Meeting of the Board of Directors
04/27/2016	James Irrigation District - Special Meeting of the Board of Directors
05/10/2016	James Irrigation District - Special Meeting of the Board of Directors
05/20/2016	James Irrigation District - Special Meeting of the Board of Directors
06/14/2016	James Irrigation District - Regular Meeting of the Board of Directors
07/12/2016	James Irrigation District - Regular Meeting of the Board of Directors
09/13/2016	James Irrigation District - Regular Meeting of the Board of Directors
09/29/2016	James Irrigation District and Reclamation District No. 1606 - Joint Board of Directors Meeting
10/11/2016	James Irrigation District - Regular Meeting of the Board of Directors
10/20/2016	James Groundwater Sustainability Agency - Special Meeting of the Board of Directors
11/08/2016	James Irrigation District - Regular Meeting of the Board of Directors
12/06/2016	James Irrigation District - Special Meeting of the Board of Directors
01/26/2017	James Groundwater Sustainability Agency - Regular Meeting of the Board of Directors
02/02/2017	Reclamation District No. 1606 - Regular Meeting of the Board of Directors
02/14/2017	James Irrigation District - Regular Meeting of the Board of Directors
03/14/2017	James Irrigation District - Regular Meeting of the Board of Directors
03/16/2017	Reclamation District No. 1606 - Regular Meeting of the Board of Directors
03/22/2017	James Irrigation District - Annual Meeting
04/18/2017	James Irrigation District - Regular Meeting of the Board of Directors
04/20/2017	James Groundwater Sustainability Agency - Regular Meeting of the Board of Directors
05/09/2017	James Irrigation District - Regular Meeting of the Board of Directors
05/18/2017	James Groundwater Sustainability Agency - Advisory Committee Meeting
06/13/2017	James Irrigation District - Regular Meeting of the Board of Directors
06/15/2017	Reclamation District No. 1606 - Special Meeting of the Board of Directors
07/11/2017	James Irrigation District - Regular Meeting of the Board of Directors
07/20/2017	James Groundwater Sustainability Agency - Regular Meeting of the Board of Directors
08/08/2017	James Irrigation District - Regular Meeting of the Board of Directors
08/17/2017	James Groundwater Sustainability Agency - Advisory Committee Meeting
09/12/2017	James Irrigation District - Regular Meeting of the Board of Directors
09/21/2017	Reclamation District No. 1606 - Regular Meeting of the Board of Directors
10/19/2017	James Groundwater Sustainability Agency - Regular Meeting of the Board of Directors
12/14/2017	Reclamation District No. 1606 - Regular Meeting of the Board of Directors

Date	Type of Meeting/Location
01/25/2018	James Groundwater Sustainability Agency - Regular Meeting of the Board of Directors
02/13/2018	James Irrigation District - Regular Meeting of the Board of Directors
02/15/2018	James Groundwater Sustainability Agency - Advisory Committee Meeting
03/15/2018	Reclamation District No. 1606 - Regular Meeting of the Board of Directors
03/16/2018	James Irrigation District - Annual Meeting
04/10/2018	James Irrigation District - Regular Meeting of the Board of Directors
04/19/2018	James Groundwater Sustainability Agency - Regular Meeting of the Board of Directors
05/16/2018	James Irrigation District - Regular Meeting of the Board of Directors
05/17/2018	James Groundwater Sustainability Agency - Regular Meeting of the Board of Directors
05/29/2018	James Groundwater Sustainability Agency - Special Meeting of the Board of Directors
07/19/2018	James Groundwater Sustainability Agency - Regular Meeting of the Board of Directors
08/14/2018	James Irrigation District - Regular Meeting of the Board of Directors
08/23/2018	James Groundwater Sustainability Agency - Advisory Committee Meeting
09/20/2018	Reclamation District No. 1606 - Regular Meeting of the Board of Directors
10/09/2018	James Irrigation District - Regular Meeting of the Board of Directors
10/18/2018	James Groundwater Sustainability Agency - Regular Meeting of the Board of Directors
10/23/2018	James Irrigation District - Special Meeting of the Board of Directors
11/13/2018	James Irrigation District - Regular Meeting of the Board of Directors
11/15/2018	James Groundwater Sustainability Agency - Advisory Committee Meeting
01/08/2019	James Irrigation District - Regular Meeting of the Board of Directors
01/17/2019	James Groundwater Sustainability Agency - Regular Meeting of the Board of Directors
01/27/2019	James Irrigation District - Special Meeting of the Board of Directors and Public Hearing
01/29/2019	Reclamation District No. 1606 - Special Meeting of the Board of Directors
02/15/2019	James Irrigation District - Regular Meeting of the Board of Directors
02/21/2019	James Groundwater Sustainability Agency - Advisory Committee Meeting
03/12/2019	James Irrigation District - Regular Meeting of the Board of Directors
04/09/2019	James Irrigation District - Regular Meeting of the Board of Directors
04/11/2019	Reclamation District No. 1606 - Regular Meeting of the Board of Directors
04/18/2019	James Groundwater Sustainability Agency - Regular Meeting of the Board of Directors
05/16/2019	James Groundwater Sustainability Agency - Advisory Committee Meeting
06/11/2019	James Irrigation District - Regular Meeting of the Board of Directors
07/09/2019	James Irrigation District - Regular Meeting of the Board of Directors
07/18/2019	James Groundwater Sustainability Agency - Regular Meeting of the Board of Directors
07/23/2019	James Groundwater Sustainability Agency - Special Meeting of the Board of Directors
08/01/2019	Reclamation District No. 1606 - Regular Meeting of the Board of Directors
08/09/2019	James Irrigation District - Regular Meeting of the Board of Directors
8/13/2019	James Irrigation District – Regular Meeting of the Board of Directors
8/15/2019	James Groundwater Sustainability Agency - Advisory Committee Meeting
9/5/2019	James Groundwater Sustainability Agency - Special Meeting of the Board of Directors
9/16/2019	James Irrigation District - Regular Meeting of the Board of Directors
9/19/2019	Reclamation District No. 1606 - Regular Meeting of the Board of Directors
10/8/2019	James Irrigation District – Regular Meeting of the Board of Directors

Date	Type of Meeting/Location
11/21/2019	James Groundwater Sustainability Agency - Advisory Committee Meeting

Public Comment and Response Management

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

A system for managing public comments and responses has been developed to help track all received comments and the status of comments. A tracking document is maintained by James GSA staff to ensure all comments are recorded. All comments received and a summary of responses will be included **Appendix 8-A** of this GSP.

2.5.2 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.

The GSA was created under a MOU between James ID and RD 1606. The memorandum of understanding contains provisions that the decision-making process of the GSA at a high level, specifically the structure of the Board of Directors, the qualifications to be a director, and voting. The high-level decision-making process and the structure that supports and informs the process are discussed below.

Board of Directors
The Board of Directors for the James GSA is a five-member board. Directors are appointed by either James ID or RD 1606 under the provisions of the MOU. The directors may be elected officials, appointed officials, agency employees, landowners, or residents. The Board of Directors is governed by the authorities granted to the GSA under SGMA as well as duly adopted bylaws, resolutions, and policies. The Board of Director is the decision-making body for the GSA and is informed in making those decisions by the Executive Director, the Advisory Committee, Interested Parties, and the general public. All decisions require an affirmative vote by the majority of the directors.

Executive Director
The Executive Director for the James GSA is appointed by the Board of Directors. The Executive Director presently serves as one of the James GSA directors, but this is not a requirement. The Executive Director is responsible for the management and administration of the James GSA and has been delegated certain tasks related to the development and implementation of the GSP. One of the roles of the Executive Director is to work with the President of the Board of Directors to develop the meeting agenda and to advise the Board of Directors on matters on that agenda. The Executive Director also serves as the liaison between the Board of Directors and the Advisory Committee and Interested Parties and will inform the Board of Directors of any comments, concerns, opinions, or positions from these groups.

Advisory Committee
The Advisory Committee was formed by the Board of Directors for the purpose of informing the GSA and the Board of Directors about concerns or issues related to groundwater sustainability. The Board of Directors appoints individuals to the Advisory Committee and there are no limitations or restrictions on the number of appointees or the types of individuals that can be appointed. Should an appointee not be able to attend, they are welcome to send another staff member in their place. The Advisory Committee is an informal workgroup and the committee does not vote or take any official action on items; however, meeting notes are kept and provided to the Board of Directors.

The Advisory Committee is made up of representatives from the City of San Joaquin, the County of Fresno, the Kings River Conservation District, and landowner-growers. There are currently three landowner-grower representatives. Two of these representatives do not own land or have agricultural operations with the James GSA. All three landowner-grower representatives own and/or have agricultural operations in the MAGSA.

The Advisory Committee recommendations or opinions are provided in meeting notes and furnished to the Board of Directors as a part of their meeting materials. The Executive Director also provides a verbal report on Advisory Committee meetings and summarizes discussions that occurred during the meeting. Advisory Committee members are also invited to attend the board meetings.

Interested Parties
The James GSA maintains a list of all individuals that have requested to be included as Interested Parties. Individuals identified as interested parties are provided notice to all Board of Directors and Advisory Committee meetings as well as workshops or other events held by the James GSA. Other communications, notices and outreach materials are also provided to the Interested Parties. As of July 31, 2019, there are twenty individuals listed on the Interested Parties list. Interested parties are invited to attend all meetings and are encouraged to attend Advisory Committee meetings where technical presentations are made and general question and answer sessions occur.

General Public
The public is encouraged to attend all James GSA Board of Director meetings and Advisory Committee meetings. Members of the public having an interest in groundwater sustainability and knowledge or involvement on various issues surrounding groundwater sustainability are often encouraged to seek appointment to the Advisory Committee.

2.5.3 Public Engagement / Public Outreach Plan

Regulation Requirements:

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

Outreach Plan
The James GSA developed a strategy for outreach and engagement in January 2017. The strategy was not considered to be comprehensive and other activities would also be undertaken as needs or opportunities arise. This strategy has guided the outreach efforts throughout the past two years. Key elements of the outreach strategy that was developed are provided below:

- Interested Parties. The GSA is required to maintain an Interested Party List and provide certain notices and information to interested parties. In addition to these mandatory communications, the GSA will have workshops to inform interested parties and others about the Sustainable Groundwater Management Act (SGMA) and the district's efforts to develop and implement a GSP per that act.

- Advisory Committee. The GSA may create an Advisory Committee and appoint members to the committee. It is anticipated that the Advisory Committee would meet quarterly or as frequently as required. The GSA may consider appointing representatives from the County of Fresno and the Kings River Conservation District to the Advisory Committee

- Newsletter. The GSA may create a newsletter and provide it to interested parties and landowners. The newsletter would likely be an annual publication and would be issued between the winter and summer issue of the James Irrigation District newsletters.

- Workshops. The GSA will have workshops to inform interested parties and others about the Sustainable Groundwater Management Act (SGMA) and the district's efforts to develop and implement a GSP per that act. The GSA may also hold single-issue workshops to obtain information that will assist in the development and implementation of the GSP. The workshops would be held as frequently as quarterly.

- Information Sheet. The GSA will develop a one-page information sheet explaining its role in the implementation of SGMA. The information sheet may define key terms and include responses to frequently asked questions.

In addition to the elements in the initial outreach strategy, a number of other elements have been incorporated into the overall outreach strategy. These elements include:

- Forums. The GSA has participated in two forums discussing Kings Subbasin groundwater conditions, strategies for SGMA compliance, and water quality. While the forums are not targeted at individuals specifically interested in the GSP being developed by the James GSA, the forums did serve to inform the public and representatives of non-governmental organizations on specific issues of concern.

- Correspondence. The GSA has engaged a number of individuals directly through correspondence inviting them to participate in the James GSA and work with the James GSA on projects and efforts that are intended to benefit groundwater sustainability within the Kings Subbasin.

- Open Door Meetings. The GSA has hosted dozens of open door meetings where landowners, growers, and members of the public have discussed general and specific issues related to groundwater sustainability, the James GSP, and efforts being undertaken by GSAs within the Kings Basin and Central Valley.

- Website. The GSA is in the process of developing a website that will be used to ensure effective and current communications with interested and involved stakeholders. The website will contains timely information about the status of GSP development and implementation, notices of meetings and outreach events, public opportunities to learn more or provide input, key outreach opportunities, and links to key documents.

- Electronic Mail. The GSA has and will continue to use electronic mail to communicate with the public and interested parties. The James GSA will transition from using a traditional list to a list to a subscription-based service that allows the public and interested parties to easily subscribe to e-mail notifications.

Each of the above elements has been employed by the James GSA. In some cases, meetings have been consolidated to facilitate attendance and participation. For example, the Advisory Committee meetings typically have a workshop component where a topic is discussed initially in a presentation and then in an open forum style. The outreach has been productive in communicating SGMA requirements to the public and interested parties. The outreach has also been successful in identifying approaches towards sustainability that have a wide base of support.

Public Engagement

The James GSA has worked to engage the general public and the beneficial users of groundwater identified in Section 2.5.1 above. This engagement can be generally categorized into a number of areas which are discussed below.

The Advisory Committee was formed and is intended as a means to engage with those beneficial users and agencies having responsibility for managing the resource. Beneficial users outside the James GSA were also appointed to the Advisory Committee to assist identifying concerns from beneficial users outside of the Plan Area and to develop collaborative approaches or solutions to groundwater sustainability challenges. The Advisory Committee also serves as an open forum for Advisory Committee members and Interested Parties to engage the GSA on technical and policy matters.

The James GSA has targeted engagement directly from individuals, agencies, and non-governmental organizations through correspondence, one-on-one meetings, or phone conversations. Information gathered from this direct engagement has been used extensively to develop the draft GSP. The goal of the engagement is to address any concerns and comments from individuals, agencies, and non-governmental organizations within the GSP in an open and transparent manner.

The James GSA has sought out engagement from the public and beneficial users through workshops, newsletters, and e-mail communications. The response rate from this form of engagement is less than the response rate received by targeted and direct engagement. This form of engagement; however, has generated a significant quantity of responses.

The small size of the James GSA provides more opportunities for engagement. One-on-one engagement of individuals, agencies, and non-governmental organizations is undertaken whenever possible. An effort is made to accommodate everyone interested in participating the development and implementation of the GSP at the maximum level of engagement desired by the participating party.

2.5.4 Encouraging Active Involvement

Regulation Requirements:

§354.10 (d) 3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of population within the basin. 4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

James GSA will undertake and engage in a number of outreach activities and produce outreach materials to encourage active engagement of diverse social, cultural, and economic elements of the population within the James GSA. In addition to the outreach efforts described above, the James GSA will undertake or engage in the further efforts as described below.

Informational Briefings Through Existing Stakeholder Engagement Venues

James GSA has and will continue to use outreach opportunities to open lines of communication with interested and affected stakeholders about the program, let them know the future opportunities for input, establish communication channels, and receive feedback on the process. Venues will be selected based on efficiency and effectiveness in reaching out to stakeholder populations and beneficial users.

- Community meetings;
- Board of supervisor meetings’
- Farm bureau meetings;
- Lions and rotary cub meetings; and
- School District meetings

Informational Briefings with Local Governments and Agencies

James GSA will reach out to local government and agency staff to inform them and receive input on James GSA activities, to better understand their interests and concerns, and to coordinate with local planning activities.

Informational Briefings with Landowners and Other Interested Parties
James GSA had held and will continue to hold informal informational briefings targeted to landowners, community residents, and other local interested parties to share information, build relationships, provide program updates, educate, and solicit input. James GSA will make use of existing venues where landowners and other local stakeholders typically meet, such as community district meetings, water board meetings, and school district meetings, as well as new venues to conduct in-the-field briefings.

Outreach Content and Materials
James GSA has and will continue to develop and disseminate outreach materials that meet the needs of various stakeholders depending on their interest and involvement and their preferred ways of receiving information. If necessary, translation services for outreach communications, materials, and events will be provided.

Direct Mail Outreach
When pertinent and timely, the James GSA has and will continue to utilize direct mail as a channel to reach all parcel owners within agency boundaries. Communication pieces developed will include messaging that communicated information about the James GSSA and updates stakeholders on recent activities.

development and implementation, notices of meetings and outreach events, public opportunities to learn more or provide input, key outreach opportunities, and links to key documents. Content specifically developed to communicate with diverse social, cultural, and economic elements of the population within the James GSA will be provided within the website.

Electronic Mail
James GSA has and will continue to use electronic mail to communicate with the public and interested parties. The James GSA will transition from using a traditional list to a list to a subscription-based service that allows the public and interested parties to easily subscribe to e-mail notifications. Once in place, and outreach effort will be undertaken to promote this means of communication to the diverse social, cultural, and economic elements of the population within the James GSA.

2.5.5 Informing the Public about Plan Implementation

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

The James GSA shall inform the public about progress implementing the Plan, including the status of projects and actions, through any or all of the various outreach means previously identified. It is expected that communications regarding plan implementation will fall into three categories: general progress communications, annual progress communications, and milestone progress communications.

General progress communications will occur periodically or when there is in interest or need to advise the public and interested parties about one or more aspects about plan implementation. General progress communications may involve soliciting participation or feedback regarding specific projects or management actions. These communications may involve items deemed to be of current or immediate interest to the public and interested parties.

Annual progress communications will occur on an annual basis. These communications will be a general update on the progress in implementing the GSP and shall cover projects, management actions, key sustainability indicators, and key elements in the annual report made to DWR. Annual progress communications are expected to have more technical content than other types of progress communications but will include a qualitative assessment of conditions within the Kings Subbasin and the within James GSA.

Milestone progress communications will occur every five years and the timing will align with the measurement of milestones. These communications will also involve communications about the five-year evaluation of the GSP as well as those elements included in annual progress communications.

In all cases, the outreach shall include direct mailing to interested parties and outreach to those members of the public that have subscribed to the various outreach methods. Outreach involving the need to receive public input will employ a broader selection of outreach methods and will require a higher level of effort in order to communicate the relevant information and to solicit feedback or engagement.

3 Basin Setting

3.1 Hydrogeologic Conceptual Model

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, geology, geologic structure, water quality, principal aquifers, and principal aquitards in the basin setting. Once developed, an HCM is useful in providing the context to develop water budgets, monitoring networks, and identification of data gaps.

An HCM is not a numerical groundwater model or a water budget model. An HCM is 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 following 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). The narrative HCM description provided in this chapter is for the Kings Subbasin, followed in each section by the description for the James GSA portion of the Kings Subbasin. The descriptions are accompanied by graphical representations that generally portray the geographic setting and regional geology. 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.

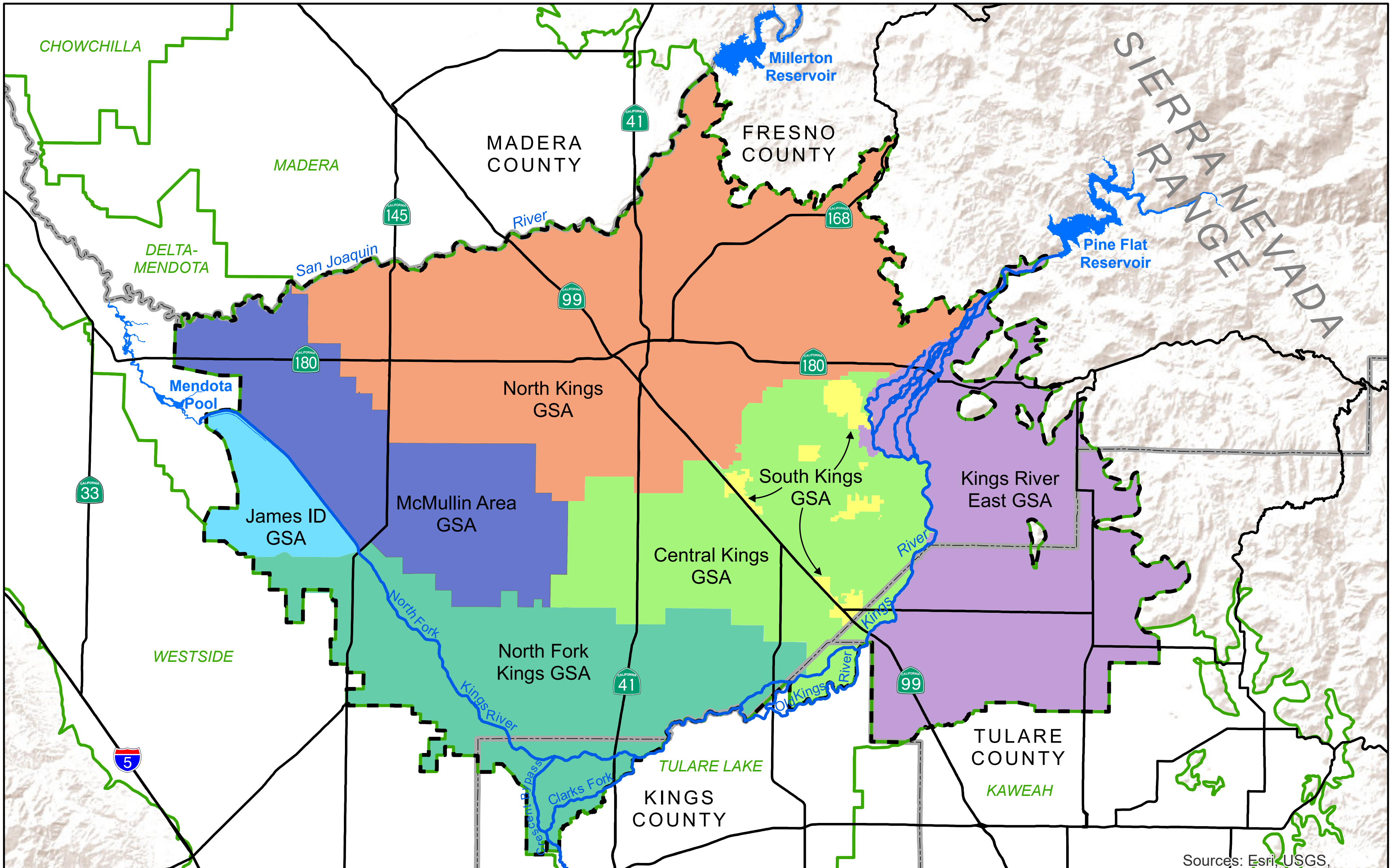
As shown in Figure 3-1 to the east, the Kings Subbasin is bounded by the Sierra Nevada foothills. To the west the subbasin is bounded by the Delta Mendota and Westside Subbasins. Starting in the southwest corner the Kings Subbasin shares a common border for a mile with the Westside Subbasin, then runs 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 (CDWR, 2006). A more detailed description for the GSA is included below.

The James GSA area is bounded to the south by the North Fork Kings GSA (Kings Subbasin), to the east by the eastern extent of the James Bypass floodway and the McMullin Area GSA (Kings Subbasin), to the north by the Fresno County Area B GSA (Delta-Mendota Subbasin), and the west by the Delta-Mendota Central GSA (Delta-Mendota Subbasin) and the Westlands GSA (Westside Subbasin). The James Bypass (Kings River) runs within and along the eastern and northern edge of the Plan Area. The northern portion of the James Bypass is continually inundated by waters impounded by Mendota Dam (i.e. the Mendota Pool) while the portion running along the eastern edge is fed by the Kings River and is typically dry during a significant portion of the year or all year during dry hydrologic conditions. The Fresno Slough runs within and along the northern portion of the western edge of the Plan Area. Mud Dam is located within a portion of the southern edge of the Plan Area while the impoundment created by Mud Dam lies just to the south of the Plan Area.

The major surface water features that affect groundwater flow are the Mendota Pool, the Fresno Slough, the Kings River, and the James Irrigation District distribution system. The major subsurface feature affecting the movement of groundwater is the E-clay, also known as the Corcoran Clay, which underlies the entire Plan Area.

Above the Corcoran Clay, groundwater traditionally flowed from the Sierra Nevada Mountains to the axial trough of the valley where it would emerge from the ground. Development east of the Plan Area has reversed the direction of groundwater flow in the Plan Area. Within the Plan Area, groundwater now flows from the axial trough of the valley southeasterly through the plan area towards the Raisin City cone of depression, see Figure 3-2.

Below the Corcoran Clay, groundwater flows from east to west in the Plan Area. The primary source of water for the confined aquifer below the Corcoran Clay is groundwater that enters the confined aquifer at its eastern extent. Groundwater flows westerly below the confined aquifer towards the Westside Subbasin. Groundwater users in the Westside Subbasin produce groundwater from the confined aquifer for agricultural irrigation.



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Kings Groundwater Subbasin (DWR 2018)
Other Groundwater Subbasins (DWR 2018)
County

James GSA

Kings Groundwater Subbasin
Groundwater Sustainability Agencies

Figure 3-1

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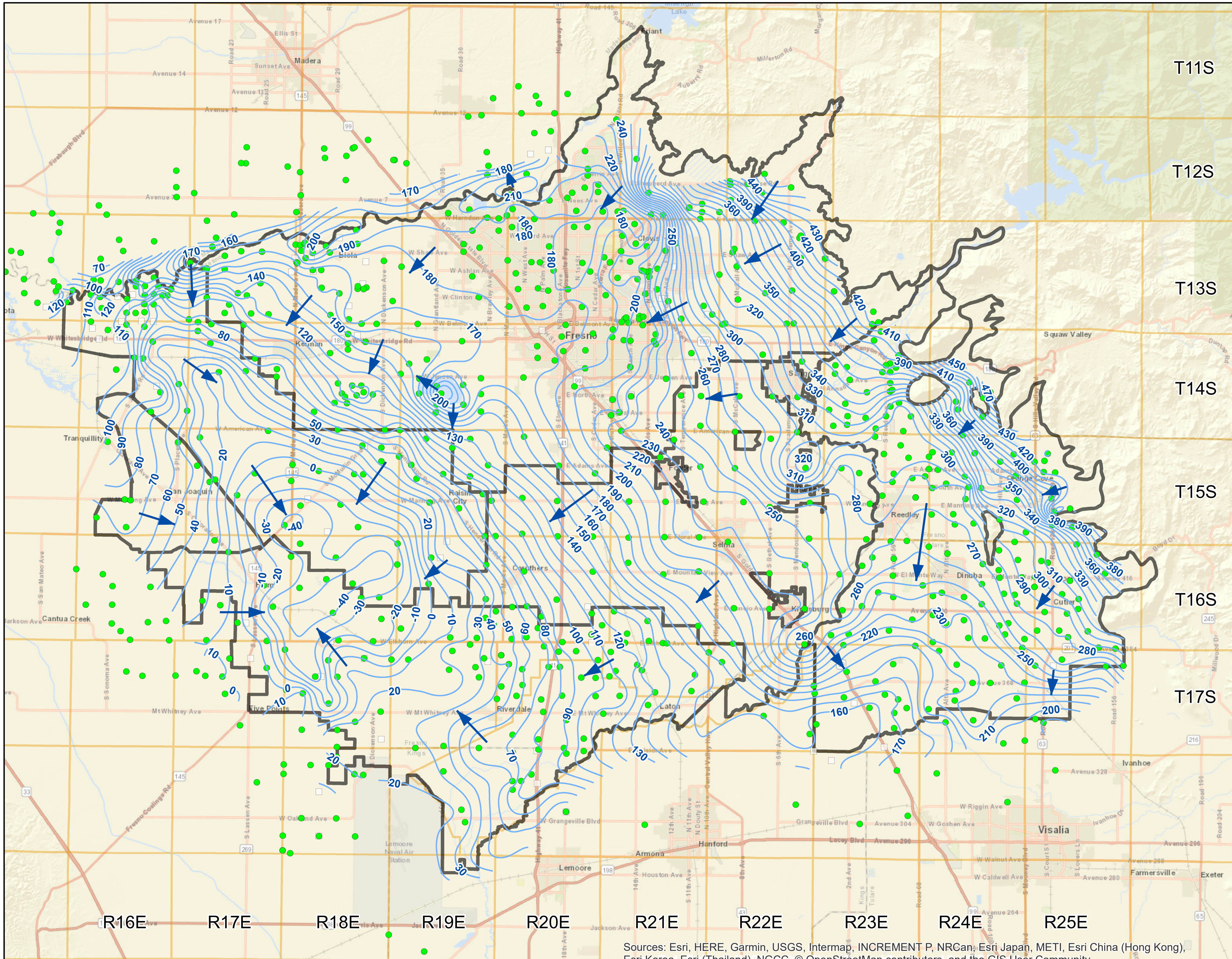

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2017
Groundwater Elevation Contours

Figure 3-2

- Kings Subbasin GSAs
- Township/Range
- Well - Data Used
- Well - Data Not Used
- Generalized GW 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.

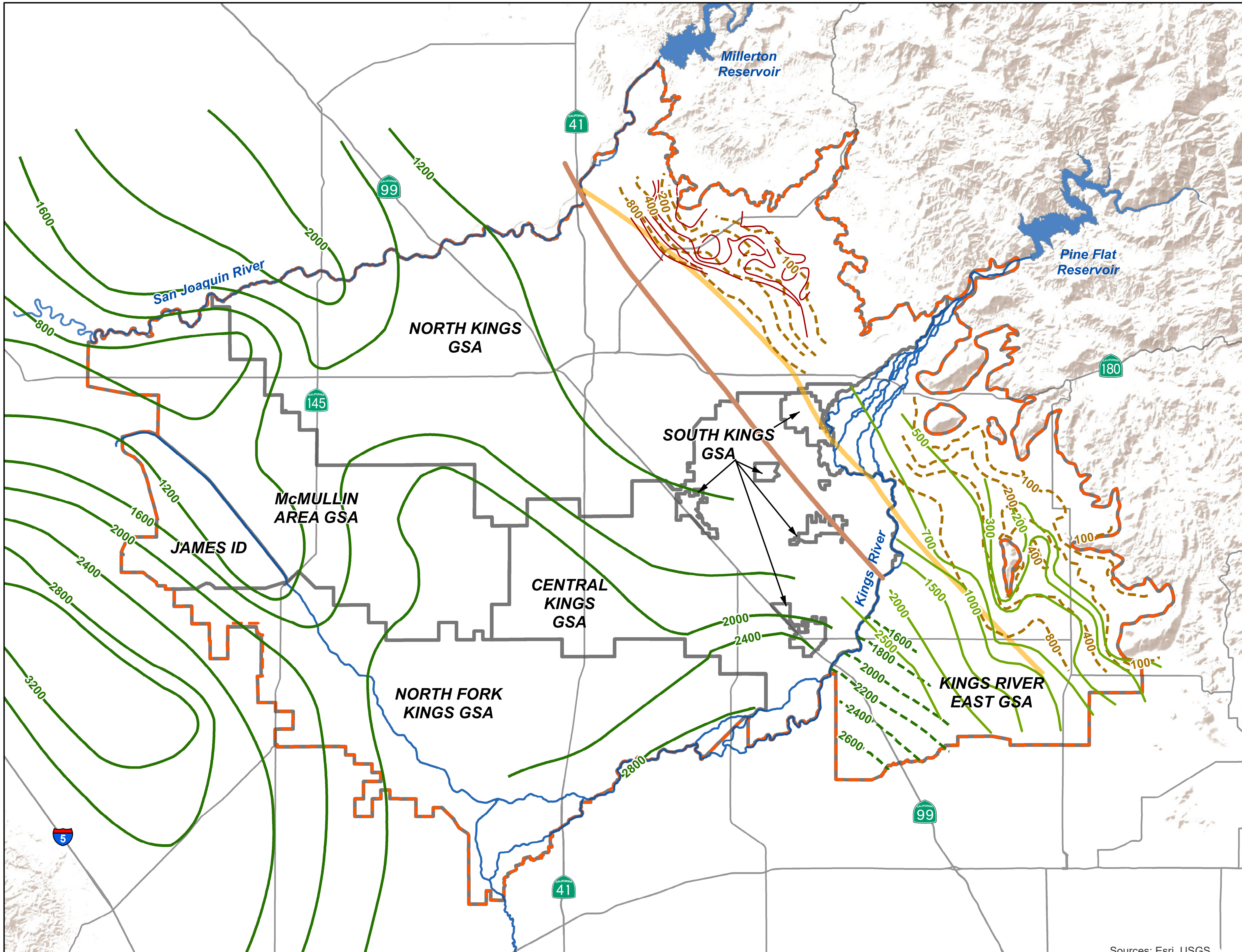
§354.14(b)(3) The hydrogeologic conceptual model shall be summarized in a written description that includes the definable bottom of the basin.

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 (CDWR, 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 connate water, and further west and southwest the base of the aquifer 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. 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.

The buried basement complex east of the James GSA 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 sub-basin and Sierra Nevada does not provide appreciable amounts of groundwater to the San Joaquin Valley (Page and LeBlanc, 1969).

The definable bottom of the basin for the Plan Area is defined as the depth to connate water. A threshold value of 2,000 mg/L total dissolved solids is used to define the interface of the connate water. This defined bottom of the basin is the deepest at the southwest boundary of the Plan Area where it is 2,200 feet. It is shallowest along the entire eastern boundary of the Plan Area where it is 1,000 feet in depth.



Kings Subbasin

Base of Aquifer

Figure 3-3

- Kings Subbasin GSAs
- Kings Subbasin (2018)
- Waterway
- Calculated Depth to Basement Complex (ft)*
- Calculated Depth to Base of Fresh Water (ft)*
- Approximate Depth to Connate Water (ft)**, KDSA (2010)
- Approximate East Edge of Connate Water, KDSA (2010)
- Approximate East Edge of Connate Water, Page & LeBlanc (1969)
- Depth to Bedrock (P&P and KDSA, 1995)
- Depth to Bedrock, Alta ID (KDSA, 2019)

*Depth to Basement Complex and Depth to Base of Fresh Water contours calculated from Page and LeBlanc (1969) basement complex elevation contours/contours on approximate base of fresh water and USGS ground elevation (USGS DEM, NAVD88, ft).

**Connate water is where Total Dissolved Solids approach 2,000 mg/L.

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Sources: Esri, USGS,

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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**. The Sierra Nevada Mountain Range and its foothills are located east of the basin, and erosion of these mountains and hills has formed alluvial deposits that slope generally southwest to west toward the axis of the San Joaquin Valley. Deep marine sediments, which are shown on **Figure 3-4** as occurring below the alluvial fan deposits, do not yield water to wells (Page and LeBlanc, 1969), and are therefore not discussed further in this HCM.

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 (Figure 3-6). 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 the James GSA is included below.

Page and LeBlanc (1969) mapped the geomorphic features east of the James GSA area in the Kings Subbasin. As shown in Figure 3-5 the landscape north and east of the James GSA area is dominated by the alluvial fans of the San Joaquin River. 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. To the east of the GSA is a relatively large sand dune deposit. The James GSA area was not included on the geomorphic features map by Page and Leblanc, but they referred to this area as “overflow lands” in their study, which are assumed to be the low lying lands that would historically flood in the center of the valley, as discussed below.

At flood stage, the Kings River has historically inundated areas along both sides of the Fresno Slough and the Fresno Slough bypass, which has created a long, narrow, low-lying plain along the western edge of the area. Davis et al. (1959) has also labeled this area as "overflow lands."

A topographic map of the Kings Subbasin including James GSA area is presented as **Figure 3-6**. The Plan area is flat. The highest point in the James GSA (approximately 180 feet above mean sea level, msl) lies in the southeastern corner of the Plan Area. The lowest point GSA (approximately 160 feet above mean sea level, msl) list within the northwest corner of the Plan Area. The overall topography of the Plan Area slopes gently to the northwest. The James GSA straddles the axial trough of the valley and is the lowest point within the Kings Subbasin.

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.

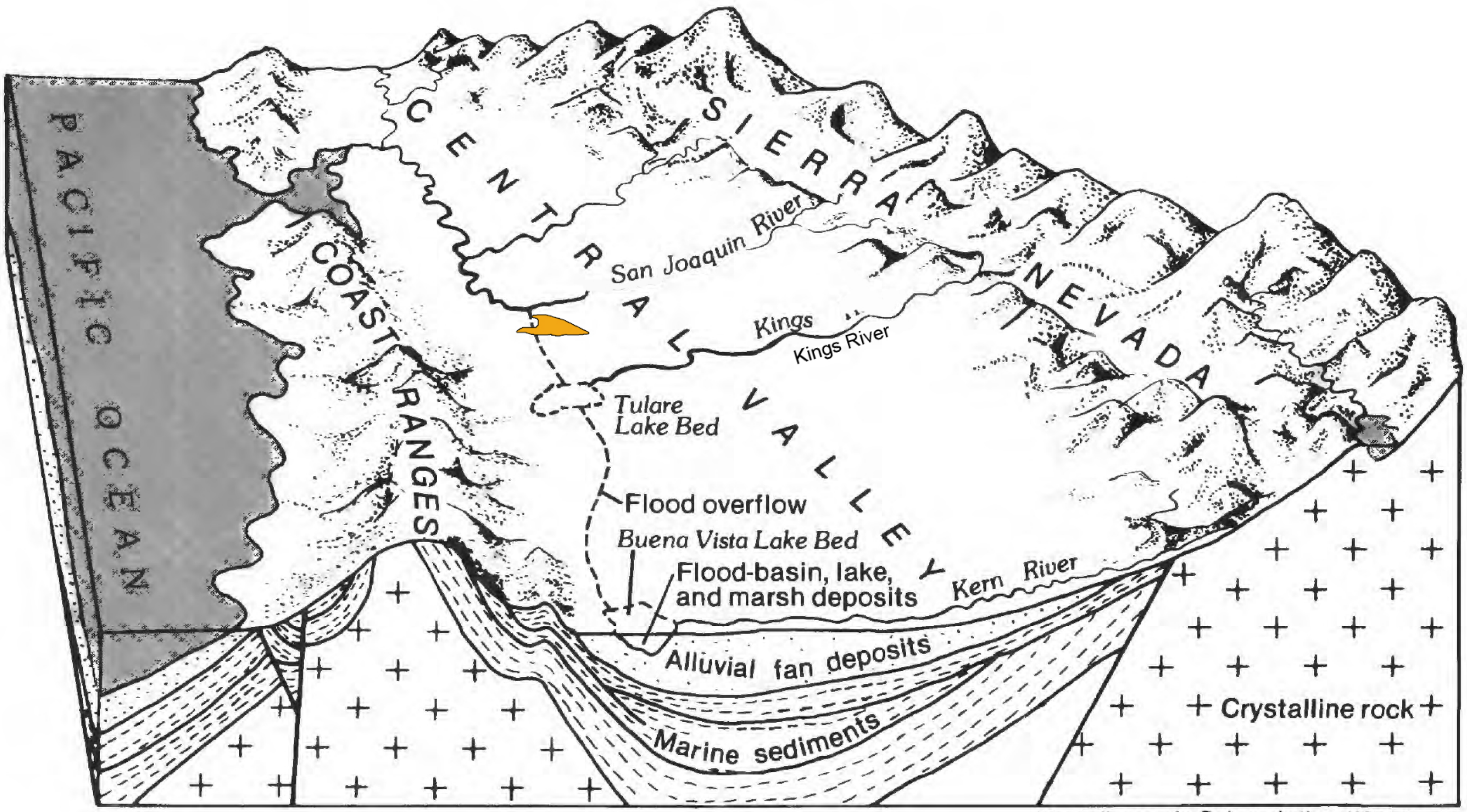
Surficial geologic materials in the Kings Subbasin consist of consolidated rocks and unconsolidated deposits. The consolidated rocks are comprised of a pre-Tertiary age basement complex, and marine and continental sedimentary rocks of Cretaceous (145 to 66 million years ago) and Tertiary age (66 to 2.6 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 3-7** is a map depicting surficial deposits in Kings Subbasin. More detailed descriptions of this GSA are included below.

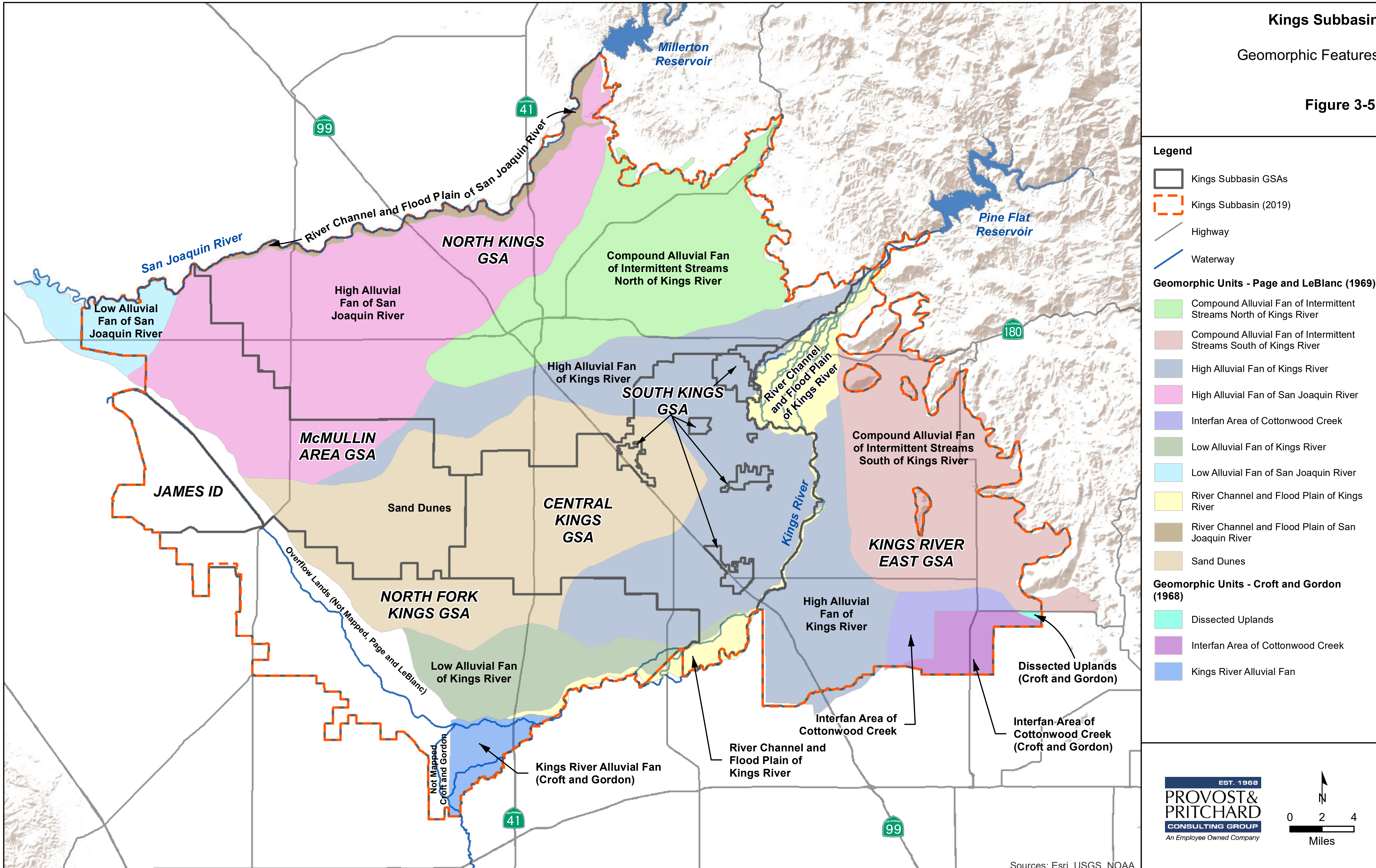
Surface geology in the Plan Area is closely related to the geomorphic features in the area. Younger Alluvium (Qya) overlies the northeasterneastern part of the GSA along the modern-day Kings River stream channel, covering an area roughly contiguous with the High Alluvial Fan of the Kings River (**Figure 3-7**). Flood-basin Deposits (Qb) lay along the southwestern part of the Plan Area nearer to the axis of the valley defined locally by the Fresno Slough. This area is west of the area mapped by Page and Leblanc (1969) as "overflow lands."

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



Block diagram by Dale and others(1964, fig. 7)
Modified by R.W. Page, 1980

Figure 3-5


Kings Subbasin
Geomorphic Features
Figure 3-5
Legend
Kings Subbasin GSAs
Kings Subbasin (2019)
Highway
Waterway
Geomorphic Units - Page and LeBlanc (1969)
Compound Alluvial Fan of Intermittent Streams North of Kings River
Compound Alluvial Fan of Intermittent Streams South of Kings River
High Alluvial Fan of Kings River
High Alluvial Fan of San Joaquin River
Interfan Area of Cottonwood Creek
Low Alluvial Fan of Kings River
Low Alluvial Fan of San Joaquin River
River Channel and Flood Plain of Kings River
River Channel and Flood Plain of San Joaquin River
Sand Dunes
Geomorphic Units - Croft and Gordon (1968)
Dissected Uplands
Interfan Area of Cottonwood Creek
Kings River Alluvial Fan
EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company
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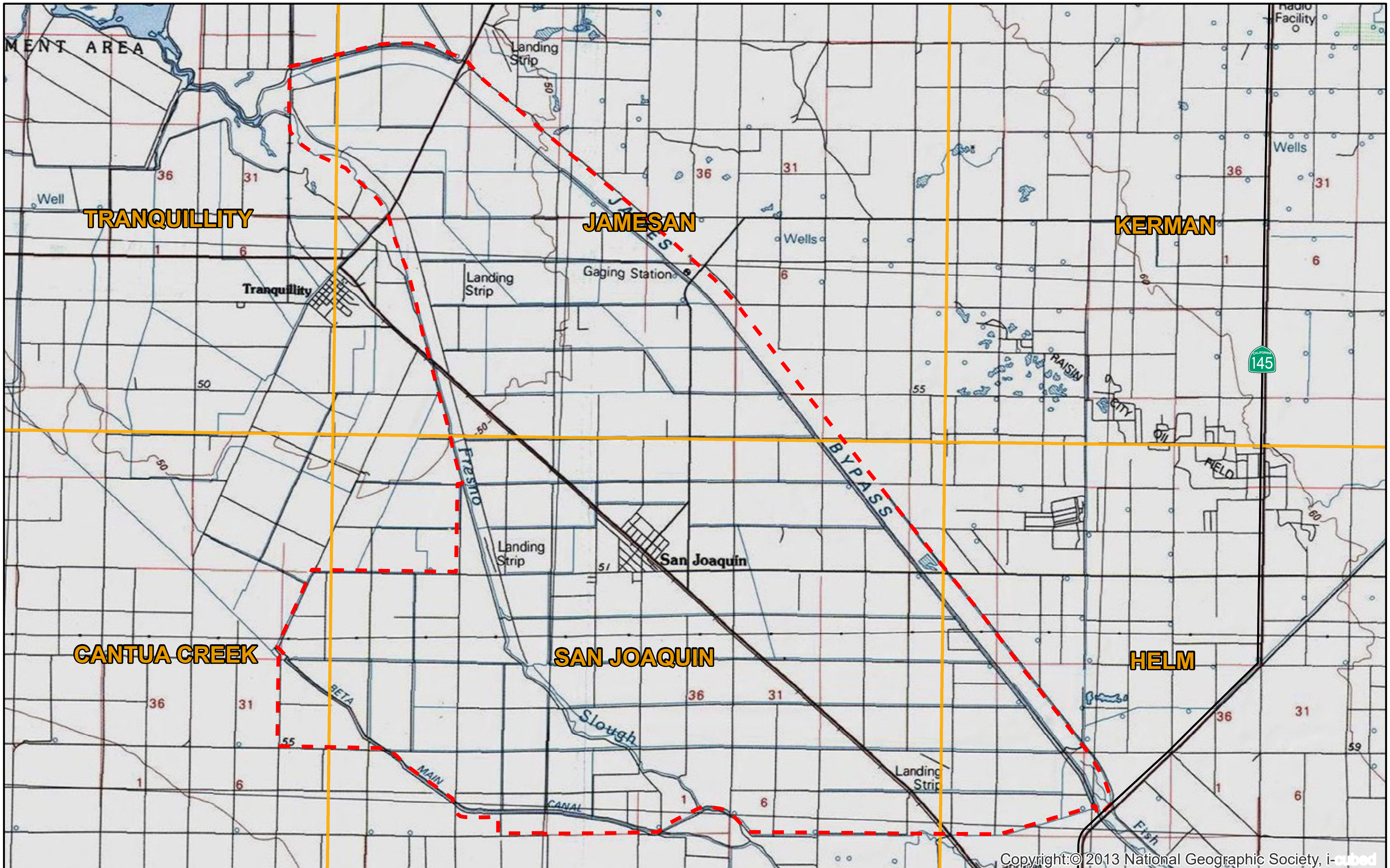
Sources: Esri, USGS, NOAA
Millerton Reservoir
Pine Flat Reservoir
San Joaquin River
River Channel and Flood Plain of San Joaquin River
Kings River
NORTH KINGS GSA
McMULLIN AREA GSA
SOUTH KINGS GSA
CENTRAL KINGS GSA
NORTH FORK KINGS GSA
KINGS RIVER EAST GSA
JAMES ID
Low Alluvial Fan of San Joaquin River
High Alluvial Fan of San Joaquin River
Compound Alluvial Fan of Intermittent Streams North of Kings River
High Alluvial Fan of Kings River
River Channel and Flood Plain of Kings River
Compound Alluvial Fan of Intermittent Streams South of Kings River
Sand Dunes
High Alluvial Fan of Kings River
Low Alluvial Fan of Kings River
Overflow Lands (Not Mapped, Page and LeBlanc)
Not Mapped Croft and Gordon
Kings River Alluvial Fan (Croft and Gordon)
River Channel and Flood Plain of Kings River
Interfan Area of Cottonwood Creek
Interfan Area of Cottonwood Creek (Croft and Gordon)
Dissected Uplands (Croft and Gordon)
99
41
180



James GSA

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Topography

Figure 3-6

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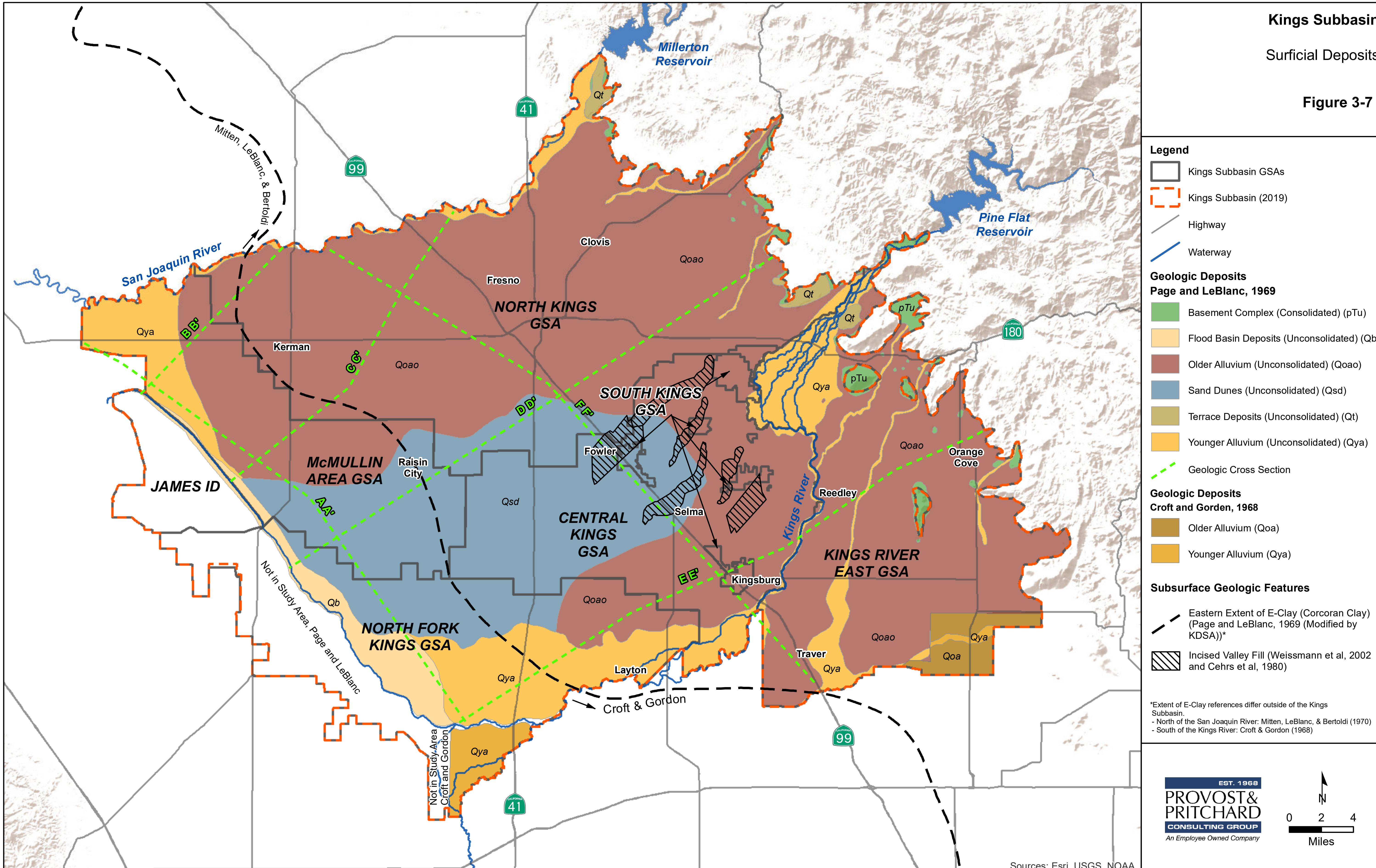

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3.1.6 Soil Characteristics

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 nearly 1-million-acre 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.

A topsoil map of the James GSA area based on Natural Resource Conservation Service (NRCS) soil textural classes is presented as **Figure 3-8**. 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 James GSA area, the NRCS has generally described soils to depths of five to seven 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 fine and very fine-grained topsoil.

As shown in Figure 3-14, general soil textural classes along the entire eastern edge of the Plan Area are moderate fine and appear to correspond to the high alluvial fan of the San Joaquin River. The general soil textural classes transition from moderate fine along this eastern edge (which runs from southeast to northwest) to fine and very fine, eventually reaching impermeable in the southwestern portion of the Plan Area. Pockets of moderately coarse soils are present along the eastern edge of the Plan Area, particularly in the northeastern portion near the toe of the high alluvial fan of the San Joaquin River. This figure can be useful for initial screening of potential recharge and groundwater banking sites, but the information is only reflective of general surface soil characteristics and must be confirmed with on-site investigations before projects are pursued.

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.

Geologic cross section from Page and LeBlanc (1969) that transverse the Kings Subbasin are presented as Figure 3-9 through Figure 3-14. Geologic cross section locations are shown on the Surficial Geology Map (Figure 3-7). They include two geologic cross sections roughly parallel to and four cross sections perpendicular to the structural trough of the San Joaquin Valley. These cross sections have been updated to show more recent interpretations of the depth to connate water and better vertical control of the depth to bedrock in a few locations near the foothills from technical studies done for the City of Clovis and the Kings River East GSA (KDSA (2010), KDSA (2019), Provost & Pritchard and KDSA (1995)). As well these geologic cross sections are updated to show the boundaries of the Kings Subbasin GSAs. More detailed discussions of the portions of the geologic cross sections for James GSA are included below.

Regional Cross-section A-A’ transverses northwest-southeast parallel to the eastern edge of the James GSA area and is shown in Figure 3-9. Regional Cross-sections B-B’, and C-C’ transverse northeast-southwest and are perpendicular to A-A’. These cross sections terminate near the eastern edge of the James GSA and are shown in Figure 3-10 and Figure 3-11, respectively.

As shown on the regional Cross-section A-A', the Quaternary Older Alluvium (Qoao and Qoar) is inferred to exist from the surface to a depth of approximately 1,060 feet in the northwest and increases in depth to approximately 1,300 feet in the southeast. On regional Cross-section B-B' (Figure 3-10), the Qoao extends to a depth of approximately 700 feet at the western extent of the cross section which is the northeastern edge of the Plan Area. At the regional Cross-section C-C' (Figure 3-11), the Qoao extends to a depth of approximately 800 feet at the western extent of the cross section which is the southeastern edge of the Plan Area. Quaternary and Tertiary age continental deposits (QTc) lie below the Qoao to depths of at least 3,000 feet.

Three different, laterally extensive clays within the Qoa are indicated in the cross-sections. The oldest, deepest, and most laterally extensive of these is the E-clay or Corcoran Clay; it is shown on the three cross-sections that are adjacent to the Plan Area (Page and LeBlanc, 1969). The depth to the E-clay is about 450 to 550 feet deep and is present in the entire Plan Area. The E-clay thins out at locations east of the Plan Area. Different authors have interpreted the eastern edge of the E-clay at slightly different locations. Figure 3-7 shows the eastern edge approximations from Page and LeBlanc (1969). In this area of the Valley, the cross-sections indicate that a lower bed of the E-clay is also present and is commonly referred to as the bifurcated E-clay.

Cross-sections A-A' and B-B' indicate the presence of the shallower C-clay in the northern area of the James GSA, occurring at a depth of approximately 250-300 feet. Another primary clay layer, the A-clay is common in the western part of the Kings Subbasin, appearing at shallower depths than the E- or C-clay units and more extensive than the C-clay. Well data in parts of the Kings Groundwater Basin indicate that confined groundwater conditions exist between the C-clay and E-clay where their boundaries overlap. At the time of writing this HCM, preliminary data suggest semi-confined groundwater conditions exist between the C-clay and E-clay within the James GSA since water levels have been above and below the C-Clay at various times in various locations. The A-clay is not a confining clay since water levels are below the depth of the A-clay, thus the aquifer between the A-clay and the C-clay is unconfined.

On Cross-sections A-A' and C-C' (Figure 3-9 and Figure 3-11), a shallow band of Quaternary Younger Alluvium (Qya) is located at relatively shallow depths immediately adjacent to the Kings River channel. The unit is lithologically similar to the underlying older alluvium (Page and LeBlanc, 1969). Where present near natural waterways it is interbedded with finer grained flood-basin deposits. Beneath river channels, the Qya unit is highly permeable but beneath the flood plains it may have poor permeability. In general, the younger alluvium is not vertically extensive enough to contain a large percentage of the area's groundwater.

Page and LeBlanc (1969) indicated in general terms, the deposits of Quaternary age yield more than 90 percent of groundwater pumped from wells, with the older alluvium (Qoao) being the most important aquifer in the area. While the Qoao is still a very 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. These deeper wells are often composite wells that are perforated above and below the clay layer. While this may be the case for the Kings Subbasin generally, active wells within the James GSA are almost exclusively perforated above the clay layer.

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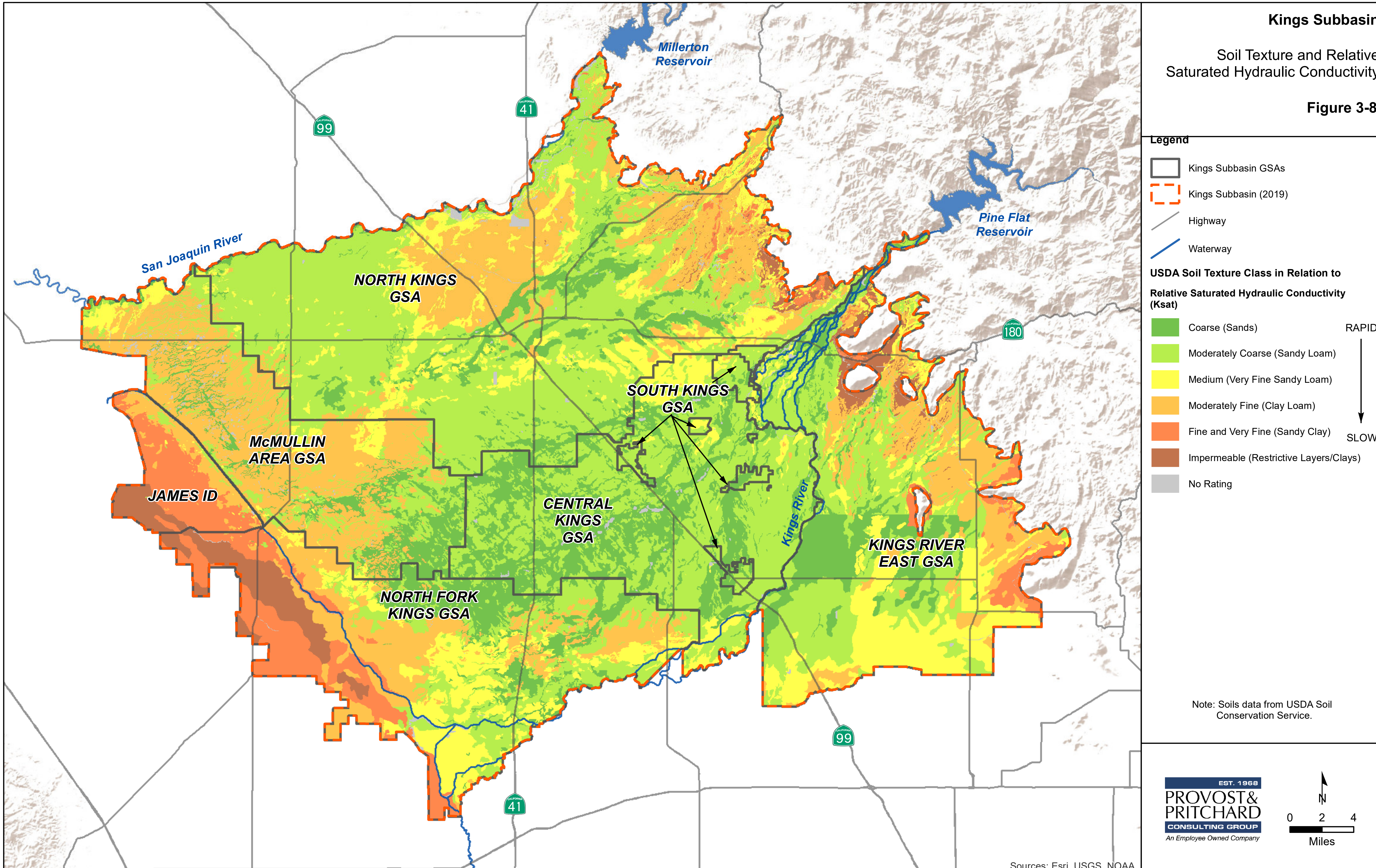

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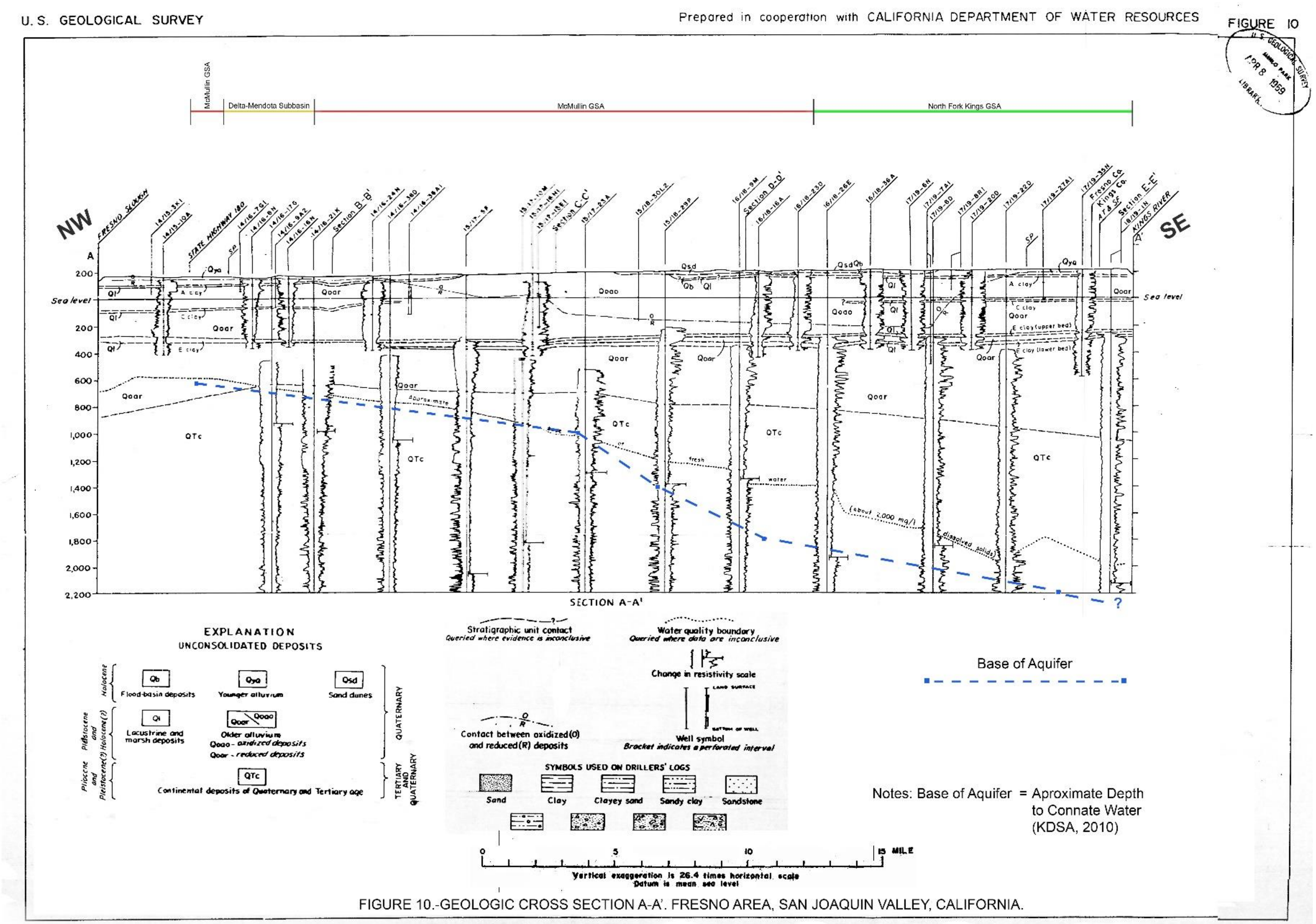


Figure 3-9 Regional Cross-Section A-A' – Kings Subbasin

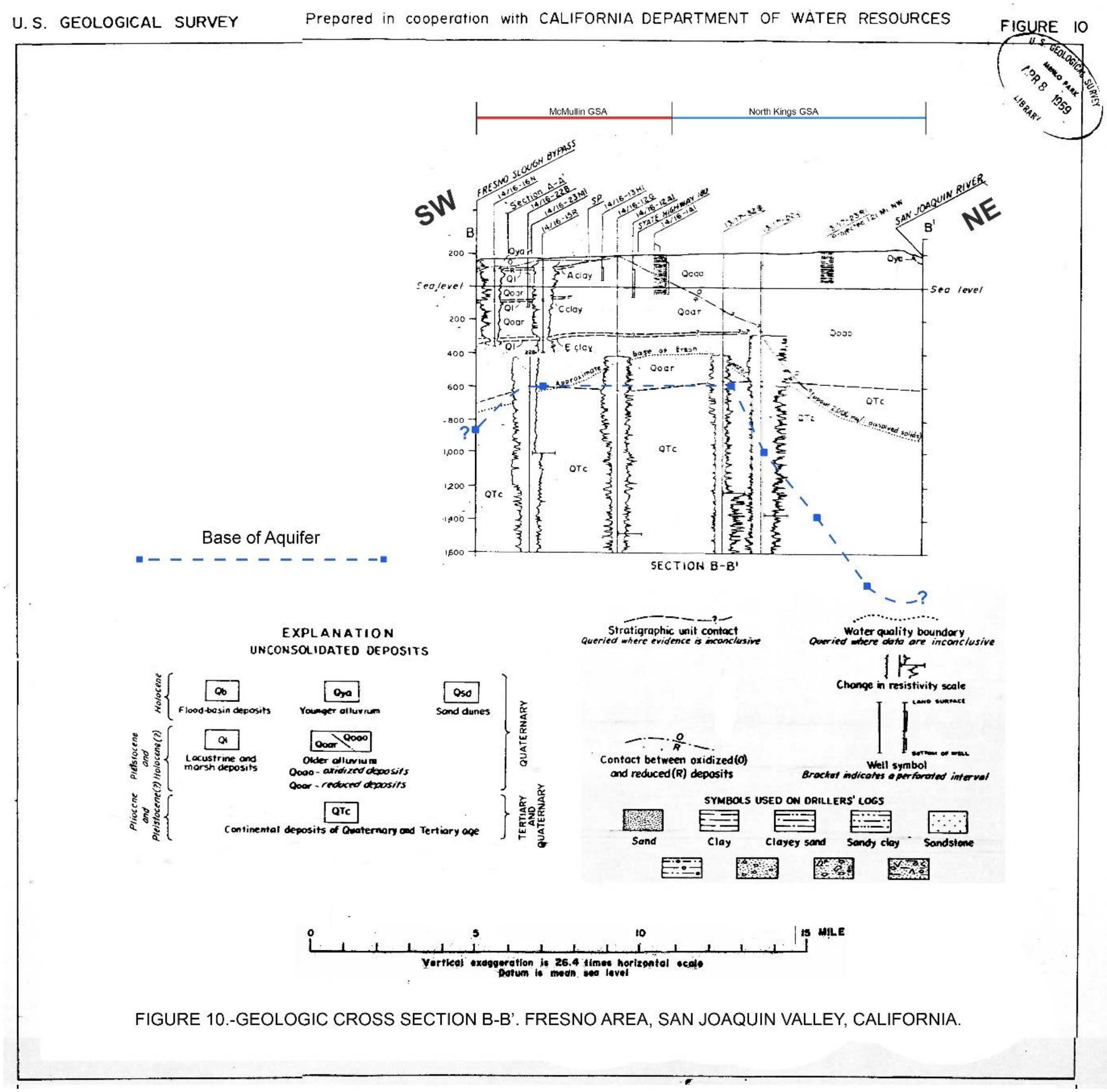


FIGURE 10.-GEOLOGIC CROSS SECTION B-B'. FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-10 Regional Cross-Section B-B' - Kings Subbasin

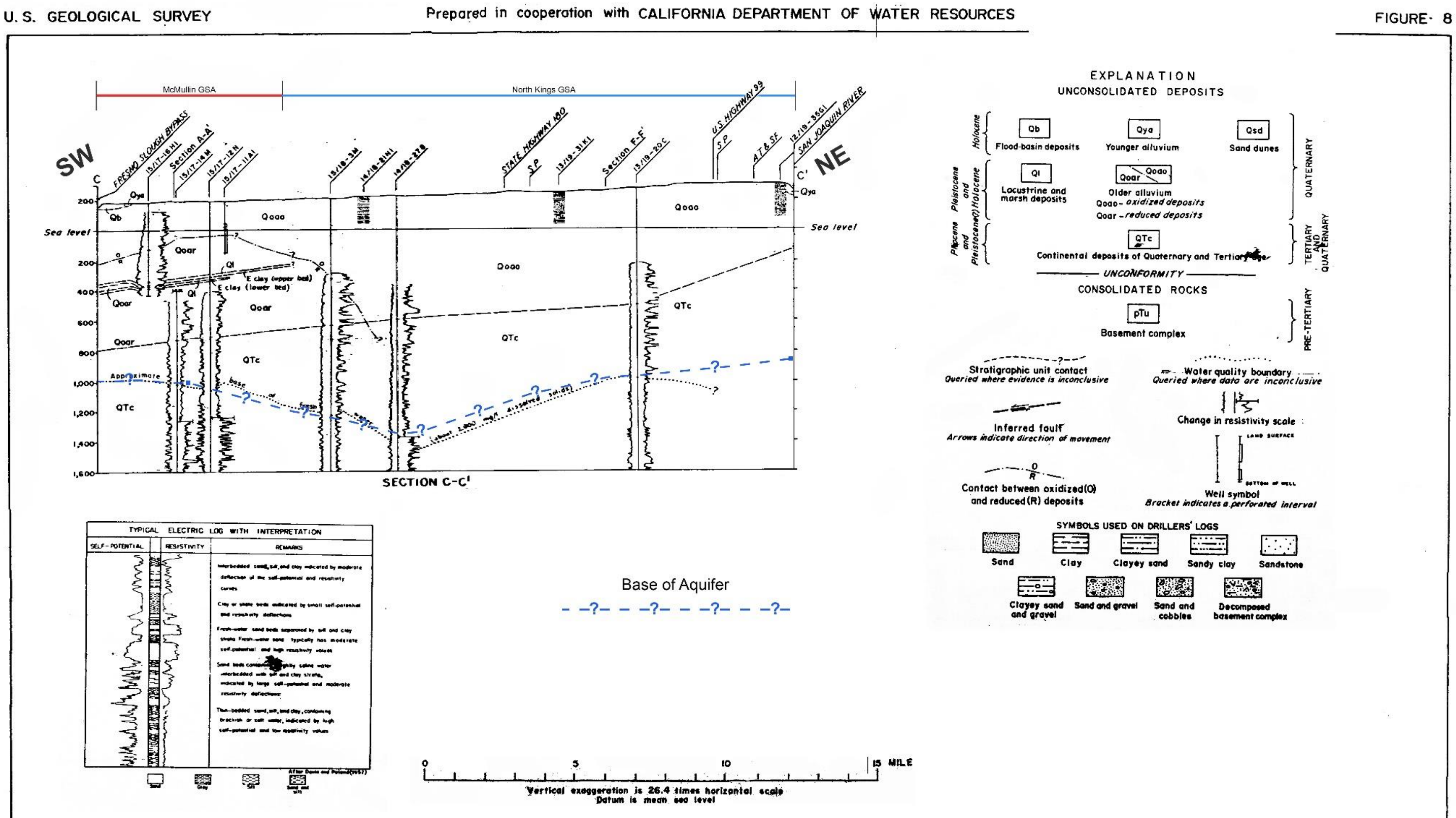


FIGURE 8 GEOLOGIC CROSS SECTIONS C-C'. FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-11 Regional Cross-Section C-C' - Kings Subbasin

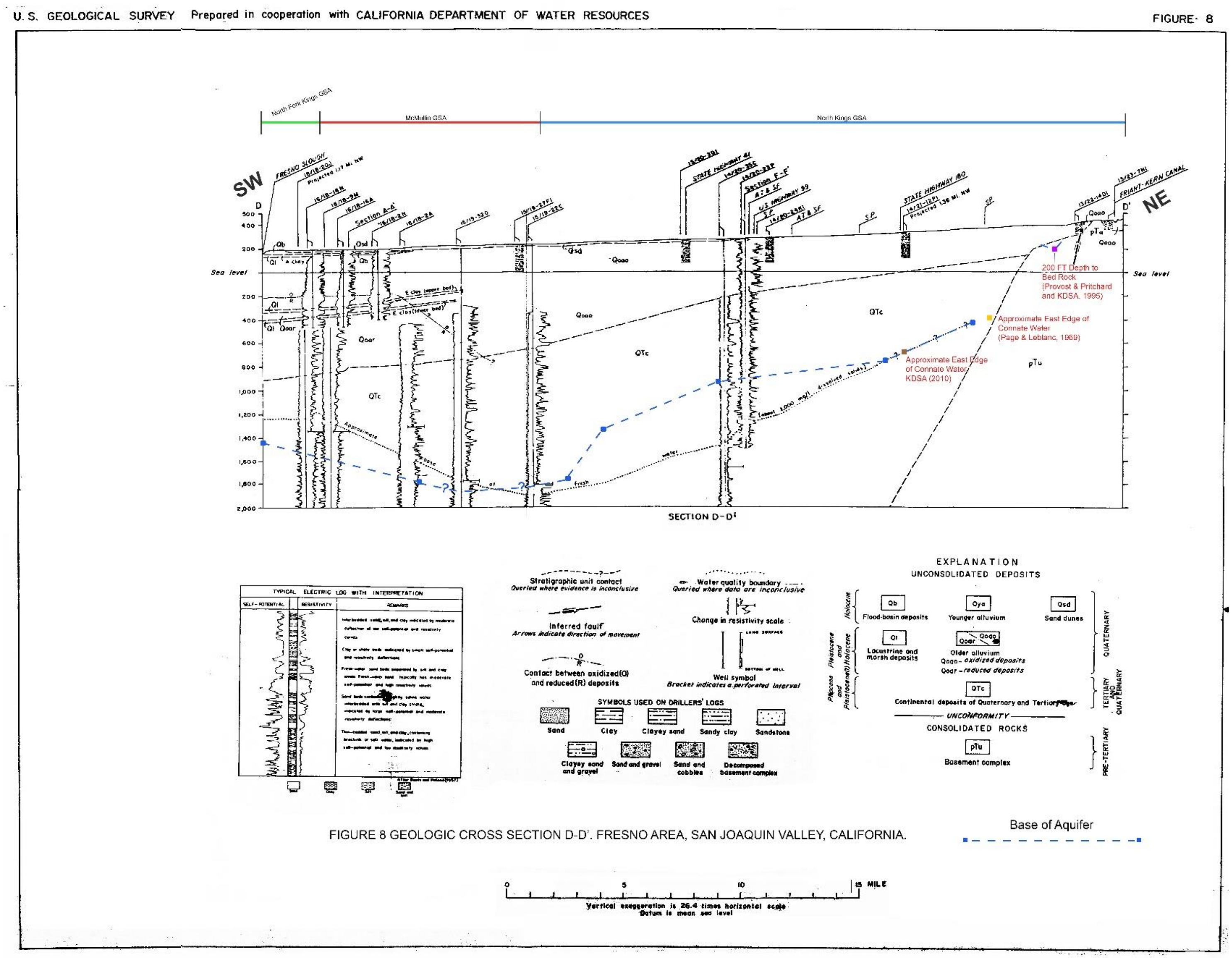


Figure 3-12 Regional Cross-Section D-D' - Kings Subbasin

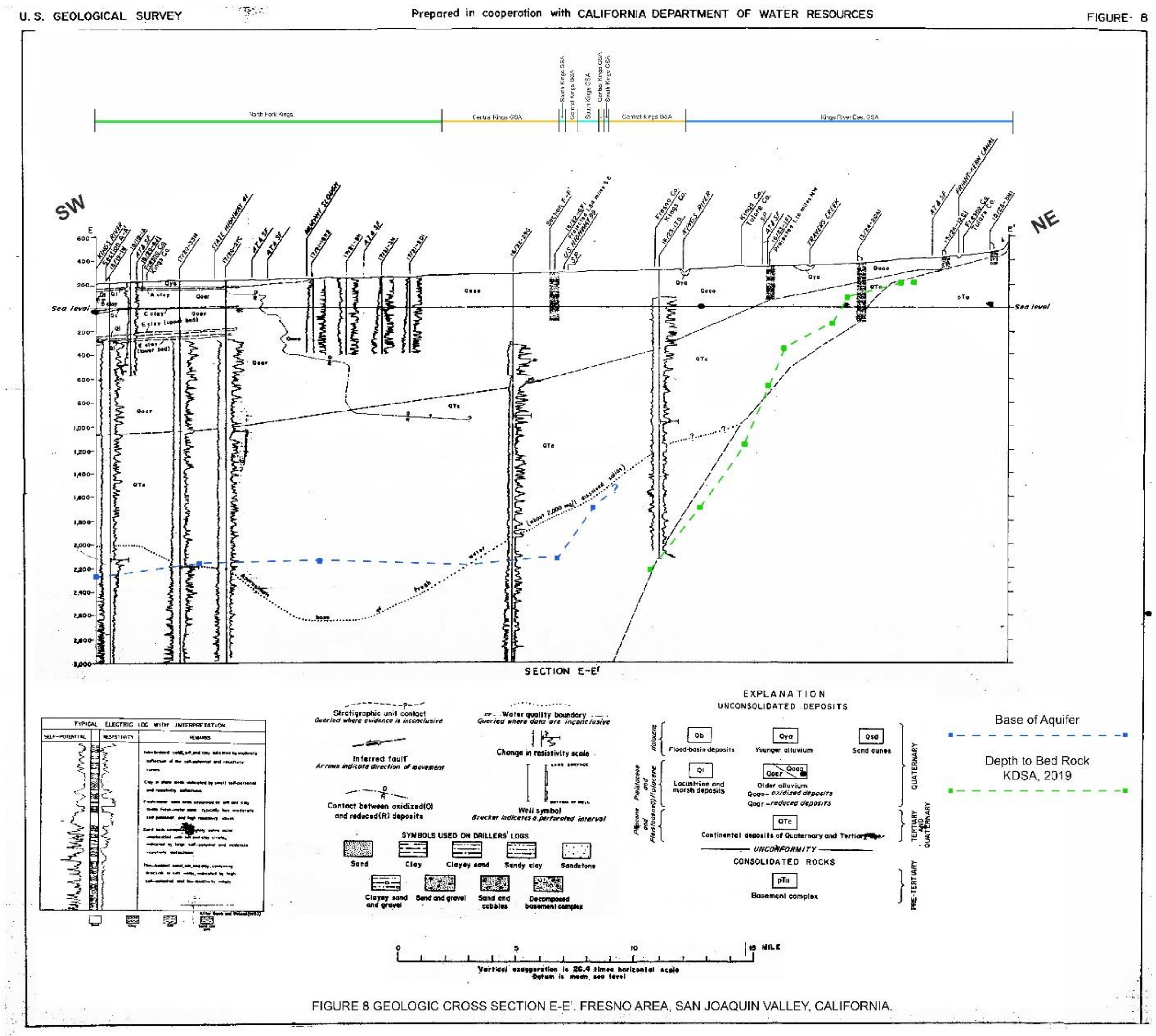


Figure 3-13 Regional Cross-Section E-E' - Kings Subbasin

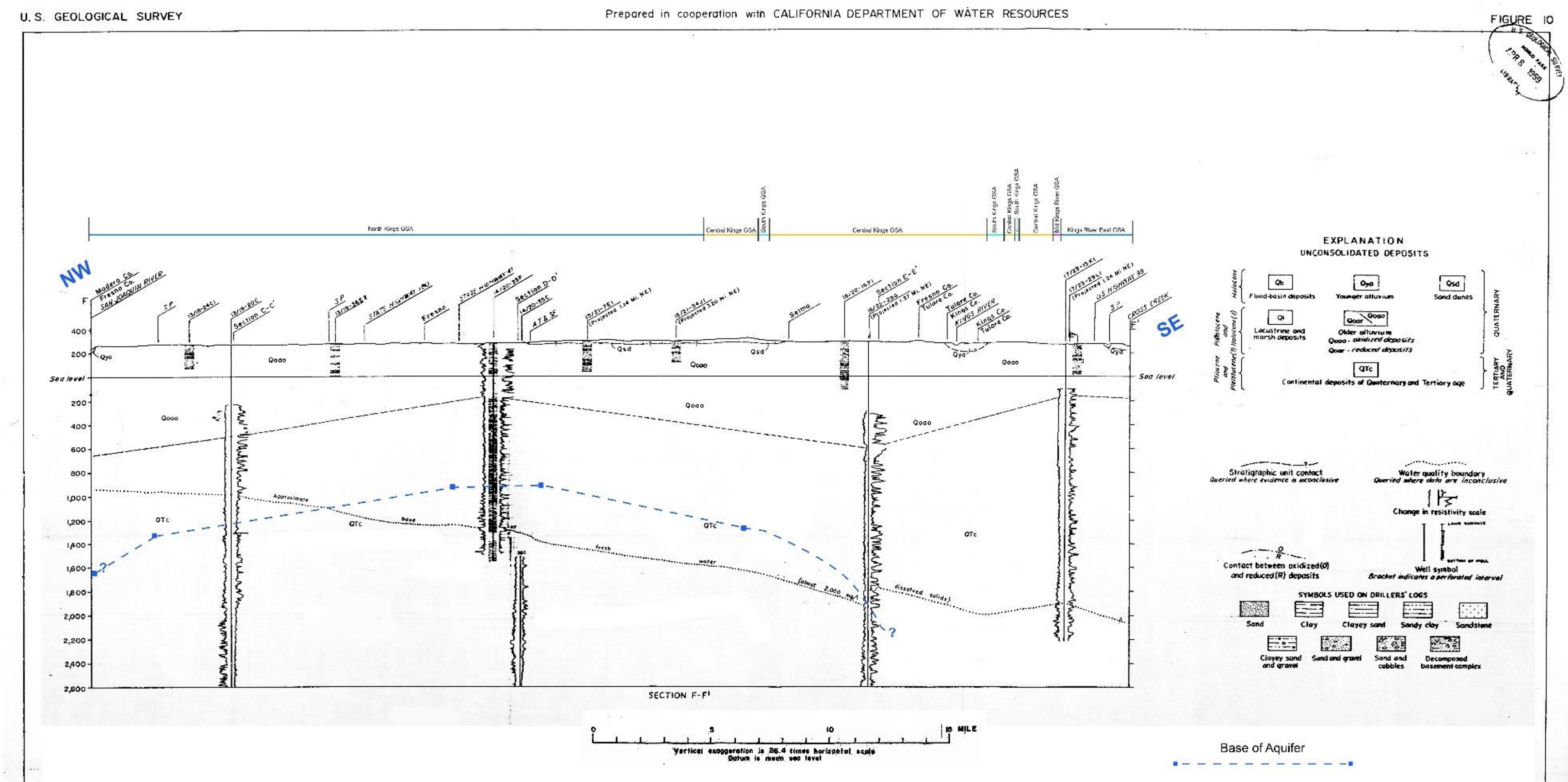


FIGURE 10.-GEOLOGIC CROSS SECTION F-F', FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-14 Regional Cross-Section F-F' - Kings Subbasin

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.

3.1.8.1 Geologic Formations

Regulation Requirement:

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

Geologists studying the lithology of the San Joaquin Valley in different areas have used many different formation names over the years to describe the same lithologic units. As a result, the nomenclature used to describe the geologic formations within the Kings Subbasin can be confusing. Conceptualized cross-sections of the Kings Subbasin as depicted from the northwest to southeast and from the southwest to northeast (perpendicular) to the basin axis are presented below as **Figure 3-15** and **Figure 3-16.** These figures show a summary of the formations present in the Kings Subbasin.

Figure 3-15 and **Figure 3-16** are conceptualized cross sections of the Kings Subbasin from the northwest to southeast and from the southwest to northeast (perpendicular) to the basin axis. 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.

These conceptualized cross sections show that in the Fresno Slough area the geologic formations from the surface downward are the post-Modesto Deposits which are underlain by the A clay. Beneath the A clay the formations are primarily Modesto and Riverbank Formations which extend down to and below the C clay to the top of the Corcoran clay. Below the Corcoran clay the formations are primarily the Turlock Lake and North Merced Gravels. Beneath the Turlock Lake and North Merced Gravels the Laguna Formation is shown to extend down the brackish water which is shown to be the top of the primarily Mehrten and older formations.

§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 Subbasin 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 and 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 and LeBlanc, 1969).

Based on the conceptual cross-sections, the older alluvium extends to maximum depths of approximately 1,200 feet beneath the James GSA (**Figure 3-15 - Figure 3-16**). Where present in the older alluvium, the E-clay is known to have created confined groundwater conditions beneath it. It should be noted that newer public supply wells are often sealed opposite the quaternary alluvium and tap into confined groundwater. Within the James GSA, less extensive confining units, known as the A-clay and C-clay, are associated with the E-clay and exist at shallower depths. These confining clay units are mapped or inferred to occur below northern and southern portions of the James GSA area, the extents of which are approximated on **Figure 3-17**.

For many decades, areas east of the E-clay were considered to have a single unconfined aquifer. Through a series of studies including subsurface geologic cross sections, test holes and geologic logs, Kenneth D. Schmidt & Associates (KDSA) has developed an enhanced concept of the aquifer system east of the E-clay (**Appendix 3-A**). 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 for most of the Kings Basin and in other parts of the San Joaquin Valley. This two-aquifer system is comprised of a shallow unconfined aquifer and a deeper confined aquifer formed by relatively non-continuous, but locally significant clay layers in the deeper parts of the older Quaternary alluvium or upper parts of the underlying continental deposits. As shown below on **Figure 3-18**, KDSA has mapped the base of the unconfined aquifer at depths ranging from approximately 200 feet deep in the eastern part of the Kings Subbasin to 550 feet deep in the west. Where the E clay is present the base of the unconfined groundwater extends to the top of the clay layer

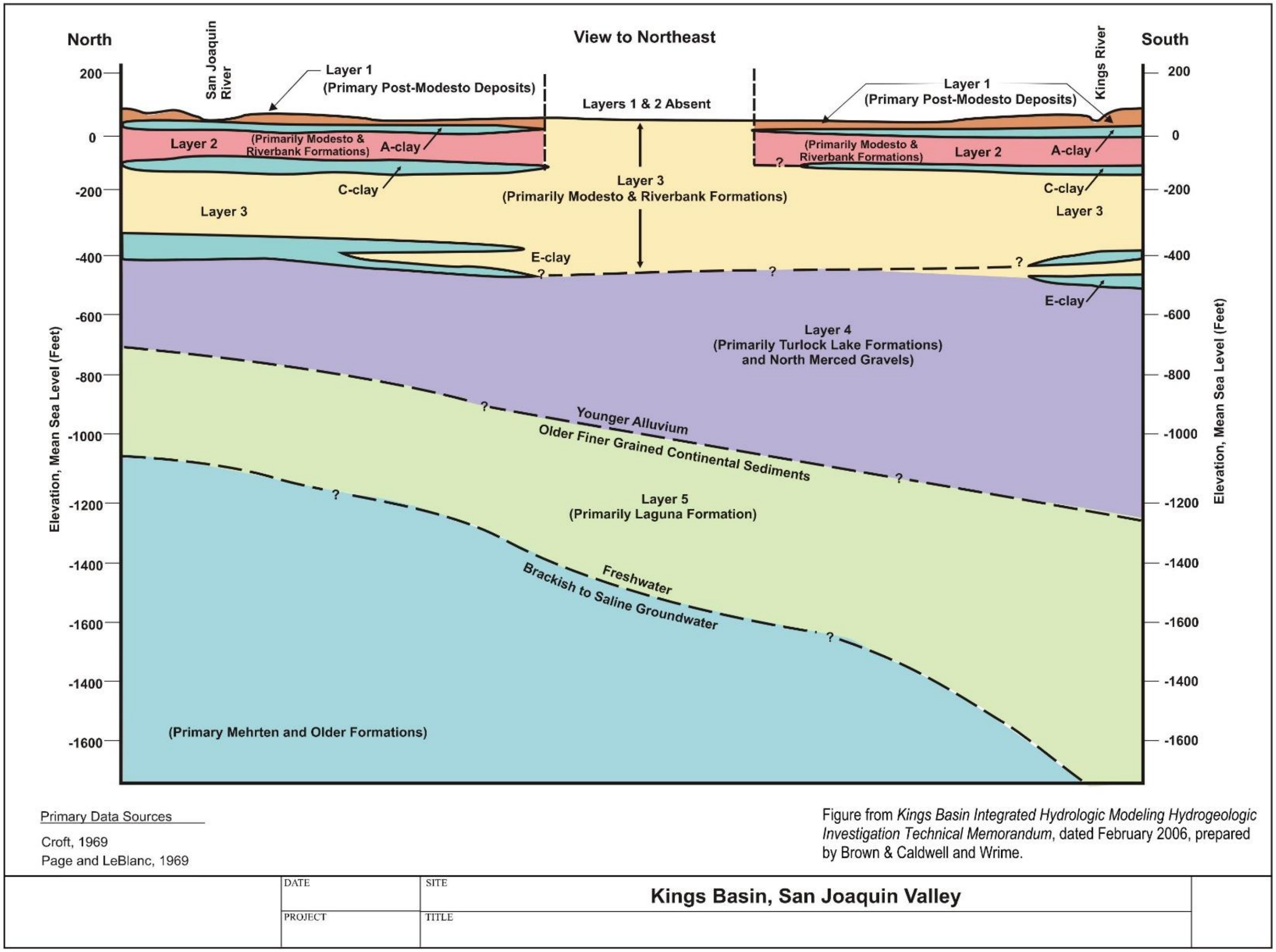


Figure 3-15 Kings Groundwater Subbasin Conceptual Cross-Section – Northwest-Southwest

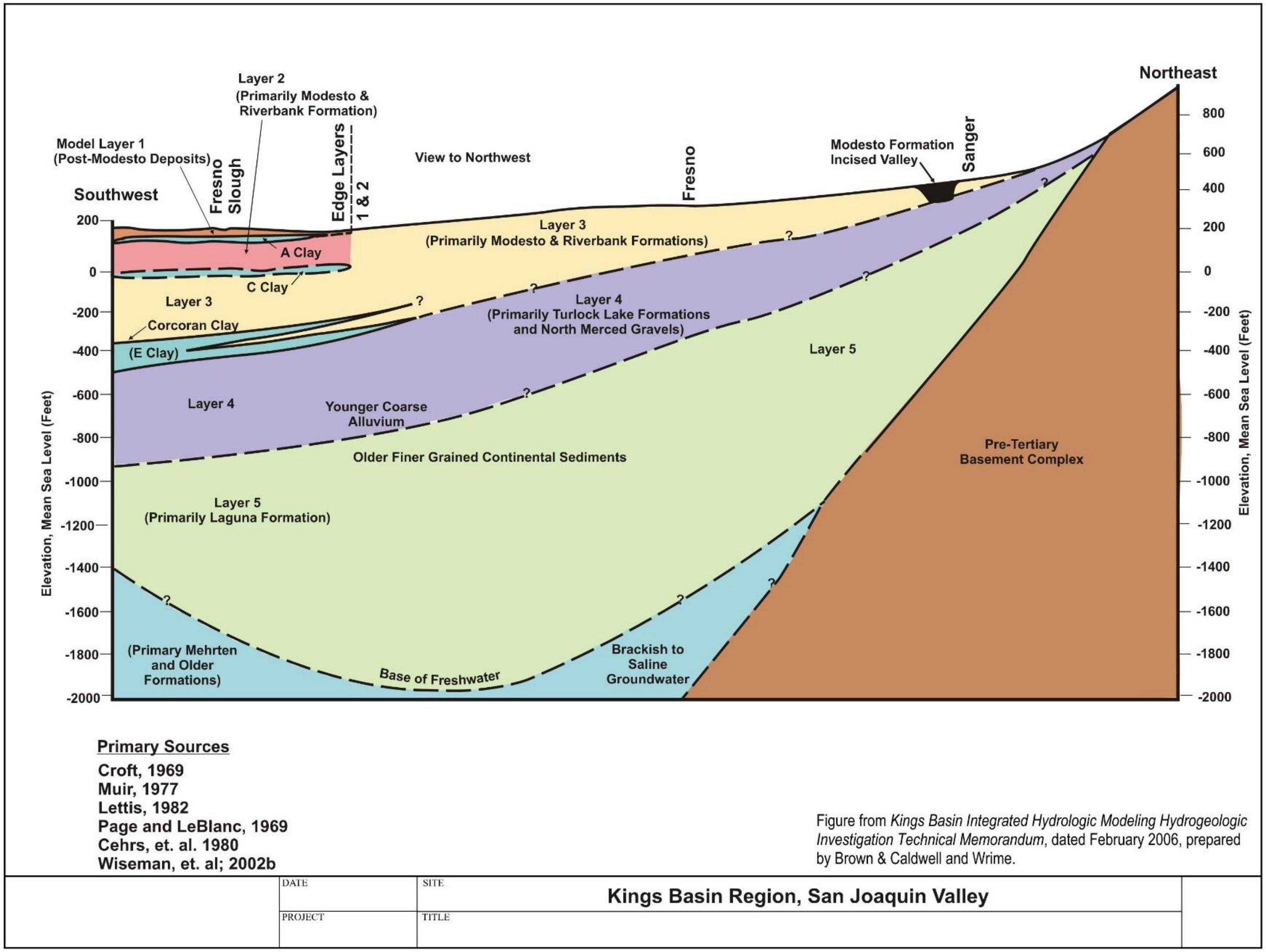
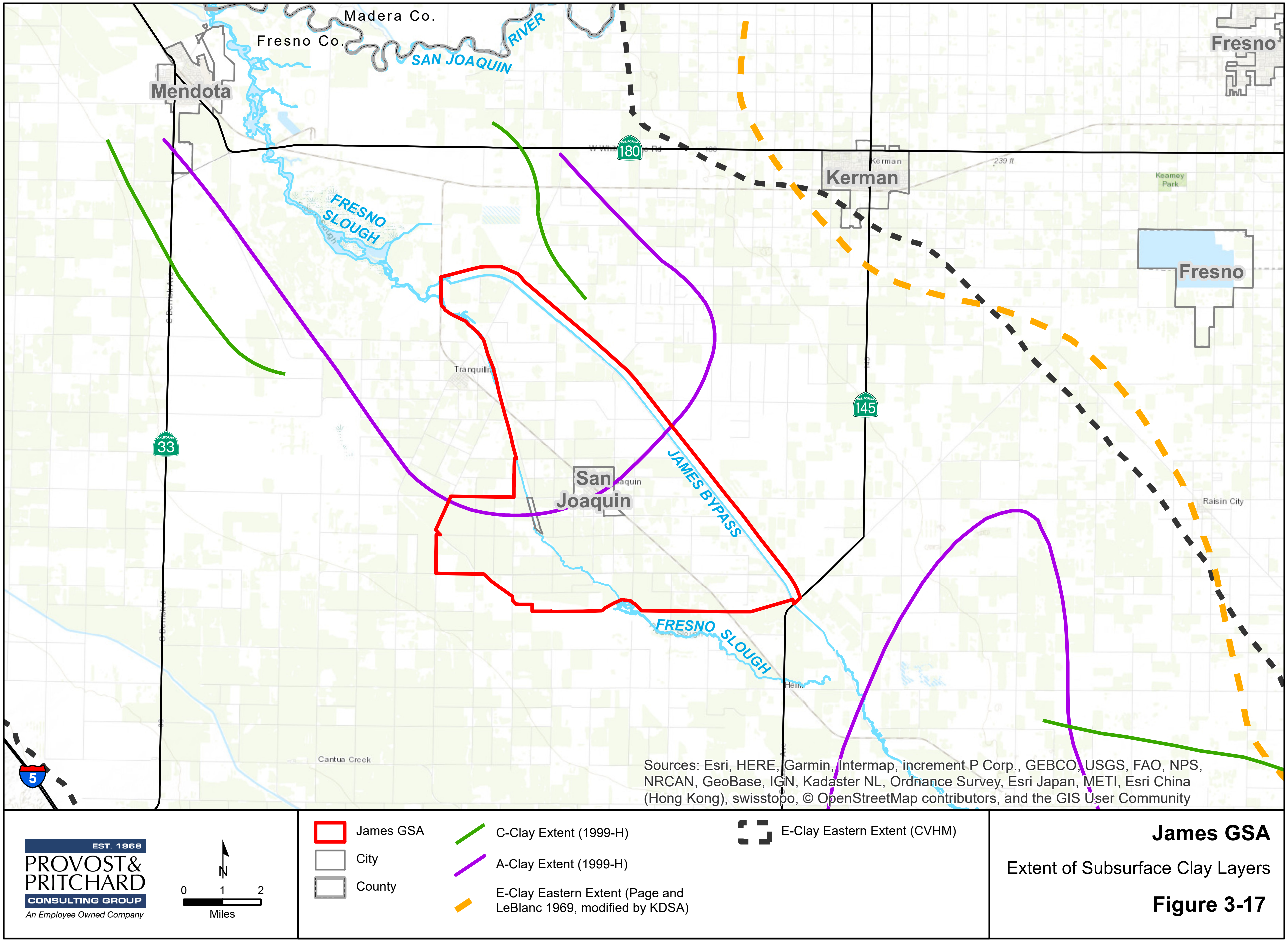


Figure 3-16 Kings Groundwater Subbasin Conceptual Cross-Section – Southwest-Northeast



James GSA

Extent of Subsurface Clay Layers

Figure 3-17

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3.1.8.2 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) or less. Laterally, the aquifer system essentially underlies the entire subbasin. Specific yields, in the subbasin range from 0.2 percent to 36 percent (CDWR, 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 et al, 1989). More detailed discussion of the vertical extent, aquifer characteristics, specific yield of deposits, and hydraulic conductivity and transmissivity of the James GSA are discussed below.

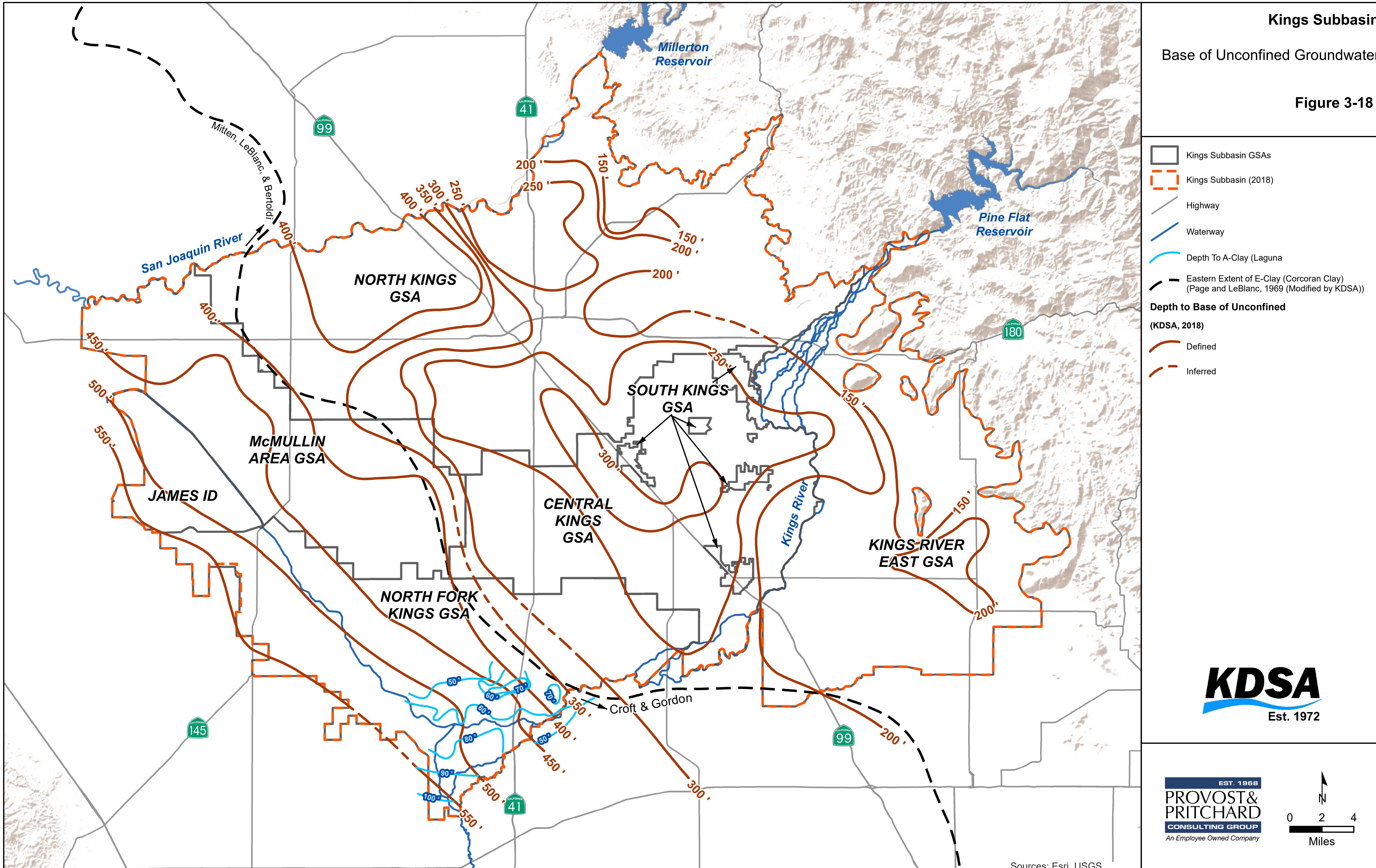
Vertical Extent

The lateral extent of the aquifer system within the Plan Area is described in Section 3.1.2 of this chapter. The vertical extent, i.e., depth, of the aquifer system in the Kings Subbasin is comprised of two separate boundary types and has been mapped by Page and LeBlanc (1969) and KDSA (2010). As shown on Figure 3-19, the vertical aquifer boundary for the Plan Area is the base of freshwater, which for the purposes of this HCM, is defined as groundwater with TDS content at or less than 2,000 milligrams per liter (mg/L). As shown on Figure 3-19, the saltwater/freshwater interface within the Plan Area is located at approximate depths ranging from 1,000 feet to 2,200 feet (KDSA, 2010). The cross sections above show the base of freshwater located mainly below the Qoao bottom and within the QTc.

For the purposes of this HCM the base of the fresh water is considered the base of the useable aquifer as James GSA is not bounded to the east by the bedrock of the Sierra Nevada nor on the west by the bedrock of the Coast Range. In 2010 KDSA developed contours for the Kings Subbasin for the depth to connate water. The depth to connate water is the depth to the base of fresh water based on a TDS of 2,000 mg/L. or about 3,000 uS/cm electrical conductivity (Figure 3-19). This map shows that the base of the aquifer, defined here as the base to fresh water (or depth to connate water), deepens southwestward across the James GSA from about 800 to 1,200 feet to at about 2,400 feet. The southwestward deepening of the base of fresh water is in general agreement with the USGS developed base of fresh water as shown on the Geologic Cross sections above (**Figure 3-9** to **Figure 3-14**)

Aquifer Characteristics

Aquifer characteristics of importance to the James GSA 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, 1932). 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.



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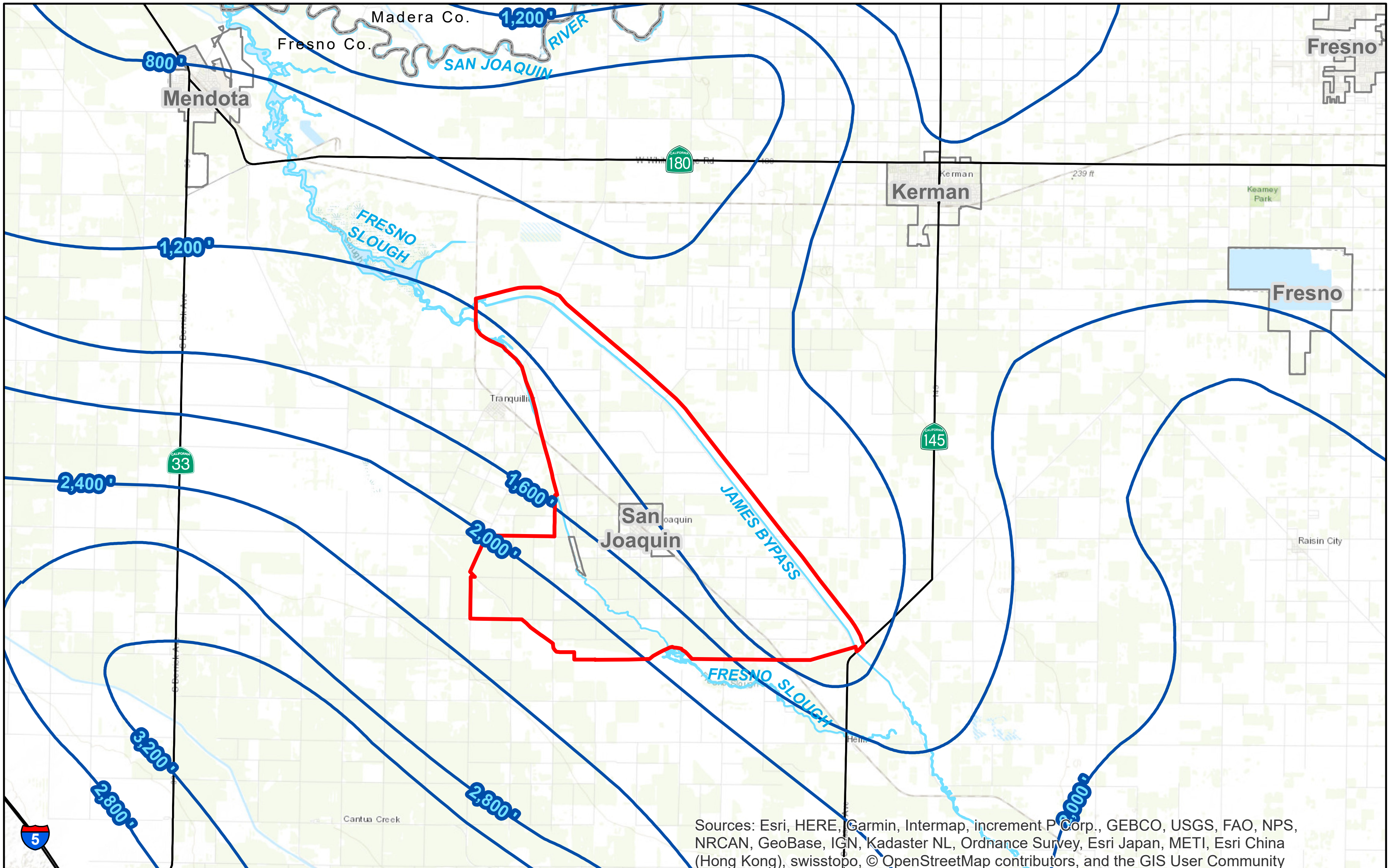

EST. 1968 PROVOST& PRITCHARD CONSULTING GROUP
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James GSA
City
County
Approximate Depth to Connate Water (ft)**

Note: **Connate water is where Total Dissolved Solids approach 2,000 mg/L, KDSA 2010.

James GSA

Base of Aquifer

Figure 3-19

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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, 1932). 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, a review of available published sources of specific yield data was conducted (**Appendix 3-A**). Initial sources of specific yield values used in the evaluation included Davis et. al. (1959), Page and LeBlanc (1969), and Williamson et. al. (1989). Additional information is available on specific yields in the basin from regional modeling efforts, but these aren't considered as accurate as the previous references. These three sources are used in most of the Kings Subbasin as the derived estimates of specific yield are based on deposit descriptions (texture), electric logs, laboratory analysis of soils samples, and a relatively simple and transparent methodology.

Within the James GSA, additional evaluation of specific yield values was performed by KDSA as part of **Appendix 3-A, TM 2** since the values from Williamson et. al. (1989) were estimated over the entire saturated thickness of the aquifer, down to depths of several thousand feet (i.e., below the E-Clay). As documented by Page and LeBlanc (1969), deep Quaternary and Tertiary age 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 are lower than specific yield values in the unconfined aquifer above the E-Clay.

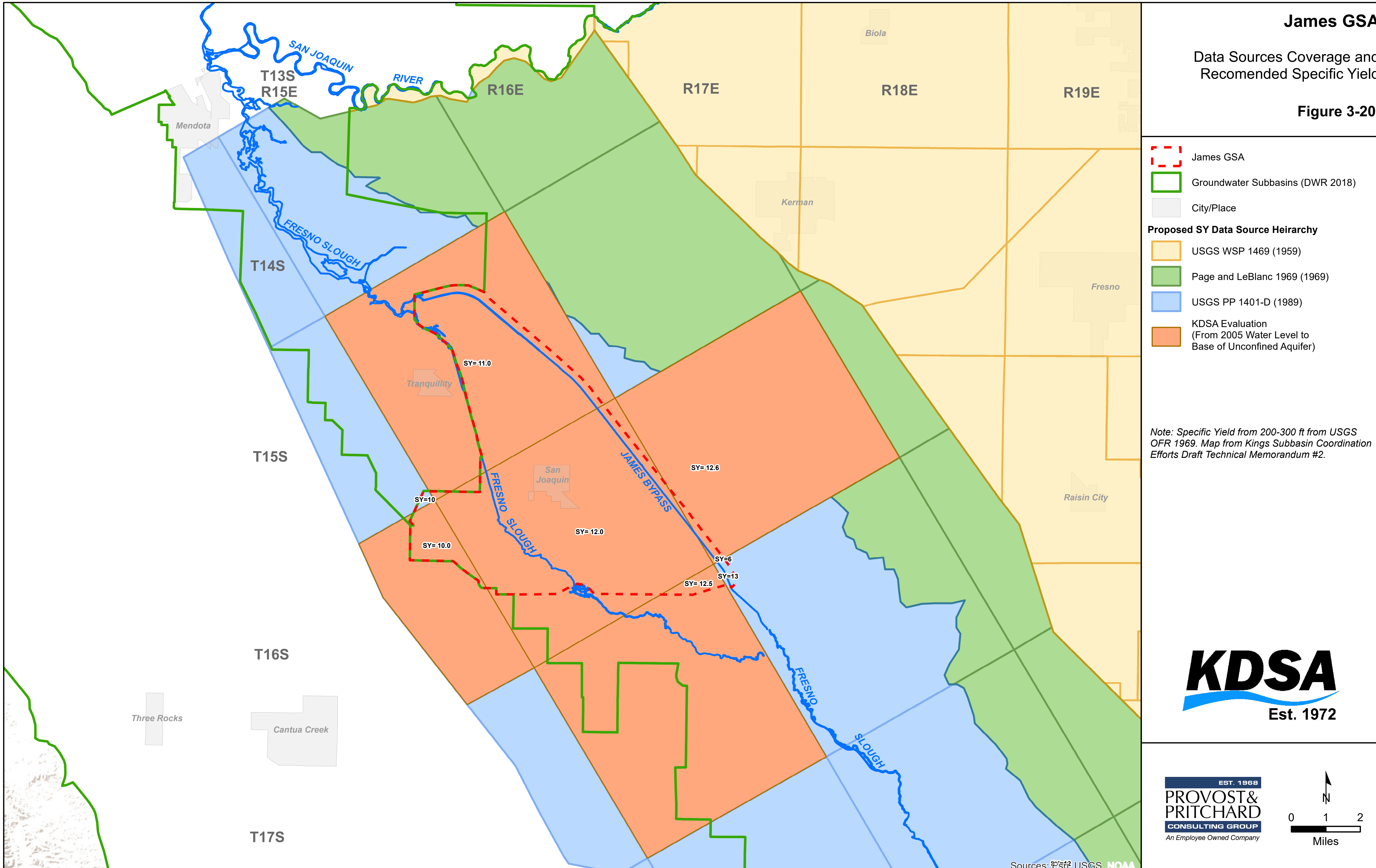
The KDSA evaluation of specific yield values for the James GSA (**Appendix 3-A, TM 2**) was based on electric logs, geologic logs, and DWR Well Completion Reports. The data were used to develop several subsurface geologic cross sections in the area. On the subsurface cross sections, three types of deposits are shown: sand or coarser materials, clay or silt, and intermediate type materials, such as sandy clay. 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 James GSA, KDSA compiled a map for the James GSA showing the recommended specific yield values for use in calculating changes in storage. This map is presented in this HCM as **Figure 3-20**. As shown on **Figure 3-20**, recommended specific yield values for the Plan Area range from 11.0% to 12.6%.

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 James GSA, estimates of hydraulic conductivity range from a high of approximately 9.4 feet/day (ft/d) to a low of approximately 8.1 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.



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As part of the Kings Basin Coordination Efforts, transmissivity values were estimated from specific capacity compiled by Davis et el. (1964). The resulting transmissivity values were then refined where KDSA had aquifer test results and then used these to estimate groundwater flows at James GSA boundaries with other GSAs within the Kings Basin (KDSA, 2018c). Based on the evaluation (**Appendix 3-A, TM 5**), estimates of transmissivity along the internal GSA borders in the Kings Subbasin range from a low of 86,000 gallons per day per foot (gpd/ft) in the south to a high of 128,000 gpd/ft along the eastern border of the GSA.

3.1.8.3 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.

Groundwater is pumped extensively for agricultural use within the Kings Subbasin, as it is in the San Joaquin Valley as a whole to supplement surface water supplies to meet water demands. Domestic and municipal use of groundwater is also significant within the subbasin.

Similar to the Kings Subbasin as a whole, the aquifers in the James GSA are used for domestic, irrigation, municipal and industrial water supply purposes. Groundwater pumping for municipal uses occurs within the City of San Joaquin. Groundwater is used by the James Irrigation District to supplement the surface water supply in agricultural areas. There is other private domestic pumping within the Plan Area for rural residential and private well systems. Industrial uses are currently served by the City of San Joaquin and there is no known pumping by private entities for industrial uses within the Plan Area. Groundwater pumping for agriculture is typically measured using propeller-type flow meters, and the pumping varies each year based on the water demands and the availability of surface water supplies. In most years, pumping for agricultural irrigation is the largest groundwater demand within the James GSA. The estimated amounts of pumping are described in the Water Budget chapter of this plan.

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.

According to CDWR 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 (DHS) 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. Dibromochloropropane (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 in sporadic areas of the western portion of the subbasin. Elevated concentrations of fluoride, boron, and sodium can be found in localized areas of the subbasin. The discussion presented below is intended to present a generalized view of groundwater quality in this GSA. A more detailed discussion on groundwater quality is included in Groundwater Conditions, **Section 3.2.5**

Nitrate is an important constituent of concern in the area. Concentrations exceeding the MCL of 45 mg/L have been detected in some domestic and municipal wells. Data from KDSA, as discussed above, also show that nitrate concentrations are higher in the unconfined aquifer and decrease below the confining beds.

Some isolated plumes of contaminants such as Ethylene-Dibromide (EDB), 1,2,3-Trichloropropane (TCP), Methyl Tert-butyl Ether (MTBE), landfill leachate, uranium, arsenic, hexavalent chromium, and petroleum hydrocarbons are present in the Kings Subbasin and can present specific problems because they pose health risks or are at concentrations above drinking water standards. Most of the groundwater contaminants in the James GSA are being addressed by responsible parties through remediation, wellhead treatment, or avoidance. In some small communities within the Kings Subbasin, many domestic wells exceed water quality standards and residents continue to use the water due to lack of alternatives. There are no small community wells within the James GSA.

The discussion presented here is intended to present a generalized view of groundwater quality in the James GSA area. A more detailed discussion on groundwater quality is included in Groundwater Conditions, **Section 3.2.5.**

Due to the lack of groundwater quality data within other geologic units, Page and LeBlanc (1969) described general water quality of the Fresno area within the older Quaternary alluvium only. However, as discussed previously, this unit yields more than 90 percent of groundwater pumped from wells and is the most important aquifer in the area. Similar to the Kings Subbasin as a whole, groundwater in the James GSA area is predominantly of sodium-bicarbonate type. The major cations are calcium, magnesium, and sodium. Sodium appears to be higher in the western portion of the sub-basin where some chloride waters are also found (Page and LeBlanc, 1969).

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 Kings River, the San Joaquin River, and related waterways. Surface water features that affect the management of the James GSA area are shown on **Figure 3-21** and are discussed below.

The Kings River flows southwest from Pine Flat Lake (located east of the James GSA) and is the primary source of surface water to the Kings Subbasin. The Kings River is a natural river along much of its upper reaches, while its lower reaches have been re-channeled in some areas and include many weirs, diversion structures, and levees. The reach of the Kings River downstream of State Highway 145 is referred to as the James Bypass. The James Bypass was constructed by Reclamation District No. 1606 to divert flows from the Kings River around land that was developed for agricultural uses. Due to the construction of Pine Flat Dam and regulation of Kings River flows, water is typically not present in the upper portion of the James Bypass. Flows will typically occur in the James Bypass if Kings River water deliveries are being made to downstream diverters or if there are flood releases from Pine Flat Dam. In recent years, the James Irrigation District has released water down the James Bypass for groundwater recharge.

Water is delivered from the Kings River into the GSA Area primarily from a weir and diversion structure located on the James Bypass near State Highway 145. Water is diverted from the pool upstream of the James Weir into the James ID Main Canal where it can be conveyed by gravity to users within James ID.

Water from the Kings River can also be diverted upstream of the James Weir into a canal, referred to as the Eastside Canal, running along the eastern extent of the James Bypass. This canal is used by James ID to store water in basins located within the James Bypass, to serve irrigation demands of water users outside of the James GSA along the Eastside Canal, to irrigate lands owned by Reclamation District No. 1606 within the James Bypass, and to divert water to other entities outside of the James GSA having agreements with James ID and/or RD 1606.

Kings River water can also be delivered down the James Bypass into the Mendota Pool where it is pumped by James ID into the James ID Main Canal where it can be conveyed by gravity and lift pumps to users within James ID.

Kings River water can also be delivered into an impoundment created by Mud Dam located at the south end of the Plan Area. Kings River water can flow into the impoundment from the Lone Willow Slough or from spills from the Crescent or Stinson Canals. Mud Dam can also be used to capture surface water runoff from local rainfall although this use is less prevalent after the construction of the San Luis Drain which limits local surface water flood flows caused by rainfall events..

The San Joaquin River flows from Millerton Lake (located northeast of the James GSA). The San Joaquin River is a natural river along much of its upper reaches, while its lower reaches have been constrained by flood protection levees. Mendota Dam, constructed north of the Plan Area, traditionally served to impound water from the San Joaquin and Kings River for irrigation purposes. The impoundment created by the Mendota Dam, the Mendota Pool, backs water up into the James Bypass and Fresno Slough.

The U.S. Bureau of Reclamation utilizes the Mendota Pool to make water deliveries to entities within the James GSA. Water is delivered into the Mendota Pool by the Delta-Mendota Canal. This water then flows from the Mendota Pool into the James Bypass where it is pumped by James ID into the James ID Main Canal where it can be conveyed by gravity and lift pumps to users within James ID.

Mendota Pool serves as an important feature in the James GSA because it continually impounds water and allows reaches of the James Bypass and Fresno Slough to be continually inundated. The continuous inundation of these surface water features serves as a source of recharge for the unconfined aquifer overlying the James GSA.

The distribution system of the James ID also serves as an important surface water feature. The system consists of the James Main Canal, a series of laterals spaced one-half mile apart, and numerous regulating, storage, and recharge basins. The system delivers irrigation water to users eleven of twelve months of the year. The basins and laterals serve as a continuous source of recharge for the unconfined aquifer.

3.1.11 Source & Point of Delivery of Imported Water

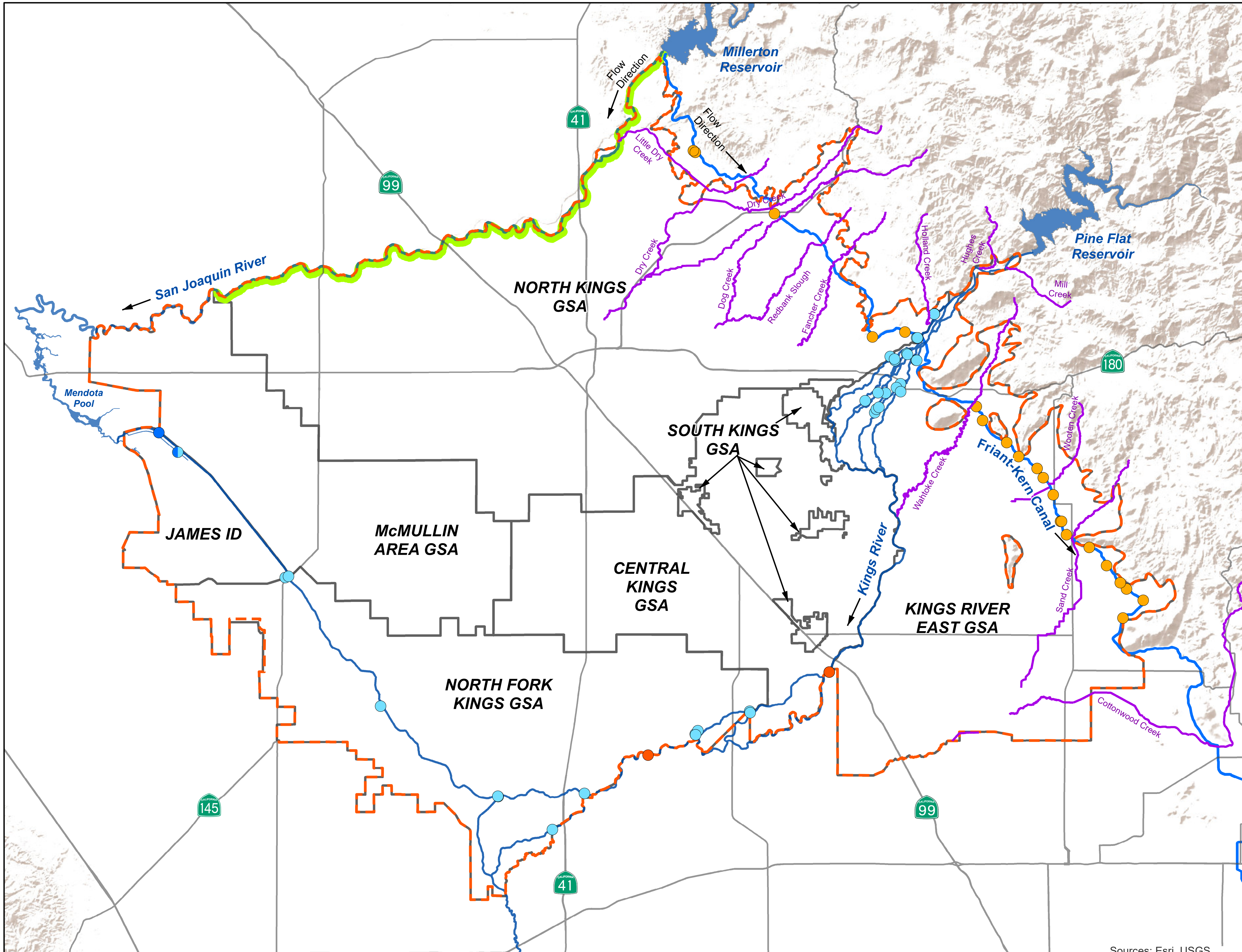
Regulation Requirements:

§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 in the Kings Subbasin occurs from diversions from the Kings River, a local water source. Additional sources of local surface water in the subbasin occur from diversions from the San Joaquin River and stored San Joaquin River water delivered via the Friant-Kern Canal. A source of imported water for the Subbasin is from the Mendota Pool via the Delta-Mendota Canal. See **Figure 3-21** for a map of surface water features significant for the management of the Kings subbasin and points of delivery for imported water supply. More detailed information on the surface water features within the GSA is discussed below.

Entities within the James GSA receives water from the Kings River, San Joaquin River, and imported Central Valley Project supplies through the Delta-Mendota Canal. A small amount of Friant-Kern Canal water may occasionally be available and imported into the Plan Area in above average water years. James ID also brings in groundwater produced within the McMullin Area GSA which is outside of the Plan Area.

The point of delivery for imported delivered from the Central Valley Project through the Delta-Mendota Canal is the James ID P-Booster Station located on the James Bypass at the southeastern extent of the Mendota Pool. (Figure 3-22) Deliveries of waters originating from the Kings River or San Joaquin River watersheds are not considered imported water by entities within the James GSA since those entities have rights to water from both rivers.



Kings Subbasin

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

Figure 3-21

- Kings Subbasin GSAs
- Kings Subbasin (2018)
- 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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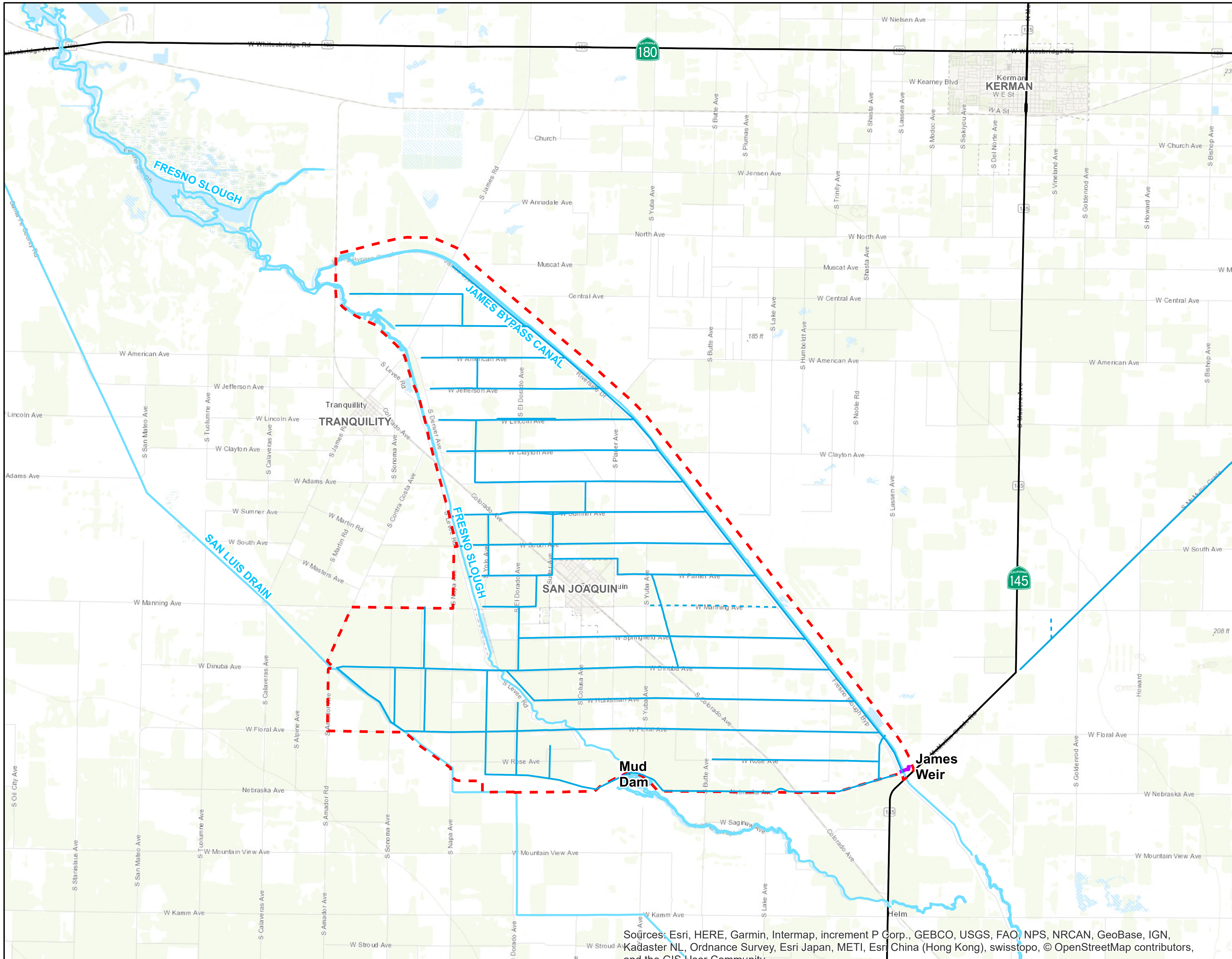


James GSA

Surface Water Features Significant to the Management of the James GSA Basin

Figure 3-22

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.

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

Existing Recharge Areas

The James GSA area includes natural recharge areas and constructed recharge basins. Natural recharge occurs from seepage from the Kings River and unlined irrigation canals and ditches. Natural recharge from percolation of precipitation is considered minor. Agencies within the James GSA engage in some form of recharge, ranging from seepage from unlined regulating reservoirs, stormwater basins, wastewater effluent ponds and dedicated recharge basins. Existing surface water features that are used for recharge are illustrated on **Figure 3-22**. Deep percolation of agricultural and landscape irrigation also makes significant contributions to groundwater recharge.

Potential Recharge Areas

Potential recharge areas can be preliminarily identified using available soil and geologic maps as described below. These maps provide a regional assessment of recharge potential and can be useful for initial screening. It should also be recognized that land availability is generally a limiting factor in the selection of recharge areas as is the availability of a water supply source.

Soils

A soils map based on Natural Resource Conservation Service soil textural classes in relation to Saturated Hydraulic Conductivity is presented as **Figure 3-8**. This map generally represents soils in the upper five to seven feet of the soil profile. The most permeable soils appear to be on the eastern side of the GSA. Refer to **Section 3.1.6** for further discussions on the soils within the James GSA.

Geologic Facies

Deeper soil conditions (7 to 50 feet in depth) are also important in evaluating recharge potential. **Figure 3-23** shows a map of geologic facies favorable for groundwater recharge prepared by Page and LeBlanc (1969). Facies is a geologic term that means the appearance and characteristics of a sedimentary deposit that is used to distinguish one subsurface material from another subsurface materials. The facies data is based on descriptions of texture to a depth of 300 feet. Six facies categories were defined, including Facies A through Facies F. **Figure 3-23** only shows the facies within the Kings Subbasin that are predominantly coarse-grained materials

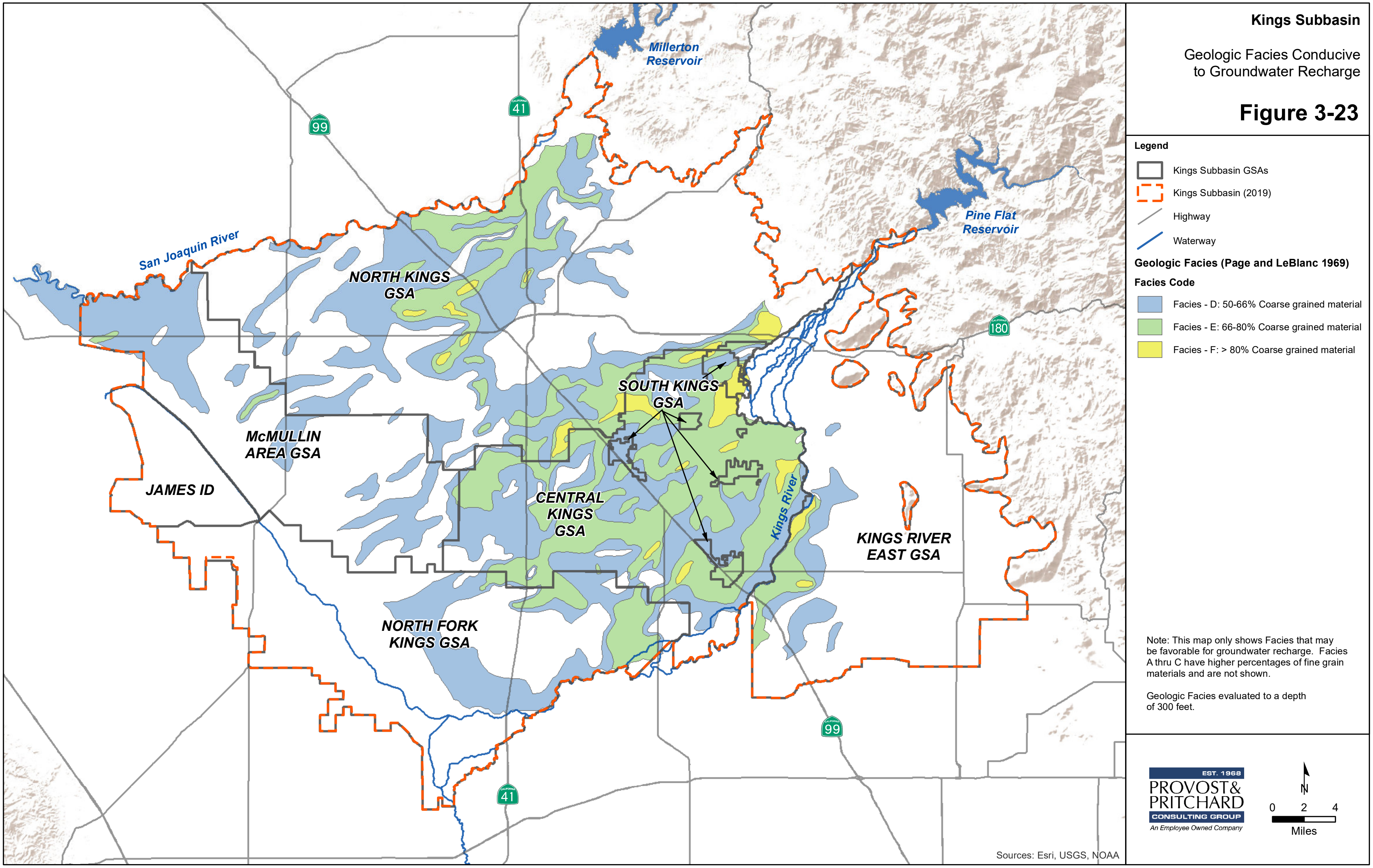
Soil Agricultural Groundwater Banking Index

The University of California, Davis and the University of California Division of Agriculture and Natural Resources developed the Soil Agricultural Groundwater Banking Index (SAGBI). The Index is a composite evaluation of the feasibility of groundwater recharge on the surface of agricultural land, which is also called Irrigation Field Flooding. Irrigation Field Flooding could have significant potential for groundwater recharge due to the large areas of irrigated agriculture in the GSA. The following five parameters are incorporated into the Index:

1. Deep percolation is dependent upon the saturated hydraulic conductivity of the limiting layer.
2. Root zone residence time estimates drainage within the root zone shortly after water application.

3. Topography is scored according to slope classes based on ranges of slope percent.
4. Chemical limitations are quantified using the electrical conductivity (EC) of the soil.
5. Soil surface condition is identified by the soil erosion factor and the sodium adsorption ratio (SAR).

Proximity to a water conveyance system is not a factor considered in the SAGBI composite evaluation. Each factor was scored on a range, rather than discretely, and weighted according to significance. Adjustments were then made to reflect soil modification by deep tillage (i.e., shallow hard pan is assumed to have been ripped by historic farming activities). **Figure 3-24** illustrates the SAGBI Index for the James GSA. Ultimately, SAGBI seeks to categorize recharge potential according to risk of crop damage at the recharge site. Usefulness of the index is diminished when evaluating locations for dedicated recharge basins that would be excavated. In these cases, a soil profile demonstrating deep percolation potential may prove to be more useful. As is the case with any model, the SAGBI is best applied in conjunction with other available data and on-site evaluation.



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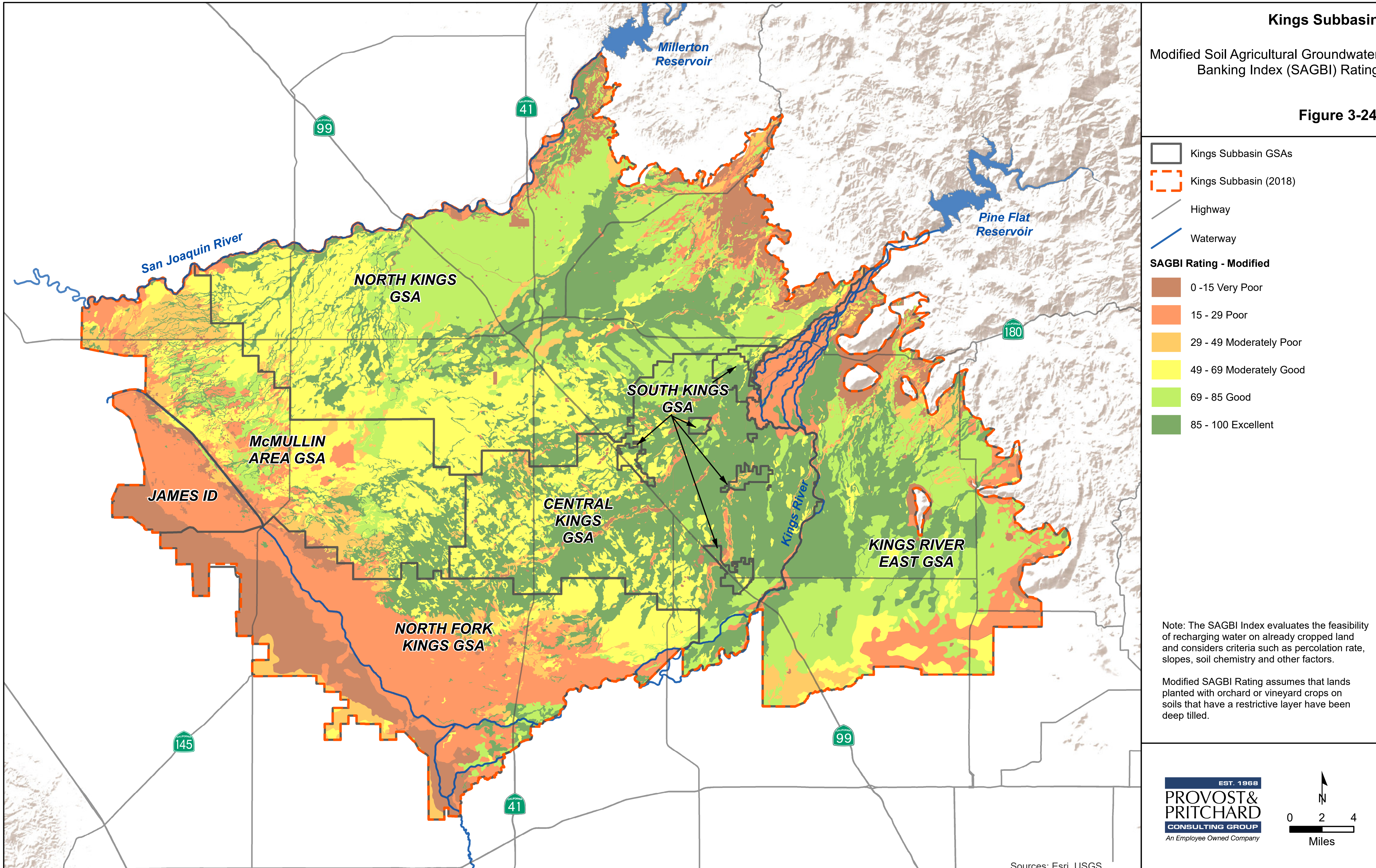

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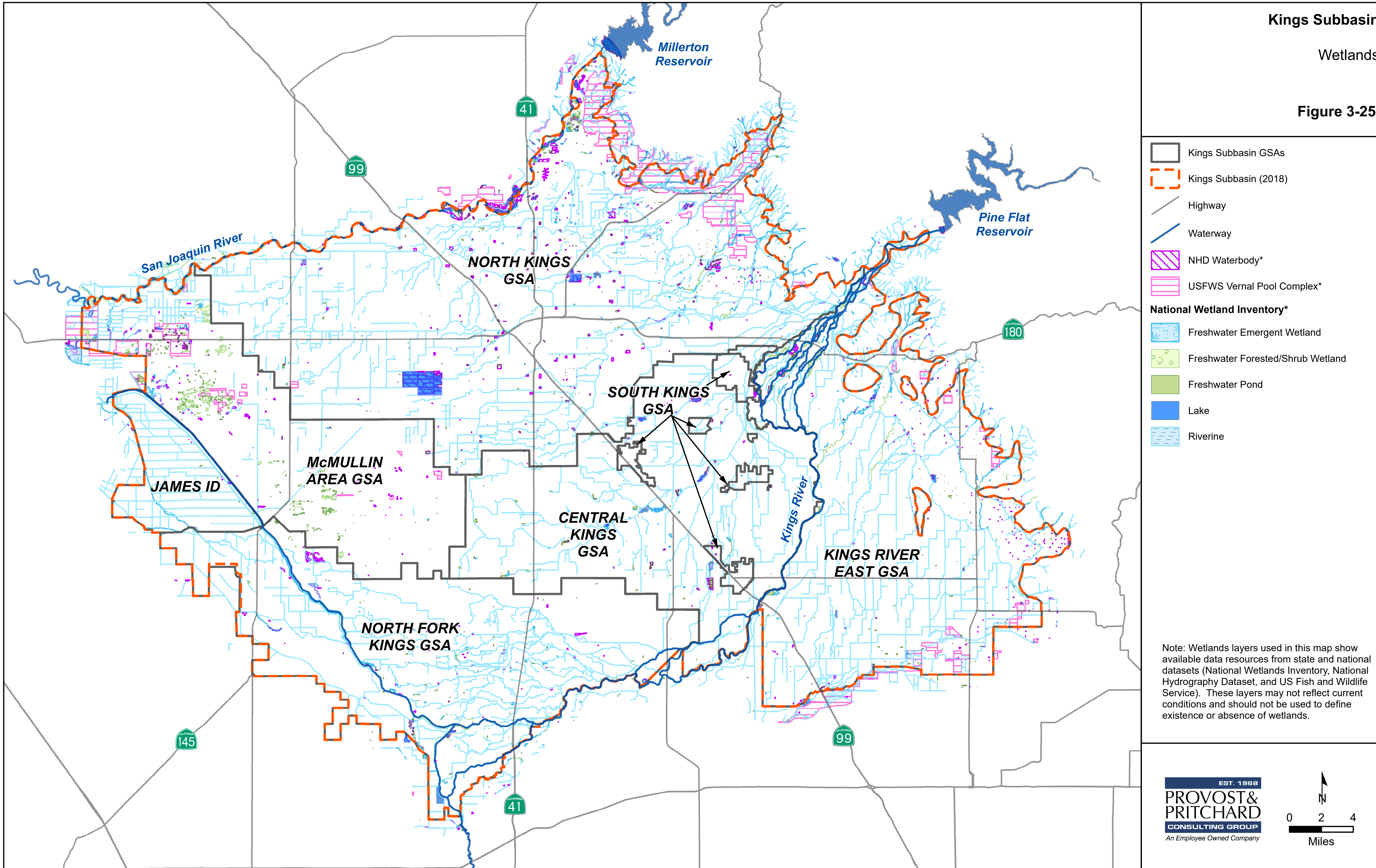
Discharge Areas

Prior to development and under natural conditions, groundwater in the Kings Subbasin moved southwestward from the Sierra Nevada and toward the center or trough of the valley. During this time, artesian conditions caused some water in the western portion of the subbasin to move upward from the confined aquifer toward the surface (Page & LeBlanc, 1969). See Section 3.2 for further discussion. Following development and significant pumping of groundwater in the subbasin, the occurrence of groundwater discharges (springs, seeps, etc.) were greatly reduced. Currently, no known springs, seeps, or artesian wells are in the James GSA.

Wetland Areas

Wetland areas from the U.S. Forest Service, National Wetland Inventory are shown on **Figure 3-25.** Most wetlands are near the Kings River, which flows sporadically in the James GSA area. Some of the areas shown indicate perched shallow groundwater conditions caused by a shallow restrictive clay layer. Some of the recharge basins in the area are also mapped as wetlands, but these basins rarely contain water for extended periods of time.



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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 3-18**. 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 (USGS 1999-H, Croft, 1971). 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 3-18**, 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 chapter includes a description of important current and historical groundwater conditions within the James GSA based on the best available data. Groundwater conditions described in this chapter include groundwater levels, groundwater storage, groundwater quality, land subsidence, and surface water and groundwater interconnections. This chapter provides historical monitoring data collected by various agencies including DWR, Kings River Conservation District (KRCD), NASA, and others. Refer to **Section 5** for descriptions of the monitoring programs that will continue to be used to collect data for implementation.

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 3-26 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 terms, 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 3-27** 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 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 parts of James ID GSA. Groundwater levels generally fell in McMullin GSA but did rise near the border with James GSA.

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 3-26**). 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 NKGSA. 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 3-26** and **Figure 3-27**). A groundwater ridge along the San Joaquin River can be seen in **Figure 3-26** and **Figure 3-27** extending approximately the length of the North Kings GSA area. Starting on the northwest corner of the North Kings GSA area, groundwater (seepage) from the San Joaquin River flows southerly to southwesterly towards the McMullin GSA.

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 3-28, 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 and Miller, 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 3-29** under natural pre-development conditions some water in the confined aquifer flowed upward throughout the entire James GSA area.

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 3-28, Inset C**). As shown on **Figure** 3-28, 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 3-28, Insets B and C** illustrate this changed flow pattern near the San Joaquin River.

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 C.C, ed. 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, CC. ed. 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 Kings Subbasin 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.

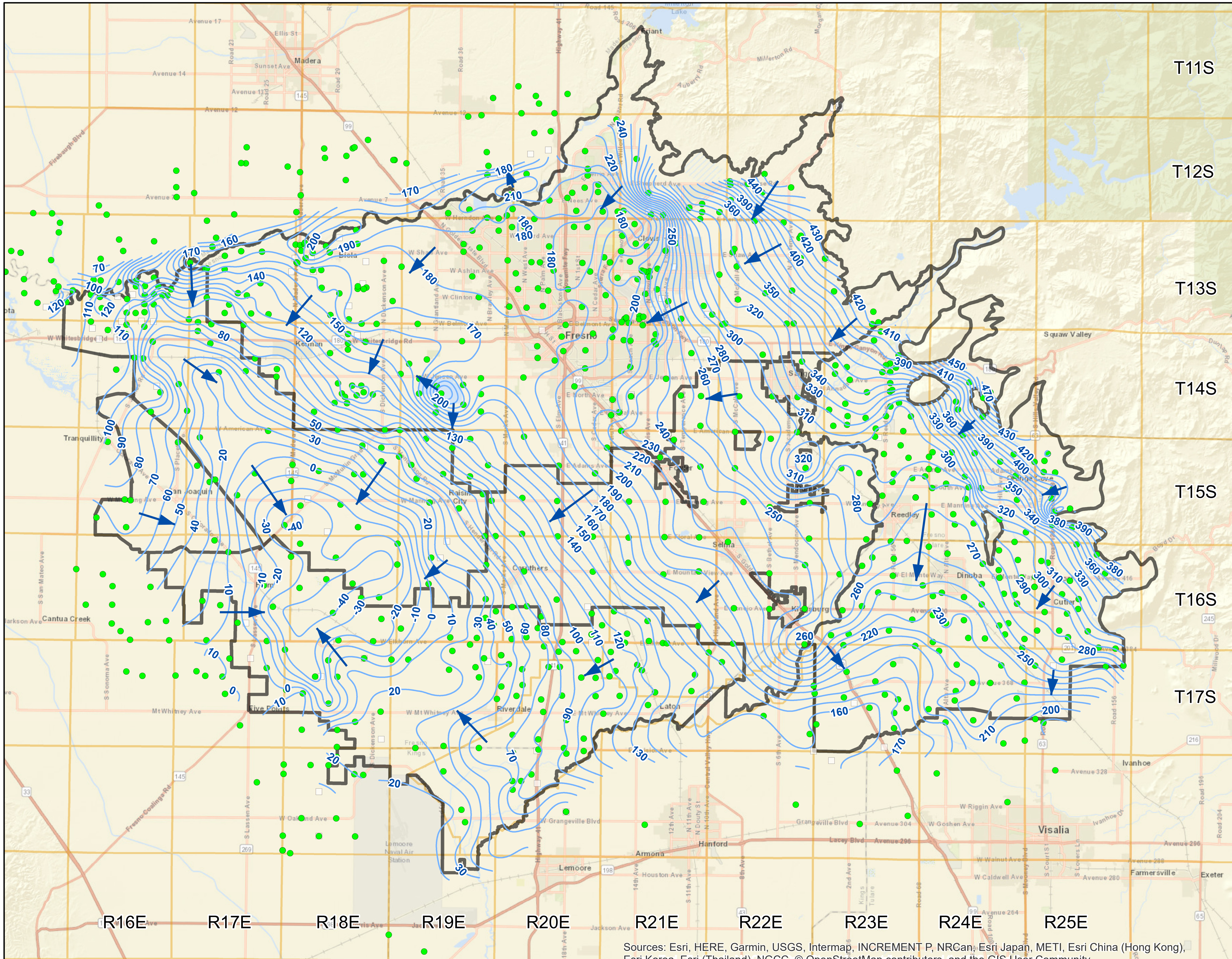
Water levels are available from four nested monitor wells installed near the boundary between the Kings Subbasin and the Westside Subbasin under a DWR DAC grant. These wells have casings perforated above and below the Corcoran clay. Water elevation differences between unconfined and confined groundwater 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.

§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.

Kings Subbasin Estimated Storage Change

As described in 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 3-30**, below, for the Kings Subbasin. The methods for estimating storage change are detailed in Technical Memorandum 4 (**Appendix 3-A, TM 4**). 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.



Kings Subbasin Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2017
Groundwater Elevation Contours

Figure 3-26

- Kings Subbasin GSAs
- Township/Range
- Well - Data Used
- Well - Data Not Used
- Generalized GW Flow Direction

Water Level Contours

- Line of Equal Elevation (10ft interval)

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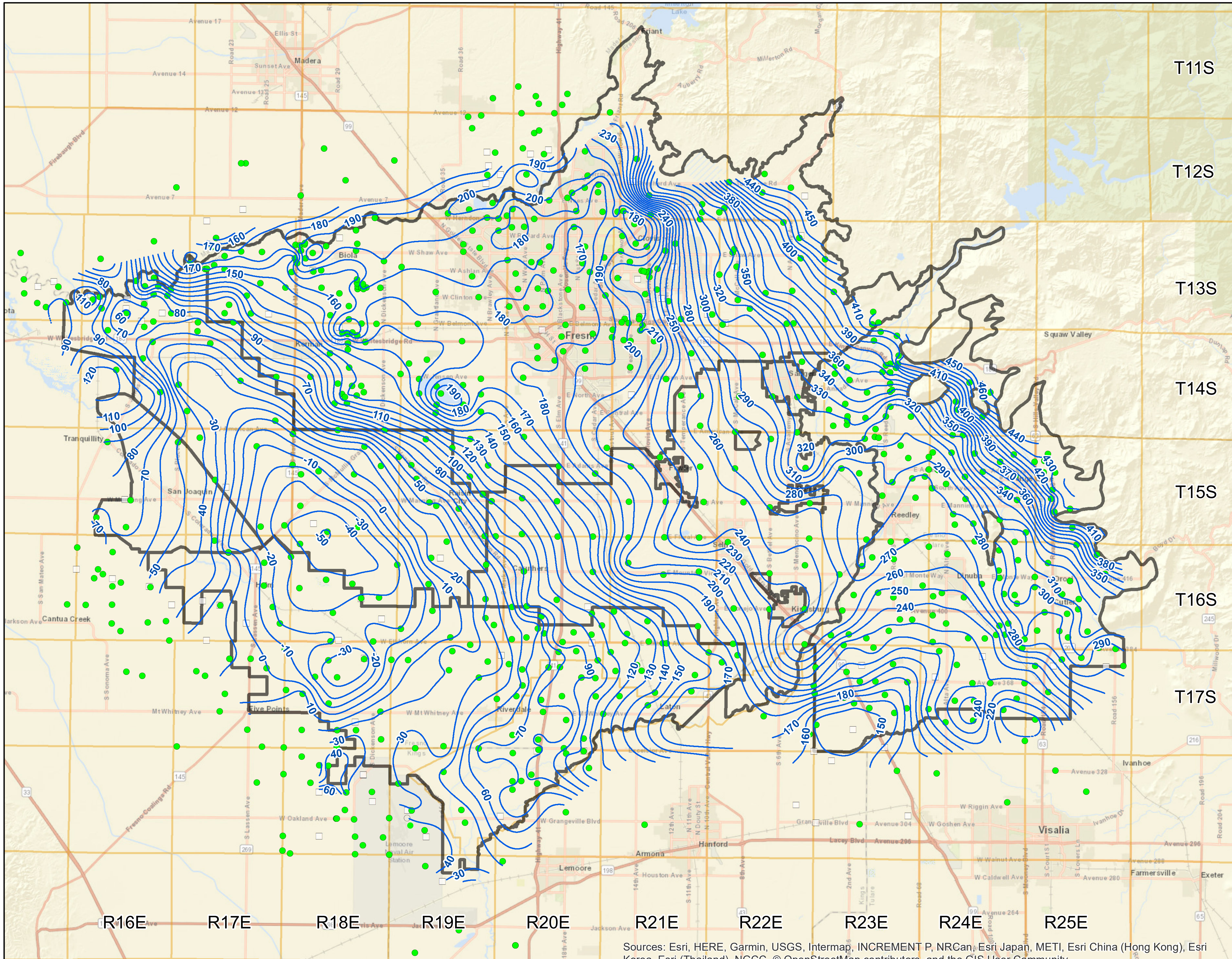

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Fall 2017
Groundwater Elevation Contours
Figure 3-27

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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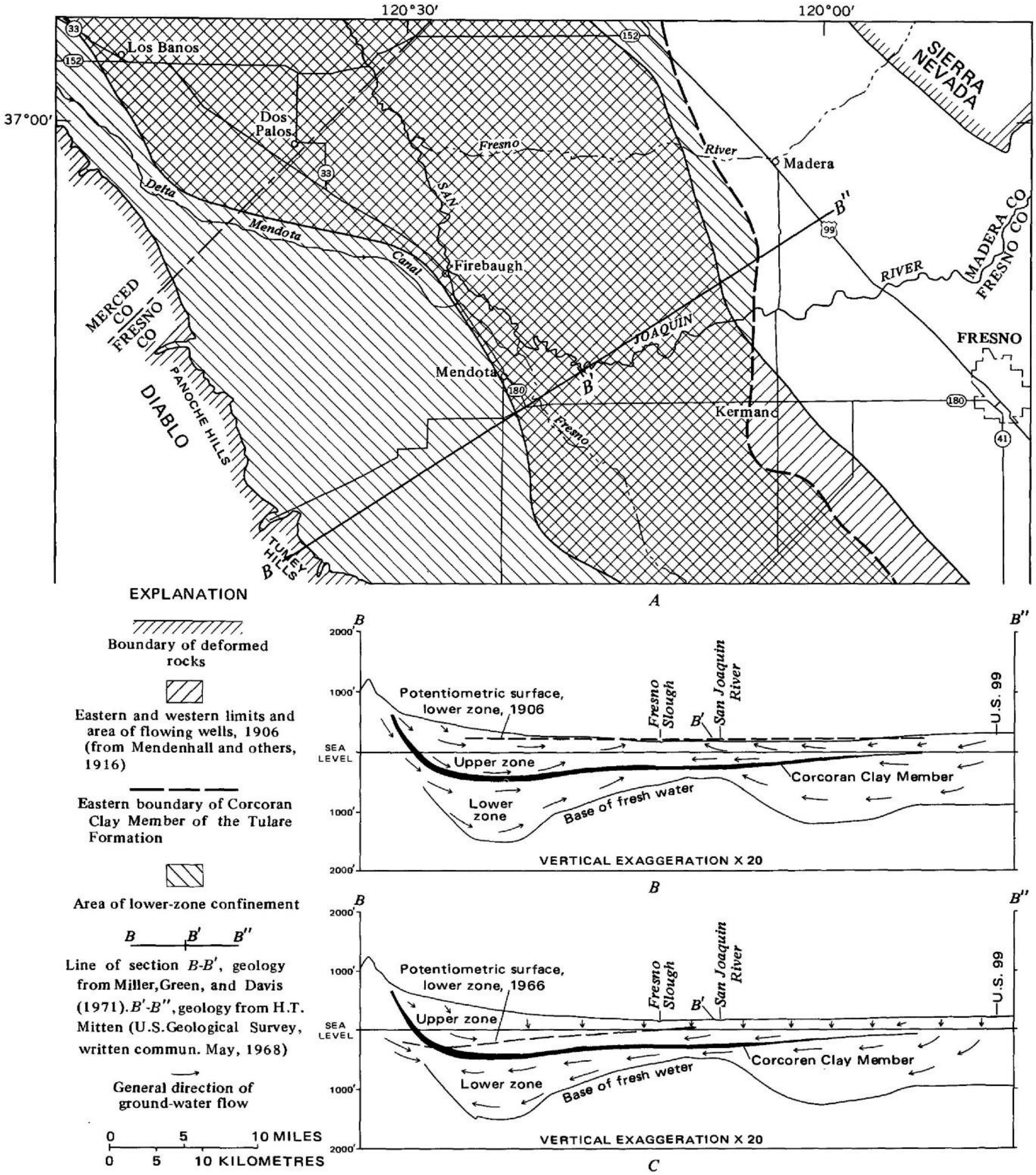
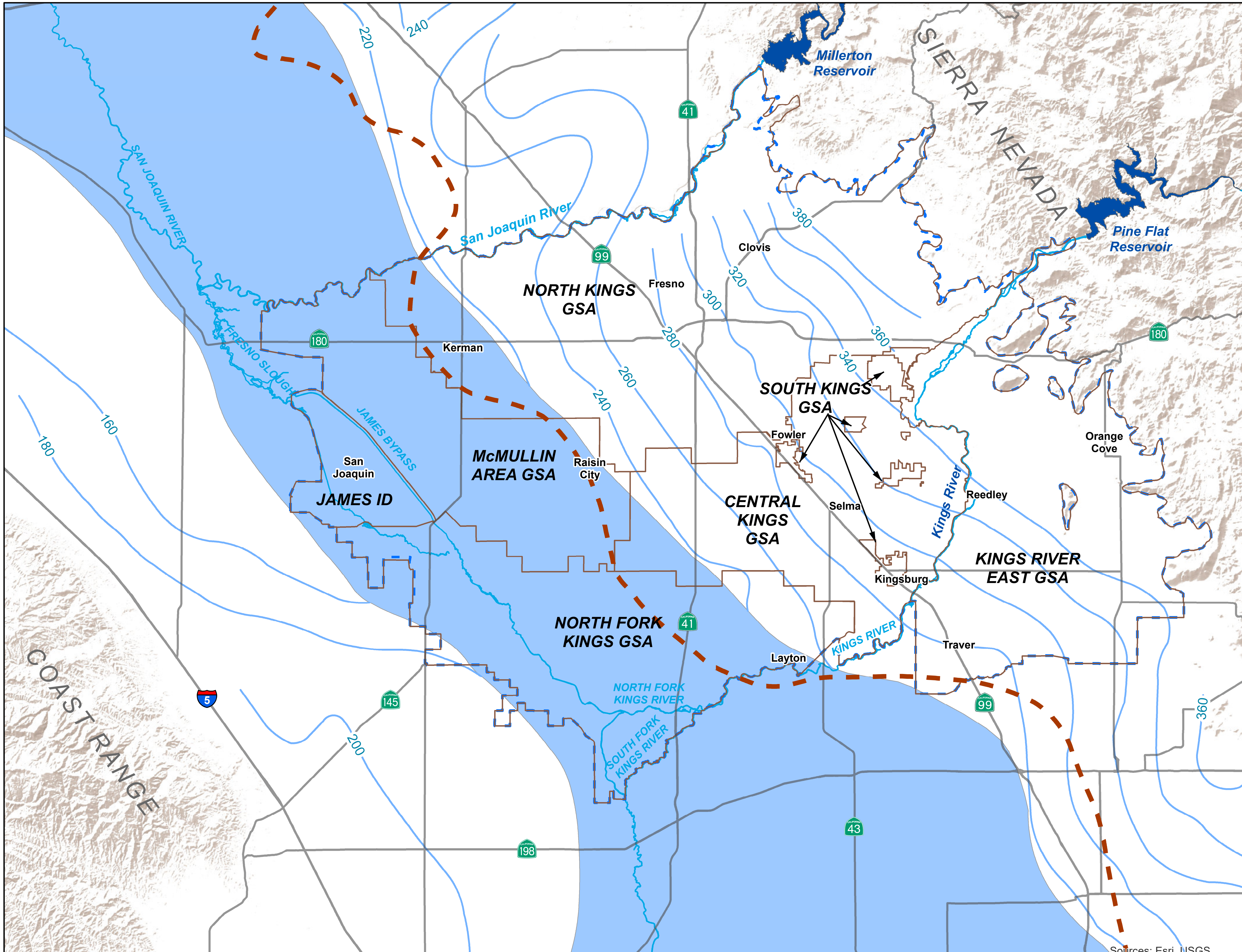


Figure 20 from Bull and Miller, 1975.

Figure 3-28 Kings Subbasin Changes to Groundwater Flow Patterns



James GSA

Areas of Flowing Wells in 1906

Figure 3-29

- 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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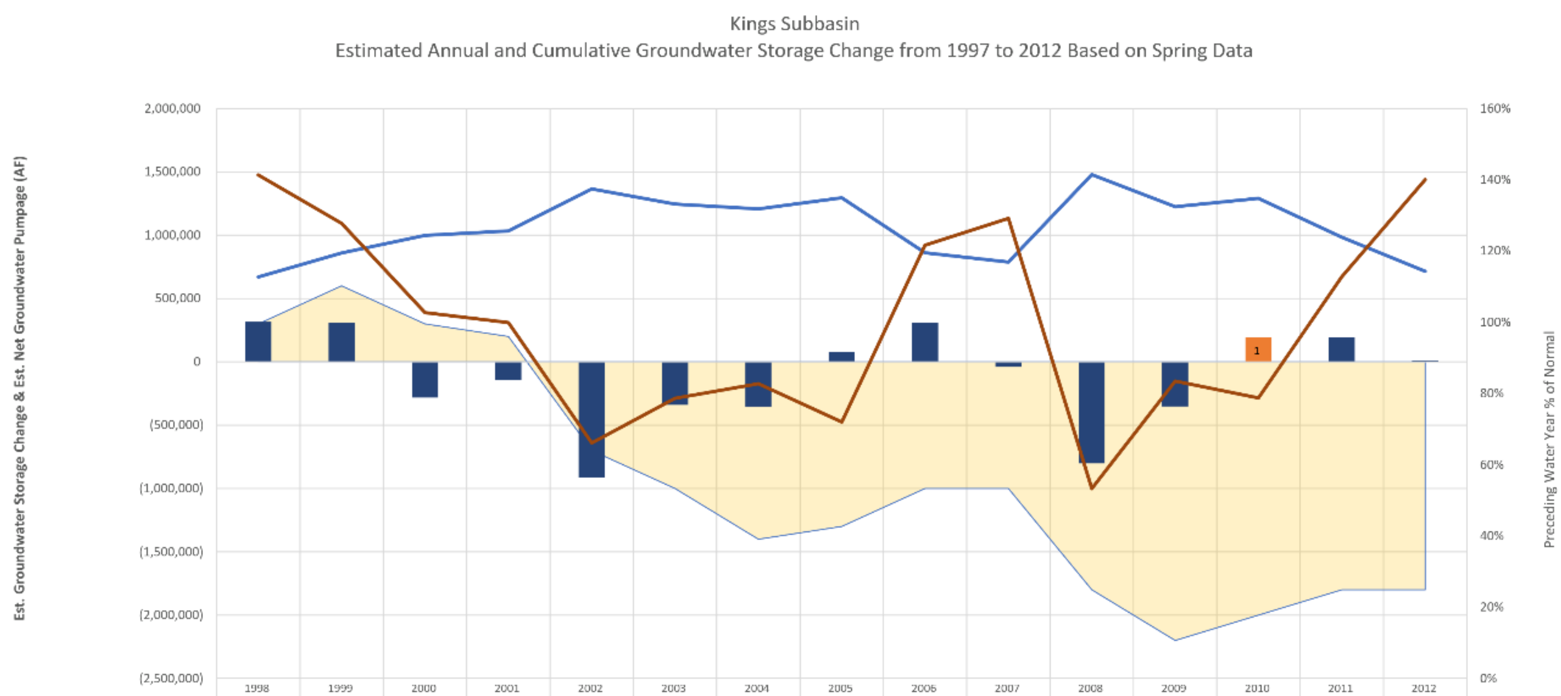


	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Cumulative Change in Storage, AF	300,000	600,000	300,000	200,000	(700,000)	(1,000,000)	(1,400,000)	(1,300,000)	(1,000,000)	(1,000,000)	(1,800,000)	(2,200,000)	(2,000,000)	(1,800,000)	(1,800,000)
2- Annual GW Storage Change, AF	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.

Figure 3-30 Graph of Storage Change, Seasonal High/Low WY, GW Pumped

This section presents groundwater elevation maps, groundwater depth maps, and well hydrographs throughout the GSA. These are provided respectively as **Figure 3-31, Figure 3-32 and Appendix 4-A**. Groundwater depth maps illustrate groundwater pumping levels. This depth to water data is what landowners are typically used to on pump test reports. Groundwater elevation maps are useful for showing the direction of groundwater flow and the locations of pumping depressions. The hydrographs illustrate long-term trends in groundwater levels.

Hydrographs of select wells within the GSA are included in **Appendix 4-A.** The locations of the wells are shown in **Figure 3-33**. The wells were selected based on the amount of historical data available and the availability of well construction information. Water level data is publicly available for a large number of wells within the GSA area, however, well construction information is often not available for many of the wells which limits their usefulness for monitoring purposes since it is not known what aquifer zone the water level is reflecting. Water elevation data for the selected well hydrographs with identified construction information was collected from the DWR CASGEM Online System and Water Data Library. The hydrographs shown include wells perforated at various intervals above the E-clay, the confining layer separating the unconfined and confined aquifer. Much of the publicly available water level data is from wells without known construction data, making the task difficult of identifying what aquifer the water level data is representing.

The hydrograph for the monitoring well in the confined aquifer (15S16E29N001M) depicts historical groundwater elevations and relationships as far back as 1929. Groundwater levels within the confined aquifer in the James GSA saw a considerable decline from 1929 to 1963 as agricultural land development progressed in the Kings Subbasin and the Westside Subbasin. There was a noticeable reversal in the trend in 1963 and the period from 1963 to 1990 experienced a continual increase in groundwater elevation in the confined aquifer. This increase is attributed to the delivery of Central Valley Project water supplies regionally. This trend of increasing groundwater levels stopped in 1990 and a period of rapid decline ensued. The rapid decline is attributed to a drastic reduction in Central Valley Project water supply allocations. There was a rebound in groundwater levels around 1996 and some stability in confined groundwater levels until 2006. There is a current declining trend in confined groundwater levels but occasional increases are noted after wet hydrologic periods.

The hydrographs for monitoring wells in the unconfined aquifer go back to 1952. Data from voluntary wells in the CASGEM program goes as far back at the 1920s but these wells are generally of unknown construction. All the hydrographs show a trend in declining groundwater elevations. The hydrograph representing conditions in the northern portion of the Plan Area (15S16E28A003M) shows changes from spring to fall readings of approximately -10 ft. The decline year over year has been gradual but more pronounced in recent years. This pattern is more pronounced in wells in the southern end of the Plan Area. The hydrograph for the monitoring well located on the southern boundary of the Plan Area (16S17E04P001M) has seasonal changes up to 50 feet but more typically 30 feet and a similar trend year over year. This is expected and believed to be representative of conditions outside the Plan Area within the groundwater cone of depression. Within the western portion of the Plan Area, the hydrograph for the unconfined aquifer monitoring well (15S16E28A003M) shows seasonal changes of up to 15 feet (in 2014 during a drought year) but typically 10 feet or less with a slight declining trend year over year.

3.2.2 Groundwater Movement

Groundwater moves from areas of high-elevation, such as recharge zones, to areas of low elevation, such as sources of withdrawal. Before groundwater supplies were extensively utilized, groundwater in the San Joaquin Valley flowed from the Sierra Nevada to the valley trough, generally southwest, and moved toward the San Joaquin and Kings Rivers (Page & LeBlanc, 1969). **Figure 3-31** shows that the current James GSA groundwater flow pattern is generally southeast towards a groundwater depression southeast of James GSA.

The natural groundwater flow generally follows the topography from east to west, sloping from the Sierra Nevada Mountains on the east to the trough of the Valley at the western edge of the GSA. Insufficient available surface water supplies in the McMullin Area GSA and the North Fork Kings GSA have caused agricultural users in those area to rely heavily on groundwater pumping. This pumping has created a groundwater elevation depression and has caused groundwater to flow away from the trough of the valley towards the depression. On groundwater elevation maps, the center of the depression appears in various locations between Raisin City and Helm within either the MAGSA or North Fork Kings GSA plan areas. The movement of the depression may be attributable to a lack of groundwater monitoring wells in the vicinity of the depression and map contouring methods.

Groundwater in the northern and eastern areas of the James GSA generally travels from northwest to southeast. Groundwater flows in the western portion of the James GSA appear to flow slowly in an easterly direction. In the southern area of the James GSA, groundwater appears to flow in an easterly direction. Groundwater elevation gradients in the unconfined aquifer are relatively flat in areas adjacent to the Westside Subbasin and the Delta-Mendota Subbasin and groundwater flows from these areas into the Kings Subbasin and the James GSA. Groundwater elevation gradients in the unconfined aquifer are rather steep in Plan Area adjoining other GSAs in the Kings Subbasin. The gradients are perpendicular to the Plan Area boundaries adjacent to MAGSA and roughly parallel to the boundaries adjoining James GSA indicating a substantial groundwater flow from the Plan Area into MAGSA.

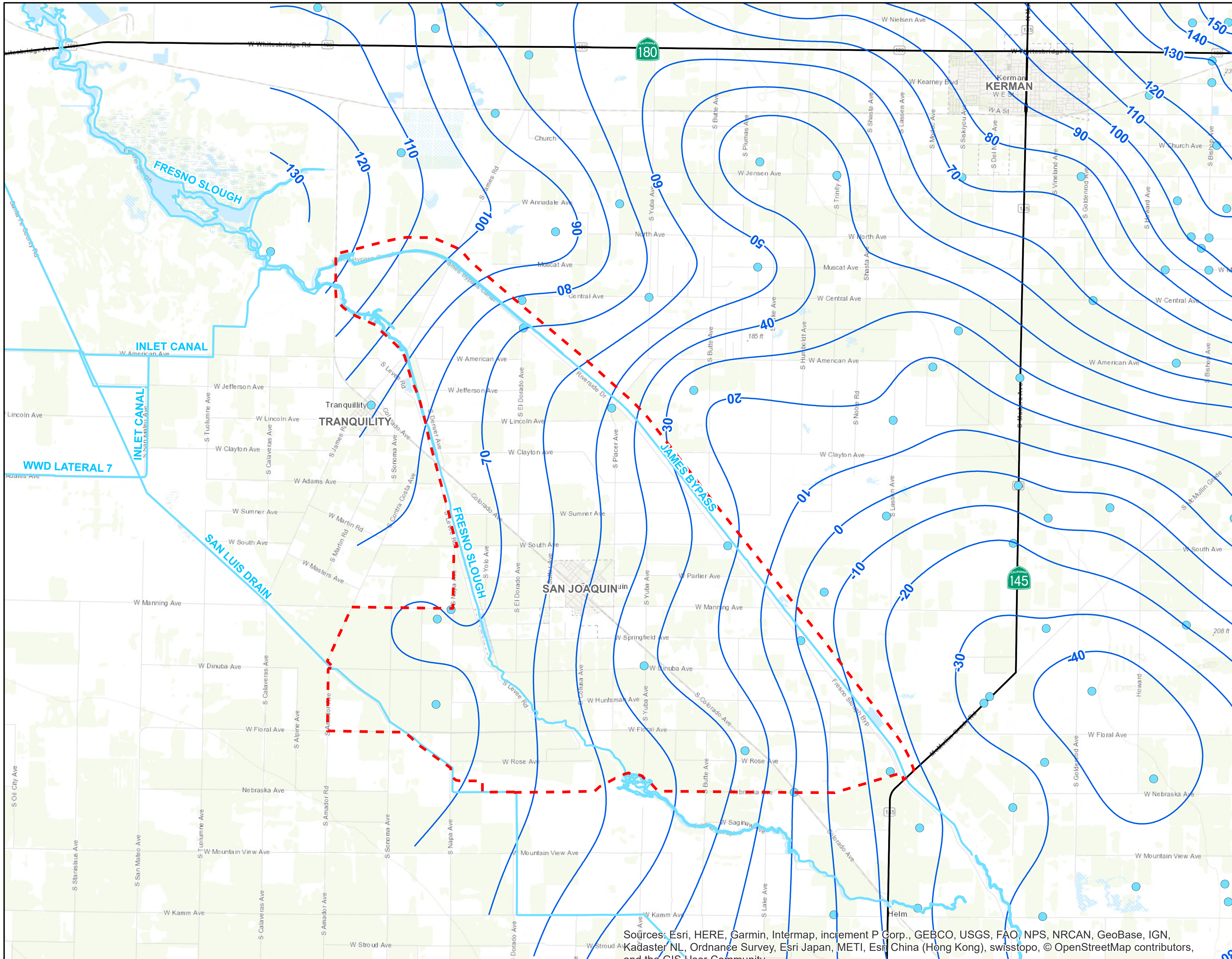
A great majority of the agricultural groundwater wells within the James GSA are owned and operated by the James ID. Most of these wells are located along the James Main Canal which runs along the eastern edge of the Plan Area. James ID also owns and operates wells in the southeastern area of the Plan Area. Wells in the southeastern portion of the Plan Area are operated more often than other wells because these wells have better water quality and can serve all areas within James ID by gravity conveyance. For this reason, the majority of the lands within James GSA are contributing water through percolation to the unconfined aquifer. As a note, flow gradients calculated from groundwater elevation contours do not account for these flows and methods using groundwater contours may underestimate groundwater flows. In dry or below-normal hydrologic years when groundwater pumping is required to augment surface water supplies, these groundwater flows are, in a sense, recaptured and brought back within the Plan Area by James ID using its wells in the southeastern portion of the Plan Area and outside of the Plan Area within MAGSA.

It is assumed that there is some flow between the unconfined and confined aquifer within the Plan Area. This flow is difficult to quantify given current information and is assumed to be negligible at this time. Vertical movement of groundwater between the unconfined and confined aquifers is generally discussed in Section 3.2.1.

James GSA

Elevation of Groundwater
Spring 2016

Figure 3-31



James GSA
Well (Used in Analysis)
Line of Equal Elevation (10 ft Interval)
Waterway

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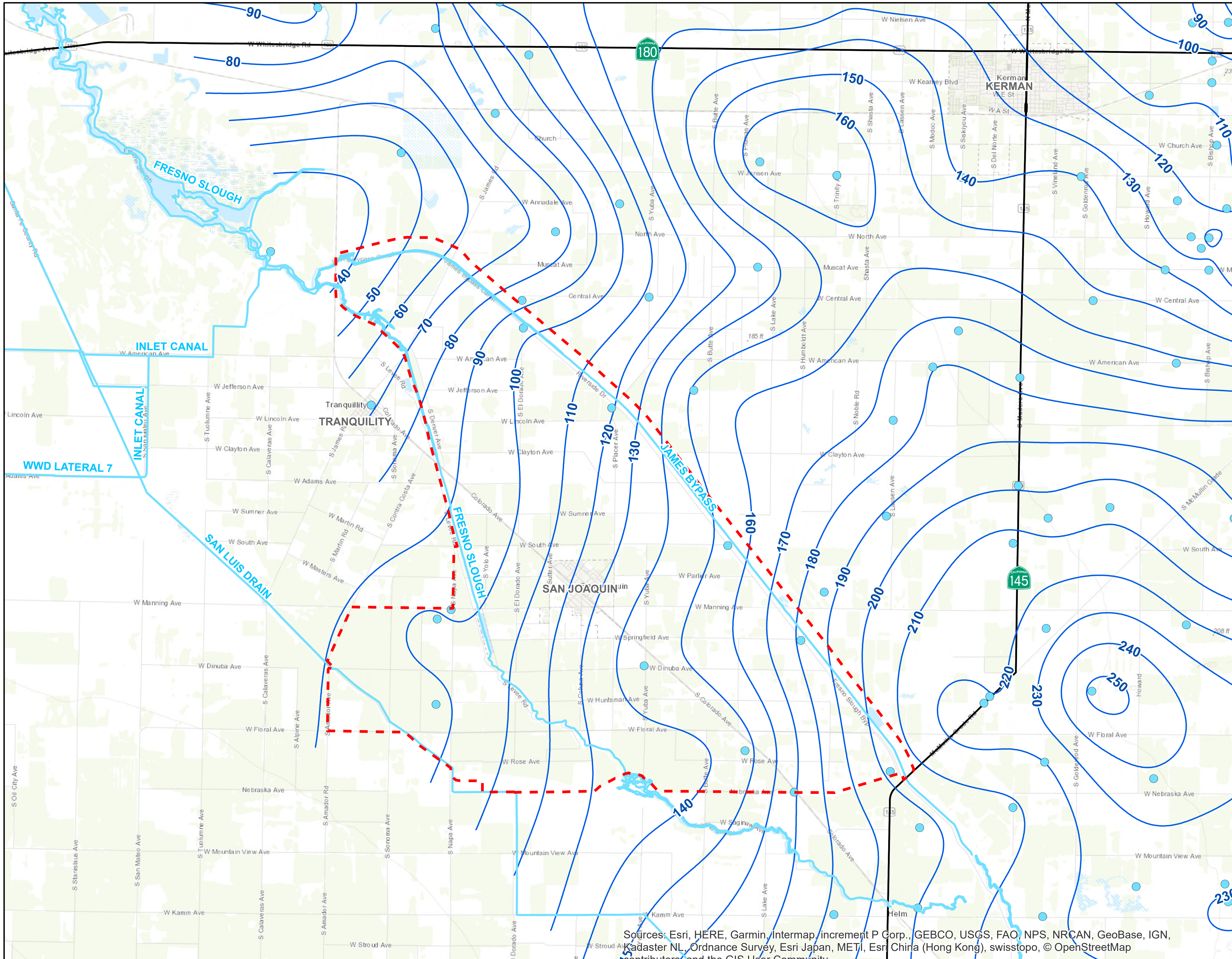

James GSA

Depth to Groundwater
Spring 2016

Figure 3-32

James GSA
Well (Used in Analysis)
Line of Equal Depth (10ft interval)
Waterway

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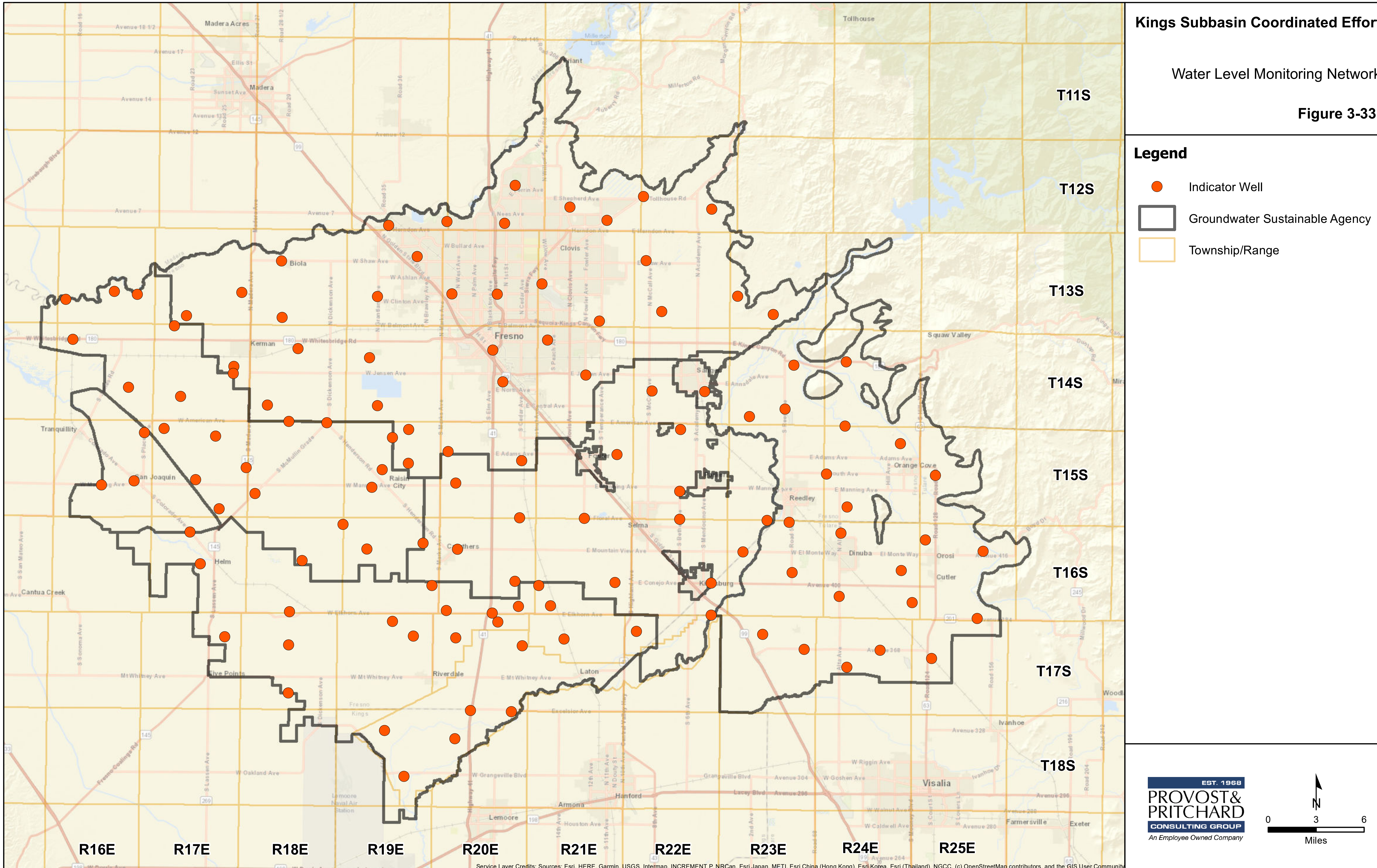

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3.2.3 Estimate of Groundwater Storage

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.

As part of the coordination of GSAs within the Kings Subbasin, a common method was utilized to estimate the change in groundwater storage for the entire subbasin and within each GSA during the hydrologic average base period. This method estimated storage within the upper unconfined groundwater aquifer. Estimated storage change in the lower confined aquifer is not possible at this time due to limited or no data from confined wells throughout the GSA. Refer to Section 3.1 – Hydrogeologic Conceptual Model for more details on the different aquifers in the GSA.

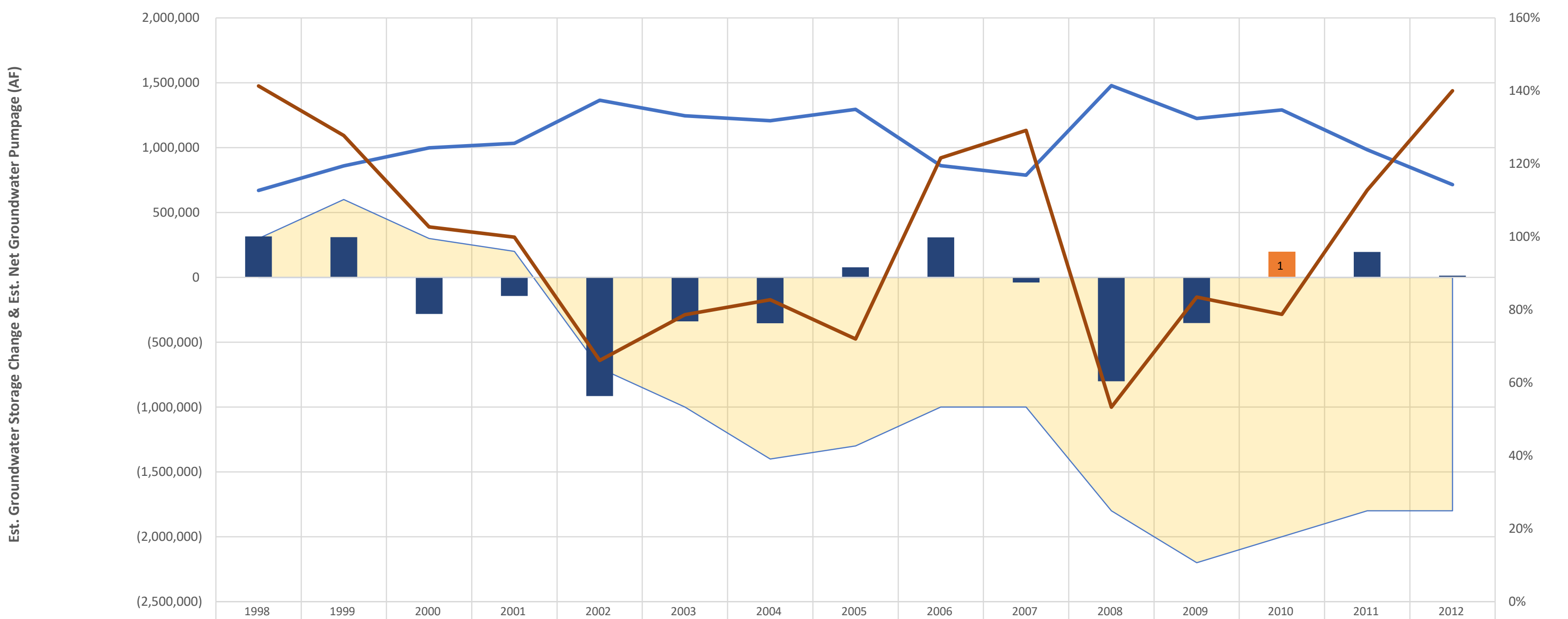
Appendix 3-A includes a Technical Memorandum that documents the basis for selecting specific yield values throughout the James GSA. The Technical Memorandum was developed as part of the Kings Subbasin coordination efforts. Specific yields for each subarea (predominantly by Township) were identified for varying depths: 0-50ft, 50-100ft, 100-200ft and 200-300 feet below the ground surface. USGS Water Supply Paper No. 1469 dated 1959 was a primary source, but other sources including USGS WSP 1401-D (1989) and Page & LeBlanc (1969) were used for portions of the James GSA which were not addressed in USGS WSP 1469. Appendix 3-A includes an evaluation of specific yield values for the entire Kings Groundwater Subbasin using the aforementioned sources. A map of the specific yield values for the James GSA is shown in Attachment 10 of that Technical Memorandum. The process for calculating storage change above 300 feet below ground surface includes the following steps:

1. Determine the base of the unconfined groundwater
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 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.

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 3-34** below, for the Kings Subbasin. The methods for estimating storage change are detailed in Technical Memorandum 4 (**Appendix 3-A**, **TM 4**). 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.

Kings Subbasin

Estimated Annual and Cumulative Groundwater Storage Change from 1997 to 2012 Based on Spring Data



	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.

Figure 3-34

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 front for each principal aquifer.

Seawater Intrusion is not a factor in the Kings Subbasin or the James GSA.

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 Data

Groundwater within the James GSA area is used to meet agricultural demands as well as those of the municipal and rural community systems shown in **Figure 3-35.** The groundwater quality assessment for the Plan Area has been prepared by using available information obtained from the California Groundwater Ambient Monitoring and Assessment (GAMA) Program database, which includes water quality information collected by the California Department of Water Resources (DWR), State Water Resources Control Board, Division of Drinking Water (SWRCB & DDW), and the United States Geological Survey (USGS).

Efforts to monitor water quality within the study area were initiated by DWR and USGS in the late 1940s and have continued over the last seventy-five years on an intermittent basis as part of a statewide program. These early water quality monitoring events focused on only a small set of water constituents.

The assessment of groundwater quality for the Southeast San Joaquin (SESJ) Valley and surrounding areas has been carried out through a series of USGS data collection and reporting efforts as part of the GAMA program. Data was assembled from three of the USGS data collection efforts (2008 USGS Data Series 351; 2013 Data Series 706; 2017 Data Series 1019) for the evaluation undertaken by this Plan. Superimposing the James GSA Plan Area boundary over the monitor wells utilized for the cited efforts allowed identification of four wells suitable for use in developing an initial characterization of groundwater conditions for the Plan Area. The wells are all used to produce agricultural irrigation water.

Additional data collection was achieved by area and downloading available water quality for wells within the Plan Area from the GAMA database. This data set was then reviewed to identify a set of wells that had either multiple years of water quality sampling data or wells with limited sampling though comprehensive in nature. An additional four wells with meaningful data sets were identified. These wells are municipal production wells used by the City of San Joaquin. Efforts were then made to correlate well identifiers to a filed DWR Well Completion Reports so the well construction information could be attained.

Final selection of water quality characterization wells was predicated on having well construction information, which for many of the recent USGS data collection efforts was provided in the cited USGS references, although this information was not always complete (e.g. may be missing well depths and/or depth of perforations). Where that information was not available, DWR Well Completion Reports were located through the GAMA online tool. In all, a total of 9 wells were used to characterize water quality in the Plan Area and its immediate environs. The list of selected wells is provided in **Appendix 3-B**. As seen in **Figure** 3-35, these wells are fairly well distributed across the Plan Area and adjoining the Plan Area and are suitable for providing a representative characterization of current groundwater conditions. No additional public water system areas or data was required for the representative characterization.

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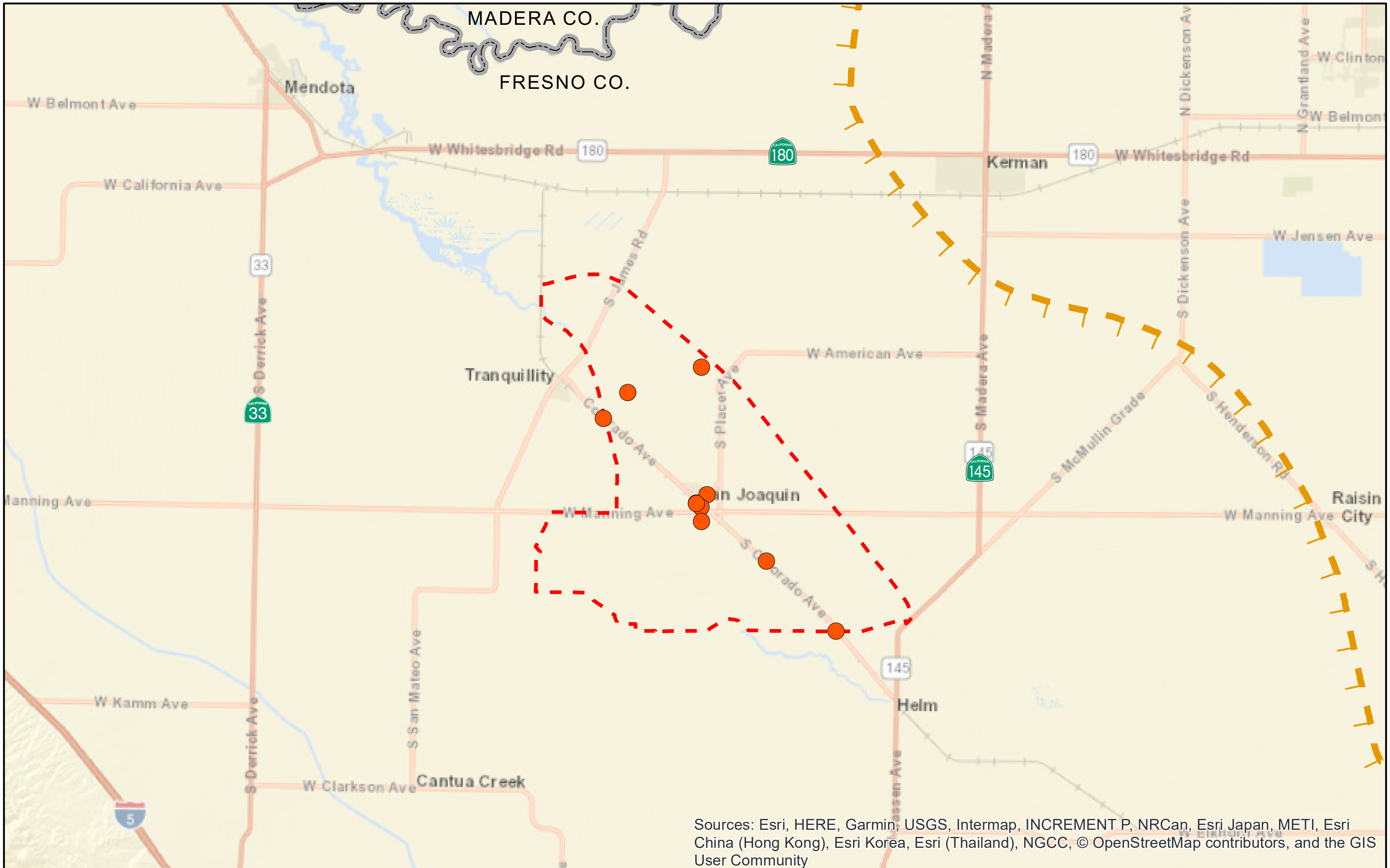

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James GSA

County

North East Edge of Corcoran Clay

Page and LeBlanc 1969, KDSA Modification

Water Quality Monitoring Well

James GSA

Water Quality Monitoring Network

Figure 3-35

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Water Quality Hydrogeologic Conceptual Model

As is discussed in Section 3.1 Hydrogeologic Conceptual Model, the Plan Area aquifer has a series of semi-confining clay formations that vary in depth and lateral extent throughout the aquifer. The three most prevalent clay formations that have historically been studied and delineated in the James GSA area within the San Joaquin Valley are known as the A-Clay, C-Clay, and E-Clay (or Corcoran Clay). Considerable information on these clay formations is provided in a report prepared by the U.S. Geological Survey (Water Supply Paper 1999-H, Croft, 1972) that includes planimetric plates and geological Cross-sections for these formations.

In order to differentiate water quality characteristics through the vertical extent of the aquifer, water quality data is grouped by four general aquifer zones: the shallow zone, coincides with groundwater above the A-Clay layer; the upper-intermediate zone, found between the A-Clay and above the C-Clay layer; the lower-intermediate zone, found between the C-Clay and above the E-Clay (Corcoran Clay); the intermediate zone found below the A-Clay and above the E-Clay where there is no C-Clay present; the unconfined zone found above the E-Clay where there is no A-Clay or C-Clay present; and the deep zone or confined zone, which is below the E-Clay and is considered the confined aquifer. The region above the E-Clay (Corcoran Clay) is defined as the base of the unconfined aquifer. Not all zones are present in the Plan Area.

Unfortunately, water quality data was not available in the shallow or deep zones. Data is only available in the unconfined aquifer which is the preferred source for both for municipal and agricultural supplies within the Plan Area.

Based on the described conceptual aquifer zones and on perforation depths for the wells sampled for water quality, each well was assigned to one of the three aquifer zones. Wells that are perforated across more than one zone were identified as composite wells and are shown in all applicable zones in subsequent characterization exhibits.

Benchmarks for Water Quality Characterization

To aide in the evaluation of existing groundwater quality a means for comparison of immediate and future water quality constituents needs to be defined. Although the largest portion of the utilized groundwater is for agricultural purpose, the use for human consumption requires supplies meet strict water quality regulations. The uniform application of water quality standards for the United States was establishment with the enactment of the Safe Drinking Water Act (SDWA) in 1974. Prior to the passage of this bill water quality standards were unenforceable and often ineffectively applied by many states (AWWA, 1990). The SDWA requires the United States Environmental Protection Agency (USEPA) to develop enforceable water quality standards for public water systems. The regulatory standards are known as maximum contaminant levels (MCLs) which dictate the maximum concentration a specific constituent may be present in potable water sources. Each state is required to enforce the federal standards as a minimum, but they may create stricter standards at their discretion. The State of California has on a number of occasions developed more stringent standards. Since the promulgation of the initial regulatory standards the number of regulated constituents has steadily grown.

Water quality standards as established by the USEPA are of two categories: National Primary Drinking Water Regulations, which are enforceable standards that have been established based on health effects from contaminants; and Secondary Drinking Water Standards, which are unenforceable standards established for contaminants that may negatively affect the aesthetics of water quality. The characterization of the Plan Area water quality is based on these standards, along with USEPA Lifetime Health Advisory (LHA) levels for unregulated constituents found in groundwater. Where no maximum contaminant level has been established for particular contaminants with the primary or secondary standards, "lifetime health advisory levels" were used as a basis for evaluation. The LHAs are non-enforceable water quality benchmarks established by the

USEPA and used in part by USGS to identify source waters that may indicated a potential for human-health concern.

Groundwater quality characterization for the plan area is based on the aforementioned data obtained from GAMA online tool and augmented with data from the USGS investigations, which is considered to be the best available information. As best practical, the groundwater assessment considers concerns from the perspective of human health for drinking water and suitability for agricultural irrigation. Water quality information for each well has been compared to the outlined benchmarks. Based on review of the available data the water quality constituents of concern within the James GSA area are provided in **Table 3-1** and discussed further in this section.

Table 3-1 Water Quality Constituents of Concern

Primary MCL	Secondary MCL	Health Advisory Level
Arsenic	Manganese	Boron
Chromium (Total)	Total Dissolved Solids	
Fluoride		
Gross Alpha		
Lead		
Nitrate		
1,2,3-Trichloropropane		
Uranium		

Water Quality Temporal Changes

As part of the water quality review an effort was undertaken to examine whether there were observed changes in individual water constituents over a period of time. This review looks at the last ten years of full data available and was taken as the period from 2008 to 2017. Unfortunately, due to a lack of data within the assessment period over time, it is not possible to perform a statically relevant assessment of observed changes in individual water quality constituents over a period of time.

National Primary Drinking Water Regulation Exceedances

The following discussion provides a summary of the constituents that are either of general concern or were found at concentrations higher than established regulatory enforceable maximum contaminate levels in the Plan Area or have generally been found at concentrations higher than established regulatory enforceable maximum contaminate levels in the Plan Area. To the degree possible with the available data, the variability of constituent concentrations by Plan Area region and aquifer zone is provided.

Arsenic.

The presence of arsenic in groundwater can be attributed naturally to desorption from arsenic-containing rocks and is often present in clay formations. Anthropogenic (caused or influenced by humans) sources include compounds used in manufacturing electronic components; processing of ceramics, paints and textiles; and agricultural related pesticides and insecticides. Arsenic is listed as a carcinogen, and when ingested at elevated concentrations may increase the risk of bladder, kidney, liver, lung and skin cancer. Prior to 2006, the MCL for arsenic was 50 µg/L, but following reevaluation by the USEPA at that time, the MCL was lowered to the present level of 10 µg/L (SWRCB, 2017a).

The presence of arsenic is found to occur in the unconfined aquifer within the Plan Area. Detections of arsenic within the Plan Area range from 2.7 to 9 µg/L. Measured values for arsenic by area and aquifer zone are provided below in **Table 3-2.**

Table 3-2 Measured Values for Arsenic

Area	Zone	Values
Northern	Upper intermediate	9 ug/L
Northern	Lower Intermediate	5.5 ug/L
Central (Municipal)	Lower intermediate	2.6 – 5.3 ug/L
Southern	Intermediate/Unconfined	3.6 ug/L

Water quality data shows only low detections of arsenic across the Plan Area. The detections are below the MCL of 10 µg/L for arsenic.

Chromium (Total).

Chromium is present in nature as trivalent chromium and hexavalent chromium. Trivalent chromium is an essential human dietary element and is found in food sources such as, vegetables, fruits, meats, and grains (USEPA, website: chromium-drinking-water). The occurrence of hexavalent chromium in groundwater is associated to the erosion of natural uranium deposits. Anthropogenic sources include the discharges of dyes and paint pigments, wood preservatives, chrome plating liquid wastes, and leaching from hazardous waste site (SWRCB, 2017b). Exposures to hexavalent chromium through inhalation is known to cause increased risks of gastrointestinal cancer and may cause damage to the lining of the nose, throat, and lungs. The USEPA has established a MCL for Total Chromium (all forms of chromium) at 100 µg/L, while the State of California has set the MCL for Total Chromium at 50 µg/L.

The presence of total chromium is found to occur in the unconfined aquifer within the Plan Area. Detections of total chromium within the Plan Area range from 0 to 5.3 µg/L. Measured values for total chromium by area and aquifer zone are provided below in **Table 3-3**.

Table 3-3 Measured Values for Total Chromium

Area	Zone	Values
Northern	Upper intermediate	< 0.3 ug/L
Northern	Lower Intermediate	< 0.3 ug/L
Central (Municipal)	Lower intermediate	0 – 5.3 ug/L
Southern	Intermediate/Unconfined	< 0.3 ug/L

Water quality data shows only low detections of total chromium across the Plan Area. The detections are well below the MCL of 50 µg/L for total chromium.

Fluoride

The presence of fluoride in groundwater drinking water occurs as rain water percolates through deposits containing fluorine which then combines with minerals to form fluoride salts. Anthropogenic sources include discharge from fertilizers and aluminum factories. Fluoride offers health benefits by helping prevent tooth decay, however, long-term exposure to elevated concentrations of fluoride can be detrimental causing discoloration of teeth and skeletal fluorosis. The U.S. Public Health Service (USPHS, 2015) recommends an optimal fluoride concentration of 0.7 mg/L for prevention of dental cavities. The USEPA has established an MCL for fluoride at 2 mg/L (or 2,000 µg/L).

The presence of fluoride is found to occur in the unconfined aquifer within the Plan Area. Detections of fluoride within the Plan Area range from 200 to 540 ug/L. Measured values for fluoride by area and aquifer zone are provided below in **Table 3-4**.

Table 3-4 Measured Values for Fluoride

Area	Zone	Values
Northern	Upper intermediate	400 ug/L
Northern	Lower Intermediate	450 ug/L
Central (Municipal)	Lower intermediate	200 – 540 ug/L
Southern	Intermediate/Unconfined	220 ug/L

Water quality data shows only low detections of fluoride across the Plan Area. The detections are well below the MCL of 2,000 µg/L for fluoride.

Gross Alpha.
Alpha particles are a radiation emitted by some radionuclides, such as U-238, Ra-226, and Rd-222, and are naturally occurring elements (SWRCB, 2017c). As groundwater travels through formations with these radionuclides it will accumulate some amount of the released alpha particles. Alpha particles are less of a threat from external exposures because they lack the energy to penetrate the outer layer of skin. Internal exposures through inhalation or ingestion are of a higher concern as living tissue is exposed. Exposure by inhalation increases the risk of developing lung cancer. Interestingly enough, alpha emitters are used for cancer treatment, as well as static eliminator in paper mills, and in smoke detectors. The MCL for gross alpha in drinking water is 15 pCi/L.

The presence of gross alpha is found to occur in the unconfined aquifer within the Plan Area. Detections of gross alpha within the Plan Area range from 0 to 112 pCi/L. Measured values for gross alpha by area and aquifer zone are provided below in **Table 3-5**.

Table 3-5 Measured Values for Gross Alpha

Area	Zone	Values
Northern	Upper intermediate	12 pCi/L
Northern	Lower Intermediate	no data
Central (Municipal)	Lower intermediate	0 – 5.52 pCi/L
Southern	Intermediate/Unconfined	112 pCi/L

Water quality data shows only detections of gross alpha above the MCL of 15 pCi/L in the southern portion of the Plan Area. Detections in the upper intermediate zone of the unconfined aquifer in the northern portion of the Plan Area are also near the MCL. The detections of gross alpha within the municipal area are below MCL values.

Lead.
Lead may be found in groundwater supplies through erosion of natural deposits. In recent years significant concern about lead in drinking water has arisen from the highly publicized widespread contamination that occurred from lead leaching from water service lines in Flint Michigan. Health effects from elevated concentration of lead include delays of mental and physical development in children, and high blood pressure and kidney disease in adults (SWRCB, 2017d). The USEPA regulates the concentration of lead in drinking water by an Action Limit, which is similar to an MCL but requires additional testing at customer services. The USEPA Action Level for lead is 15 µg/L.

The presence of lead is found to occur in the unconfined aquifer within the Plan Area. Measured values of lead within the Plan Area range from 0.063 to 1.05 ug/L. Measured values for lead by area and aquifer zone are provided below in **Table 3-6**.

Table 3-6 Measured Values for Lead

Area	Zone	Values
Northern	Upper intermediate	0.063 ug/L
Northern	Lower Intermediate	1.05 ug/L
Central (Municipal)	Lower intermediate	0 – less than 5 ug/L
Southern	Intermediate/Unconfined	0.106 ug/L

Water quality data shows only low detections of lead across the Plan Area. The detections are well below the AL of 15 µg/L for lead.

Nitrate.

The presence of nitrate in groundwater may occur from oxidation of atmospheric nitrogen gas by lightening, that may then naturally get into groundwater, but this is considered to produce low concentrations typically below 2 mg/L (as N) (SWRCB, 2017e). The largest contributors of nitrates in groundwater are anthropogenic sources, such as, fertilizer applications, septic tanks, wastewater discharges, manure fertilizer applications, and agricultural ponds. Infants under the age of 6 months are the most susceptible to health-effects from nitrates, known as methemoglobinemia ("blue baby syndrome). Methemoglobinemia is the result of ingesting nitrate and its subsequent conversion by digestive bacteria into the more toxic nitrite, which enters the bloodstream and hinders the body's ability to carry oxygen. The MCL for nitrate is 10 mg/L (as N). The appropriateness to quantify the presence of nitrates through the monitoring of public water systems may be misleading as these sources are typically taken offline as soon as there is an exceedance. This may suggest as data is being assembled for analysis that the issue has subsided, but in actuality it may still persist in the area. It too should be noted that the detection of elevated concentrations of nitrates in public wells, in areas where residential homes on septic tanks, should not be taken as a characterization of nearby agricultural fields. Care needs to be exercised in making conclusions on contributory sources and causative groundwater impacts associated to the occurrence of nitrates in groundwater

The presence of nitrate is found to occur in the unconfined aquifer within the Plan Area. Measured values of nitrate within the Plan Area range from 0.33 to 0.4 mg/L. Measured values for nitrate by area and aquifer zone are provided below in **Table 3-7.**

Table 3-7 Measured Values for Nitrate

Area	Zone	Values
Northern	Upper intermediate	0.33 mg/L
Northern	Lower Intermediate	0.4 mg/L
Central (Municipal)	Lower intermediate	No detections
Southern	Intermediate/Unconfined	0.39 mg/L

Water quality data shows only low detections of nitrate across the Plan Area. The detections are well below the MCL of 10 mg/L (as N) for nitrate.

1,2,3-Trichloropropane.

1,2,3-Trichloropropane (TCP) is a manufactured compound and does not exist naturally in the environment. TCP is largely associated with being used as a solvent and an extract agent (e.g. varnish remover, and degreaser) and is used as an intermediate in the manufacturing of other chemical compounds (SWRCB, 2017f). TCP has also been associated as a compound the manufacture of a soil fumigant (nematicide) that has since been prohibited from use in the United States. Health risks associated to long-term exposure to TCP, based on animal studies, include liver and kidney damage, reduced body weight, and tumors in organs. The State of California MCL for TCP is 0.005 µg/L. The USEPA has not set an MCL for this compound.

Water quality data shows no low detections of 1,2,3-Trichloropropane across the Plan Area. Measured values for 1,2,3-Trichloropropane by area and aquifer zone are provided below in **Table 3-8.**

Table 3-8 Measured Values for 1,2,3-Trichloropropane

Area	Zone	Values
Northern	Upper intermediate	no detections
Northern	Lower Intermediate	no detections
Central (Municipal)	Lower intermediate	no detections
Southern	Intermediate/Unconfined	no detections

Uranium.

Uranium is a natural radioactive element that exists in certain igneous, metamorphic, and sedimentary rocks, and becomes entrained in waters that pass-through deposits with this element. Uranium is derived from Sierra Nevada granitic rocks and will preferentially adhere to clays. Uranium has been reported to be mobilized by bicarbonate water and through bacterial and chemical reactions of nitrates (SWRCB, 2017c). 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. Health risks from extended exposures may result in kidney problems or a higher risk of getting cancer and of kidney toxicity. The State of California MCL for uranium is 20 pCi/L, and the USEPA MCL is 30 μg/L.

The presence of uranium is found to occur in the unconfined aquifer within the Plan Area. Detections of uranium within the Plan Area range from 0 to 147 ug/L. Measured values for uranium by area and aquifer zone are provided below in **Table 3-9.**

Table 3-9 Measured Values for Uranium

Area	Zone	Values
Northern	Upper intermediate	10.1 ug/L
Northern	Lower Intermediate	0.038 ug/L
Central (Municipal)	Lower intermediate	3.2 – 4.3 ug/L 0 – 5.7 pCi/L
Southern	Intermediate/Unconfined	147 ug/L

Water quality data shows only detections of uranium above the US EPA MCL of 30 ug/L in the southern portion of the Plan Area. Detections in the upper intermediate zone of the unconfined aquifer in the northern portion of the Plan Area are below the MCL. The detections of uranium within the municipal area are below MCL values.

Secondary Drinking Water Standard Exceedances

The following discussion provides a summary of the constituents that were found at concentrations higher than established secondary drinking water standards within the Plan Area. To the degree possible with the available data, the variability of constituent concentrations by depth is provided.

Manganese.

Manganese, like iron, is a naturally occurring element and is typically dissolved from rocks and minerals as the water flows through formations containing this element. As with iron, manganese is considered an essential element in human diet, but there are health concerns from over-exposure that can cause neurological effects (USEPA, 2004). Manganese can cause objectionable aesthetic issues such as black discoloration of water. In a chlorinated domestic or municipal water system with elevated iron and manganese levels, iron is converted to the ferric state (rust) while the manganese is converted to manganese dioxide, which is a black precipitate.

Together, these two reaction products can create permanent staining of fixtures and laundry leading to widespread customer complaints. The secondary MCL for manganese is 50 µg/L.

The presence of manganese is found to occur in the unconfined aquifer within the Plan Area. Detections of manganese within the Plan Area generally range from 89.4 to 630 ug/L. Two values of 1,300 ug/L and 1,600 ug/L were observed but were discarded as outlying data points and not considered in the assessment. Measured values for manganese by area and aquifer zone are provided below in **Table 3-10.**

Table 3-10 Measured Values for Manganese

Area	Zone	Values
Northern	Upper intermediate	414 ug/L
Northern	Lower Intermediate	89.4 ug/L
Central (Municipal)	Lower intermediate	120 – 630 ug/L
Southern	Intermediate/Unconfined	155 ug/L

Water quality data shows detections of manganese across all areas and aquifer zones within the Plan Area that are well above the secondary MCL of 50 µg/L. The presence of manganese above the secondary MCL is a known problem for the City of San Joaquin. Municipal water users have received multiple notices and communications regarding the presence of manganese. Rural residential users likely experience problems with manganese; however, levels encountered in outside of the municipal area appear lower. The presence of manganese at the levels measured does not pose an issue for agricultural uses.

Total Dissolved Solids.
The presence and accumulation of dissolved solids in groundwater may be attributed to rain water percolating through soil and rocks causing salts and minerals to leach from these formations. Another contributory source of solids and salts is imported irrigation water that may be laden with dissolved solids which can further increase the accumulation and concentrations of dissolved solids in groundwater. Anthropogenic sources include discharges from water softeners and wastewater plants, industrial discharges from cooling towers, food processors, and canning facilities (SWRCB, 2017g).

From the agricultural perspective if the accumulation of salts in soils and groundwater is not monitored and managed, salinity can reach levels that impact crop yields and may make the soil and groundwater unsuitable for production of some agricultural crops that are salt sensitive.

The secondary MCL, for taste and odor, for TDS is provided as a range from 500 mg/L (recommended) to 1,000 mg/L. For rare and limited short-term durations concentrations up to 1,500 mg/L for TDS may be permissible.

Measured values of total dissolved solids within the Plan Area range from 360 to 929 mg/L. Two values of 1,600 mg/L and 1,900 mg/L were observed but were discarded as outlying data points and not considered in the assessment. The discarded measurements also correspond to measured values of manganese that were also discarded. Measured values for total dissolved solids by area and aquifer zone are provided below in **Table 3-11.**

Table 3-11 Measured Values for Total Dissolved Solids

Area	Zone	Values
Northern	Upper intermediate	897 mg/L
Northern	Lower Intermediate	929 mg/L
Central (Municipal)	Lower intermediate	360 – 540 mg/L
Southern	Intermediate/Unconfined	591 mg/L

Water quality data shows measured values of total dissolved solids below or at the bottom end of the MCL range of 500 to 1,000 mg/L. Measured values at the northern end of the Plan Area are at the upper end of the range of MCL values. It is believed that total dissolved solids generally increased in concentration moving from south to north in the Plan Area. It is expected that groundwater in certain locations within the Plan Area exceeds 1,000 mg/L. This is naturally occurring and caused by marine deposits.

Health Advisory Level Exceedances

The evaluation of the groundwater aquifer is further developed in examining water quality constituents that do not have a MCL but rather show levels of exposure that may have some negative associated health concern. This portion of the groundwater characterization utilizes benchmark concentrations established by USEPA (lifetime health advisory levels (LHA)) which are frequently utilized by USGS for studies to quantify water supply issues throughout the nation. Where applicable Notification Levels as adopted by the State of California are used when lower than the LHA level. As with the preceding evaluations, to the degree possible with the available data, the variability of constituent concentrations by depth is provided.

Boron.

The presence of boron in groundwater is due to the element leaching from rocks and aquifer formations containing borate and borosilicate. Anthropogenic sources include whitening agents, fertilizers and herbicides, and result from manufacturing items such as insulation, fire retardants and laundry bleach. The presence of boron in drinking water is most commonly found in the form of boric acid. When boric acid is ingested at high levels it can be lethal, and at moderate levels may cause gastrointestinal tract distress, vomiting, diarrhea and nausea; while remaining important for plant growth and as a micronutrient for animals and humans (SWRCB 2017h). There is no MCL for boron, however, USEPA has established a LHA level of 6 mg/L (or 6,000 μg/L), and the State of California has adopted a Notification Level of 1,000 μg/L.

From the agricultural perspective, boron is an essential nutrient for plant growth, however, elevated concentrations of this element can cause crop boron toxicity leading to lower crop yields. The severity of impact to agriculture is plant type dependent. Some orchard trees such as almonds have been found to be quite sensitive to boron and long-term exposures to concentrations of 0.5 mg/L are a recommended maximum. Other plant materials are more resilient to higher concentrations of boron.

The presence of boron is found to occur in the unconfined aquifer within the Plan Area. Detections of boron within the Plan Area range from 258 to 1,710 μg/L. Measured values for boron by area and aquifer zone are provided below in **Table 3-12.**

Table 3-12 Measured Values for Boron

Area	Zone	Values
Northern	Upper intermediate	1,460 ug/L
Northern	Lower Intermediate	1,710 ug/L
Central (Municipal)	Lower intermediate	567 ug/L
Southern	Intermediate/Unconfined	258 ug/L

Measured values for boron within municipal areas are well below the USEPA LHA level of 6,000 ug/L and below the State of California Notification Level of 1,000 ug/L. The values exceed recommended values for sensitive crops in the northern and central portions of the Plan Area. Elevated levels of boron are generally present in water with higher levels of total dissolved solids.

Known Contamination/Plumes

To identify known plumes and contamination within the Plan Area SWRCB GeoTracker was reviewed for active clean-up sites of all types. The following site has been identified as having some level of suspect contamination., although it is not evident that a contaminant plume is migrating.

To identify known plumes and contamination within the Plan Area SWRCB GeoTracker was reviewed for active clean-up sites of all types. Three open cases were identified in the Plan Area. One case, Global ID # SL0601981359, involved as surface spill of a contaminant. Two cases involve underground storage tanks, Regional Board Case # 5T10000658 and 5T10000238. From a review of the materials provided, it is not known if any of these three cases involves groundwater contamination.

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.

Land subsidence can result from groundwater level declines, leading to compaction of the dewatered formations. Land subsidence is well documented in some isolated areas of the San Joaquin Valley, particularly to the west of the Kings Subbasin. Within the James GSA area, some land subsidence has been documented historically with the USGS reporting minimal subsidence on the east side of James GSA from 1926 to 1970 and at least four feet of subsidence near the Fresno Slough along the west side of the GSA (Williamson et. al., 1986) **Figure 3-36** and **Figure 3-37**. Most of the historical subsidence in the valley was west of the Subbasin, ranging between Los Banos and Kettleman City, and also along the axial trough of the southernmost portion of the valley between Tulare and Wasco. Historical subsidence in the James GSA has been minimal to moderate compared with these areas, so it has not historically been aggressively monitored.

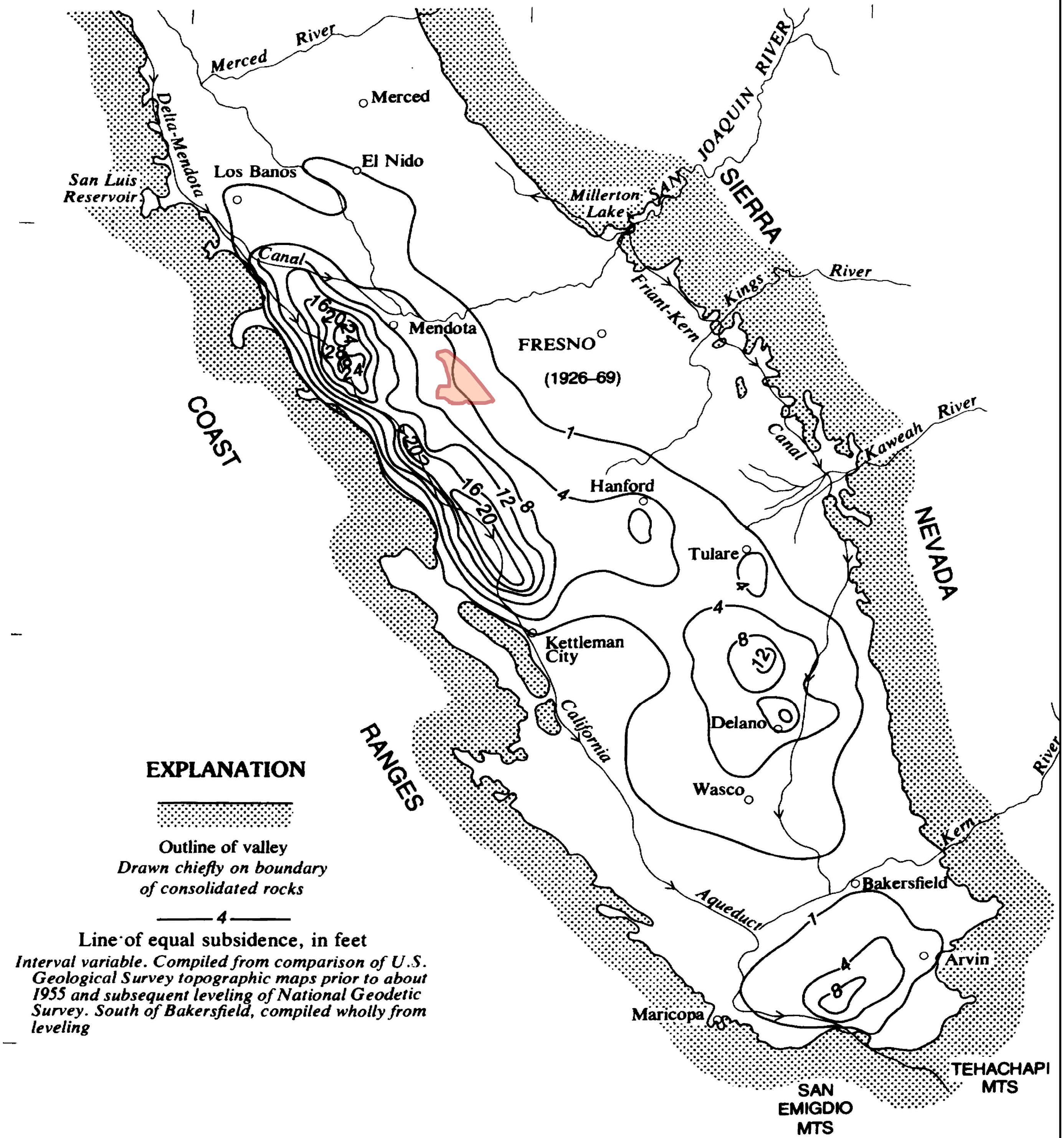
While some local agencies in the San Joaquin Valley do monitor land subsidence, the majority rely on monitoring performed by regional water agencies, or the State or Federal government. USGS, NASA, USBR and KRCD all measure subsidence in or around the GSA. USGS and NASA have maps on their websites that show subsidence over defined periods. KRCD has a seven-mile-square grid to monitor land subsidence based on a Global Positioning System (GPS) control network that has been established throughout the plan and adjacent area that is utilized to survey existing benchmarks to monitor subsidence. Refer to **Figure 3-41**.

Five types of subsidence have been found in California and the San Joaquin Valley, including oxidation of peat deposits in the river and delta areas; deep subsidence resulting from declining groundwater levels caused by overdraft; shallow subsidence caused by hydrocompaction of collapsible soil layers; tectonic subsidence resulting from earthquake-caused ground deformation; and subsidence caused by fluid withdrawal from oil and gas fields. The main form of subsidence in the James GSA area is deep subsidence from declining groundwater levels. Subsidence is also occurring in areas adjacent to the James GSA, especially to the south and west. 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.

Deep land subsidence occurs when groundwater levels decline due to excessive withdrawals of groundwater. There are two types of deep subsidence related to groundwater withdrawals: elastic and inelastic. These are illustrated in **Figure 3-38**. Elastic subsidence is recoverable if water levels later rise, while inelastic subsidence is permanent; land does not recover its original elevation even if the groundwater level rises. Elastic subsidence generally occurs in the unconfined portions of the aquifer where the materials compact. Ground elevations which have fallen due to elastic subsidence can rebound if groundwater levels are restored.

Although there are several causes of inelastic land subsidence, compression of clay soil strata as a result of groundwater extraction from confined aquifers is the cause of the vast majority of subsidence documented in the San Joaquin Valley. 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 randomly oriented 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 reabsorb water, thus the subsidence in these areas cannot be reversed. This inelastic process is known as aquifer system compaction.

The Corcoran Clay member (or E-clay) of the Tulare Formation has been mapped beneath much of the western side of the San Joaquin Valley and the aquifer beneath it is confined. Most of the permanent subsidence in the San Joaquin Valley has been correlated to overdraft in this confined aquifer. The entire James GSA is located above the Corcoran Clay, and much of the GSA is above the C-Clay, a shallower clay layer that exhibits some confining characteristics. The land subsidence that has been observed is total subsidence – it is not known at this time whether the subsidence is occurring between the C-clay and the E-clay or below the E-clay, or a combination of both. This is recognized as a data gap. With increased reliance on groundwater to meet both municipal and agricultural irrigation demands, some moderate land subsidence is now occurring in areas outside the geographic boundaries of the Corcoran Clay.



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James GSA

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

James GSA

Land Subsidence from 1926 to 1970

Figure 3-36

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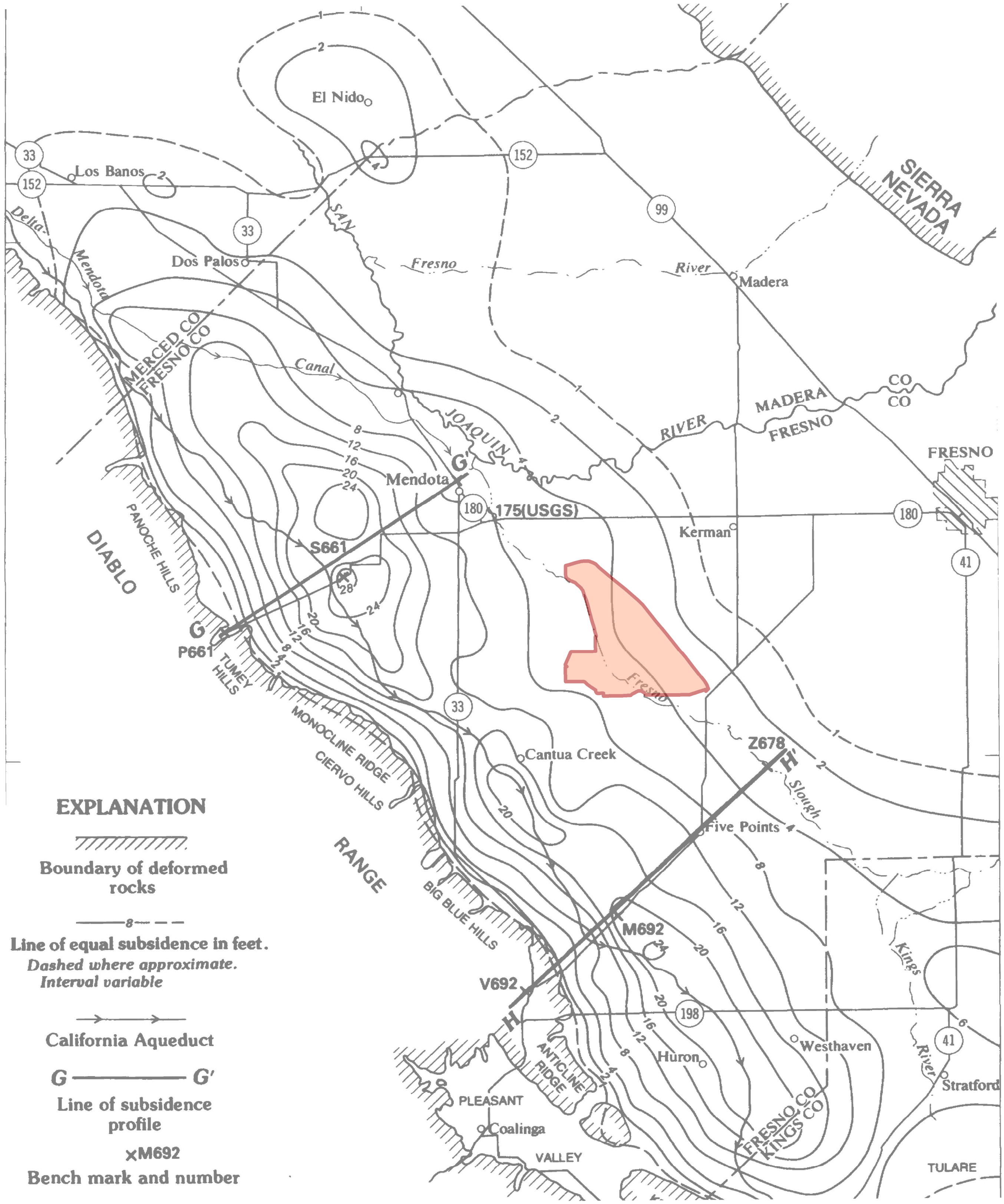

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Source: USGS PP 437-I, 1984, Land Subsidence in the San Joaquin Valley, California, as of 1980

James GSA

Land Subsidence from 1926 to 1972

Figure 3-37

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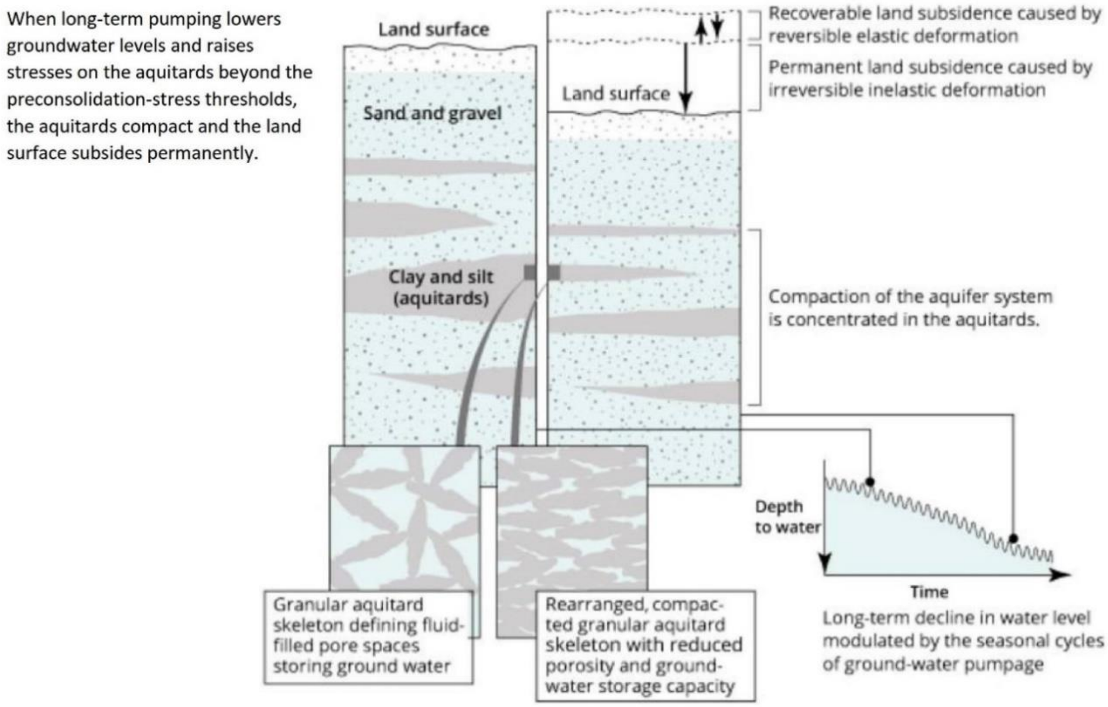


Figure 3-38 Aquifer Compaction Due to Groundwater Pumping as Identified by USGS (Galloway et. al., 1999)

3.2.6.1 Review of Existing Data

Available land subsidence data was reviewed to establish what information is available and to aid in determining if additional monitoring is required. This effort included a review of the Hydrogeologic Conceptual Model (HCM), recorded subsidence, historic groundwater levels and infrastructure impacts, remote sensing data, and data available from Continuous Global Positioning System stations. The results of this review are described below, including identification of any known regional or correlative geologic conditions where subsidence has been observed.

Most recorded subsidence in the San Joaquin Valley has historically occurred on the west side of the valley, decreasing laterally away from the areas of greatest subsidence. Recent subsidence has been observed on both the west and east sides of the San Joaquin Valley, in some cases affecting critical infrastructure such as the Delta-Mendota Canal and California Aqueduct on the west side, and the Friant-Kern Canal on the east side of the San Joaquin Valley. Some of the lateral extents of subsidence has been documented in the western and southern portions of the James GSA. Subsidence that is occurring in neighboring areas to the south appear to be impacting subsidence in the James GSA.

Areas prone to subsidence, 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, '70s and '80s. The areas prone to subsidence were typically underlain by deposits where the clayey deposits are dominated by the clay mineral montmorillonite (USGS 497-C, Meade 1967). Both the historic and recent subsidence maps show that subsidence increases westerly and southerly from James GSA, indicating it is likely that groundwater is increasingly confined and there is likely a higher percentage of montmorillonite in the finer-grained sediments to the west. It should also be noted that historically and currently, those areas with the most significant subsidence are underlain by the Corcoran Clay and/or C-Clay. As shown on Figure **3-7,** the Corcoran Clay underlies the entire James GSA area.

In addition to the clay mineralogy, aquifer compaction and the resultant land subsidence are also dependent on over-extraction of groundwater from the confined aquifer.

Recent evaluation of well completion logs from the DWR website as well as soil stratigraphy in the GSA area from Croft (1972) indicates that many wells are or were slotted to pump water from the semi-confined aquifer in the intermediate zone (below the shallower C-clay and above the top of the E-clay) or were composite wells that draw water from both above and below the Corcoran Clay. **Figure 3-17** shows the estimated areas of overlap of the C-clay and the E-clay in the James GSA. Since water has historically been withdrawn from the aquifers below the C-clay as well as below the E-clay, it is not possible at this time to assess whether the surface subsidence is resulting from one or the other confined aquifers or is a combined impact of overdraft from both aquifers.

Review of historic range of groundwater levels in the principal aquifers of the basin.
Groundwater levels are discussed in Section - 3.2.1 Groundwater Levels. Groundwater elevation hydrographs from a number of wells in the James GSA area were reviewed to evaluate historic groundwater levels. The evaluated wells are geographically distributed across the James GSA area. These hydrographs provide a reasonable basis to determine historic groundwater trends in the region. Naturally, groundwater levels in the James GSA area fluctuate seasonally and annually based on weather conditions and the amount of surface water received from the Kings River. The long-term trend in the James GSA area, however, is a relatively steady decline in water levels, with the water level reduction increased in the recent drought. The hydrographs display declining groundwater levels caused by overdraft, which is the primary cause of deep subsidence.

Review of historic records of infrastructure impacts, including, but not limited to, damage to pipelines, canals, roadways or bridges, or well collapse potentially associated with land surface elevation changes.
The USGS has reported that reduced surface-water availability during the drought periods of 1976-77, 1986-92, 2007-09 and 2012-2015 caused groundwater-pumping increases in the San Joaquin Valley, declines in water levels to near or new historic lows, and renewed aquifer compaction. The resulting land subsidence has reduced the freeboard and flow capacity of the Delta-Mendota Canal, the California Aqueduct and the Friant-Kern Canal, as well as other conveyance facilities that transport floodwater and deliver irrigation water. This has resulted in the need for expensive repairs to maintain delivery capacity in these important water transport systems. Faunt, et al., (2009) reports land subsidence in the Central Valley has also resulted in damage to buildings, well casings, bridges and highways, and has caused flooding. These damages have cost millions of dollars. Locally, the irrigation district within the James GSA have raised the canal banks of some facilities by approximately 2 feet in localized areas to restore original design freeboard and circumvent canal overtopping. In addition, uneven subsidence may also be a contributing factor to pipeline fractures in the aged monolithic pipe infrastructure commonly found in portions of the GSA.

Review of remote sensing results such as InSAR or other land surface monitoring data.
A review of existing land subsidence data from remote sensing techniques such as InSAR is discussed below.

Review of existing CORS. Continuously Operating Reference Stations (CORS) stations can be used to monitor land subsidence, however no CORS are located in the James GSA. There are stations located nearby, outside of the GSA, in Mendota (P304), Madera (P307), Visalia (P566), and on Interstate 5 near Highway 145 (P300). Active measurements and graphical information is available on the CORS website:

https://www.ngs.noaa.gov/CORS_Map/

3.2.6.2 Subsidence Monitoring Results

Land subsidence was first monitored beginning in the 1920s, then occasionally through the 1970s during periods when there was less access to surface water in portions of the San Joaquin Valley. During this timeframe, subsidence rates were at a historical high in parts of the valley, being measured at rates of approximately one foot per year in some areas. Figure 2 from the U.S. Geological Survey Professional Paper 437-I (1984) shows most subsidence occurring on the west side of the San Joaquin Valley (**Figure 3-36** and **Figure 3-37** above). These figures also show cumulative subsidence in the James GSA area was in the range of four feet from 1926 to 1970. The frequency of subsidence monitoring decreased after the 1970s, by which time access to surface water had increased due to the canals and water storage projects built in California, with less reliance on groundwater in the 1970's and 1980's to meet water demands in areas west of the Kings Subbasin.

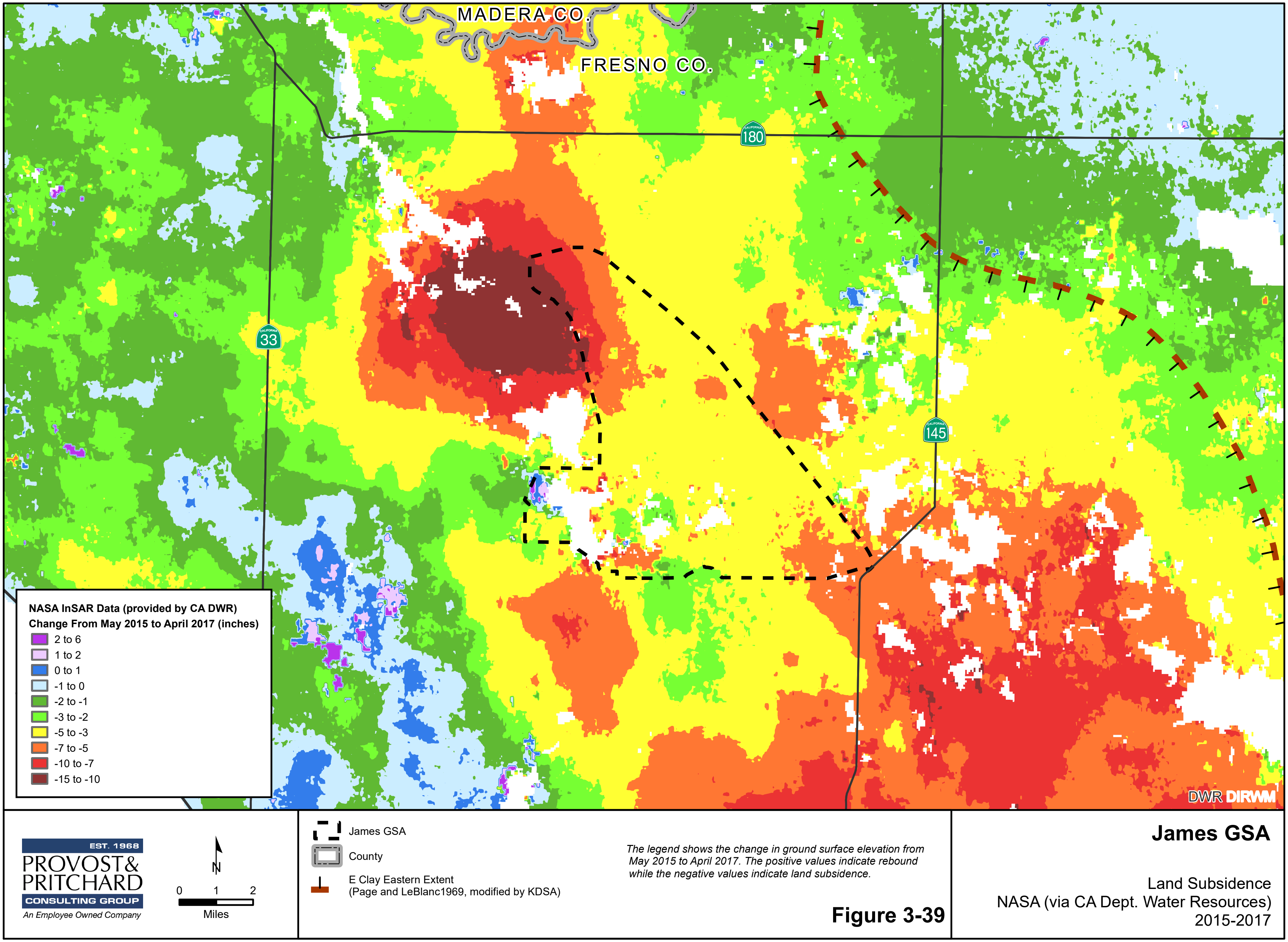
Subsidence monitoring increased again in the 2000s due to more-frequent drought conditions, environmental regulations that resulted in lower surface water allocations to State Water Project (SWP) and Central Valley Project (CVP) contractors, and the local farmers and cities increasing reliance on groundwater. Data sources include USBR San Joaquin River Restoration Program (limited to the northwestern end of the James GSA), KRCD, and NASA InSAR data provided by DWR. Data primarily from 2011 through 2016, and into 2017 for the InSAR data, were used to evaluate the land subsidence in the James GSA area.

Figure 3-39 shows NASA InSAR data provided by DWR from May 2015 through April 2017. Subsidence in the northwestern corner of the James GSA area was measured at one to two inches in that two-year period, which is considered significant. Subsidence reduced significantly east and south of that location. The southern third of the James GSA area, in areas underlain by the C-Clay and Corcoran Clay, show subsidence over the period ranging between three and five inches. Subsidence in the James GSA is likely originating in neighboring areas given the absence wells extracting from the confined aquifer in the Plan Area and will need to be closely monitored in the future.

Figure 3-40 shows the USBR SJRRP land subsidence monitoring data over the 5-year period from December 2011 to December 2016. This data extends to the San Joaquin River on the north, but only provides subsidence information for the northwestern end of the James GSA. Cumulative subsidence measurements over the period range between 0.31 and 0.32 feet (3 to 15 inches), with subsidence decreasing to the east, which generally correlates with the NASA InSAR data.

Figure 3-41 shows the KRCD land subsidence monitoring locations and results from 2013 to 2016. There are four monitoring locations near the Plan Area. Cumulative subsidence measured near the plan area range from approximately 0.5 feet to 1.5 feet over the given 4-year period which was in the middle of the recent extended drought. The other points within the Kings Subbasin indicate a decrease in the magnitude of subsidence to the northeast and an increase to the south. No other monitoring locations are within or near the plan area. These measurements are similar to those reported by NASA.

As shown in the figures mentioned, there appears to be minimal subsidence occurring in the plan area. The greatest subsidence in the plan area has been observed in the northwestern three-quarters of the Plan Area. The areas with the most significant subsidence are adjacent to the Tranquillity area within the Delta-Mendota Subbasin where substantial subsidence has recently occurred.



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.

Figure 3-39

James GSA

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

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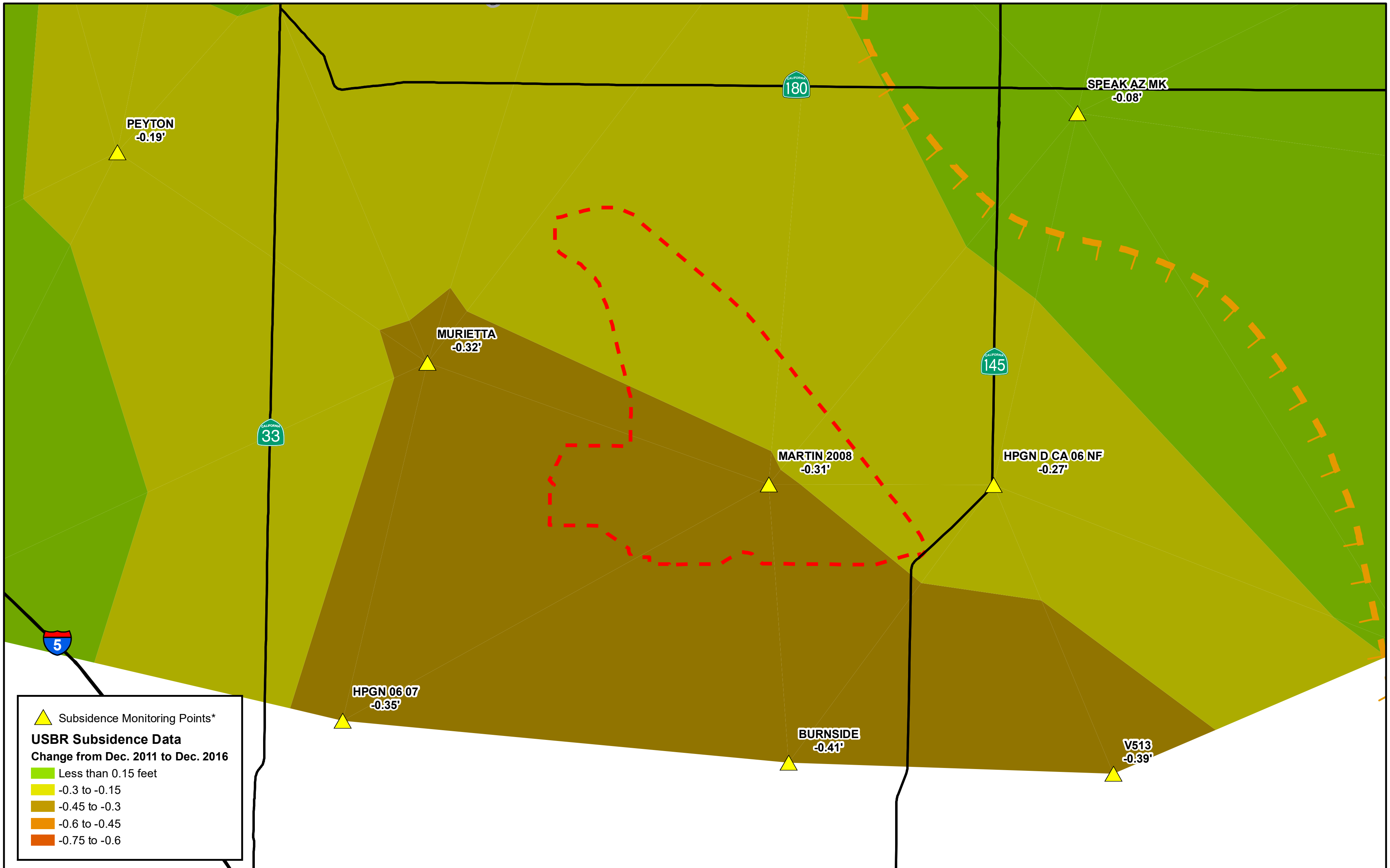

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James GSA
County
North East Edge of Corcoran Clay
Page and LeBlanc 1969, KDSA Modification

**Subsidence Monitoring Points labeled with Free Adjusted delta values from Dec. 2011 to Dec. 2016*

Figure 3-40

James GSA

Land Subsidence
U.S. Bureau of Reclamation
2011-2016

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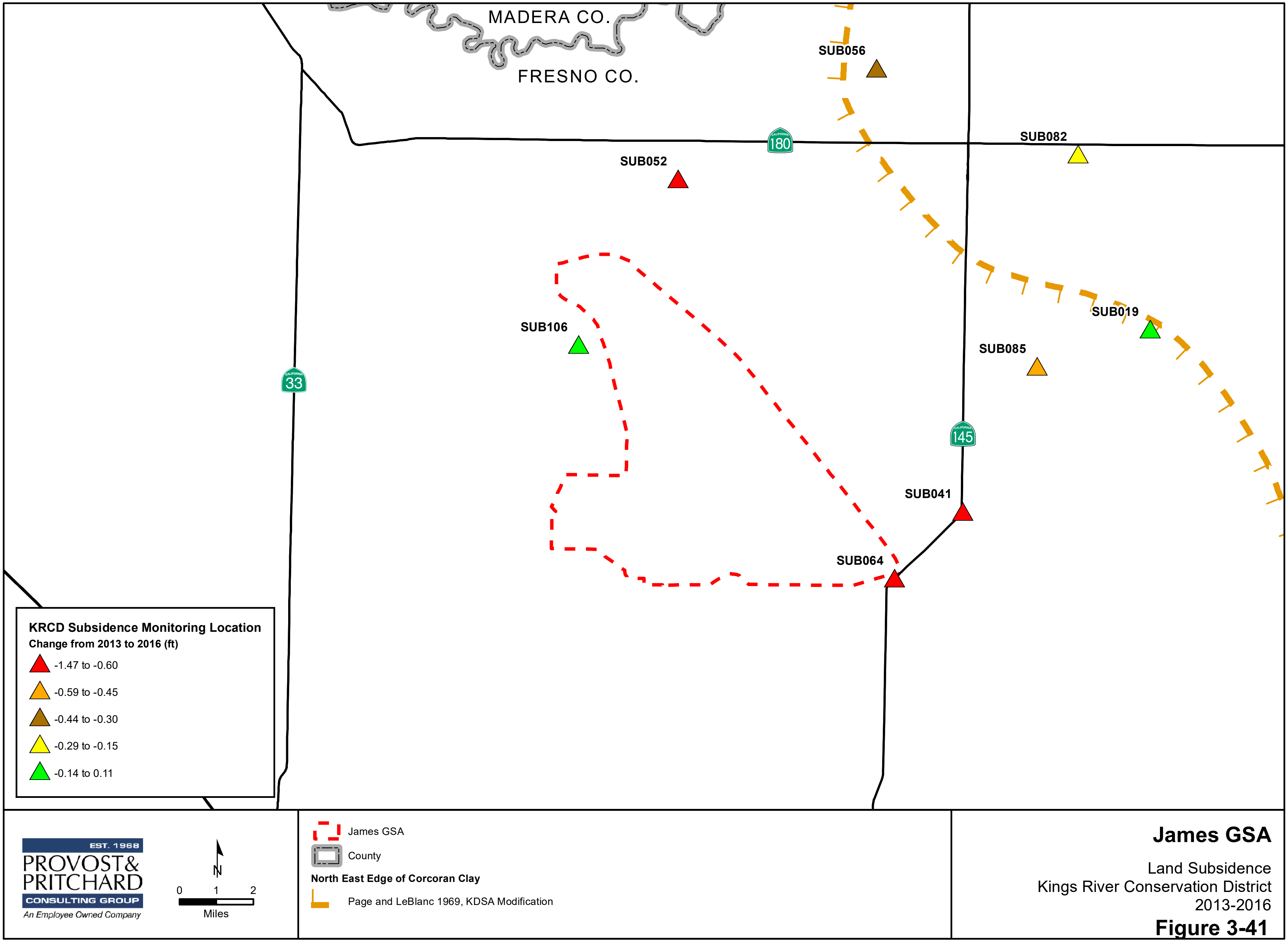

James GSA

Land Subsidence
Kings River Conservation District
2013-2016

Figure 3-41

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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 systems are defined by DWR (2016) 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*". GSP Regulations are concerned with the volume or rate of surface water depletion in areas where surface water and groundwater are interconnected. From a practical standpoint then, the key is whether or not groundwater pumping affects surface water connections.

Brunner, Cook, and Simmons (2011) discusses the different surface water-groundwater systems. A gaining stream is always part of an interconnected system. A system with a losing stream can be either interconnected or disconnected, both of which involve contribution of surface water to the subsurface. However, in a disconnected system the losing stream is separated from the aquifer by an unsaturated zone. A disconnected system can be evidenced by identifying an unsaturated zone under the stream or by demonstrating that groundwater levels do not affect the infiltration rate of the stream (Brunner et al., 2011).

Three waterways were reviewed to determine if any interconnected surface water systems were present in the James GSA. These waterways were: (1) the reach of the Kings River, referred to as the James Bypass, upstream from Mendota Pool; (2) the reach of the Fresno Slough upstream of the Mendota Pool; and (3) the reaches of the James Bypass and Fresno Slough influenced by the Mendota Pool.

The James Bypass upstream of the Mendota Pool is a losing system as documented by river losses calculated each month for each reach of the river by the KRWA. Present day regional groundwater elevations of the unconfined aquifer are significantly lower than the James Bypass channel indicating that there is an unsaturated zone between the bottom of the river and the top of the unconfined water table. Further, during the last ten water years, water was only present less than 14% of the time. Accordingly, the James Bypass upstream of the Mendota Pool is not considered to be an interconnected surface water system.

The other waterway present in the Plan Area is the Fresno Slough. The Fresno Slough was severed from the Kings River in the early 1900's as a part of a comprehensive plan to provide flood control for the region. Flows into the Fresno Slough are controlled by a number of structures on the Kings River and along the slough. After the construction of Pine Flat Dam in 1954, the Fresno Slough waterways were no longer needed for Kings River water deliveries. Presently, flows within the Fresno Slough upstream of Colorado Avenue, where water levels in the Fresno Slough are influenced by the Mendota Pool, only occur when water is introduced into it by James ID. Present day regional groundwater elevations of the unconfined aquifer are significantly lower than the Fresno Slough channel indicating that there is an unsaturated zone between the bottom of the river and the top of the unconfined water table. For these reasons, the Fresno Slough upstream of the Mendota Pool is not considered to be an interconnected surface water system.

Downstream reaches of the James Bypass and Fresno Slough are inundated by the Mendota Pool throughout the year. The Mendota Pool is an impoundment created by Mendota Dam. The Mendota Pool is presently used to deliver water to various public and private entitles adjacent to or having access to the pool. Water is delivered into the Mendota Pool from the Kings River, San Joaquin River, and the Central Valley Project Delta-Mendota Canal. The elevation of the Mendota Pool is controlled within a fixed range to facilitate water conveyance to receiving entities.

Losses occur within the Mendota Pool on a year-round basis and, based on regional groundwater contours, the James Bypass or Fresno Slough are losing streams within the Plan Area. It is not known at this time whether there is an unsaturated zone between the bottom of the channels influenced by the Mendota Pool and the top of the unconfined water table. For this reason, the downstream reaches of the James Bypass and Fresno Slough that are inundated by the Mendota Pool will be considered to be a possible interconnected surface water system. Additional information will be gathered through monitoring to make a more definitive determination at a later date.

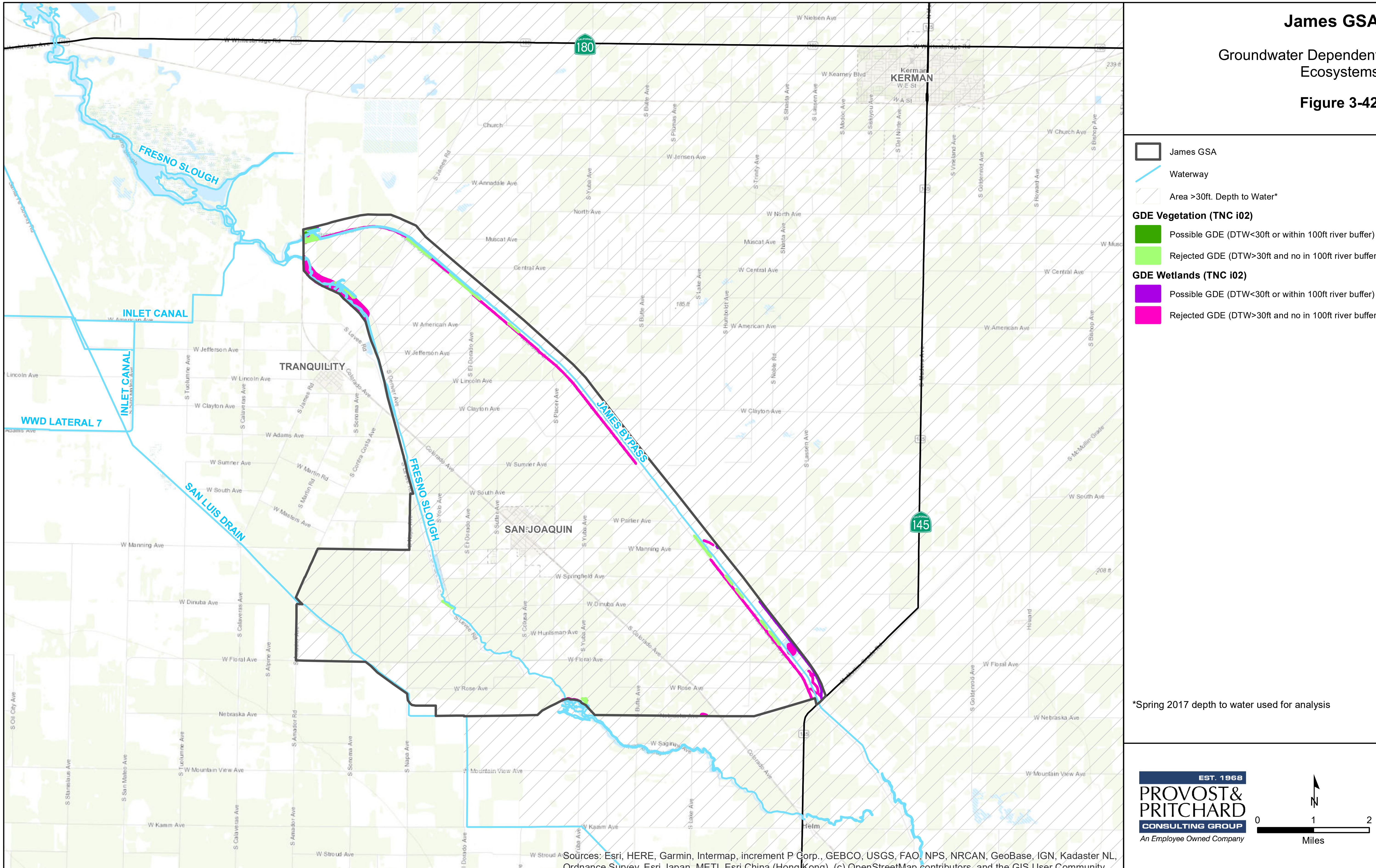
3.2.8 Groundwater Dependent Ecosystems

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.

Interconnection between the surface water and groundwater could lead to groundwater dependent ecosystems (GDEs) and must be considered. From review of the potential GDE mapping from the Nature Conservancy and recognizing that groundwater depths of producing aquifers are more than 50 feet deep beneath the James GSA, the vegetation and wetlands listed by the Nature Conservancy are believed to be surface water dependent rather than dependent on groundwater that is actively pumped. Some shallow groundwater does periodically exist in some areas within the GSA and this perched groundwater condition may serve as a source of water for GDEs when this shallow groundwater is available, but it is believed there is not a continuous saturated zone from the perched groundwater to the producing groundwater aquifers. Surface flows are periodically completely depleted in the Plan area for much of the year, and vegetation and wetlands identified by the Nature Conservancy are thought to be dependent on the surface flows in the river rather than on groundwater.

While it is believed the vegetation and wetlands identified by the Nature Conservancy on **Figure 3-42** are surface water dependent rather than groundwater dependent, a shallow groundwater monitoring program is proposed to verify the condition as discussed in **Section 4.7.**



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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 James GSA. A schematic diagram of a water budget indicating the primary inflows and outflows and impacts on the groundwater system is shown in **Figure 3-43** below:

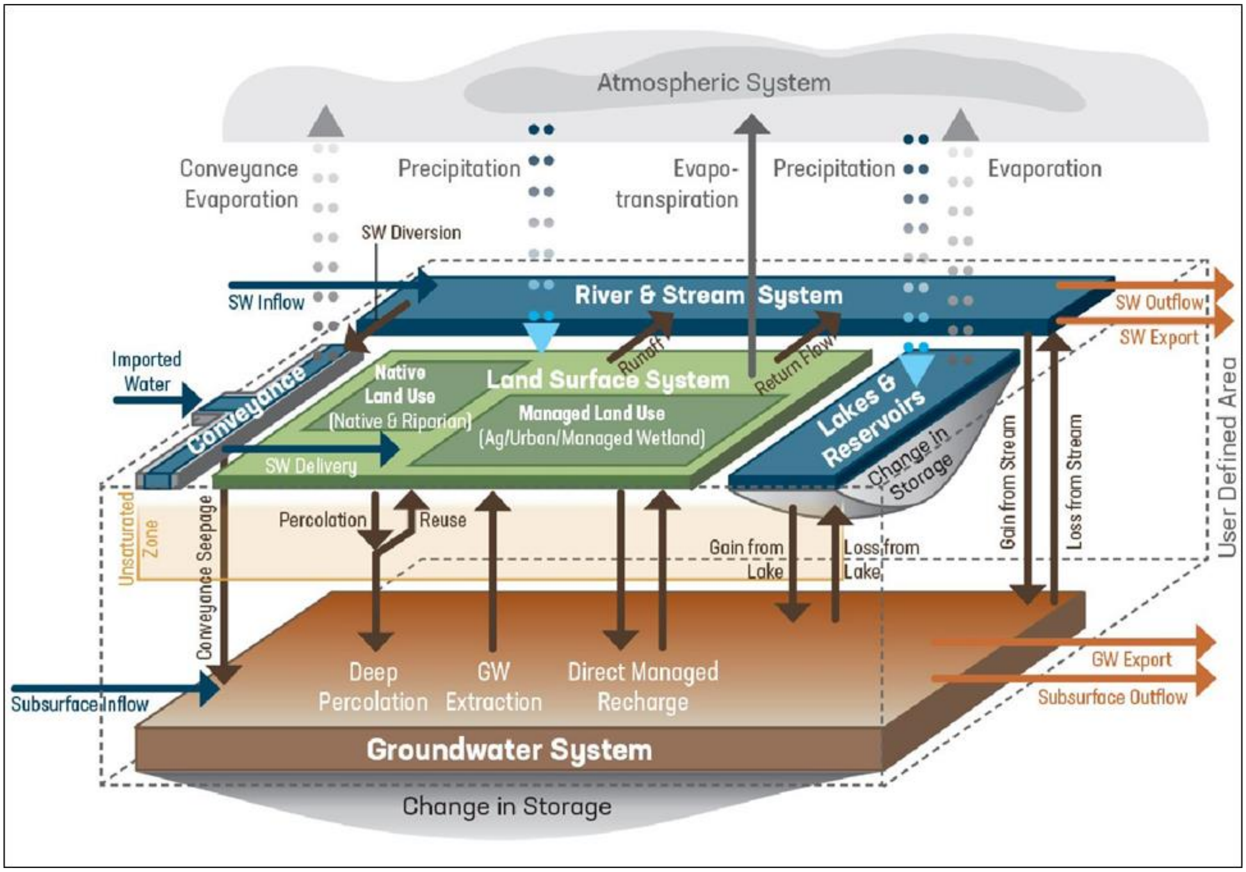


Figure 3-43 Water Budget Schematic

Purpose of Water Budget

As provided for in SGMA, coordinated water budgets were prepared by each GSA within the Kings Subbasin and then aggregated together for the subbasin. The water budgets quantify the components of water supply and use along with 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

3.3.2 Best Available Information

§354.18
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.

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 Water Budget

Regulation Requirements:

§354.18
e) 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.

Water Budget Methodology

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 Susbasin, 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.

Water Budget Requirements

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.

Water Budget Periods

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

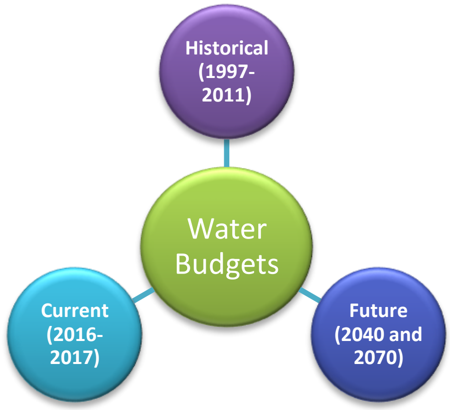


Figure 3-44 Water Budgets Evaluated

Historical. A historical water budget was prepared covering Water Years 1996/97 through 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 average (normal), dry and wet years.

Historical water budgets were developed for each GSA in the Kings Subbasin and then rolled up together to obtain a water budget for the entire Kings Subbasin. 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.

Hydrologically Average Period

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 for the historical period as it is a 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 selected as the basis for determining average conditions as 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 to the Kings Subbasin. Average 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 than Kings River runoff because water can be stored 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 acre-feet. Average diversions during the selected 1997-2011 historical analysis period were 1,081,700 acre-feet, 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 AF, 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.

Water Budget Types

The inflow and outflow components were used to prepare two separate historical water budgets: 1) a budget representing the groundwater system; and 2) a budget representing the groundwater basin. The groundwater system budget is the classical water budget that quantifies all inputs and outputs and includes groundwater pumping (extraction) and recharge (infiltration), among other parameters. The groundwater system budget is used to estimate groundwater pumping in the area since the volume of groundwater pumping is not currently measured.

The groundwater basin budget only includes components that are either flowing into or out of the borders of the GSA and does not include groundwater pumping (extraction) or recharge (infiltration) since those are internal to the aquifer system. The primary inflows to the groundwater basin balance are surface water diversions and the primary outflows are evapotranspiration. The calculated change in groundwater storage is the same with the groundwater system water budget and the groundwater basin water budget since parameters used are either the same or computed using a consistent methodology. A simplified schematic of the water budget is shown **Figure 3-45**, where the groundwater system budget is represented by all the components shown, and the groundwater basin budget is represented by the components entering or leaving the basin boundary.

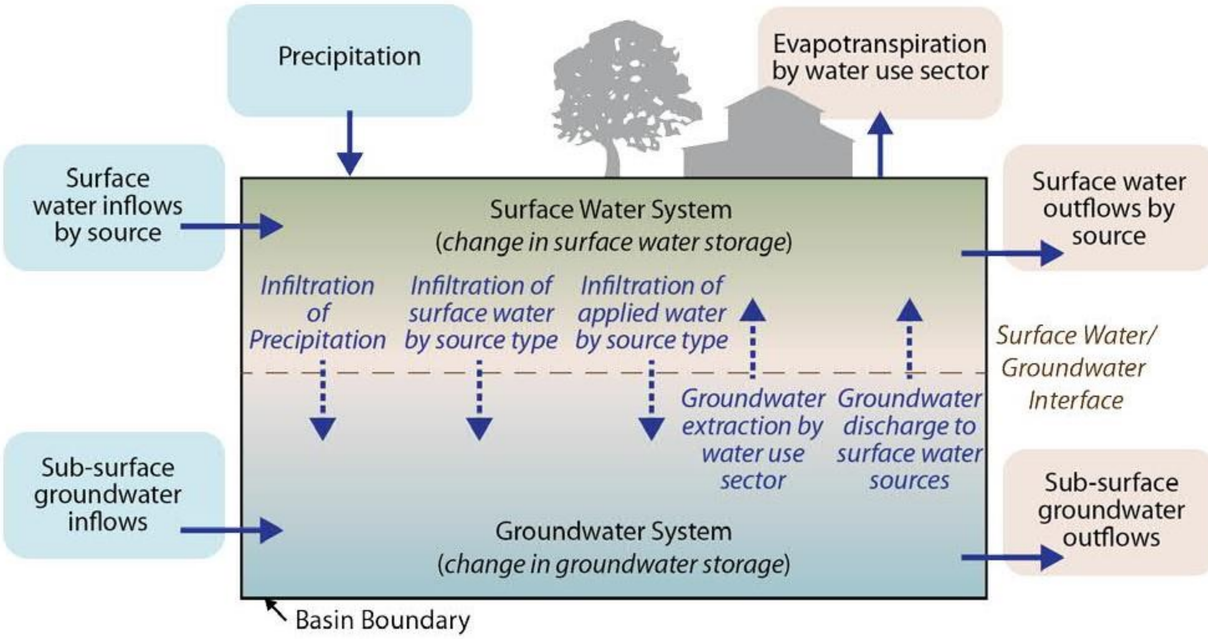


Figure 3-45 Groundwater Basin Water Budget Schematic

Water Year Types

In developing quantities for the water budgets, in addition to average conditions, 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 for the King Subbasin have been defined based on percentage of average Kings River diversions to the Kings Subbasin for a 50-year hydrologic period from 1968-2017, which matches the average from the 1955-2018 period, which is the period since the construction of Pine Flat Reservoir. Year types were selected for Dry, Normal and Wet conditions based on the historical Kings River diversions. A summary of the water year types is shown in **Table 3-13** below

Table 3-13 Water Year Types

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

The annual Kings River runoff (referred to as Pre-Project Piedra) and the average diversions and corresponding year type classification are indicated in **Table 3-14.**

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 San Joaquin Valley (SJV) Index classification is also shown in **Table 3-14** for reference. 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 the reservoir and the ability to store water for the following year.

Table 3-14 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**.

The following sections describe the variables used in the water budget, as well as assumptions and criteria used. **Table 3-15** below lists all of the water budget variables. The same variables were used in all the water budgets throughout the Kings Subbasin.

Table 3-15 Water Budget Variables

Surface Water Entering and Leaving (Section 3.3.4)	Inflows to Groundwater System (Section 3.3.5)
○ Surface Water for Irrigation ○ Surface Water for M&I ○ Surface Water for Recharge ○ Precipitation ○ Spill Inflows ○ Operational Spills	○ Groundwater Inflows ○ Deep Percolation of Irrigation Water ○ Deep Percolation of Precipitation ○ Deep Percolation of M&I Water ○ Seepage of Channels and Pipelines ○ Seepage of Reservoirs ○ Urban Stormwater – Recharge ○ Local Streams - Recharge
Outflows from Groundwater System (Section 3.3.6)	**Change in Groundwater Storage (Section 3.3.7)**
○ Groundwater Pumping for Irrigation ○ Groundwater Pumping for M&I ○ Evapotranspiration of Applied Water -Irrigation ○ Evapotranspiration of Applied Water – M&I ○ Evapotranspiration of Effective Precipitation ○ Evapotranspiration of Conveyance Channels ○ Evapotranspiration of Reservoirs and Recharge Basins ○ Evaporation and Runoff of Precipitation ○ Groundwater Exports ○ Groundwater Outflows ○ Irrigation efficiencies	○ Unconfined Groundwater Storage Change ○ Groundwater Released from Aquifer Compaction

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.

Quantities of water entering the Kings Subbasin at the surface, either as surface flows or precipitation, are described and quantified in this section using the procedures described below.

The total surface water entering and leaving the Kings Subbasin by water source type is not provided in this Plan at this time. While not ideal, it is assumed that the intent of the Kings Subbasin GSAs is for the reader to refer to each individual GSA and to cumulate the total surface water entering and leaving the Kings Subbasin by water source type manually.
The total quantities of water entering and leaving the James GSA plan area by water source type have been quantified and provided in water budgets prepared by the James GSA. The James GSA water budgets are provided in **Appendix 3-C**. Five surface water streams enter the James GSA and four surface water streams leave the James GSA.

These streams entering the James GSA with their corresponding source water type are: (1) the Kings River at State Highway 145 conveying water from Pine Flat Dam and the Kings River watershed; (2) the James Bypass at the Union Pacific railroad tracks conveying water from the Central Valley Project or the San Joaquin River; (3) the James ID siphon conveying waters from various sources including Pine Flat Dam and the Kings River Watershed, Fresno Irrigation District operational spills and transfers, storm runoff from the Fresno and Clovis metropolitan areas, and the James ID well field; (4) the James ID connection to the Tranquillity ID distribution system carrying waters from various sources including intra-district transfers; and (5) the Fresno Slough at Mud Dam carrying water from various sources including local storm runoff.

The streams leaving the James GSA with their corresponding source water type are: (1)) the James Bypass at the Union Pacific railroad tracks conveying water from Pine Flat Dam and the Kings River watershed; (2) the Fresno Slough conveying local storm runoff or operational spills from James ID; (3) James Bypass at the Union Pacific railroad tracks conveying water from the Central Valley Project or the San Joaquin River; (3) the James ID connection to the Tranquillity ID distribution system carrying waters from various sources including operational spills and intra-district transfers; and (4) other non-specific locations including diversions of Kings River water from the James Bypass to areas outside of the James GSA.

Each of these surface water flows is measures using the best available methods to quantify the flow on a volumetric basis. For smaller flows or fully submerged pipeline flows, the measurement is typically performed using a propeller-type flow meter. For flows involving partially submerged pipes, the measurement is typically performed using an ultrasonic device that will quantify the flow based on velocity and flow area. For larger flows, rating tables are used, and the rating table is derived from engineering principles or, in the case of James Bypass flows, from periodic stream flow measurements.

James GSA water budgets were prepared using control volume for the overall Plan Area envelope and the surface water and groundwater systems. Water budgets prepared by other GSAs and for the Kings Subbasin use different conventions. The most noticeable difference is that the James GSA water budget measures and accounts for the total inflow and outflow of the Kings River while individual GSA water budgets only account for diversions from the river as inflows. The water budgets prepared by James GSA are used to provide information for the Kings Subbasin water budgets. Methods used by the James GSA to obtain values for the Kings Subbasin water budget variables for surface water entering and leaving are described below.

Surface Water for Irrigation
The amount of surface water for irrigation represents all surface water diverted into the James ID and RD 1606. These diversions occur along the James Bypass and typically include diversions of Kings River water flowing from south to north down the James Bypass and water delivered through the Mendota Pool from north to south up the James Bypass. The James GSA water budgets provided in **Appendix 3-C** classify the inflows by source but do not distinguish the various types of water that may come from that source. For example, James ID received water from the Mendota Pool but that water may be delivered to James ID under its CVP Water Supply contract, Schedule 2 settlement water contract, a Section 215 water contract, or a water transfer. Similarly, water received by James ID through its siphon may come from water extracted using James ID well field, Kings River water delivered through Fresno Irrigation District facilities, Friant Kern water delivered through Fresno ID facilitates, operational spill from Fresno ID, storm water from the Fresno and Clovis metropolitan areas, or exchanges with Fresno ID.

Surface Water for Municipal and Irrigation Uses
No surface water is used for municipal and industrial purposes in the James GSA.

Surface Water for Recharge
The water budgets prepared by James GSA and provided in **Appendix 3-C** do not distinguish inflows by intended use. Values used as surface water for recharge in the Kings Subbasin water budgets will correspond to quantities reported as managed recharge in the James GSA water budgets. As explained later, no quantities have been reported for managed recharge in the historical and current water budgets but recharge activities were performed.

Precipitation
Actual precipitation measurements were obtained from the James ID. The measurements were taken at the James ID office located in the City of San Joaquin. The measurement point is centrally located and considered to be representative of conditions throughout the Plan Area. The measured precipitation values were consistent with those derived by methods employed by other Kings Subbasin GSAs.

Spill Inflows
The water budgets prepared by James GSA and provided in **Appendix 3-C** account for inflows by geographic location and do not distinguish inflows by source. Any operational spills flowing onto the James GSA are reported as surface water for irrigation. Operational spills typically occur from Fresno ID and flow into the James ID siphon. These spills are comingled with water from other sources before entering the James ID siphon. No spills inflows were used by the James GSA for the Kings Subbasin water budgets.

Operational Spills
This represents spills of surface water leaving the boundary of the James GSA and are included as an outflow. Values are based on measurements at outflow locations by James ID. Measured values were considered to be small and negligible for purposes of preparing the water budget. Accordingly, no operational spills were used by the James GSA for the Kings Subbasin water budgets.

3.3.5 Inflow to Groundwater System

Regulation Requirements:

§354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data: (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.

The quantities of water entering the groundwater body in the Kings Subbasin as forms of recharge are not comprehensively described and quantified in this Plan at this time. While not ideal, it is assumed that the intent of the Kings Subbasin GSAs is for the reader to refer to each individual GSA and to cumulate the quantities of water entering the groundwater body by form or type manually.

The total quantities of entering the groundwater body in the James GSA plan area by type have been quantified and provided in water budgets prepared by the James GSA. The James GSA water budgets are provided in **Appendix 3-C**. Five types or forms of water entering the groundwater body from the surface have been identified. These five types are: (1) deep percolation; (2) distribution system seepage; (3) wastewater disposal; (4) managed recharge; and (5) waterbody losses. Deep percolation is further classified by source as coming from either precipitation, irrigation, urban and storm water, or other sources. Waterbody losses are further classified as losses from either areas inundated by the Mendota Pool or wetlands and sloughs. Groundwater flows into the James GSA boundaries from groundwater within the Kings Subbasin or other subbasins has been quantified and distinguished by subbasin and GSA.
James GSA water budgets were prepared using types or forms of water entering the groundwater basin than were used in the Kings Subbasin water budgets. Methods used by the James GSA to obtain values for the Kings Subbasin water budget variables for inflows to the groundwater system are described below.

Groundwater Inflows

Unconfined groundwater inflows 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: $Q\ is$ 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 to use to estimate groundwater flows,
- The aquifer is relatively homogenous and isotropic

For the Kings Subbasin, a comprehensive analysis was prepared for unconfined groundwater flows at GSA boundaries. 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). The contour maps were generally complete each year for the Kings Subbasin, with exceptions for some years in the James ID GSA, Central Kings GSA and the Laguna Irrigation District portion of the James GSA when water level data was missing. 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.

Confined subsurface groundwater inflows were not calculated because there is a lack of confined groundwater level information available within the Kings Subbasin. Estimates of confined inflow to the James GSA were made based on calculated confined groundwater outflow to an adjacent subbasin.

In the James GSA, the unconfined subsurface inflows from other GSAs within the Kings Subbasin averaged 18,100 acre-feet and unconfined subsurface inflows from adjacent subbasins averaged 1,400 acre-feet for the historical period. Confined subsurface inflows, all from other GSAs within the Kings Subbasin, were not calculated because of the lack of confined aquifer water level data but were assumed to be 15,000 acre-feet. Total groundwater inflow was estimated to be 34,500 acre-feet per year during the historical base period. Most of the subsurface flows were from the Central Kings GSA, with minor amounts of subsurface inflow from other adjacent GSAs.

Deep Percolation of Irrigation Water

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, if the GSA average irrigation efficiency is estimated to be 80%, then deep percolation of irrigation water would be 100% – 80% = 20% of the applied water.

Irrigation efficiencies within the James GSA vary depending on irrigation method, soil type, crop, irrigation scheduling methods, and irrigation practices. James ID has information on crop types, irrigation system type, and water usage. With this information, it is possible to perform a rigorous analysis and prepare a good estimate of overall irrigation efficiency within the James GSA.

A rigorous analysis was not performed at this time and an irrigation efficiency of 95% was used. Values at or near 80% were used in other areas within the Kings Subbasin. There has been a trend within the James ID for growers to convert from row crops to permanent crops and a majority of the agricultural lands within the James GSA are now dedicated to permeant crops. Permanent crops within the James ID typically utilize high-efficiency irrigation methods because of the cost of water and the volumetric cost structure for water deliveries. Soils within the James GSA tend to be heavier than those encountered throughout the remainder of the Kings Subbasin. For these reasons, a higher irrigation efficiency was assumed.

<u>Deep Percolation of Precipitation</u>

Deep percolation of precipitation was estimated based on the following empirical formula:

$$DP = 0.64 \times P - 6.2$$

Where:

DP = Deep percolation (inches)
P = Annual precipitation (inches)
Source: Williamson, Prudic and Swain, 1989

This empirical equation was developed for the San Joaquin Valley 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 (see **Section 3.3.1.6).**

James GSA water budgets were prepared assuming that 10% of precipitation over the entire GSA acreage would percolate into the confined aquifer. Other Kings Subbasin GSAs prepared water budgets assuming an empirical equation for deep percolation of precipitation. Consideration will be given to the latter approach in future water budgets. It is likely that other components involving the water budget involving evapotranspiration and the root zone, such as irrigation efficiency above, will also be refined in later water budgets.

<u>Deep Percolation of M&I Water</u>

For purposes of the Kings Subbasin water budget for the James GSA, it was assumed that the only source of deep percolation of municipal and industrial water was treated effluent from the City of San Joaquin municipal wastewater treatment plant. Measured values of treated effluent were provided by the City of San Joaquin. If measured values were not available for a given year, an estimate of treated effluent was made based on assumed per-capita values and known population. The treated effluent is disposed using percolation ponds. It was assumed that all treated effluent percolated into the groundwater and no adjustments were made for evaporation as it was considered negligible.

<u>Seepage of Channels and Pipelines</u>

Calculated distribution system seepage values from the James ID were used. The values were calculated using the measured quantity of surface water brought into the James ID distribution system and the measured quantity of groundwater pumped into the distribution system less the measured quantity of water delivered to individual grower head gates. The calculated value will include losses in regulating basins and other similar facilities. Water intentionally percolated for groundwater recharge will also be included in this value unless those quantities are measured and accounted for elsewhere. No adjustments were made for evaporation as it was considered negligible.

Seepage of Reservoirs

Seepage of reservoirs was not individually measured or calculated due to a lack of measurement data from James ID. Rather than estimate the value, seepage of reservoirs is accounted for as a part of seepage of channels and pipelines within the James GSA water budgets.

Urban Stormwater – Recharge

For the James GSA water budget, recharge from urban storm water was estimated to be 10% of precipitation that occurred on urban land uses. Other Kings Subbasin GSAs have assumed higher values. The North Kings GSA has assumed a value of 20% in the North Kings GSP.

Local Streams – Recharge

For the James GSA, recharge from local streams was assumed to occur in the portions of the James Bypass and Fresno Slough that are continuously inundated by the Mendota Pool. The value was estimated based on the measured area that was inundated and an estimated infiltration rate. This is a category in the James GSA water budget that has high uncertainty. Losses from Kings River flows in the reach upstream of the Mendota Pool were not estimated nor included in the James GSA water budget at this time. These losses may be estimated and included in future water budgets.

Intentional Recharge of Groundwater

The James GSA has included a category for Managed Recharge in their water budget and this category is used as the James GSA value for Intentional Recharge of Groundwater in the Kings Subbasin water budgets. For the James GSA, the category is used to indicate the amount of groundwater recharge that the GSA plans to perform in future years to reach sustainability.

For the historical water budget, no value is provided. This is not representative of historical conditions as managed recharge activities occurred during the period used for the historical water budget. All of these recharge activities cannot be quantified at this time and are included in the historical analysis as distribution system seepage.

For the current water budget, no managed recharge activities are assumed, and a zero value is provided. This is intended to provide a baseline condition to assess and quantify the need to utilize existing projects and implement new projects.

For future water budgets, values are based on future projects that will be implemented to achieve groundwater sustainability. It should be noted that the values do not represent the maximum future utilization of all projects and management activities, rather the degree of implementation that is only necessary to achieve sustainability.

3.3.6 Outflows from Groundwater System

Regulation Requirements:

§354.18(b) The water budget shall quantify the following, either through direct measurements or estimates based on data: (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 quantities of water leaving the groundwater body in the Kings Subbasin by form or type are not comprehensively described and quantified in this Plan at this time. While not ideal, it is assumed that the intent of the Kings Subbasin GSAs is for the reader to refer to each individual GSA and to cumulate the quantities of water leaving the groundwater body by form or type manually.

The total quantities of entering the groundwater body in the James GSA plan area by type have been quantified and provided in water budgets prepared by the James GSA. The James GSA water budgets are provided in **Appendix 3-C**. Two types or forms of water leaving the groundwater body to the surface have been identified. These two types are: (1) groundwater extraction; and (2) groundwater seeps or springs. Groundwater extraction is further classified by use and extractor. Given that there are no known seeps or springs within the Plan Area, and that hydrological conditions make any seeps or springs highly unlikely, these are not included in the James GSA water budget.

Differences exist between the conventions used in the James GSA water budgets and the Kings Subbasin water budgets. The Kings Subbasin water budgets include evapotranspiration as an outflow from the groundwater system whereas the James GSA accounts for evapotranspiration as a use. Methods used by the James GSA to obtain values for the Kings Subbasin water budget variables for outflows from the groundwater system are described below.

<u>Groundwater Pumping for Irrigation</u>

All groundwater extractions for agricultural irrigation uses within the James GSA are measured using propeller-type flow meters. This is in contrast to the remainder of the Kings Subbasin where most groundwater pumping for irrigation is not metered and extractions are quantified using indirect and less accurate methods.

Groundwater pumping by James ID for agricultural irrigation is measured using propeller-type flow meters. These extractions comprise about 96% of all groundwater extractions within the James GSA. Groundwater extractions for agricultural uses by entities other than James ID, such as landowners, typically do not occur. There are only two known wells within the James GSA that are used for agricultural irrigation and it is not known whether these wells are metered. There is currently no reporting mechanism in place for quantifying extractions from these wells. If extractions from these wells are observed, the quantity of groundwater extracted will either be measured and reported on a voluntary basis or estimated by the James GSA. Both of these categories of users within the James GSA water budget are included in the Kings Subbasin water budget as groundwater pumping for irrigation.

<u>Groundwater Pumping for Municipal and Industrial Uses</u>

All groundwater extractions for municipal and industrial uses within the James GSA are measured using propeller-type flow meters. This is in contrast to the remainder of the Kings Subbasin where these amounts are quantified using indirect and less accurate methods.

Groundwater pumping by the City of San Joaquin for municipal and industrial uses is measured using propeller-type flow meters. These extractions comprise all of the groundwater extractions within the James GSA for municipal and industrial uses and about 3% of the extractions within the James GSA area.

The James GSA also accounts for rural domestic uses in the James GSA water budget. These uses extract groundwater from private domestic wells. It is not known but assumed that many of these wells are not metered. These wells will also include wells that fall under the SGMA definition of a de minimis extractor, or "a person who extracts, for domestic purposes, two acre-feet or less (of groundwater) per year." The amount extracted for rural domestic uses was estimated based on an approximate count of these users and an assumed annual usage of two acre-feet per year. Extractions for rural domestic uses comprise less than 1% of the extractions within the James GSA area.

Both of these categories of users within the James GSA water budget are included in the Kings Subbasin water budget as groundwater pumping for municipal and industrial uses.

Evapotranspiration of Applied Water - Irrigation

In the James GSA water budget, the evapotranspiration of applied water for irrigation was calculated as the difference between the water applied for irrigation and the water lost through deep percolation. As discussed earlier, an irrigation efficiency of 95% was assumed within the James GSA water budget. Accordingly, 95% of all applied irrigation water was assumed to be consumed by evapotranspiration in the James GSA water budget. This value is then used in the Kings Subbasin water budget for evapotranspiration of applied irrigation water.

Evapotranspiration of Applied Water – Municipal and Industrial

The James GSA water budget accounts for municipal and industrial consumptive use. The value for municipal and industrial consumptive use is calculated to be the difference between groundwater extractions for municipal and industrial use and wastewater disposal. This value is then used in the Kings Subbasin water budget for evapotranspiration of applied water for municipal and industrial uses.

Evapotranspiration of Effective Precipitation

In the James GSA water budget, the evapotranspiration of effective precipitation was calculated as the difference between precipitation that occurred over agricultural land uses and the water lost through deep percolation of precipitation. As discussed earlier, an assumed 10% of all precipitation that occurred over agricultural land uses was assumed lost to deep percolation. The remaining 90% is then assumed to satisfy agricultural evapotranspiration demands. This value is then used in the Kings Subbasin water budget for evapotranspiration of effective precipitation.

Evapotranspiration from Conveyance Channels

Evapotranspiration from conveyance channels was not included in the James GSA water budget because it was considered negligible. The James GSA considered studies performed by the Kings River Conservation District that estimated channel evaporation to be 0.45% and 1.0% of flows in Consolidated Irrigation District and Alta Irrigation District, respectively. Operations in these districts are seasonal and during periods of high evaporation losses whereas operations in the James ID occur almost year-round and during periods of low and high evaporation losses. Accordingly, evaporation losses in James ID are estimated to be 0.25 to 0.50% of flows and are effectively negligible. No value was provided for evapotranspiration from conveyance channels for the James GSA within the Kings Subbasin water budget.

Evapotranspiration from Reservoirs and Recharge Basins

Evapotranspiration from reservoirs and recharge basins was not included in the James GSA water budget because it was considered negligible. The surface area of reservoirs and recharge basins was considered to be comparable to the surface area of conveyance channels within the James GSA. Evaporation from these two water features was considered negligible because it was estimated to be equivalent to evaporation from conveyance channels which was considered to be negligible. Accordingly, no value was provided for evapotranspiration from reservoirs and recharge basins for the James GSA within the Kings Subbasin water budget. In order to provide a more rigorous analysis and to provide consistency in data reported by Kings Subbasin GSAs, future water budgets prepared by the James GSA may include evaporation.

Evaporation and Runoff of Precipitation

Evaporation of precipitation was not included in the James GSA water budget because it was considered negligible. The majority of the land use within the James GSA is for agricultural uses and precipitation in these areas was expected to be absorbed by soils and contribute to water used for evapotranspiration and deep percolation. As one component of evapotranspiration is evaporation, the loss of water from the evaporation of precipitation on agricultural land uses is already included in the water budget. Evaporation from precipitation on municipal land uses was not accounted for in the James GSA water budget but is assumed to occur and is accounted for within the component of precipitation on municipal land types that does not contribute to deep percolation. This component, which includes 90% of the precipitation on municipal land types, is assumed to either be used by municipal landscape or lost through evaporation. Precipitation on other land types, including wetlands and sloughs, is treated similarly. For these reasons, no value was provided for evaporation and runoff from precipitation for the James GSA within the Kings Subbasin water budget.

<u>Groundwater Exports</u>

There are no groundwater exports from the James GSA and no groundwater exports are expected to occur in the future. Each GSA within the Kings Subbasin is defining groundwater exports differently and there is no consistent definition or application of the variable among all the GSAs within the Kings Subbasin. As groundwater exports are not occurring or are expected to occur, a groundwater export category or use type was not included in the James GSA water budget and no value was provided for the Kings Subbasin water budget.

<u>Groundwater Outflows</u>

Groundwater outflows were computed using Darcy's Law with the same efforts described previously for groundwater inflows and documented in P&P Technical Memorandum #5 (Appendix 3-A). Groundwater outflow can occur from either then unconfined or the confined aquifer. Average transmissivities were taken from aquifer tests or USGS reports of specific capacities. Available groundwater level data for the unconfined aquifer was plotted onto contour maps and average gradients and flow directions were identified by boundary flow segments. The unconfined flows across GSA boundary segments were then summarized for GSAs. Estimates of confined groundwater outflow was made using available confined aquifer groundwater level data at the subbasin boundary and historical DWR confined aquifer contour maps.

Confined subsurface groundwater outflows were not calculated because there is a lack of confined groundwater level information available within the Kings Subbasin. Estimates of confined aquifer outflow to the James GSA were made based on calculated confined groundwater inflow to an adjacent subbasin.

As discussed previously for groundwater inflows in Section 3.3.5, due to significantly differing conditions between the James GSA and the MAGSA, estimated groundwater flows between the two GSAs may vary significantly from actual conditions. The calculation of groundwater flows using water surface gradients relies on the assumption that the amount of surface water percolating into the groundwater over a unit of area, or flux, is consistent. Where significant inconsistencies occur, the gradient method does not account for these contributions to the aquifer. Due to the presence of the James ID distribution system, which is filled most of the year, there are substantial differences in the percolation flux between the James GSA and MAGSA. These errors can be reduced by utilizing additional groundwater elevation monitoring points to create a finer grid for contouring. These errors will likely manifest as mass of volume balance closure errors when performing water balance calculations.

3.3.7 Change in Groundwater in 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.

<u>Unconfined Groundwater Storage Change</u>

Water storage change in the unconfined aquifer for the 1997-2011 hydrologic period was estimated based on measured groundwater level data. Water surface elevation contour maps were generated for Spring 1997 and Spring 2012 based on the available water level data using measured water levels from more than 900 wells within the Kings Subbasin. In preparing the contour maps, 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 could be erroneous or anomalous to other nearby measured wells because they are composite wells pumping from two or more aquifers, confined wells pumping from below the Corcoran Clay, or for other reasons.

Specific yield values for use in the storage change calculation were estimated from USGS reports and other sources as documented in **Appendix 3-A, TM 2**). 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 following procedure (**Appendix 3-A, TM 4**). Water surface elevation contour maps for the beginning and ending periods were used to determine the average depth value for each unique Specific Yield area. Within each Specific Yield area, the height of water within each specific yield depth zone was determined from the average depth to water of that area. 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. Values for each depth zone were added to determine Specific Yield area total. The Specific Yield area totals for each GSA area were added to determine the GSA total for that year. 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. 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.

Values for the average annual unconfined groundwater storage change were calculated and included in the Kings Subbasin water budget.

<u>Groundwater Released from Aquifer Compaction</u>

Water released from aquifer 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.

Subsidence data was not available for the entire hydrologic base period (1996 to 2011); data was only available during certain years from 2007 to 2017. However, it was assumed that no subsidence occurred from 1996 to 2006, due to more stable groundwater levels and a lack of physical observations indicating land subsidence. Most of the observed land subsidence occurred during the extended drought from 2012 to 2016. For recent years, NASA/JPL processed satellite inSAR data of vertical ground surface displacement; this data was available on DWR's website (DWR, 2018) for May 31, 2015 through April 30, 2017 (23 months). Subsidence was generally minimal before the most recent drought in 2012, except in James ID, McMullin Area and James GSA. Luhdorff and Scalmanini (2014) provided land subsidence data from March 2007 to March 2011, also using inSAR data. The subsidence in the three affected GSAs was estimated to be about 0.25 feet over the 50 months, or 0.72 inches/year, equating to approximately 12,000 AF/year for the Kings Basin over the hydrologic base period.

Water released from aquifer compaction was not included in the James GSA water budget because it is considered negligible for purposes to the analysis. Also, it appears that there may be the potential to account for water released from aquifer compaction twice if true and accurate water surface elevations (which have corrected well reference points for subsidence) are used to generate groundwater contours for change in storage calculations. No value for groundwater released from aquifer compaction was provided by the James GSA to the Kings Subbasin water budget.

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.
> (d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:
> (1) Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.

A historical water budget was prepared for the entire Kings Subbasin and for the James GSA for the hydrologically average period of 1997-2011 by inputting values determined using the procedures described above. 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 Subbasin Water Budget

Table 3-16 shows a groundwater system water budget for the Kings Subbasin as a whole along with the equivalent individual water budgets for each GSA 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).

As shown in **Table 3-16**, the historical water budget for the Subbasin indicates an annual decline in groundwater storage of 198,200 AF (Method 1), which is about 64,000 AF higher than the estimate of 134,000 AF based on unconfined groundwater levels and estimated water released from the confined aquifer (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 64,000 AF is about 3% of the estimate of ETAW, 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 unconfined groundwater levels and water released from the confined aquifer (Method 2: 134,000 AF/year) is considered the more accurate value. The water budget helped to validate this number.

Table 3-16 Kings Subbasin Historical Average Water Budget

(all units in acre-feet)

Description	TOTAL	McMullin GSA	NFKings GSA	North Kings GSA	Central/South	Kings River East	James ID
Total Supply	***3,547,400***	**379,500**	***616,200***	***1,167,200***	**614,700**	***677,500***	***92,300***
Consumptive Use Subtotal	***2,094,600***	**296,000**	**399,100**	**544,500**	**358,000**	**428,400**	**68,600**
GW Recharge Subtotal	***1,362,500***	**239,800**	**202,300**	**460,900**	**216,100**	**210,400**	**33,000**
Nonrecoverable Subtotal	***631,200***	**31,900**	**65,500**	**325,000**	**110,400**	**76,300**	**22,100**
Method 1							
Estimated Annual Change in Groundwater Storage	**-198,200**	**-61,600**	**-91,500**	**-6,500**	**-10,500**	**-23,500**	**-4,600**
GW Recharge	1,362,500	239,800	202,300	460,900	216,100	210,400	33,000
GW Pumping	-1,341,800	-282,900	-277,600	-345,400	-191,200	-229,200	-15,500
GW Outflow	-200,400	0	-16,200	-122,000	-35,400	-4,700	-22,100
Other Change in GW Storage	-18,500	-18,500	0	0	0	0	0
Method 2							
Calculated Annual Change in Groundwater Storage (unconfined and confined)	***-134,000***	**-18,000**	**-59,000**	**-24,000**	**-17,000**	**-11,000**	**-5,000**

James GSA Historical Water Budget (Kings Subbasin Format)

The detailed historical water budget for the James GSA is shown in **Table 3-17**. 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 based on the wet and dry year averages described above. Water demands for wet and dry year types were assumed to remain the same as average conditions. 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 indicating significant differences in effects on groundwater conditions by year type, with groundwater storage actually increasing in wet year types and decreasing more than average in dry year types.

The groundwater system water budget is graphically depicted in **Figure 3-46**, which illustrates the water budget variables and their normal year values.

Convention for Normal Year Type

The James GSA water budgets in **Appendix 3-C** estimate conditions in normal, dry and wet year types and them accumulates the year types and assumed frequencies of those year types into a long-term average. The Kings Subbasin water budgets only include normal, wet and dry year types and the normal year is intended to reflect average conditions. To properly reflect "normal" or long-term average conditions in the Kings Subbasin water budgets, the long-term averages provided in the James GSA water budgets included in **Appendix 3-C** were used for the normal water year type for the Kings Subasin historical, current, early future, and later future water budgets.

Uncertainty in Water Budgets

A historical average water budget using a groundwater basin format for the James GSA is shown in **Table 3-18** including estimates of the uncertainty associated with various components. The budget excludes dependent variables, but still shows an overall change in groundwater storage similar to the water budget provided in **Table 3-17**. As indicated in **Table 3-18**, there is considerable uncertainty in many of the water budget parameters. The parameters with the least uncertainty, estimated as plus or minus 2%, are those directly measured using propeller-type flow meters such as surface water diversions, groundwater extractions, irrigation deliveries, diversions to recharge basins, other inflows, and spills. Precipitation is also directly measured at the center of the plan area; however, there is uncertainty associated with the distribution of precipitation across the entire plan area. The largest single component of water use, evapotranspiration of applied water, is estimated to have an accuracy of plus or minus 5%. The water applied is directly measured using propeller-type flowmeters and also verified against the crop type and irrigation method. The uncertainty resulting from the residual amount of water that percolates into the groundwater and is not used towards evapotranspiration. The greatest uncertainty is associated with the calculation of groundwater inflows and outflows and is estimated to be 30%.

The water budget and calculated storage change was compared to observed storage change. It is noted that year-to-year comparisons will deviate significantly but the comparison over the historical period from Fall 1996 to Fall 2011 demonstrated little difference. Discrepancies in the year-to-year values are attributed to the method used to compute observed storage change. The method utilizes a sparse distribution of observed groundwater levels and infers the groundwater level surface using computer generated contours. While this method is believed to be sufficiently accurate over the long term, it may yield values on a year-to-year basis that deviate significantly with values calculated using the water budget.

Most GSAs within the Kings Subbasin have concluded that the observed storage change is a more accurate estimate than the calculated storage change. However, the James GSA has concluded, based in part on the fact that most surface water flows and groundwater extractions are measured, that the calculated storage change is a more accurate estimate than the observed storage change for year-to-year comparison. This conclusion may be influenced by the fact that groundwater outflows are a substantial component of the James GSA water budget. For long-term comparisons, both methods appear to provide similar accuracies.

Table 3-17 James GSA Historical Water Budget

Description		Volume (AF)		
Supply		Normal Year	Dry Year	Wet Year
1)	Surface Water for Irrigation and Recharge	60,407	60,132	66,109
2)	Surface Water for M&I and Recharge	0	0	0
3)	Groundwater Pumping for Irrigation (Agency Wells)	14,879	18,820	5,109
4)	Groundwater Pumping for Irrigation (Private Wells)	0	0	0
5)	Groundwater Pumping for M&I (Agency Wells)	522	574	470
6)	Groundwater Pumping for M&I (Private Wells)	100	100	100
7)	Precipitation	16,414	11,016	24,383
8)	Spill Inflows	0	0	0
9)	Other Supply:	0	0	0
	Total Supply	**92,322**	**90,642**	**96,171**
Demand				
Consumptive Use				
10)	Evapotranspiration met by Applied Water	53,466	58,144	48,663
11)	Evapotranspiration met by Effective Precipitation	14,783	9,921	21,940
12)	Evapotranspiration of M&I	313	365	261
13)	Other Consumptive Use:	0	0	0
	Consumptive Subtotal	**68,562**	**68,430**	**70,864**
Groundwater Recharge				
14)	Groundwater Inflow	9,087	12,433	4,250
15)	Deep Percolation of Irrigation Water	2,814	3,060	2,561
16)	Deep Percolation of Precipitation	1,580	1,060	2,345
17)	Deep Percolation of M&I Water	209	209	209
18)	Seepage of Channels & Pipelines	16,591	15,292	17,544
19)	Seepage - Reservoirs	0	1	2
20)	Urban Stormwater - Recharge	63	42	94
21)	Local Streams/Rivers - Recharge	2,600	2,600	2,600
22)	Groundwater - Intentional Recharge	0	0	0
23)	Other Groundwater Recharge:	0	0	0
	GW Recharge Subtotal	**32,944**	**34,697**	**29,605**
Nonrecoverable Losses				
24)	Groundwater - Outflow	22,141	32,533	13,125
25)	Evaporation - Channels	0	0	0
26)	Evaporation - Reservoirs & Recharge Basins	0	0	0
27)	Precipitation - Evaporation and Runoff	0	0	0
28)	Operational Spills	0	0	0
29)	Groundwater - Export	0	0	0
30)	Other Nonrecoverable Loss:	0	0	0
	Nonrecoverable Subtotal	**22,141**	**32,533**	**13,125**
	Estimated Annual Change in Groundwater Storage	**(4,698)**	**(17,330)**	**10,801**
	GW Recharge - #14 thru #23	32,944	34,697	29,605
	GW Pumping - #3 thru #6	-15,501	-19,494	-5,679
	GW Outflow - #24 and #29	-22,141	-32,533	-13,125

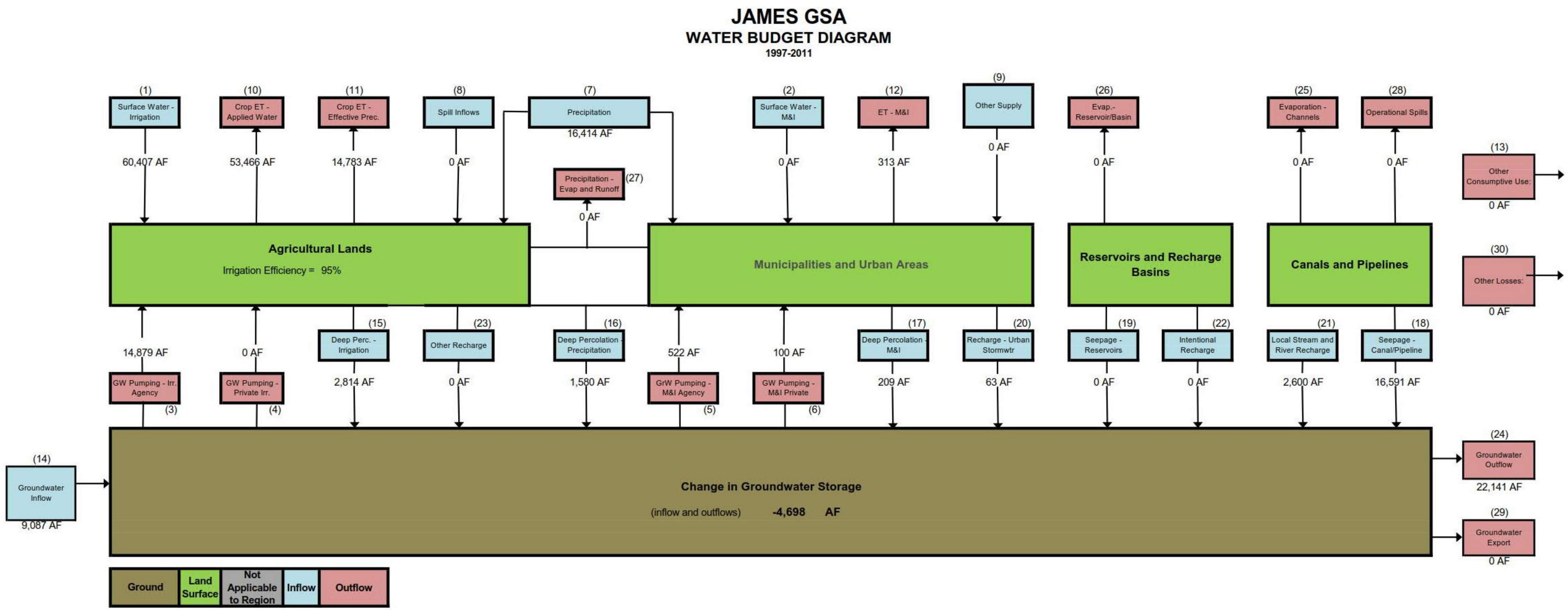


Figure 3-46 James GSA Historical Water Budget Diagram

Table 3-18 Uncertainty associated with James GSA Historical Average Water Budget

(all units in acre-feet)

Description		Volume (AF)	Source	Confidence Interval % +/-	Confidence Interval Volume (AF)
Supply					
1)	Surface Water for Irrigation and Recharge	60,407	Measured	2%	1,200
2)	Surface Water for M&I and Recharge	0	Measured	2%	0
	Groundwater Pumping quantities not included in Basin Water Budget				
7)	Precipitation	16,414	Measured	5%	800
8)	Spill Inflows	0	Calculated	2%	0
9)	Other Supply	0	Calculated	5%	0
	Total Supply	**76,821**			**2,000**
Demand					
Consumptive Use					
10)	Evapotranspiration met by Applied Water	53,466	Calculated	5%	2,700
11)	Evapotranspiration met by Effective Precipitation	14,783	Calculated	15%	2,200
12)	Evapotranspiration of M&I	313	Calculated	15%	0
13)	Other Consumptive Use	0	Calculated	25%	0
	Consumptive Use Subtotal	**68,562**			**4,900**
Groundwater Recharge					
14)	Groundwater Inflow	9,087	Calculated	30%	2,700
	Internal Groundwater Recharge quantities not included in Basin Water Budget				
	GW Recharge Subtotal	**9,087**			**2,700**
Nonrecoverable Losses					
24)	Groundwater Outflow	22,141	Estimated	30%	6,600
25)	Evaporation - Channels	0	Calculated	30%	0
26)	Evaporation - Reservoirs & Recharge Basins	0	Calculated	30%	0
27)	Precipitation - Evaporation and Runoff	0	Residual	15%	0
28)	Operational Spills	0	Measured	2%	0
29)	Groundwater - Export	0	Measured	2%	0
	Nonrecoverable Subtotal	**22,141**			**6,600**
Method 1					
	Estimated Annual Change in Groundwater Storage	**(4,795)**	Calculated		
	Supply + GW Recharge	85,908			4,700
	Demand + Nonrecoverable Losses	(90,703)			(11,500)
Method 2					
	Calculated Annual Change in Groundwater Storage	**(5,000)**		20%	(1,000)
	Difference (AF)	**205**			
	Difference in groundwater storage change is within confidence interval, therefore water budget closes within acceptable limit				

3.3.9 Current water budget

Regulation Requirements:

§354.18
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.
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 entire Kings Subbasin and for the James GSA to represent current water demands. The current water budget was determined based primarily on the historical water budget, with adjustments for the long term 50-year baseline. The 50-year baseline selected for use was the 1968-2017 period, which contains the most recent period of available data.

Kings Subbasin Water Budget

Similarly to the historical water budget, a current water budget for the Kings Subbasin as a whole was developed along with the equivalent individual water budgets for each GSA as shown in **Table 3-19**. 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 current annual change in groundwater storage based on the water budget components (Method 1).

Table 3-19: Kings Basin Current Water Budget (2016-2017)

(all units in acre-feet)

Description	TOTAL	McMullin GSA	NFKings GSA	North Kings GSA	Central/South	Kings River East	James ID
Total Supply	***3,490,400***	**389,400**	***621,300***	***1,110,300***	**604,900**	***671,500***	***93,000***
Consumptive Use Subtotal	***2,043,000***	**303,800**	**403,200**	**493,600**	**350,300**	**424,600**	**67,500**
GW Recharge Subtotal	***1,352,000***	**241,900**	**203,300**	**449,400**	**215,700**	**208,400**	**33,300**
Nonrecoverable Subtotal	***635,400***	**31,900**	**65,500**	**330,400**	**109,200**	**76,300**	**22,100**
Method 1							
Estimated Annual Change in Groundwater Storage	**-119,400**	**-69,400**	**-63,100**	**39,200**	**-1,100**	**-19,500**	**-5,500**
GW Recharge	1,352,000	241,900	203,300	449,400	215,700	208,400	33,300
GW Pumping	-1,285,000	-292,800	-282,700	-288,200	-181,400	-223,200	-16,700
GW Outflow	-200,400	0	-16,200	-122,000	-35,400	-4,700	-22,100
Other Change in GW Storage	14,000	-18,500	32,500	0	0	0	0

The water budget shows a groundwater storage change of -119,400 AF/year, which is less than the -198,200 AF/year estimated for the historical period. This reduction is attributed to increased surface water use in some cities, water meter installations, and residual effects of conservation measures implemented during the 2012-2015 drought.

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 may not be applicable long-term. Nevertheless, this water budget is still the best representation of current water conditions available.

Because the historical water budget was selected to represent average conditions, the values of components (e.g. precipitation) that are not directly affected by water management are considered to be representative of current conditions for a long-term average period. Kings River water diversions for the Kings Subbasin used in the historical water budget were within less than 1% of the average for the 50-year baseline and are considered average "normal" for current conditions. For the Kings Subbasin as a whole, only Friant-Kern

Canal deliveries, cropping demand, and M&I demand (surface water treatment and groundwater pumping) were modified for the current water budget. More details are provided below.

All the components of water supply for the historical water budget on an average annual basis were used to develop the current water budget, with the exception of Friant Kern Canal which was subject to recent regulatory and management actions associated with the San Joaquin River Restoration Program. For purposes of the current water budget, projected Friant Kern Canal deliveries (from Friant Water Authority) were substituted for historical Friant Kern Canal deliveries to the Kings Subbasin. For GSAs without any long-term Friant Division contracts, such as James GSA, this was not a factor in the water budget.

In addition to revising Friant Kern Canal water supply availability, adjustments were made to consumptive use components of the water budget for irrigation and M&I purposes. Urban water demands were revised to reflect average demands for 2016 and 2017, which represent a dry year and wet year, respectively. No recent single year was considered a better representation of current hydrology than these two years. Current crop water use was estimated based on 2014 DWR land use data (most recent available) and the historical estimates of unit evapotranspiration of applied water for the 1997-2011 period developed by DWR.

James GSA Current Water Budget (Kings Subbasin Format)

The current water budget using the Kings Subbasin format for the James GSA for normal, wet and dry year scenarios is shown in **Table 3-20.** For the current water budget, no managed recharge activities are assumed. This assumption is intended to provide a baseline condition to assess and quantify the need to utilize existing projects and implement new projects. As a practical matter, the James GSA is currently utilizing existing projects and undertaking managed recharge activities to varying degrees. Accordingly, actual storage change declines are expected to be less than those budgeted for normal and wet year conditions.

The water budget indicates a reduced decline in storage change values for the aquifer underlying the James GSA when compared to the historic water budget. This is due in large part to increases in utilization of Kings River water supplies and occurs in wet and normal years. Declines in dry year periods increase due to a reduction in current Central Valley Project water supplies when compared to those same supplies during the historic period.

The current water budget assumes increased in municipal and industrial water uses consistent with an increase in population for the City of San Joaquin. Agricultural water demands are currently similar to those experienced during the historic water budget. Groundwater inflow and outflows are assumed to remain unchanged from historic flows.

Table 3-20 James GSA Current Water Budget

Description	Volume (AF)		
Supply	Normal Year	Dry Year	Wet Year
1) Surface Water for Irrigation and Recharge	59,891	47,913	71,816
2) Surface Water for M&I and Recharge	0	0	0
3) Groundwater Pumping for Irrigation (Agency Wells)	16,034	31,187	0
4) Groundwater Pumping for Irrigation (Private Wells)	0	0	0
5) Groundwater Pumping for M&I (Agency Wells)	587	657	517
6) Groundwater Pumping for M&I (Private Wells)	100	100	100
7) Precipitation	16,414	11,016	24,383
8) Spill Inflows	0	0	0
9) Other Supply:	0	0	0
Total Supply	**93,026**	**90,873**	**96,816**
Demand			
Consumptive Use			
10) Evapotranspiration met by Applied Water	53,637	58,140	48,659
11) Evapotranspiration met by Effective Precipitation	13,501	9,060	20,055
12) Evapotranspiration of M&I	352	422	282
13) Other Consumptive Use:	0	0	0
Consumptive Subtotal	**67,490**	**67,622**	**68,996**
Groundwater Recharge			
14) Groundwater Inflow	9,087	12,433	4,250
15) Deep Percolation of Irrigation Water	2,823	3,060	2,561
16) Deep Percolation of Precipitation	1,579	1,060	2,345
17) Deep Percolation of M&I Water	235	235	235
18) Seepage of Channels & Pipelines	16,865	15,300	17,996
19) Seepage - Reservoirs	0	1	2
20) Urban Stormwater - Recharge	63	42	94
21) Local Streams/Rivers - Recharge	2,600	2,600	2,600
22) Groundwater - Intentional Recharge	0	0	0
23) Other Groundwater Recharge:	0	0	0
GW Recharge Subtotal	**33,252**	**34,731**	**30,083**
Nonrecoverable Losses			
24) Groundwater - Outflow	22,141	32,533	13,125
25) Evaporation - Channels	0	0	0
26) Evaporation - Reservoirs & Recharge Basins	0	0	0
27) Precipitation - Evaporation and Runoff	0	0	0
28) Operational Spills	0	0	0
29) Groundwater - Export	0	0	0
30) Other Nonrecoverable Loss:	0	0	0
Nonrecoverable Subtotal	**22,141**	**32,533**	**13,125**
Estimated Annual Change in Groundwater Storage	**(5,610)**	**(29,746)**	**16,341**
GW Recharge - #14 thru #23	33,252	34,731	30,083
GW Pumping - #3 thru #6	-16,721	-31,944	-617
GW Outflow - #24 and #29	-22,141	-32,533	-13,125

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.

(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:

(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 an early future (2040 level) and a late future (2070 level) period. The early future (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. The early future water budget is based on interpolation of available 2030 and 2070-level climate change projections. The early future water budget was developed for average, wet and dry year conditions to indicate changes resulting from differing hydrologic conditions, with the focus on achieving sustainability in the planning and implementation period (through 2040). In the late future water budges, crop water demands were adjusted to account for 2070-level climate change projections for ET, which are subject to greater uncertainty than the 2040 water budgets due to uncertainty about the performance of supply projects, management actions and more distant climate change.

Projected water budgets are based initially on the Current water budget, with appropriate changes (if known) made to various variables, as shown in the Figure below.

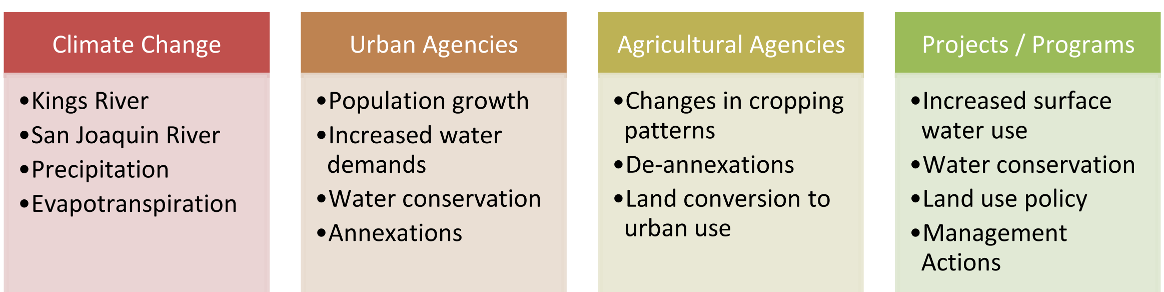


Figure 3-47 Variables Impacting Projected Water Budget

Climate Change

Climate change impacts were based on *Guidance for Climate Change Data Use during Groundwater Sustainability Plan Development* (DWR, 2018) and the related SGMA climate change website:

https://data.cnra.ca.gov/dataset/sgma-climate-change-resources. This document provided estimates of climate change impacts 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, and incorporates 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 late future (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. In addition to the three DWR datasets used, projections were also used for Friant Kern Canal water supplies that were developed by the Friant Water Authority (Friant Water Authority, 2018) that are based on CALSIM projections for WSIP.

Kings River Flows

Kings River inflows for early future and late future conditions were analyzed based on the WSIP water supply projections. It was concluded that climate change will have no significant impact on future Kings River diversions, as explained below.

Kings River inflows for early future and late future conditions were analyzed based on the WSIP water supply projections. As shown in **Figure 3-48**, the central tendency projections for both 2030 and 2070 show a slight increase in annual projected Kings River runoff (inflows to Pine Flat Reservoir); however, there was a significant shift in the timing of runoff under both scenarios. 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, predicted warmer temperatures mean that snowfall will tend to melt earlier than it would have melted historically.

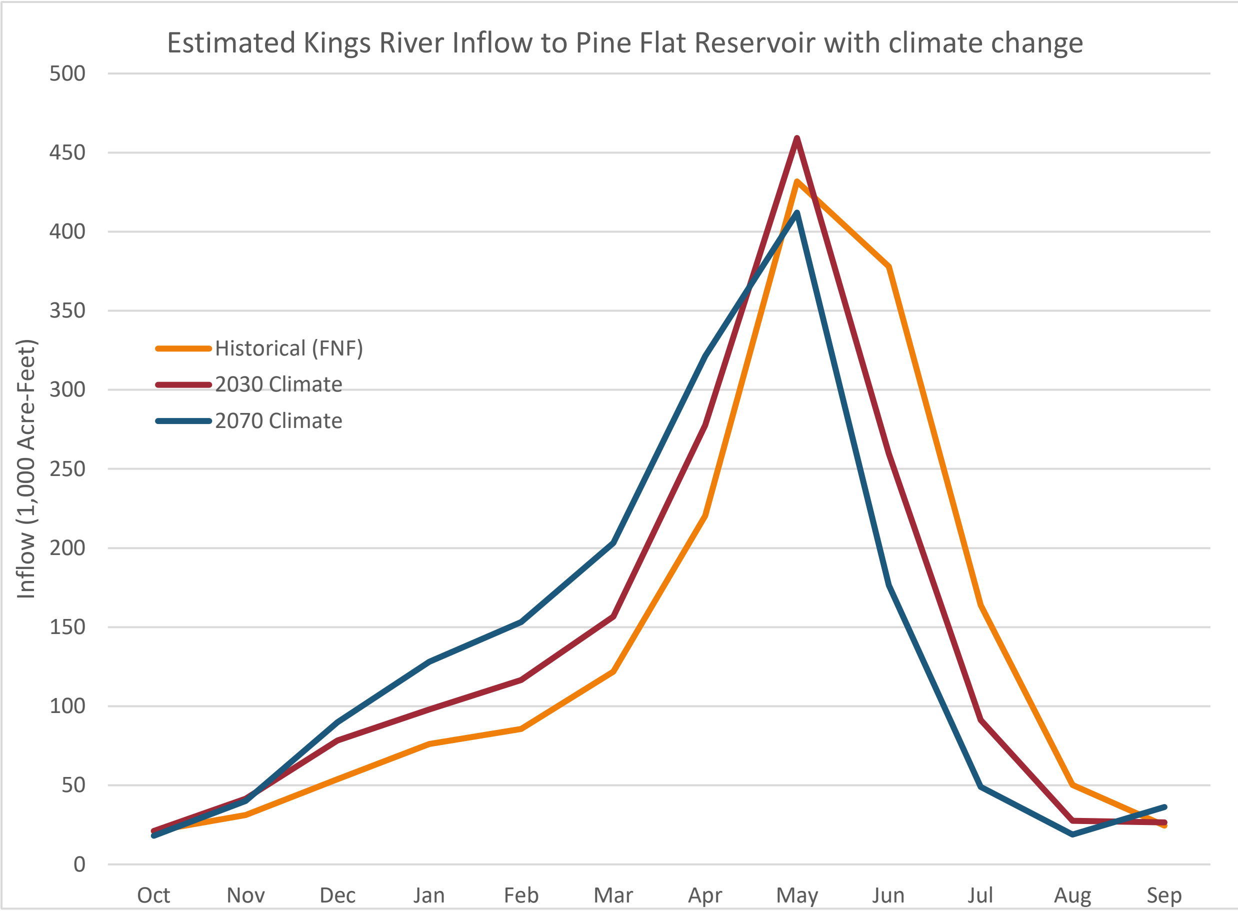


Figure 3-48 Estimated Climate Change impacts on Kings River Runoff

As noted earlier, the overall change in predicted annual Kings River inflows is a very slight increase. Inflows increased about 0.7% between historical and 2030 conditions and increased 0.3% between historical and 2070 conditions according to the model. 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 are predicted to increase 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, if the climate change models are correct, 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 modifying historical practices regarding reservoir 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 month.

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, which preclude the possibility of a simplified analysis. 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 climate change. For the James GSA, the historical water supply values described earlier will be used for both the early future (2040) and late future (2070) water budgets.

Precipitation

The WSIP climate change datasets provided by DWR for the Kings Subbasin were also reviewed for precipitation and evapotranspiration conditions. For precipitation, the datasets generally showed minimal changes.

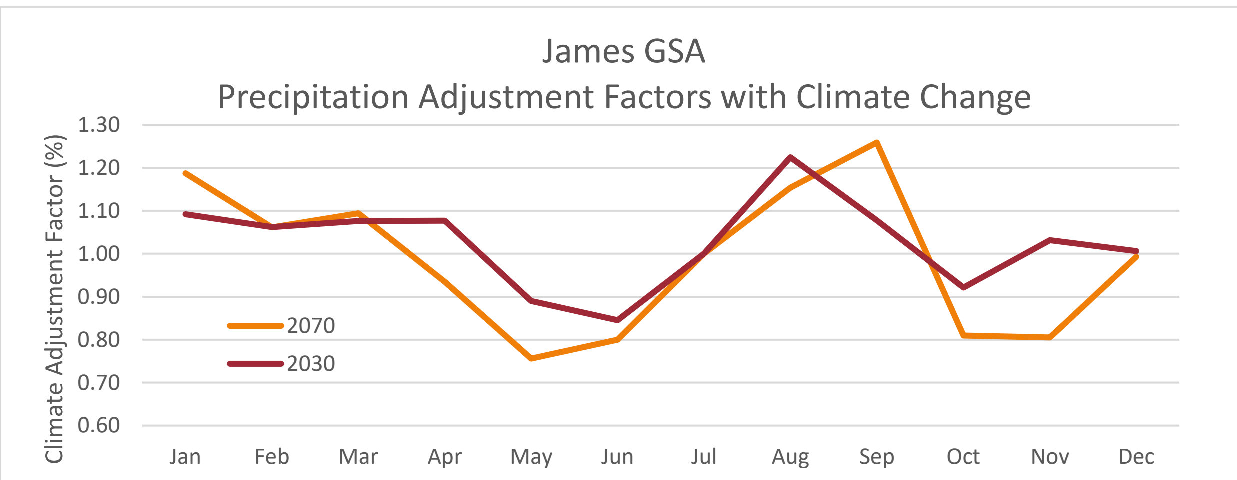


Figure 3-49 DWR Precipitation Adjustment Factors with Climate Change

The text for this section will be provided at a later date.

Evapotranspiration

The WSIP climate change projections provided by DWR project consistently higher evapotranspiration rates for early future and late future conditions. For 2030 conditions, the projected adjustments indicate an average increase of 3%, which is very little variation by month on average. For 2070 conditions, the projected adjustments indicate an average increase of 7%. 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 increases during the irrigation season (April through September).

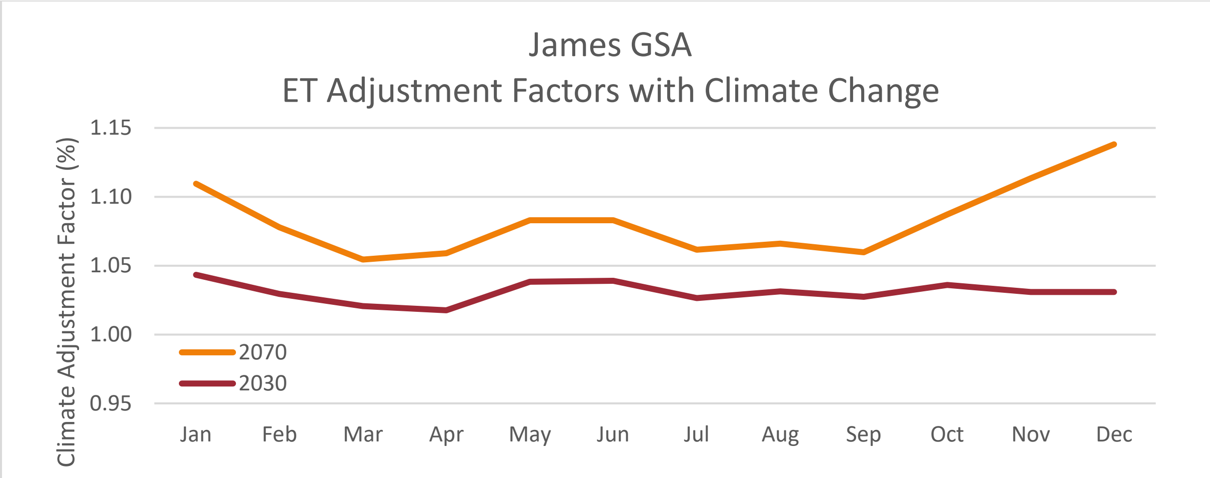


Figure 3-50 DWR ET Adjustment Factors with Climate Change

The effect of projected increased evapotranspiration rates on irrigated water use were reviewed, with reference to a 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, 2015)

For the Kings Subbasin, evapotranspiration adjustment factors were applied to the ET values based on the documentation in the USBR, 2015 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 (2030) and late future (2070) WSIP projections. Crop acreages for future baseline conditions were left at current levels, based on uncertainty in projecting future crop use. Crop water use declined slightly over the historical period, so leaving crop acreages at current levels is considered to be a conservative assumption for identifying groundwater sustainability.

Municipal Water Use

Future water use for municipal areas assumes projected annual population growth rate of 1.8% with per capita water use remaining unchanged. The projected annual growth rates show a projected population increase of 42.9% and 144.0% over current population levels for 2040 and 2070 respectively. These assumed growth rates are far greater than projected populations for smaller urban areas provided in the Fresno County Council of Governments 2017 report "Fresno County 2050 Growth Projections" for the unincorporated portion of Fresno County. That report shows a projected increase of 11.1% from 2015 through 2040. The population increase for 2070 was estimated as 23.3% based on the Fresno County COG report and projecting the rates of increase through 2050 forward to 2070.

Kings Basin Projected Water Budget

Table 3-21 shows a projected 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 proposed mitigation measures are shown at the bottom of the table including water supply augmentation, demand reduction from project development (e.g. land taken out of agricultural production to build recharge basins), and management actions. These all result in net zero change in groundwater storage in 2040.

Table 3-21 Kings Basin Projected Water Budget (2040)

(all units in acre-feet)

Description	TOTAL	McMullin GSA	NFKings GSA	North Kings GSA	Central/South	Kings River East	James ID
Total Supply	***3,686,945***	***404,800***	***628,800***	***1,238,356***	***627,000***	***687,000***	***100,989***
Consumptive Use Subtotal	***2,139,841***	***297,500***	***409,000***	***547,000***	***365,200***	***435,000***	***67,641***
GW Recharge Subtotal	***1,434,453***	***245,100***	***205,000***	***518,400***	***219,500***	***213,100***	***33,353***
Nonrecoverable Subtotal	***645,541***	***50,400***	***65,500***	***336,100***	***113,500***	***76,400***	***22,141***
Method 1							
Estimated Annual Change in Groundwater Storage	**0**	**0**	**0**	**0**	**0**	**0**	**0**
GW Recharge	1,434,453	245,100	205,000	518,400	219,500	213,100	33,353
GW Pumping	-1,467,406	-308,200	-290,200	-412,200	-199,200	-239,700	-17,906
GW Outflow	-200,441	0	-16,200	-122,000	-35,400	-4,700	-22,141
Other Change in GW Storage	14,000	-18,500	32,500	0	0	0	0
Projects for Water Supply Augmentation	168,494	40,600	62,800	15,800	15,100	27,500	6,694
Demand Reduction from Project Development	7,500	800	2,900	0	0	3,800	0
Management Actions for Demand Reduction	43,400	40,200	3,200	0	0	0	0

<u>James GSA Early Future (2040) Water Budget (Kings Subbasin Format)</u>

The early future water budget using the Kings Subbasin format for the James GSA format for normal, wet and dry year scenarios is shown in **Table 3-22.** The water budget shows a net zero change in groundwater storage during normal years. For the early future water budget, water use is expected to increase for municipal and industrial users and corresponds to growth in those areas. As a conservative assumption, this growth is expected to occur within the current municipal land types and no corresponding reduction in agricultural use was made. Cropping patterns are not expected to change appreciably from current conditions to early future or late future conditions. Conversions to permanent crops or conversions from permanent crops have not changed the annual water demands within the James GSA appreciably, rather the conversions change the timing of water deliveries within the year. Groundwater outflows are assumed to remain constant for the early future and late future water budgets. This assumption is conservative as groundwater elevations are expected to be higher (and flow gradients more gradual) from current conditions as projects and management actions occur in the MAGSA area.

For the early future water budget, managed recharge quantities are assumed that are sufficient to eliminate long term reductions in groundwater storage in the aquifer underlying the James GSA. A slight increase in Kings River water diversions is anticipated and corresponds to water utilized for managed recharge activities. The increase in Kings River water diversions only occurs in wet and normal years. As the water budget in **Appendix 3-C** indicates, there is sufficient Kings River water for these additional diversions.

Table 3-22 James GSA Early Future (2040) Water Budget

Description	Volume (AF)		
Supply	Normal Year	Dry Year	Wet Year
1) Surface Water for Irrigation and Recharge	66,669	47,913	89,350
2) Surface Water for M&I and Recharge	0	0	0
3) Groundwater Pumping for Irrigation (Agency Wells)	16,967	31,187	0
4) Groundwater Pumping for Irrigation (Private Wells)	0	0	0
5) Groundwater Pumping for M&I (Agency Wells)	839	1,007	671
6) Groundwater Pumping for M&I (Private Wells)	100	100	100
7) Precipitation	16,414	11,016	24,383
8) Spill Inflows	0	0	0
9) Other Supply:	0	0	0
Total Supply	**100,989**	**91,223**	**114,504**
Demand			
Consumptive Use			
10) Evapotranspiration met by Applied Water	53,637	58,140	48,659
11) Evapotranspiration met by Effective Precipitation	13,501	9,060	20,055
12) Evapotranspiration of M&I	503	671	335
13) Other Consumptive Use:	0	0	0
Consumptive Subtotal	**67,641**	**67,871**	**69,049**
Groundwater Recharge			
14) Groundwater Inflow	9,087	12,433	4,250
15) Deep Percolation of Irrigation Water	2,823	3,060	2,561
16) Deep Percolation of Precipitation	1,579	1,060	2,345
17) Deep Percolation of M&I Water	336	336	336
18) Seepage of Channels & Pipelines	16,865	15,300	17,996
19) Seepage - Reservoirs	0	1	2
20) Urban Stormwater - Recharge	63	42	94
21) Local Streams/Rivers - Recharge	2,600	2,600	2,600
22) Groundwater - Intentional Recharge	0	0	17,534
23) Other Groundwater Recharge:	0	0	0
GW Recharge Subtotal	**33,353**	**34,832**	**47,718**
Nonrecoverable Losses			
24) Groundwater - Outflow	22,141	32,533	13,125
25) Evaporation - Channels	0	0	0
26) Evaporation - Reservoirs & Recharge Basins	0	0	0
27) Precipitation - Evaporation and Runoff	0	0	0
28) Operational Spills	0	0	0
29) Groundwater - Export	0	0	0
30) Other Nonrecoverable Loss:	0	0	0
Nonrecoverable Subtotal	**22,141**	**32,533**	**13,125**
Estimated Annual Change in Groundwater Storage	**0**	**(29,995)**	**33,822**
GW Recharge - #14 thru #23	33,353	34,832	47,718
GW Pumping - #3 thru #6	-17,906	-32,294	-771
GW Outflow - #24 and #29	-22,141	-32,533	-13,125
Projects for Water Supply Augmentation	**6,694**		
Demand Reduction from Project Development	0		
Management Actions for Demand Reduction	0		

James GSA Late Future (2070) Water Budget (Kings Subbasin Format)

The late future water budget using the Kings Subbasin format for the James GSA format for normal, wet and dry year scenarios is shown in **Table 3-23**. For the late future water budget, water use is expected to continue to increase from current and 2040 quantities for municipal and industrial users and corresponds to growth in those areas. The conservative assumption regarding growth of municipal and industrial uses and no reductions in agricultural uses is still used. The assumption regarding impacts of crop conversions is also still used although it is possible that increasing regional water costs will drive the need to convert to crops that utilize less water. Groundwater outflows are again assumed to remain constant and is still considered to be a conservative assumption.

For the late future water budget, managed recharge quantities are increased over early future water budget quantities. Amounts for managed recharge that are sufficient to eliminate long term reductions in groundwater storage in the aquifer underlying the James GSA were assumed. Decreases in diversions from the Mendota Pool were assumed for all year types and correspond to an estimated 2% reduction in Central Valley Project water supply contract allocations. Decreases in Kings River diversions were assumed for dry and normal year types and correspond to a 2% decrease in water entitlement and river runoff. Diversions from the Kings River in wet years were assumed to increase slightly and correspond to additional water utilized for managed recharge activities. As the water budget in **Appendix 3-C** indicates, there is sufficient Kings River water for these additional diversions.

Groundwater sustainability will have been achieved by 2040 and maintained through 2070 through development of projects and implementation of management actions as identified in **Chapter 6 – Projects and Management Actions**. The projected late future (2070) water budgets with implementation of projects and management actions assume the projects were completed prior to 2040, and the anticipated difference in groundwater storage change would be made up by increased management actions.

Table 3-23 James GSA Late Future (2070) Water Budget

Description	Volume (AF)		
Supply	Normal Year	Dry Year	Wet Year
1) Surface Water for Irrigation and Recharge	66,292	47,913	89,692
2) Surface Water for M&I and Recharge	0	0	0
3) Groundwater Pumping for Irrigation (Agency Wells)	17,658	31,939	0
4) Groundwater Pumping for Irrigation (Private Wells)	0	0	0
5) Groundwater Pumping for M&I (Agency Wells)	1,433	1,720	1,146
6) Groundwater Pumping for M&I (Private Wells)	100	100	100
7) Precipitation	16,263	10,908	24,143
8) Spill Inflows	0	0	0
9) Other Supply:	0	0	0
Total Supply	**101,746**	**92,580**	**115,081**
Demand			
Consumptive Use			
10) Evapotranspiration met by Applied Water	53,637	58,140	48,659
11) Evapotranspiration met by Effective Precipitation	13,376	8,971	19,858
12) Evapotranspiration of M&I	860	1,147	573
13) Other Consumptive Use:	0	0	0
Consumptive Subtotal	**67,873**	**68,258**	**69,090**
Groundwater Recharge			
14) Groundwater Inflow	9,087	12,433	4,250
15) Deep Percolation of Irrigation Water	2,823	3,060	2,561
16) Deep Percolation of Precipitation	1,565	1,050	2,323
17) Deep Percolation of M&I Water	573	573	573
18) Seepage of Channels & Pipelines	16,865	15,300	17,996
19) Seepage - Reservoirs	0	1	2
20) Urban Stormwater - Recharge	63	42	94
21) Local Streams/Rivers - Recharge	2,600	2,600	2,600
22) Groundwater - Intentional Recharge	6,694	0	20,266
23) Other Groundwater Recharge:	0	0	0
GW Recharge Subtotal	**40,270**	**35,059**	**50,665**
Nonrecoverable Losses			
24) Groundwater - Outflow	22,141	32,533	13,125
25) Evaporation - Channels	0	0	0
26) Evaporation - Reservoirs & Recharge Basins	0	0	0
27) Precipitation - Evaporation and Runoff	0	0	0
28) Operational Spills	0	0	0
29) Groundwater - Export	0	0	0
30) Other Nonrecoverable Loss:	0	0	0
Nonrecoverable Subtotal	**22,141**	**32,533**	**13,125**
Estimated Annual Change in Groundwater Storage	**0**	**(31,233)**	**36,294**
GW Recharge - #14 thru #23	40,270	35,059	50,665
GW Pumping - #3 thru #6	-19,191	-33,759	-1,246
GW Outflow - #24 and #29	-22,141	-32,533	-13,125
Projects for Water Supply Augmentation	0		
Demand Reduction from Project Development	0		
Management Actions for Demand Reduction	1,062		

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 and current water budgets 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 Kings Subbasin during this period, as "directly" estimated based on groundwater levels and specific yields is 122,000 acre-feet.

The James GSA cannot corroborate this value to the water budget prepared for the entire Kings Subbasin at this time as it is not yet available.

The estimated annual decline in groundwater storage for the aquifer underlying the James GSA during this period, as "directly" estimated based on groundwater levels and specific yields is 5,000 acre-feet. This result was corroborated by the computed water budget, which identified an estimated annual groundwater storage decrease of 4,698 acre-feet.

<u>Administrative Allocation of Overdraft Responsibility</u>

The Kings Subbasin GSAs have allocated responsibility for the 122,000 acre-feet of overdraft in the Kings Subbasin based on the change in groundwater storage for the area of the aquifer underlying each GSA and differences between historic and recent groundwater flows across the GSA boundaries. This administrative allocation of overdraft is provided for in the Kings Subbasin Coordination Agreement and is explained in Technical Memorandum 6. Under this administrative allocation, the James GSA is not responsible for any overdraft within the Kings Subbasin and has a surplus of 16,700 acre-feet.

One reason for the surplus is the fact that wells serving lands within the James GSA are located outside of the James GSA and within the MAGSA. If the water extracted from these wells, which totaled 18,540 acre-feet (annual average during the evaluation period) were to be charged against the surplus in overdraft responsibility for James GSA, it would result in the James GSA being responsible for 1,840 acre-feet of overdraft and the MAGSA being responsible for 72,560 acre-feet instead of 91,100 acre-feet.

To date, no agreement has been reached between the James GSA and MAGSA on this reallocation of overdraft responsibility.

3.3.12 Water Year Type Associated with Water Budget Components

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.

As described earlier, water year types were identified for the Kings Subbasin that are based on Kings River diversions to member units within the Kings Subbasin 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.

Figure 3-51 summarizes water year types for annual current water budget inputs, outputs and change in groundwater storage within the James GSA using the Groundwater Basin Water Budget Format. This figure shows relatively consistent amounts of water demands (outputs), with large variations in water supply (inputs) between wet years and dry years. Groundwater storage generally reflects the changes in supply availability between wet years and dry years, with an increase in wet years and much larger decreases in groundwater storage in dry years, resulting in an overall average decrease in groundwater storage.

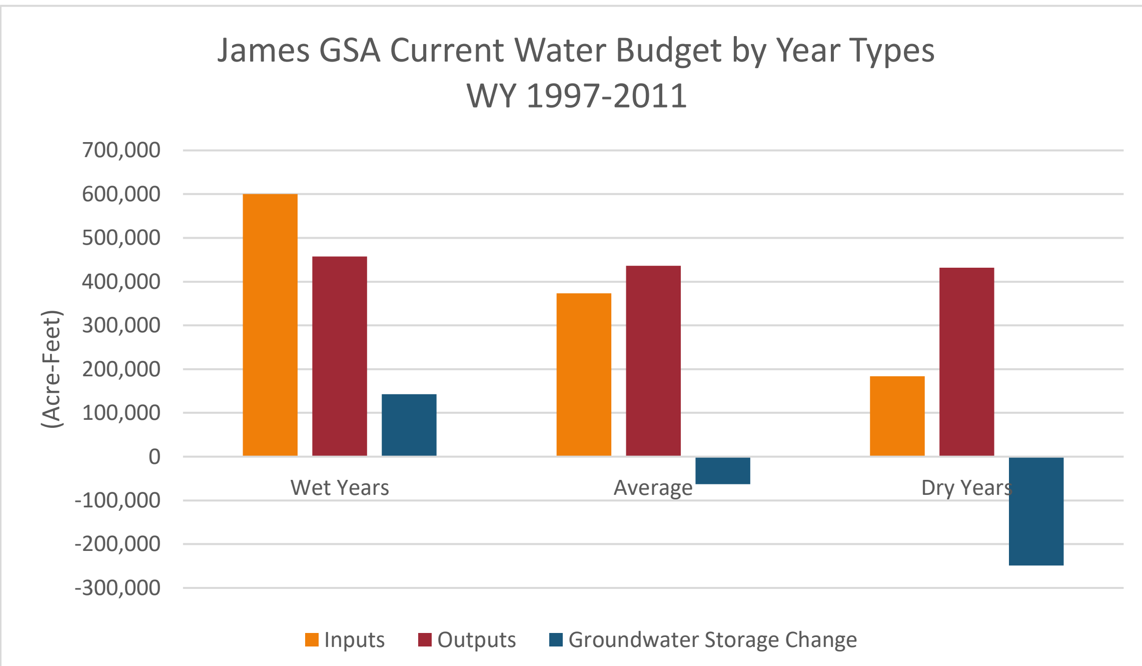


Figure 3-51 James GSA Current Water Budget by Year Type

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 3-16**), the sustainable yield is estimated to be:

1,370,000 AF – 200,000 AF = **1,170,000 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.

The amount of sustainable yield for the Kings Subbasin is the amount of groundwater pumping that results in water levels being maintained at sustainable levels and avoiding any undesirable results. On average, maintaining groundwater pumping at levels that result in no long-term storage declines is used as the initial estimate of sustainable yield. The amount of sustainable yield, using this definition, can be computed by reducing the amount of crop Evapotranspiration to achieve sustainable conditions with reduced groundwater pumping. For current conditions, the annual groundwater overdraft in the James GSA is currently estimated at 63,100 acre-feet. In order to eliminate this amount of groundwater overdraft, there must be a reduction in groundwater pumping of approximately 78,900 acre-feet. The reason for the higher reduction in groundwater pumping is that reduced pumping results in a corresponding smaller reduction in deep percolation, based on irrigation efficiencies estimated as 80 percent. The current estimated amount of groundwater pumping is 271,400 acre-feet/year, so the current level of sustainable yield for the James GSA is 192,500 acre-feet/year (271,400 – 78,900).

3.4 Water Supply Availability for Augmentation

A number of potential projects and management actions are described in Chapter 6 of this GSP as tools to achieve sustainability. The potential projects for supply augmentation have a surface water supply that was identified as being the most likely to be available. Each of the current projects described in **Section 6.2** 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 James GSA, 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 appropriative water rights, including pre-1914 rights, to the historic flows of the Kings River. These entities formed the Kings River Water Association (KRWA) in 1927, which, as the name implies, is a private unincorporated association. The KRWA oversees Kings River entitlements and water deliveries. There are 28 KRWA member agencies (or "units" as they are known) that are united in their interests in issues and overall water conditions affecting the river, but they remain highly individualistic. The member unit sizes vary greatly, as do their local needs. Not only do the 13 public districts and 15 private mutual water companies have unique characteristics, but each unit also enjoys Kings River water entitlements and Pine Flat Reservoir storage rights separate and distinct from those of the other units. The KRWA member units collectively serve nearly 20,000 central San Joaquin Valley farms, covering an area of approximately 1.1 million acres of highly productive farmland. James ID, located entirely withn the James GSA, is one of the 28 KRWA member units with entitlement to the Kings River.

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 3-52** 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.

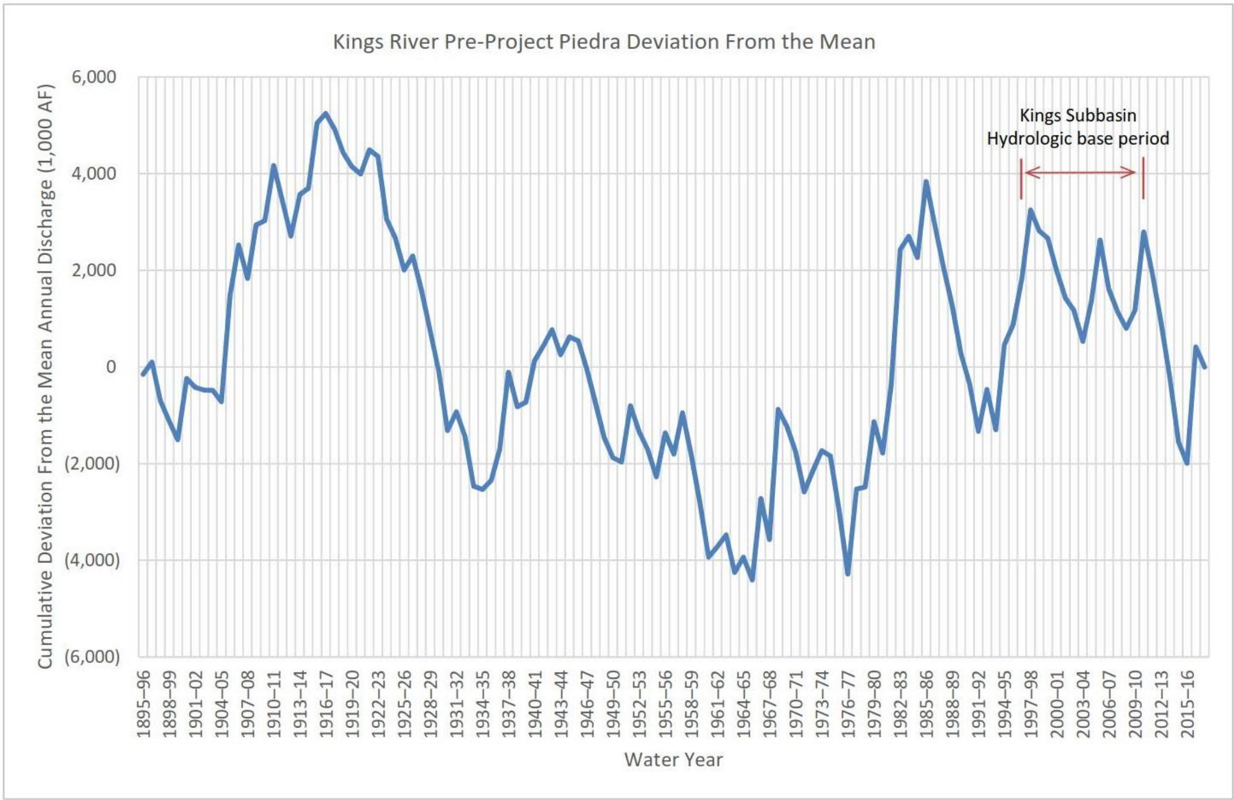


Figure 3-52 Kings River Cumulative Runoff Deviation from the Mean

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. James ID, A KRWA member unit, is considered a "lower river unit."

In above average water years, the U.S. Army Corps of Engineers, who owns and operates Pine Flat Dam, may require a flood release based on criteria established in the Pine Flat Reservoir Regulation Manual. The Reservoir Regulation Manual describes a complex system of determining how the Army Corps determines when and how additional flows must be released from Pine Flat Dam for purposes of flood control and dictates that any floodwater first be conveyed out the North Fork of the Kings River. Floodwater in the North Fork that leaves the Kings River Service Area is measured at the James Bypass gaging station. 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 3-24**, 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 that inflate the average, such as 1968-69 and 1982-83.

Table 3-24. Floodwater Discharge at James Bypass Gaging Station Since the Construction of Pine Flat Dam (1954/55 – 2017/18)

Water Year	% of Avg.	Total (Acre-Feet)	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, the historical amount of floodwater leaving the Kings River Service Area shown in **Table 3-24** 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 supply augmentation projects that are planned to be built within the Kings River area 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 with essentially all Kings River water used in the Kings River area in the future.

As shown in **Figure 3-53** below, the amount of Kings River water maintained within the Service Area for use has been increasing in recent years, and this trend is expected to continue as additional water supply augmentation projects are developed. **Figure 3-53** indicates the total amount of "Kings River for Irrigation" (KRI), which is an indication of actual measured releases into the Kings River and divides the KRI each year into two components – discharges out James Bypass and the remainder maintained within the Kings River Service Area for use. Items to note in **Figure 3-53** about recent high flow water years on the Kings River include:

- The KRI in WY 2010-11 was larger than in WY 2005-06, but less floodwater was discharged out James Bypass and more water was maintained for use within the Kings River Service Area.
- KRI was significantly larger in WY 2016-17 than most of the previous years and the amount maintained within the service area was also significantly more than prior years, partly a result of large river losses following the extended drought.
- The amount of water maintained 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.

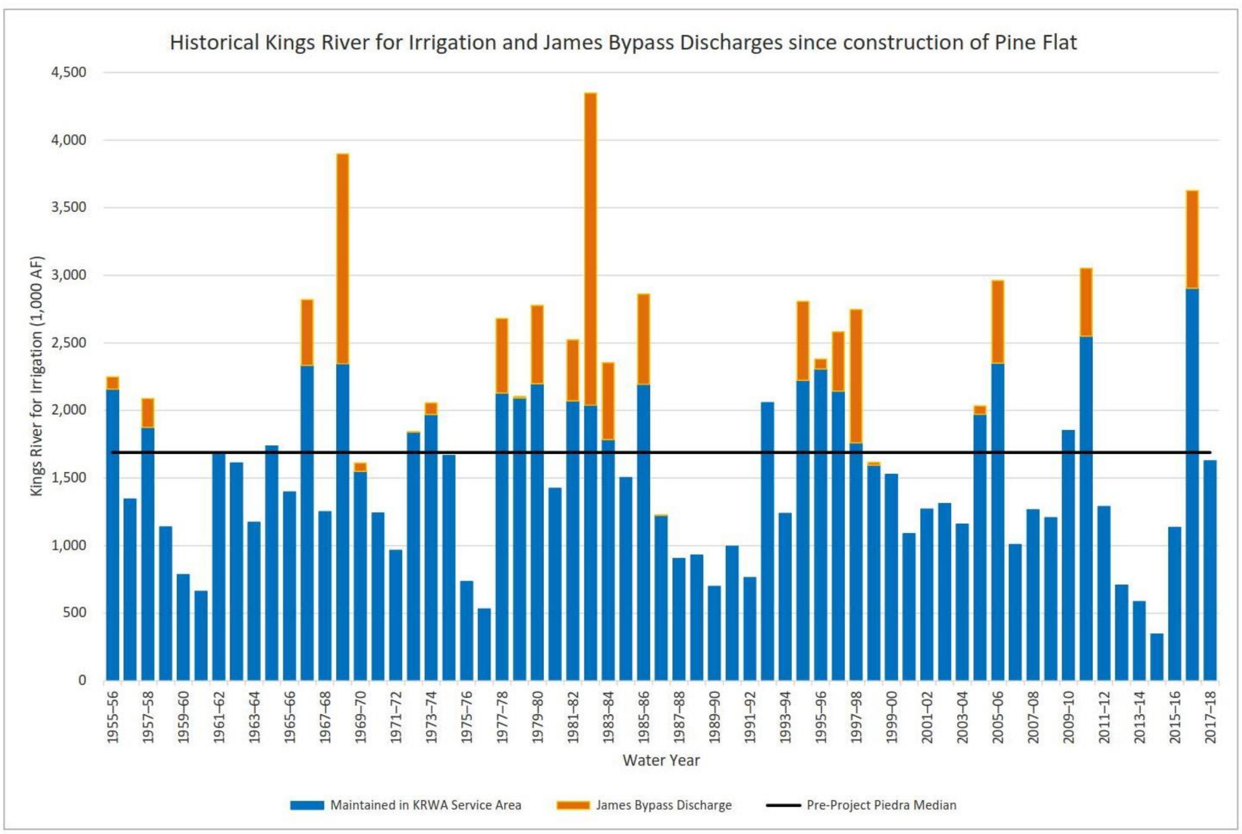


Figure 3-53 Historic Kings River for Irrigation and James Bypass Discharge (AF)

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, 2018). 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 projects. This second step of project recharge capability is described for individual potential projects identified in Chapter 6. Based on the similar level of amount of water available, the historical James Bypass supplies identified above are being used to evaluate water supplies developed by potential projects in Section 6.2.

Possible Kings River Implications

While most of the James GSA 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 will not accept an application 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 (all KRWA member units) 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 a proposed Semitropic project to export Kings River water to Kern County indicates Semitropic intends to use all flood flows in excess of 100 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 3-53** though, the amount of floodwater that has historically been 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(s). 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 will be developing additional water supply augmentation projects to utilize high flow Kings River water when it is available.

3.4.3 Central Valley Project (Friant Division) Supplies

Another potential source of water for supply augmentation projects would be Central Valley Project (CVP) water from the Friant Division that could take the form of several types of CVP water, including Section 215 water and contracted CVP Class 1 or Class 2 supplies or uncontrolled season water that might be available for purchase. CVP water from the Friant Division could be delivered within the James GSA after obtaining proper approvals since the GSA is located within the CVP Place of Use, although the areas outside the Friant Division (such as the Kings Subbasin) are not high on the priority beneficiary list. Delivery of CVP water would not have the same Place of Use restrictions as Kings River water for any proposed projects within the Kings Subbasin that are located outside of the Kings River Service Area.

Quantifying the amount of CVP water that might be available is difficult to predict and would need to presume that historical hydrology will repeat itself. Section 215 water is a high flow federal designation for floodwater that 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 USBR flood control criteria. When available, Section 215 water has typically occurred during the period between December and July with historical availability of approximately every 2 years out of every 5 years.

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. While some Section 215 water has been purchased in the past by entities within the James GSA when available, as discussed below, it is expected there will be minimal Section 215 water available in the future to non-long-term contractors.

It should be noted that the San Joaquin River Restoration Program (SJRRP) can be expected to utilize available flood releases prior to be 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 (Friant Water Authority, 2018) indicated that Section 215 water supply availability will be significantly reduced in the future and may be presumed to be nearly zero for planning purposes. Other CVP water, including Class 1 or Class 2 supplies, may be available for purchase periodically from Friant Division contractors on a spot market basis from time to time.

3.4.4 Central Valley Project (Delta Division) Supplies

A third potential source of water for supply augmentation projects would be Central Valley Project (CVP) water from the Delta Division. This source could take the form of several types of CVP water, including Section 215 water and contracted water supplies that might be available for purchase. CVP water from the Delta Division could be delivered within the James GSA after obtaining proper approvals since the GSA is located within the CVP Place of Use. Again, delivery of CVP water would not have the same Place of Use restrictions as Kings River water for any proposed projects within the Kings Subbasin that are located outside of the Kings River Service Area.

Section 215 water is a high flow federal designation for floodwater that 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 USBR flood control criteria. Section 215 water is also available from the Delta Division when the demands of contractors along the San Luis Canal, Delta-Mendota Canal, and Mendota Pool are met

and there is no space in San Luis Reservoir to store water pumped from the delta. When available, Section 215 water has typically occurred early in the year with historical availability of approximately every 1 year out of every 5 years. James ID has purchased Section 215 water from the Delta Division in prior years.
Other CVP water, specifically contractual supplies, may be available for purchase periodically from Delta Division contractors or other CVP contractors from time to time. James ID has participated in transfers, both as a buyer and as a seller, in prior years.

3.4.5 Excess Water Supplies

The last potential source of water for supply augmentation projects would be excess water supplies from entities within the James GSA, specifically James ID and Reclamation District No. 1606. James ID has a CVP contract for 35,300 acre-feet and a settlement contract for 9,700 acre-feet. Reclamation District No. 1606 has similar contracts for 228 and 342 acre-feet, respectively. During wet or above-average years, a substantial portion of the demands of these two entities will be met using Kings River entitlement and/or flood water and the remaining demands will be satisfied by utilizing a portion of the quantity available under their respective CVP water supply contracts. The remaining portion can be utilized as a source of water for supply augmentation projects. Settlement contract water is preferentially utilized by these two entities and must only be utilized in contractually identified areas.
The amount of excess water available from entities in the James GSA will vary depending on hydrology and Kings River diversions. Based on prior experience, these supplies can range from 5,000 to 20,000 acre-feet and will occur every 1 year out of 4 or 5 years.
The James GSA has implemented a management action related to this excess water supply. For additional details on the management action, please refer to Chapter 6, Projects and Management Actions.

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. (b) A basin that includes one or more management areas shall describe the following in the Plan:

3.4.1 Reason for Creation of Each Management Area

Regulation Requirements:

§354.20 (b) (1) The reason for the creation of each management area.

The Kings Subbasin is home to seven GSAs, and each GSA is considered its own Management Area. This is appropriate because of the variations in land uses, crop mixes, groundwater conditions, and surface water supplies between the GSAs; all of which will affect the fundamentals and details of the resulting GSPs. The James GSA is currently being managed as one area, although future consideration will be given to managing the GSA in sub-areas if it is determined to be beneficial in achieving groundwater sustainability.

3.4.2 Minimum Thresholds and Measurable Objectives

Regulation Requirements:

§354.20 (b) (2) The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.

The Kings Subbasin has coordinated efforts in establishing minimum thresholds and measurable objectives, although each GSA has revised the common methodology as needed to fit their unique situation. Minimum thresholds and measurable objectives for the James GSA are discussed in Chapter 4.

3.4.3 Level of Monitoring and Analysis

Regulation Requirements:

§354.20 (b) (3) The level of monitoring and analysis appropriate for each management area.

The Kings Subbasin has coordinated monitoring efforts and analysis, although each GSA has revised the common methodology as needed to fit their unique situation. Monitoring within the James GSA is discussed in Chapter 5.

3.4.4 Description of Management Areas

Regulation Requirements:

§354.20 (b) (4) An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable. (c) If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas.

As noted above, each GSA within the Kings Subbasin is considered its own Management Area. There has been a coordinated approach within the Kings Subbasin for each GSA preparing their own GSP that is unique to their situation but does not cause undesirable results outside their GSA.

4 Sustainable Management Criteria

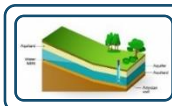
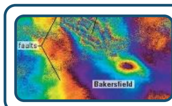
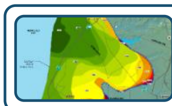
Regulation Requirements:

> **§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.

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. Development of these Sustainable Management Criteria is dependent on basin information developed and presented in the hydrogeologic conceptual model, groundwater conditions, and water budget chapters of the James GSA plan (DWR, 2017).

Indicators for the sustainable management of groundwater were determined by SGMA based on that are important to the health and general well-being of the public. There are six indicators that must be monitored throughout the planning and implementation period of the GSP and identified in **Table 4-1**. This chapter will describe the indicators and why they are significant and will define the management thresholds.

Table 4-1 Monitoring Requirements

	**Groundwater Levels**
	**Groundwater Storage**
	**Water Quality**
	**Land Subsidence**
	**Depletion of Interconnected Surface Water**
	**Seawater Intrusion**

The Sustainable Management Criteria described herein were prepared following the requirements set forth in the California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5, Subarticle 3 (§354.22 through §354.30).

4.1 Sustainability Goal

> **§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 Subbasin 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 **Chapter 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 – Projects and Management Actions to Achieve Sustainability 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 **Table 4-2**.

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 that 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. As shown in **Chapter 3**, recent water levels are several hundred feet above the base of the aquifer in much of the basin. 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.

Within much of the basin, there will still be a significant aquifer of suitable quality below the levels set as the minimum threshold. This means that a productive well of suitable water quality could still be constructed if the water level drops below the minimum threshold. **Figure 4-1** 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.

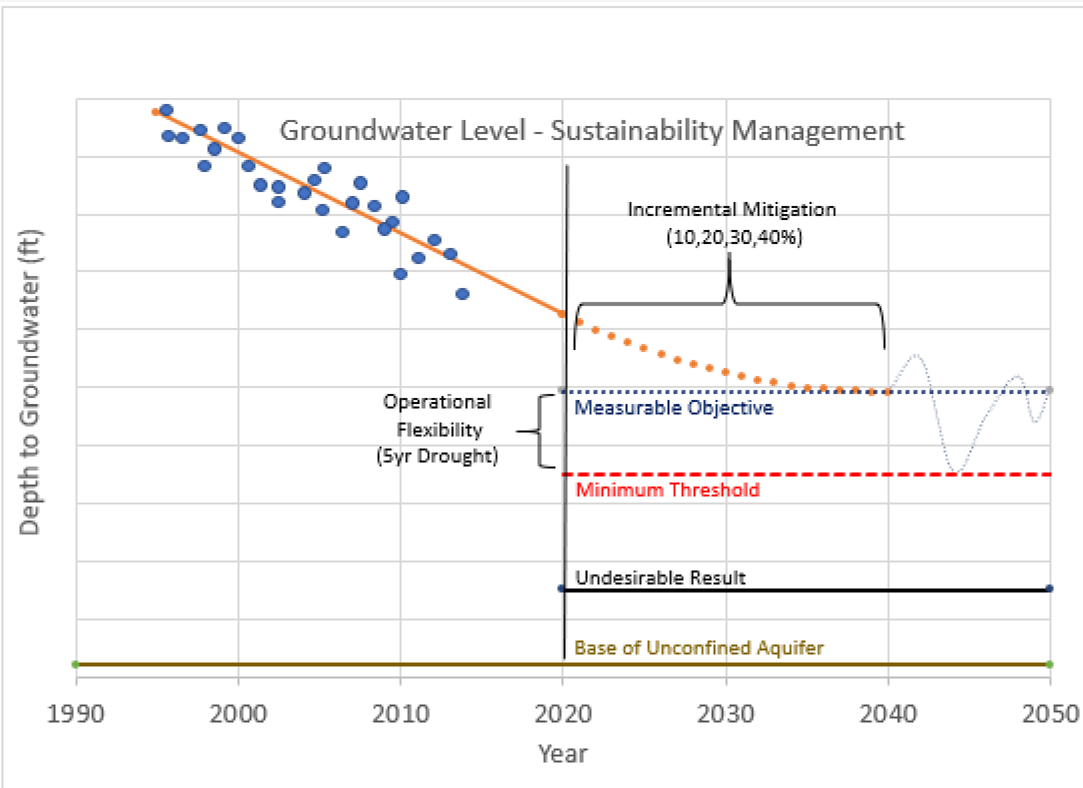


Figure 4-1 Sustainable Management Criteria Graph

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 James GSA 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. James GSA defined undesirable results when 1/3 of the indicator wells in the monitoring network drop below the minimum threshold for two consecutive years at the same wells. 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.

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 are 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 **Chapter 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 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.

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 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.
§354.28 (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 4-1** 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 2012-2016 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 one of the indicator wells, Well 15S16E23R001, there is a lack of historical water level readings given that the well was recently converted from an abandoned municipal well to a monitoring well. The Minimum Threshold was set to be consistent with other indicator wells by using basin-wide contours of minimum threshold values. The established minimum threshold value will avoid impacts to nearby City of San Joaquin municipal supply wells. An another indicator well, Well 15S16E29N001, the well is heavily influenced by piezometric head of the confined aquifer and conditions in the Westside subbasin. The minimum threshold was set at the minimum water level observed at the indicator well, 26.5 below mean sea level on 12/21/1964. The latter well is not used to generate basin-wide contours of the unconfined aquifer.

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. 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 **Appendix 4-A**. 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 Groundwater Level Minimum Thresholds

Well ID	Minimum Threshold (WSE)
366502N1201782W001	-32.2
16S17E04P001	-41.3
15S16E29N001	-26.5
15S16E28A003	40.0
15S16E23R001	-4.0

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.
§354.28 (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: **(B)** Potential effects on other 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 determine the desired minimum groundwater storage volume to be maintained. As mentioned in much of the GSA and the basin, there will remain a very significant amount of groundwater below the minimum threshold elevations. The SMC section on Groundwater Storage describes this further.

- Sea Water Intrusion. This indicator is not applicable to this basin.
- Groundwater Quality. Changing groundwater levels can affect groundwater constituent 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 not experienced significant 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.
- Interconnected Surface Water. There are no Interconnected Surface Waters in the GSA. No criteria were set, but groundwater levels will continue to be monitored along the Fresno Clough and James Bypass.

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 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 **Chapter 3**, these flows have increased overtime compared to historical flows prior to significant development in the valley of groundwater as a resource. 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 James GSA 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. Changes in demands will 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 currently no state, federal, or local regulatory standards applicable to groundwater levels. This GSP will become the basis for local regulatory standards.

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 **Chapter 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 **Chapter 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 available water level readings from 1997 to

2012 which corresponds to the hydrologic base period for the basin. 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 then projected from the more recently measured fall water level to year 2020 for each well. The basin wide agreed incremental mitigation rate for correction (shown in **Table 4-4**) was applied to each well's hydrograph. The incremental correction provides the calculation of the anticipated water level at 2040. By 2040, there should no longer be a long-term average decline, therefore, the water level estimated for 2040 becomes the measurable objective. 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 **Appendix 4-A**. 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.

Table 4-4 Water Level Mitigation Rate

Year	Correction	Cumulative % Correction
2025	10%	10%
2030	20%	30%
2035	30%	60%
2040	40%	100%

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.

The basin wide approach could not be fully utilized for the five indicator wells within the Plan Area for a number of reasons. The approach was modified slightly to accomplish the intent of the basin wide procedure while accommodating unique conditions found within the Plan Area. An explanation for each deviation from the basin wide approach provided below:

1. 366502N1201782W001 – The trend line was shifted 27.4 feet downward to use Fall 2016 readings instead of Spring 2018 as an initial starting point. Nearby groundwater recharge operations at the James ID K-Basin site which started early in 2017 and lasted 12 months created groundwater elevations that were not representative of typical local conditions.

2. 16S17E04P001 – The trend line was shifted 8.0 feet downward to use Fall 2016 readings instead of Spring 2018 as an initial starting point. Nearby groundwater recharge operations at the James ID Basin 1 and 2 sites which started early in 2017 and lasted 12 months created groundwater elevations that were not representative of typical local conditions.

3. 15S16E29N001 – The well is completed in the confined aquifer and is heavily influenced by conditions in the adjacent Westside subbasin. The basin procedure was developed for unconfined water levels influenced by Kings subbasin conditions. The trend line was established using Fall 2007 (76.1 ft amsl) and Fall 2016 (47.9 ft amsl) to provide a more accurate representation of the decline. In order to establish the mitigation curve for the well, the trend line (3.13 feet per year) was extended 3.5 years to Spring 2020 (36.9 ft amsl).

4. 16S17E28A003 – The trend line was shifted 9.0 feet downward to use Fall 2016 readings instead of Spring 2018 as an initial starting point. Nearby groundwater recharge operations by James ID in the old Fresno Slough which started early in 2017 and lasted 12 months created groundwater elevations that were not representative of typical local conditions.

5. 15S16E23R001 – This well has a lack of historical water level readings given that the well was recently converted from an abandoned municipal well to a monitoring well. The Measureable Objective was set to be consistent with other indicator wells by using basin-wide contours of measurable objective values. The established measurable objective value is consistent with operations for nearby City of San Joaquin municipal supply wells.

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.

A margin of operational flexibility, or margin of safety, allows for variation in groundwater levels due to historical water budgets, seasonal and yearly variations, and drought and also takes into consideration levels of uncertainty. Drought years may cause pumping to increase, but wet years may provide enough opportunity for surface water recharge to offset drought years. The operational flexibility for each well in the GSA will vary based on current groundwater levels and rate of decline. As shown in **Figure 4-1**, the Operational Flexibility is the difference 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.

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 James GSA and the other GSAs in the basin will implement projects and programs to correct the declining groundwater levels and reach sustainability. The James GSA projects and programs are described in **Chapter 6** and implementation discussed in **Chapter 7** of the GSP. The interim milestones for water level correction are unique to each Indicator Well, but follow the same basin wide agreed incremental mitigation rate for correction (shown in **Table 4-4**). The 5-year milestones to achieve measurable objectives are shown in **Table 4-5**. 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 James GSA has identified the schedule for implementation of each project and management action as well as that project's anticipated benefit or yield. The combined benefit of each project and management action at each milestone shows that the GSA has identified projects and management actions to correct the total overdraft by 2040. Future projects and management actions are included in the anticipated reduction in demand and overdraft.

Table 4-5 Groundwater Level Interim Milestones and Measurable Objectives

ID	Interim Milestones (WSE)			Measurable Objective (WSE)
	2025	2030	2035	2040
366502N1201782W001	2.1	-8.9	16.2	-18.5
16S17E04P001	-14.8	-21.2	-25.5	-26.8
15S16E29N001	16.2	0.8	-9.5	-12.7
15S16E28A003	69.8	67.4	65.8	65.3
15S16E23R001	42.34	33.39	27.24	25.00

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 available for cyclic use one the Subbasin reaches sustainability. 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 estimation of the amount of groundwater storage change is dependent on water level elevations from multiple wells and the depth of groundwater at the beginning and end of the period for which storage change is estimated multiplied by specific yield values in the interval that water level is fluctuating. The amount of groundwater storage 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 estimates of this volume are included in **Table 4-6**.

Table 4-6 Estimate of Groundwater in Storage between Measurable Objective and Minimum Threshold

GSA	Volume (Acre-Feet)
Central Kings	680,000
James ID	110,000
Kings River East	620,000
McMullin Area	570,000
North Fork Kings	940,000
North Kings	1,070,000
South Kings	42,000
Total for Subbasin	**4,032,000**

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, and as mentioned above is the groundwater storage operational flexibility.

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 portion of the aquifer through downward seepage through the confining layer and wells screened across multiple aquifer zones.

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.

The Groundwater Level Minimum Threshold elevations across the James GSA and Subbasin were used to calculate the amount of groundwater in storage between the Minimum Thresholds and the Measurable Objectives. An undesirable result would occur if the total amount of water in storage was less than the estimated amount of groundwater in storage below the Minimum Thresholds. Since the Subbasin plans to maintain water levels above the Minimum Thresholds and only periodically use the storage between the Minimum Threshold and Measurable Objective, the total amount of groundwater below the Minimum Threshold was not calculated.

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 the 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 Subbasin 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 below which an undesirable result for would occur for groundwater storage volume.

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 could be significant enough to require additional treatment, but ongoing evaluation of groundwater quality is needed to understand these potential changes. Stabilizing the water table should 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 James GSA, in coordination with the other GSAs in the Subbasin utilized multiple wells to develop groundwater contours and estimate groundwater storage change. The amount of groundwater in storage was estimated from Minimum Threshold to the Measurable Objective and Interim Milestones. Water level surfaces were created from the Minimum Thresholds, Measurable Objectives and Interim Milestones, and the amount of groundwater in storage above the Minimum Thresholds to the Measurable Objective and Interim Milestones was 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.

The groundwater storage minimum threshold is based on the groundwater level Minimum Thresholds (described previously) as the basis for the estimation of groundwater in storage above those water levels to the Measurable Objective and Interim Milestones. 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 4-6**.

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.

The minimum thresholds used for groundwater levels will set the overall groundwater storage volume desired to be maintained.

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: **(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.

The criteria for minimum thresholds for water levels are also used for groundwater storage as they define the elevations that are used to estimate the volume of groundwater in storage from the water level Minimum Thresholds to the Measurable Objective and Interim Milestones. The criteria for water level minimum thresholds are described in **Section 4.2.2.1**. The Minimum Threshold for groundwater storage is the Minimum Threshold groundwater surface elevations for water levels at monitored wells. An exceedance for water level may not cause an exceedance for groundwater storage.

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.
§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 Minimum thresholds used for groundwater levels will set the overall groundwater storage volume desired to be maintained above the minimum threshold groundwater levels to the measurable objective and interim milestones. 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 James GSA and the Subbasin, there will remain a very significant amount of groundwater below the minimum threshold elevations, but again it should be noted that the critical storage volume is the volume between the Minimum Threshold and Measurable Objective, i.e., the operational flexibility.

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 neighboring basins and GSAs have likely taken different approaches to establishing thresholds. Once the neighboring basin GSPs are completed, the James 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 beneficial use in the Subbasin 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 (or storage change) 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 from the Minimum Threshold to the Measurable Objective. 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 above those levels to the Measurable Objective and Interim Milestones. The groundwater in storage between the ultimate Measurable Objectives and Minimum Thresholds provides the operational flexibility for pumping during dry years. With current groundwater 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 5-year Interim 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 **Sections 3** and **4.2**. Utilizing the process for groundwater storage change estimation described in **Section 3.2.3**, the groundwater in storage between the measurable objective at each interim milestone and the minimum threshold was estimated and shown in **Table 4-7** below.

Table 4-7 Estimate of Groundwater in Storage between Minimum Threshold and Measurable Objective 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)
Central/South Kings	900,000	780,000	700,000
James	150,000	130,000	110,000
Kings River East	810,000	710,000	640,000
McMullin	790,000	670,000	590,000
North Fork Kings	1,420,000	1,170,000	1,000,000
North Kings	1,300,000	1,180,000	1,090,000
South Kings	51,000	46,000	43,000
Total for Subbasin	**5,421,000**	**4,686,000**	**4,173,000**

Groundwater contour maps at the interim milestones, measurable objective and minimum threshold used to estimate the associated storage volume, as well as the supporting informational tables for the storage volume estimations are included in Appendix 4-B. Hydrographs included in Appendix 4-A 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 groundwater storage Measurable Objectives and Minimum Thresholds are based on the estimation of volume using the water level Measurable Objectives and Minimum Thresholds.

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 James 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 James GSA 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 **Chapter 6** of this GSP and implementation discussed in **Chapter 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 James 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. Other future projects and management actions which are currently unknown and not specifically identified in **Chapter 6** would be included in the anticipated reduction in demand and overdraft.

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 (c) (3) Seawater Intrusion. The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results. Minimum thresholds for seawater intrusion shall be supported by the following: **(A)** Maps and cross-sections of the chloride concentration isocontour that defines the minimum threshold and measurable objective for each principal aquifer. **(B)** A description of how the seawater intrusion minimum threshold considers the effects of current and projected sea levels.
§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.

By definition, seawater intrusion occurs when saline water from the ocean infiltrates the groundwater system and begins to flow into areas of freshwater due to pressure differentials, in many cases caused by groundwater pumping. The Kings Subbasin and James GSA do not need to account for seawater intrusion since they are not located adjacent to the coast.

4.5 Groundwater Quality

As discussed in these previous chapters, groundwater quality in the James GSA is generally well suited for irrigation and domestic use, although groundwater issues for drinking water exist in localized areas within the James GSA. While some of these chemical concerns are caused by humans, several are naturally occurring. Groundwater quality concerns within the James GSA have been identified in Section 3.2.5 and corresponding water quality figures included in Appendix 30F. 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 James GSA 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.

Groundwater pollution characterization and mitigation are typically enforced by local agencies and state level programs. The GSA will only have authority related to groundwater pumping policies, however James GSA will review and analyze publicly available routine groundwater monitoring data reported by the community and non-community public supply wells and monitoring wells around the American Avenue Landfill in order to understand how and if groundwater pumping is exacerbating groundwater quality concerns and where to enforce pumping restrictions 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. Some of these are significant concerns while others are minor or geographically limited. The James GSA chemicals of concerns and California MCLs are identified in Table 4-8.

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 as it relates to groundwater pumping and recharge projects such that the groundwater is no longer generally suitable for agriculture irrigation and domestic use. James GSA will only have authority related to groundwater pumping policies and recharge supply project, however the James GSA will review and analyze publicly available routine groundwater monitoring data reported by the community and non-community public supply wells, 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.

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 Bain 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 when related to groundwater pumping policies and recharge projects.

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 tracking and remediation of groundwater quality. As described in the Plan Area chapter, these other agencies and programs include IRLP, CV-SALTS, Fresno County Rural Domestic Well Program (Volunteer basis), Dairy General Order, RWQCB, SWRCB, Division of Drinking Water, and DTSC.

While there are several existing groundwater monitoring programs, they do not monitor all contaminants of concern within James GSA 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 and the Fresno County Rural Domestic Well Program is voluntary and relies on well owners to have some knowledge of preexisting groundwater quality issues to opt in. 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 public 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 3 to 12 months depending on well history and well location relative to known groundwater impacts. Groundwater monitoring results from the community and non-community wells within James GSA 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. Chemical of concern within the James GSA along with their respective MCL values are listed below in **Table 4-8.**

Undesirable results determinations will be based on the aggregated 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 statistically 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 6 of the 12 representative monitoring wells having reached either of these two criteria for two consecutive years at the same wells. For the purposes of this GSP statistical significance is defined as a result not likely to occur from random fluctuations (seasonal or otherwise) or by chance but instead can likely be attributed to a specific cause (i.e., groundwater pumping).

Table 4-8 Chemicals of Concern and California MCLs

Chemical of Concern	California Primary MCL (mg/L unless otherwise shown)	California Secondary MCL	Lifetime Health Adivosry Level
Arsenic	10 µg/L		
Chromium (Total	50 µg/L		
Flouride	2,000 µg/L		
Gross Alpha	15 pCi/L		
Lead *	15 µg/L		
Nitrate	10 mg/L (as N)		
1,2,3-Trichloropropane (TCP)	0.005 µg/L		
Uranium	20 pCi/L		
Manganese		50 µg/L	
Boron		500 mg/L to 1,000 mg/L	6,000 µg/L

*=The USEPA regulates the concentration of lead in drinking water by an Action Level, which is similar to an MCL but requires additional testing at customer services.

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. However, some of these causes are not GSA's responsibility and include, but not limited to:

- The accumulated effects of fertilizer nutrient application and other farming practices leading to accumulation of chemicals of concern in groundwater, such as nitrates;
- 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; and
- The accumulated effects of regulated and unregulated waste discharge streams from wastewater treatment facilities, septic systems, industry, and food processors;

The following groundwater quality degradation that could lead to undesirable results which fall under the GSA's management responsibility include:

- 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.
- Recharge projects that improperly located, causing downward movement of contaminants in the vadose zone or mobilize groundwater contaminant plumes.

Potential effects of reaching undesirable results on beneficial users will ary by location and which constituent has been exceeded. Concerns for agricultural versus municipal or domestic beneficial users vary in concentrations and constituents. Impacts of significantly degraded water quality could include decreased crop productivity, cost of deepening ells, and expensive water treatment for municipal beneficial users.

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 heavily as the criteria for defining undesirable results. An undesirable result determination will be based on exceedances in multiple monitoring locations within the GSA, rather than isolated exceedances.

Undesirable results determinations will be based on the aggregated 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 one municipal well or 15% of all other types of the representative monitoring wells having reached either of these two criteria for two consecutive years when shown to be altered by groundwater pumping or recharge activities.

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.

Irrigation water quality is a critical factor in crop production and can be complicated as not all crops have the same sensitivity to water quality. Groundwater with high Total Dissolved Solid (TDS) or EC concentrations or general mineral concentrations can cause issues for plants and soil health, leading to crop yield impacts. High salinity content in irrigation water can detract from the amount of water and nutrient uptake in plant roots and leads to a crusty top layer in soil that makes seed sprouting difficult. Water quality within James GSA is generally of such quality that groundwater degradation leading to impacts to crop is not considered a likely scenario.

Under California law, entities 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 and are publicly available. Degraded water quality can make drinking water treatment more difficult and expensive. Therefore, groundwater quality degradation has potential effects to rural residential drinking water quality.

Residential structures not located within the service area of the City of San Joaquin 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 James GSA is generally suited for irrigation and domestic use, although groundwater issues for drinking water exist in some areas within the GSA. 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 4-8**

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.

Water quality data will be monitored and sampled for analysis according to the monitoring network, as discussed in Section 5. This includes regularly recurring analysis of various water quality constituents depending on the monitoring program the monitoring site is a participant of.

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 the Groundwater Conditions chapter, **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.

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.

Because the water quality issues in James GSA are primarily not migratory problems, 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 James GSA area and already being monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyor 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 and American Avenue Landfill monitoring wells will form the basis of the monitoring network for groundwater quality as shown oin Chapter 5..Water quality will be measured in accordance with the measurement protocols described in Chapter 5 – Monitoring Network of this GSP. The selected groundwater quality monitoring network will be evaluated and augmented in subsequent GSP 5-year revisions.

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 NCLs, the measurable objectives 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 James GSA 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 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 mitigation are typically 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 and the monitoring wells around the American Avenue Landfill 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. 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; and
- 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.

James GSA will not be setting measurable objectives or interim milestones for additional plan elements described in Water Code Section 10727.4.

4.6 Land Subsidence

According to USGS, land subsidence is a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials. The main form of subsidence is the James GSA area is deep subsidence from declining groundwater levels. As discussed previously, subsidence is a concern within the Plan Area. Because there are no extractions from the confined aquifer within the Plan Area, any subsidence is caused by activities in areas adjacent to the Plan Area where extractions from the confined aquifer are occurring. The definition of undesirable results, minimum thresholds, and measurable objectives discussed below will guide the James GSA towards implementing projects, programs, and management actions in areas outside of the Plan Area that will avoid any undesirable results.

4.6.1 Undesirable Results

The GSAs within the Kings Subbasin have defined an undesirable result for land subsidence as significant and unreasonable loss of functionality structures and infrastructure and major damage to roads within the Kings Subbasin due to land subsidence.

Infrastructure that is susceptible to subsidence within the Plan Area includes various County of Fresno roadways and bridges, an airport, the City of San Joaquin Wastewater Treatment Facility, James Irrigation District canals and pipelines, and Reclamation District No. 1606 flood protection levees. Potential impacts to these infrastructure facilities from subsidence are related to subsidence-caused changes in water surface elevation and any additional risk of flooding caused by those induced changes. Water conveyance and flood protection infrastructure are considered most at-risk from land subsidence due to effects caused by minor changes in flow gradients.

4.6.1.1 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 process used to develop the criteria for undesirable results began with the review of KRCD, USGS, DWR, NASA INSAR, and USBR land subsidence data, and through discussions with stakeholders and landowners regarding locally observed conditions. The KRCD and NASA INSAR data will be used to monitor land subsidence and check that the annual rate and cumulative subsidence stay less than the minimum threshold criteria. The criteria for an Undesirable Result related to land subsidence will be the significant loss of functionality of a structure or a facility to the point that, due to subsidence, the feature cannot be operated as designed requiring either retrofitting or replacement.

Based on the discussions with stakeholders and landowners, there have been no known undesirable results within the Plan Area. Since there have been no known issues with historic land subsidence in James GSA, the historical subsidence rate and cumulative subsidence would not lead to undesirable results over the 20 year implementation period. The historical rate and cumulative subsidence were used to set the minimum threshold (see **Section 4.5.3.1**).

4.6.1.2 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 primary cause of groundwater condition that could lead to undesirable results is extraction of groundwater from the confined aquifer in adjacent GSAs. A secondary cause would be the extraction of groundwater from the confined aquifer within the James GSA.

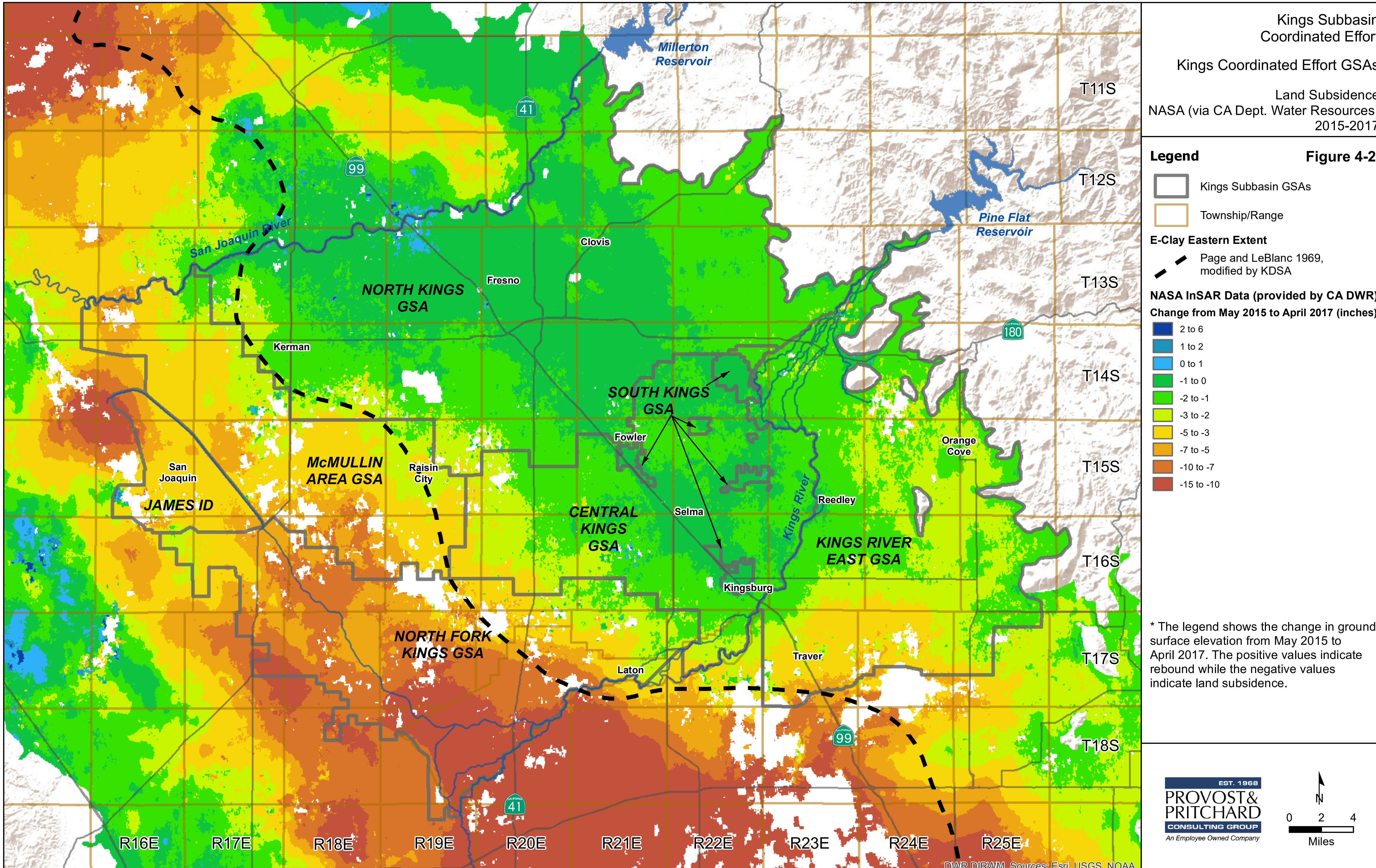
There are no groundwater production wells in the Plan Area that extract groundwater from the confined aquifer. James ID historically had "deep wells" that produced groundwater from the confined aquifer but the historical trend has been to located wells in the unconfined aquifer in areas within and outside of the Plan Area that have higher water quality and better water production characteristics. Over time, all of the deep production wells were phased out and some have been converted to monitoring wells.

Groundwater extraction from the confined aquifer occurs in all of the GSAs that are adjacent to the James GSA. The severity of the subsidence occurring from these activities varies depending on the proximity of the extractions to the Plan Area, the volume of extraction and the area over which the extractions are occurring, and the rate and timing of the extractions.

The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for subsidence are based on the extent and severity of subsidence occurring within the Plan Area. Overall subsidence of the Plan Area should be avoided due to operational issues related to primarily to flood protection levees and water conveyance infrastructure. Localized subsidence should be avoided due to operational issues with water conveyance facilities and damage to structures and infrastructure.

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.
§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.



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4.6.1.3 Evaluation of Multiple Minimum Thresholds

Monitoring for land subsidence will be done by evaluating data released from KRCD and NASA InSAR, therefore minimum thresholds will be set GSA-wide using the historical data across the Kings Basin and evaluated by mapping the subsidence over the area. Monitoring sites for these programs extend beyond the Kings Basin boundaries which is adequate for covering the GSA's using contouring and interpolation techniques. The determination that undesirable results are occurring shall depend upon measurements from multiple monitoring sites from KRCD and InSAR mapping over the entire basin

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.

There is a need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring within the Plan Area. As stated previously, overall subsidence and localized subsidence of the Plan Area is an undesirable result and should be avoided. Two separate minimum thresholds are necessary to evaluate whether an undesirable result is occurring.

4.6.2 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 minimum threshold for land subsidence is the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. The process used to establish minimum thresholds for land subsidence included an identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin. Each identified use and interest was evaluated and minimum thresholds were established in light of those effects. The minimum thresholds established for land subsidence that have been established are provided in **Table 4-9**.

Table 4-9 Minimum Threshold for Land Subsidence

Minimum Threshold Parameter	Minimum Threshold Quantity
Annual Land Subsidence Rate	6 inches/year over an area of 4 square miles
Maximum Cumulative Land Subsidence	3 feet over 20 years

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 levels will not be used as a proxy for land subsidence due to a lack of quality data on the confined aquifer potentiometric surface. In the Central Valley, land subsidence usually occurs from the Corcoran Clay layer including the confined aquifer below. The Corcoran Clay layer lies under the entire Plan Area.. Since the Corcoran Clay is a confining layer, land subsidence would occur when water is pumped from the confined aquifer below the Corcoran Clay. To monitor land subsidence based on water level, the well would have to be perforated below the Corcoran clay, and not be composite (i.e. constructed across multiple aquifers). There are a limited number of monitoring wells within the Plan Area that are drilled below the Corcoran Clay with reliable well construction information that are not composite wells. The James GSA will work on developing a confined aquifer monitoring network and may reevaluate using groundwater level from the confined aquifer as a proxy for land subsidence.

4.6.2.1 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: **(5)** Land Subsidence. The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. Minimum thresholds for land subsidence shall be supported by the following: **(A)** Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including and explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects. **(B)** Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.

Most subsidence in the San Joaquin Valley has happened and is happening west of the James GSA area over the axial trough of the Valley, in an area west and south of the Plan Area. Refer to **Section 3.2.6** of the basin setting for more information on land subsidence conditions. Areas prone to subsidence, soil textures, clay mineralogy, and other geologic and geochemical properties were intensely studied by the USGS in a series of Professional Papers in the 1960's, 1970's and 1980's. Regionally, the areas prone to subsidence were underlain by deposits where the clayey deposits are dominated by the clay mineral montmorillonite (USGS 497-C, Meade 1967). The historic subsidence map, **Figure 4-3,** and the recent subsidence map, **Figure 4-4,** both show that generally subsidence increases westerly to southwesterly across James GSA indicating that groundwater is likely increasingly confined to the west, and there is likely a higher percentage of montmorillonite in the finer-grained sediments near the axis of the valley. The maps and summary table that were used in establishing the minimum threshold for land subsidence are included in this section. **Table 4-10** shows the summary of land subsidence in James GSA as estimated by different agencies over various time frames and **Table 4-11** shows the summary of the land subsidence rates. The tables include a minimum and maximum value for each map to show the variation of land subsidence in the James GSA.

The Minimum Threshold for land subsidence has been established as 6-inches/year over an area of at least 4 square miles, with a maximum cumulative land subsidence of 3 feet over 20 years. The maximum historical land subsidence rate in the Plan Area was 10 to 15 inches from May 2015 to April 2017, or 5.0 to 7.5 inches/year, as measured by NASA, **Figure 4-5**. With this historical rate, there has been no evidence of undesirable results within James GSA. Local stakeholders and landowners noted that they have not had any issues with land subsidence within James GSA. Since there have been no undesirable results with the maximum short-term rate of subsidence, it is anticipated that the minimum threshold will not cause undesirable results.

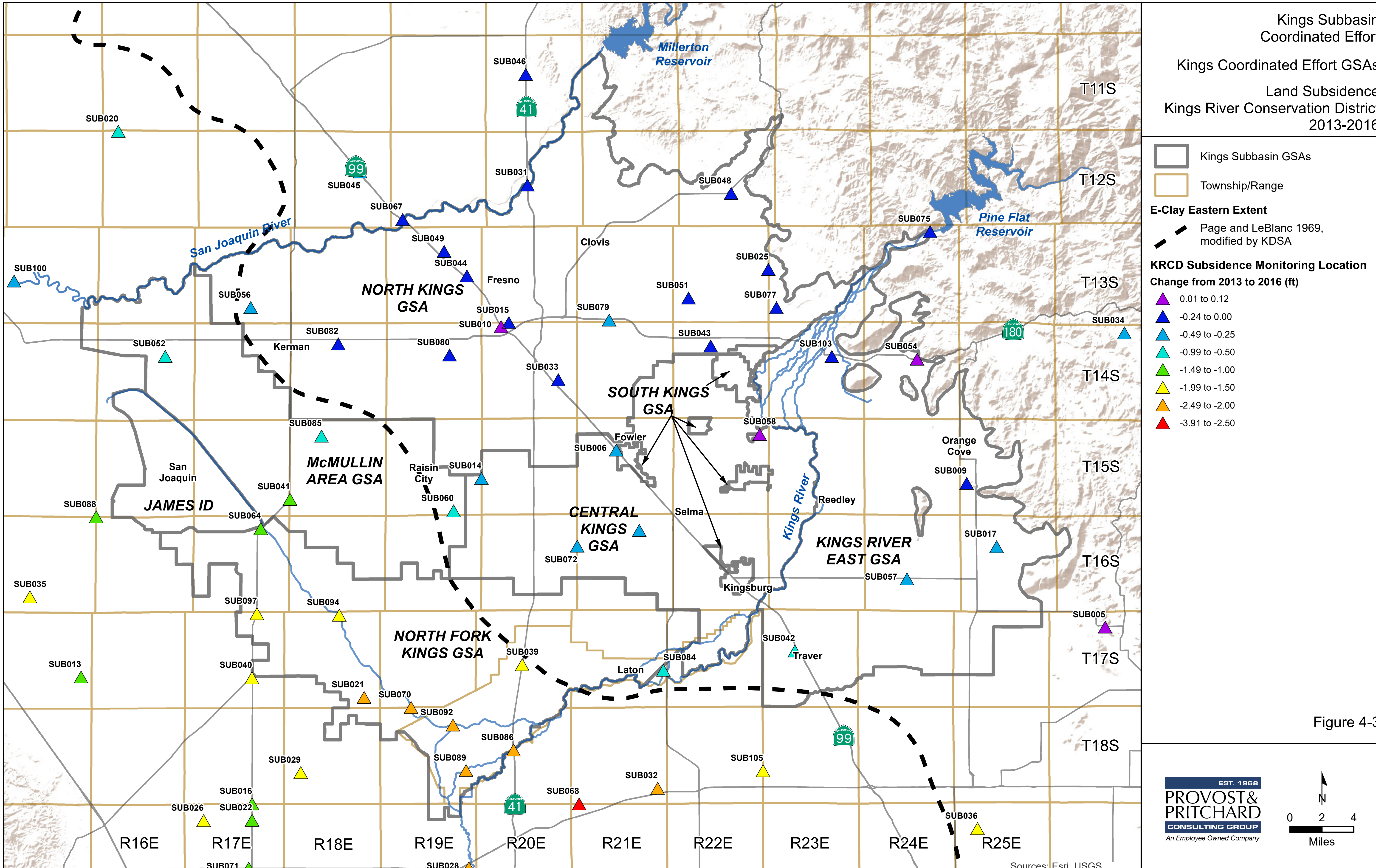
The Minimum Threshold for maximum cumulative amount of land subsidence has been established as 3 feet over 20 years. A review of a 1949-2005 map of land subsidence by DWR, **Figure 4-4**, shows the maximum subsidence in the Plan Area over a period of 56 years was around 15 feet. The 15 feet of land subsidence over 56 years has an annual rate of 3.2 inches/year. This rate over a 20-year period would result in 64 inches, or 5.3 feet, of subsidence. Given the criteria used to establish undesirable results, this cumulative amount of subsidence would likely be unacceptable as it would impact flood protection and water conveyance infrastructure. Based on input from stakeholder agencies and making certain assumptions, it was determined that an amount of 3.0 feet would be the maximum amount of subsidence that could be tolerated over a 20 year period. These assumptions include the assumption that nearby areas outside of the Plan Area are also experiencing subsidence at a similar rate and the assumption that the subsidence is not localized within the Plan Area. These assumptions will be reevaluated periodically during the plan evaluation process.

Table 4-10 Historical Total Land Subsidence in James GSA

Total Subsidence in James GSA				
Monitoring Agency	Date Range			
	Start	End	Min (in)	Max (in)
USGS	1926	1970	-36.0	-90.0
DWR	1949	2005	0.0	-180.0
USBR	2011	2016	-1.8	-5.4
KRCD	2013	2016	-0.6	-5.9
NASA	2015	2017	-3.0	-15.0

Table 4-11 Historical Land Subsidence Rates in James GSA

Subsidence Rate in James GSA				
Monitoring Agency	Date Range			
	Start	End	Min (in/yr)	Max (in/yr)
USGS	1926	1970	-0.8	-2.0
DWR	1949	2005	0.0	-3.2
USBR	2011	2016	-0.4	-1.1
KRCD	2013	2016	-0.2	-2.0
NASA	2015	2017	-1.5	-7.5



Kings Subbasin Coordinated Effort
Kings Coordinated Effort GSAs
Land Subsidence
Kings River Conservation District
2013-2016
Kings Subbasin GSAs
Township/Range
E-Clay Eastern Extent
Page and LeBlanc 1969, modified by KDSA
KRCD Subsidence Monitoring Location
Change from 2013 to 2016 (ft)
0.01 to 0.12
-0.24 to 0.00
-0.49 to -0.25
-0.99 to -0.50
-1.49 to -1.00
-1.99 to -1.50
-2.49 to -2.00
-3.91 to -2.50
Figure 4-3
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PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company
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0 2 4
Miles
Millerton Reservoir
Pine Flat Reservoir
San Joaquin River
Kings River
NORTH KINGS GSA
SOUTH KINGS GSA
McMULLIN AREA GSA
JAMES ID
CENTRAL KINGS GSA
KINGS RIVER EAST GSA
NORTH FORK KINGS GSA
Clovis
Fresno
Kerman
San Joaquin
Fowler
Raisin City
Selma
Reedley
Orange Cove
Kingsburg
Laton
Traver
T11S
T12S
T13S
T14S
T15S
T16S
T17S
T18S
R16E
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R19E
R20E
R21E
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R23E
R24E
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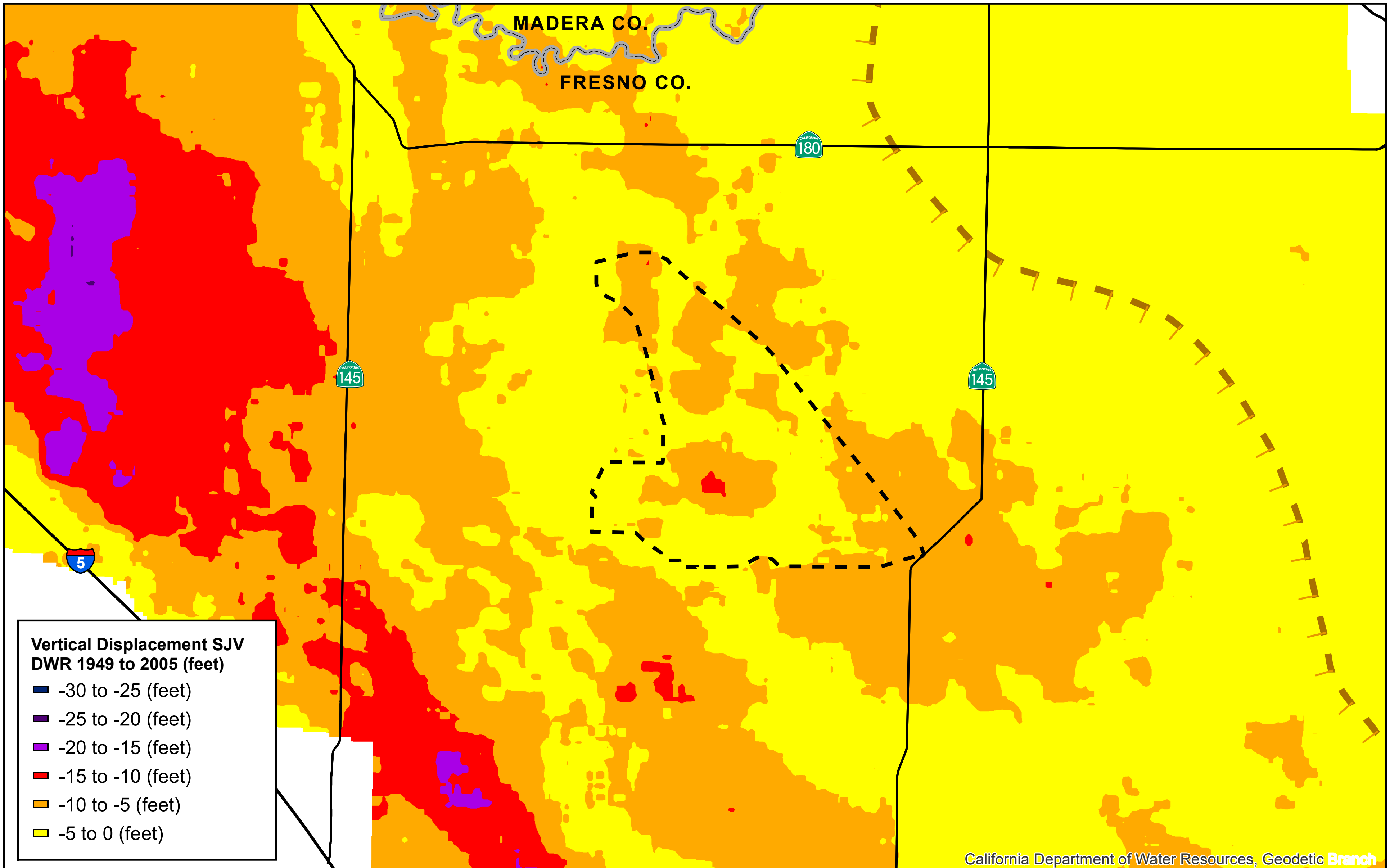
Sources: Esri, USGS,



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Miles

James GSA
County
North East Edge of Corcoran Clay
Page and LeBlanc 1969, KDSA (A Modification of Croft and Gordon 1968)

Figure 4-4

James GSA

Land Subsidence
Department of Water Resources
1949-2005

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4.6.2.2 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 threshold for land subsidence was set using the annual rate of historical subsidence. The historical rate has not caused undesirable results within the Plan Area, so it should not cause undesirable results if the rate of subsidence and maximum cumulative subsidence remains less than the minimum threshold. **Table 4-12** lists the relationship to land subsidence for each sustainability indicator.

Table 4-12 Relationship for Each Sustainability Indicator

Sustainability Indicator	Relationship to Land Subsidence
Water Level	Land subsidence occurs when water levels drop below historical lows due to groundwater pumping from the confined aquifer
Storage Change	There is loss of storage when land inelastic land subsidence occurs
Groundwater Quality	Not related to land subsidence
Interconnected Surface Water Groundwater	Not related to land subsidence

Land subsidence does not impact water levels, rather the water levels impact land subsidence. Land subsidence occurs due to a decline in water levels from confined groundwater pumping. It is assumed that the neighboring GSA's will reduce pumping to some extent from the confined aquifer to become sustainable. The reduction in confined groundwater pumping would lead to water levels stabilizing because of the water level sustainable management criteria, that would lead to land subsidence stabilizing.

Land subsidence impacts storage change when there is inelastic land subsidence. Once inelastic land subsidence occurs, the loss in storage cannot be reversed.

Land subsidence is not directly related to groundwater quality sustainability indicators. Groundwater quality is, however, impacted by water levels. Different water quality constituents may be found at different depths which would cause the water quality to change depending on the groundwater elevation.

Interconnected surface water groundwater is not directly related to land subsidence. Interconnected surface water groundwater is impacted by water levels. The surface water may be interconnected to the groundwater depending on the groundwater level.

4.6.2.3 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 highly unlikely that groundwater extractions in the Plan Area will cause subsidence in adjacent basins because of the Plan Area has no wells that extract groundwater from the confined aquifer. The minimum thresholds have been selected to avoid groundwater extractions in adjacent basins from causing undesirable results in the Plan Area. For this reason, minimum thresholds have been established that will not cause undesirable results in adjacent basins.

4.6.2.4 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.

At the minimum threshold, the impact on beneficial uses and water users will be minimal. If ground surface elevations change due to subsidence and water conveyance invert gradients are altered, James ID infrastructure will be adversely affected. The minimum thresholds established will not avoid all adverse impacts to James ID infrastructure, but the minimum thresholds are expected to avoid significant or substantial impacts.

Some impacts to flood control facilities owned and operated by RD 1606 are also expected. During flood releases occurring in 2017, observed water level elevations during peak releases, which were near the floodway design capacity of 4,500 cubic feet per second, indicated that there was approximately five (5) feet of freeboard in critical areas. Some isolated areas may have had less freeboard due to irregularities in the crest height of the flood protection levee but any needed repair of these areas is not considered an undesirable result. A three (3) foot decline in these areas will require a moderate level of work to reestablished minimum desired freeboard elevations.

4.6.2.5 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.

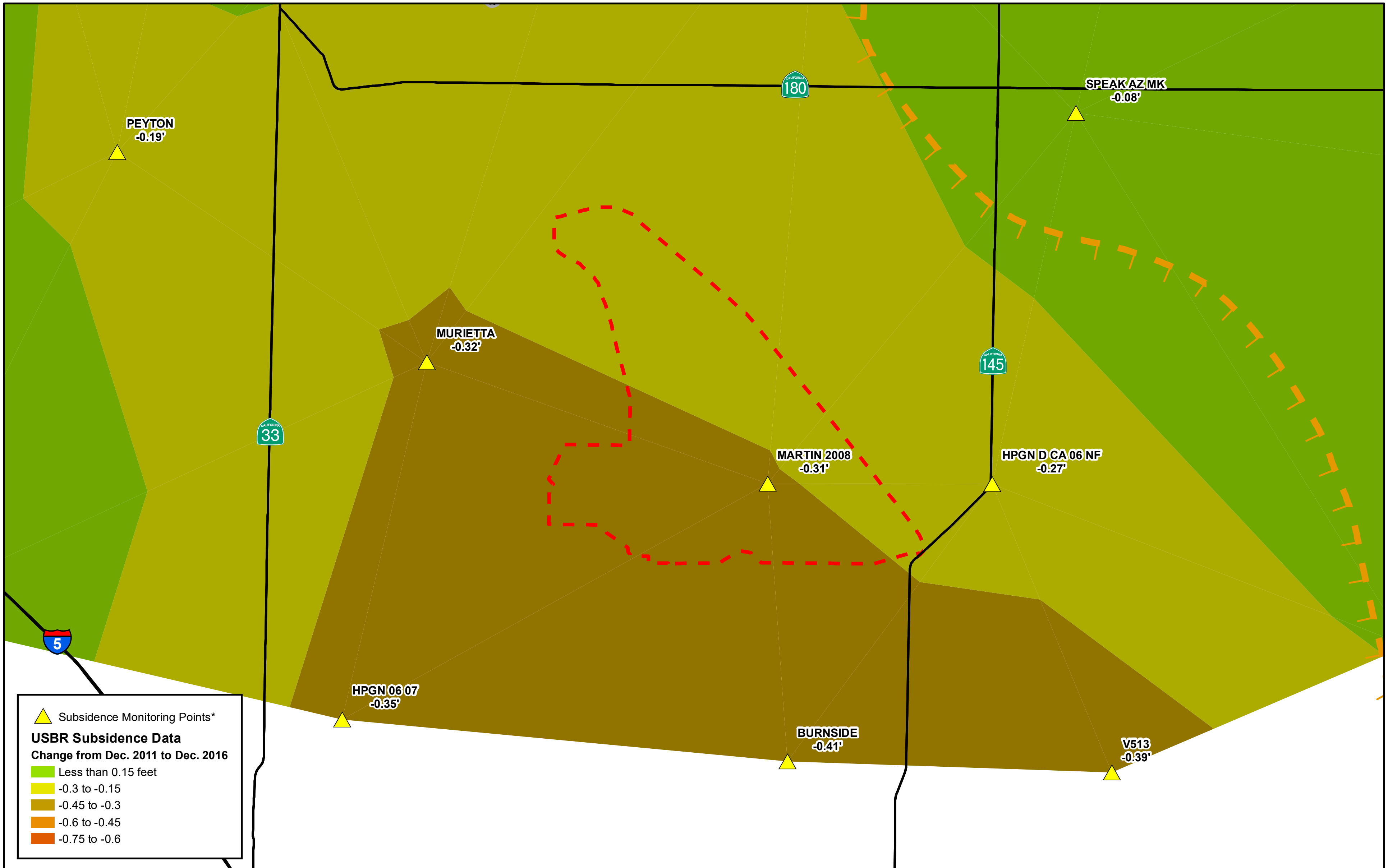
There are currently no standards for land subsidence. If state, federal, or local agencies implement a land subsidence standard, then it will be reviewed and may be incorporated into the GSP. If the minimum threshold differs from the regulatory standard, the nature and basis for the difference will be explained.

4.6.2.6 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.

The minimum threshold values will be monitored using the NASA remote sensing monitoring network, the U.S. Bureau of Reclamation monitoring network, the KRCD monitoring network, and the James ID monitoring network. Certain points will be monitored annually while others will be monitored depending on the observed rate of subsidence and observed hydrological conditions but no less frequently than a period of five years.



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James GSA
County
North East Edge of Corcoran Clay
Page and LeBlanc 1969, KDSA Modification

**Subsidence Monitoring Points labeled with Free Adjusted delta values from Dec. 2011 to Dec. 2016*

Figure 4-5

James GSA

Land Subsidence
U.S. Bureau of Reclamation
2011-2016

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4.6.3 Measurable Objectives

The measurable objective for land subsidence was established to achieve the sustainability goal for the Kings Subbasin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon. The measurable objectives established for land subsidence that have been established are provided in **Table 4-13.** Further details about the establishment of the measurable objective for land subsidence are provided below.

Table 4-13 Measurable Objective for Land Subsidence

Measurable Objective Parameter	Measurable Objective Quantity
Annual Land Subsidence Rate	3 inches/year over an area of 4 square miles
Maximum Cumulative Land Subsidence	2 feet over 20 years

4.6.3.1 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.

Measurable objectives for land subsidence were based on historical rates and experience from the beneficial users and owners of the water conveyance infrastructure. The Measurable Objective for land subsidence will be 3 inches/year over an area of at least 4 square miles with a cumulative amount of land subsidence of 2 feet over 20 years. The rate of 3 inches/year is equivalent to the rate experienced during the period from 1949 to 2005 as shown in the map of land subsidence by DWR, **Figure 4-4**. While a rate of 3 inches per year was determined to be an acceptable rate to avoid infrastructure impacts, additional limitations were placed on the cumulative amount of subsidence to provide a conservative operational margin from minimum threshold values and undesirable results.

4.6.3.2 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.

The operational flexibility is the difference between the measurable objective and minimum threshold. For James GSA , the operational flexibility is 6 in – 3 in = 3 in/year or 3 feet – 2 feet = 1 feet of cumulative subsidence. James GSA will not establish measurable objectives that exceed the reasonable margin of operational flexibility.

4.6.3.3 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.

At this time, groundwater levels will not be used as a proxy for land subsidence due to a lack of quality data on the confined aquifer potentiometric surface. In the Central Valley, land subsidence usually occurs from the

Corcoran Clay layer, including the confined aquifer below. The Corcoran Clay layer lies under the entire Plan Area. Since the Corcoran Clay is a confining layer, land subsidence would occur when water is pumped from the confined aquifer below the Corcoran Clay. To monitor land subsidence based on water level, the well would have to be perforated below the Corcoran clay, and not be composite (i.e. constructed across multiple aquifers). There are a limited number of monitoring wells within the Plan Area that are drilled below the Corcoran Clay with well construction information that are not composite wells. The James GSA will work on developing a confined aquifer monitoring network and may reevaluate using groundwater level from the confined aquifer as a proxy for land subsidence.

4.6.3.4 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.

Table 4-14 Land Subsidence Interim Milestones and **Figure 4-6** present values of land subsidence based on the historical rates discussed earlier for each of the interim milestone years. Following the Measurable Objective milestones, the total subsidence experienced from 2020 to 2040 would be approximately -3 feet. If land subsidence exceeds the 3 in/year annual rate or exceeds the interim milestones, then there will be outreach and education to make the affected areas and adjacent GSAs aware of the land subsidence. There will also be increased monitoring and observing the impacts on facilities. If the land subsidence deviates neatively form the Interim Milestones, then James GSA will implement appropriate projects, programs, and management actions, see **Chapter 6** for more information.

Table 4-14 Land Subsidence Interim Milestones

	Cumulative Subsidence (feet)	
Year	Measurable Objective	Minimum Threshold
2020	0.00	0.00
2025	-0.50	-0.75
2030	-1.00	-1.50
2035	-1.55	-2.25
2040	-2.00	-3.00

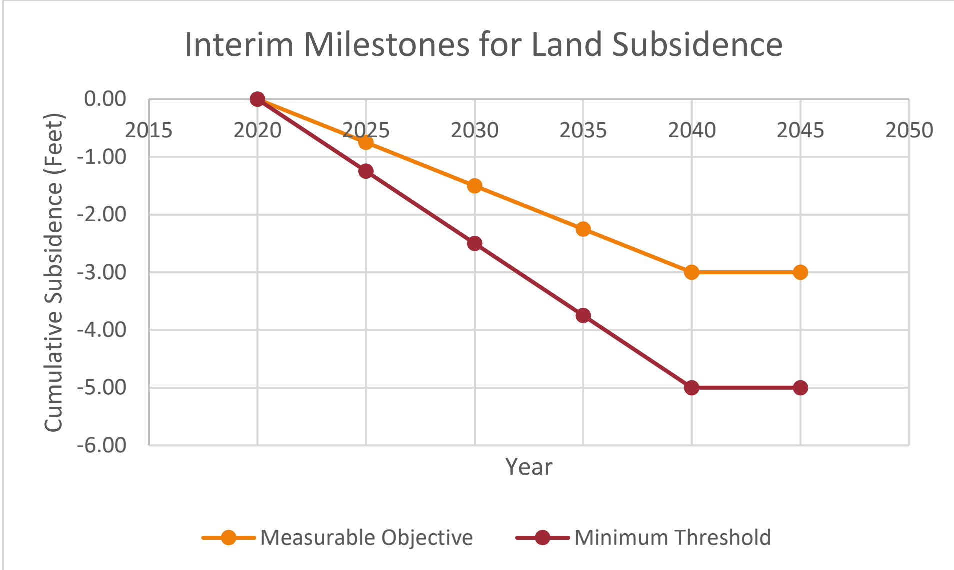


Figure 4-6 Interim Milestones for Cumulative Land Subsidence

4.6.3.5 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..

James GSA will not be setting measurable objectives or interim milestones for additional plan elements described in Water Code Section 10727.4.

4.7 Interconnected Surface Water and Groundwater

4.7.1 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.

§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.

An undesirable result would be the significant and unreasonable reduction of surface waters within the Kings Basin due to groundwater pumping. The major surface waters in the Kings Basin include the Kings River and the San Joaquin River. Other surface waters in the Kings Basin and within the James GSA include the James Bypass and Fresno Slough. Downstream reaches of the James Bypass and Fresno Slough contain water throughout the year as they are used for irrigation water conveyance from the Mendota Pool.
Due to existing Kings River and Mendota Pool operations and the lack of continuous interconnected surface water within the James GSA, undesirable results to surface water related to groundwater pumping are not likely to occur. Accordingly, criteria to define undesirable results have not been established under §354.26 (d).

4.7.2 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. (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 o establish minimum thresholds related to those sustainability indicators.

Undesirable results to surface water within the Kings Subbasin related to groundwater pumping within the James GSA are not likely to occur and minimum thresholds have not been set under regulation §354.26 (d).

4.7.3 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.

Undesirable results to surface water within the Kings Subbasin related to groundwater pumping within the James GSA are not likely to occur and measurable objectives have not been set under regulation §354.26 (d).

4.8 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.

James GSA will not be setting measurable objectives or interim milestones for additional plan elements described in Water Code Section 10727.4

5 Monitoring Network

Regulation Requirements:

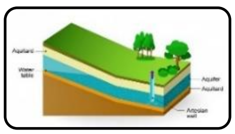
> §354.32 This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to 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, **Table 5-1** includes the monitoring programs needed to comply with SGMA monitoring and reporting requirements.

Table 5-1 Monitoring Requirements

Groundwater Levels

- Monitoring of static groundwater levels each Spring and Fall

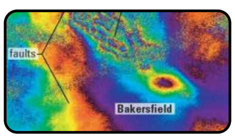


Groundwater Storage

- Measurement of the annual change in groundwater storage

Water Quality

- Monitoring for water quality degradation that could impact available groundwater supplies

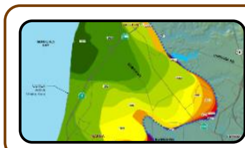


Land Subsidence

- Surface land subsidence caused by groundwater extraction

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 James GSA

Monitoring programs for these indicators are described below including the history of the monitoring programs, proposed monitoring to comply with SGMA, and the adequacy and scientific rationale for each monitoring network. Monitoring of groundwater pumping, groundwater recharge, and surface water deliveries is discussed in Section 3.3 – Water Budget Information.

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 chapter describes the current and developing monitoring networks in the James Groundwater Sustainability Agency (James GSA) that will collect data to determine short-term, seasonal, and long-term trends in groundwater and surface conditions related to the sustainability indicators. Data collected from the monitoring networks will yield information necessary to support the implementation of this Plan, evaluate the effectiveness of this Plan, and guide decision making by the James GSA management. Information and data from historical monitoring efforts can be found in Section 3.2 – Current and Historical Groundwater Conditions.

Figure 5-1 through **Figure 5-3** show the currently proposed monitoring site locations for groundwater levels and groundwater storage, groundwater quality, and land subsidence, respectively. Areas of potential monitoring for interconnected surface water are included in **Figure 5-4.**

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 comparable data from various places in the Plan Area and Subbasin;
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; and
10. Provide sufficient detail to guide annual water management actions for the present water year.

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]

Sections 5.2 through 5.7 describe existing networks within the GSA's boundary which track groundwater levels, groundwater storage, water quality, land subsidence, and depletion of interconnected surface water. For each sustainability indicator, the adequacy of the monitoring network is discussed, as well as the quantitative values for minimum thresholds, measurable objectives, and interim milestones. The sections also include a review of each monitoring network for monitoring frequency and density, identification of data gaps, plans to fill data gaps, and future site selection. This information will be reviewed and evaluated during each five-year assessment.

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.

Kings Basin monitoring networks for each GSA will utilize existing wells that are currently monitored for groundwater level including but not limited to CASGEM, KRCD, municipality, DWR, agency and private wells. Data gap areas will have new dedicating monitoring wells or other available wells that do not have the longer history as other wells within the basin. Each GSA will discuss their individual monitoring network in their respective GSP. The groundwater elevation measurements will be collected every March and October to provide data on the seasonal low and seasonal high groundwater conditions. Each GSA will provide the data to the Plan Manager for the Basin for inclusion in the Data Management System and annual reports

The CASGEM program was created by SBx7-6, Groundwater Monitoring, a part of the 2009 Comprehensive Water Package. Groundwater levels have been regularly monitored in fifty-six (56) wells within the GSA and seven (7) just outside the GSA and reported to the CASGEM program. Twenty-four (24) wells included in the monitoring network have no historic measurements available but will be monitored in the future to cover data gap areas. Water level data is publicly available for a large number of additional wells within the GSA area. However, well construction information was not available for these wells which limits their usefulness for monitoring purposes as the well could be perforated in multiple aquifer zones, and therefore, it is unknown which aquifer zone is being reflected in the measured water level. Figure 5-1 shows the locations of the wells in the water level monitoring network and an attribute table of the well information is Table 5-1, shown below in **Appendix 5-A.** The current water level monitoring network is a combination of production wells and dedicated monitoring wells.

5.2.2 Adequacy of Monitoring Network

§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 Kings Basin is not establishing management areas, rather the Basin is split into 7 GSAs that will each have their own GSP. Each GSA has a minimum monitoring density of 2 wells within each 36-square-mile township within the GSA. The monitoring networks include wells that are currently being monitored. GSAs plan to include additional wells to monitor in areas where minimal water level information has historically been collected, and for areas of the confined aquifer.

The existing groundwater-level monitoring network has provided adequate data to prepare groundwater contour maps and identify groundwater level trends over the years. The average density of the monitoring network in the region is adequate for the unconfined aquifer, however there are Townships in the GSA that have sparse coverage. A more detailed discussion is included in Section 5.2.8.2.

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.

Throughout the Basin, groundwater levels will be measured 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 (Hopkins, 2016) provide recommendations for groundwater-level monitor well densities. The densities range from 1 well per 100 square miles to 1 well per 25 square miles based on the quantity of groundwater pumped. A minimum density of 1 well/25 square miles is recommended for areas using over 100,000 AF of groundwater per year. Groundwater use in the James GSA currently exceeds 100,000 AF/year and will likely exceed this value even after groundwater usage declines to comply with SGMA. As a result, a minimum well density of 1 well/25 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 <u>1 well/18 square miles</u>. This is a bare minimum density, and the GSA will strive to maintain a denser network when economically feasible and practical.

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, known information on the well depth and perforated interval, and adequate 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.

The GSA groundwater level network shown in **Figure 5-1** contains an average of 4.0 wells per Township. The DWR guidelines for monitoring well spacing recommend "*a higher-resolution contour map would be warranted in an area with a greater reliance upon groundwater in order to anticipate potential problems, such as supply and groundwater contamination concerns, while a lower-resolution contour map might be sufficient in an area with few people or a low reliance upon groundwater*." This point is well taken when the intent is to map changes from year-to-year and accurately report progress to meeting measurable objectives. The James GSA intends to expand its groundwater level network as additional well construction information is obtained for existing wells and as new dedicated monitoring wells are installed. Through public education, outreach, video logging of existing wells that have routinely been measured but do not have well construction information available at this time, and construction of nested monitoring wells, the GSA plans to fill data gaps as discussed further in 5.2.3.3. The goal for the expanded network is to produce more accurate groundwater elevation contours.

The hydrological conceptual model for the Plan Area includes two (2) principal aquifer zones, the unconfined above the E-clay and confined below the E-clay. However, as previously noted, two other primary clay layers underlie the GSA. The A-clay is an extensive shallow clay layer under much of the GSA. The intermediate C-clay layer appears to periodically exhibit confining characteristics and could be considered semi-confining. As indicated by **Figure 5-1**, the monitoring network includes wells that are perforated in the unconfined aquifer above the E-clay and the confined aquifer below the E-clay. There are no monitoring wells above the A-clay or between the A-clay and the C-clay.

5.2.4 Monitoring Network Information

5.2.4.1 Scientific Rationale for Site Selection

Regulation Requirements:

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

The 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

The rationale for selecting monitoring points in the current groundwater level monitoring network includes:

1. The monitoring points contribute to the minimum density of an average of 2 points per Township, with the plan to expand the density in the near future;
2. The monitoring point is anticipated to be available for measurements in the future;
3. The monitoring point has historic measurement data available and has had a measurable objective determined, if the well has existed for some time; and
4. The monitoring point has well construction information available.

The following scientific rationale will be used to add new wells to the groundwater level monitoring network:

- Add wells where necessary to fill spatial data gaps laterally and vertically;
- Avoid wells perforated across multiple aquifer zones;
- Select dedicated monitoring wells over production wells, when feasible;
- Select wells with available construction information; and
- Select wells that will be available for monitoring in the future.

5.2.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

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

The data gathered through the monitoring networks is and will continue to be consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as **Appendix 5-B.**

- Data reporting units and accuracy;
- Monitoring site information;

- Well attribute reporting;
- Map standards;
- Hydrograph requirements;
- Groundwater and surface water models; and
- Availability of input and output files to DWR.

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.

For the groundwater level sustainability indicator, the quantitative values that will be measured at each monitoring site for the minimum threshold, measurable objective, and interim milestones will be the distance from the monitoring well reference point to the water level. The measurement will be taken in units of feet. The measurement will be rounded to the nearest tenth of a foot. The measurements will be converted to a groundwater surface elevation above mean sea level using the surveyed elevation of the reference point.

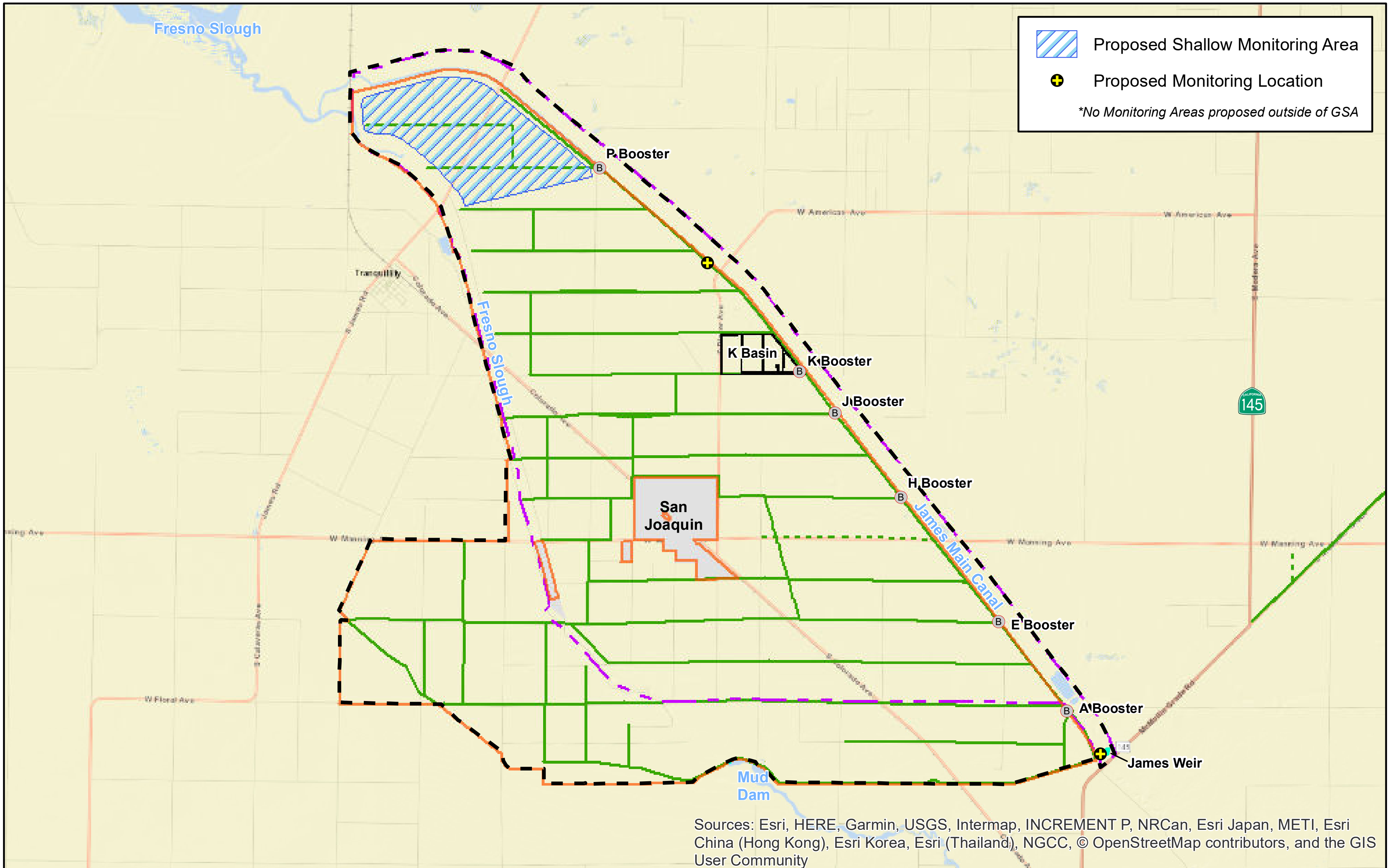
5.2.5 Monitoring Locations

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.

5.2.5.1 Map

Figure 5-1 shows the groundwater level indicator well locations for the Kings Basin. Seasonal monitoring will be compared to the interim milestones, measurable objective, and minimum threshold established for these indicator wells. Well information in tabular format is included in each GSP within the Kings Basin in Section 5.2.5.2.



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James GSA

Proposed Monitoring

Figure 5-1

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5.2.5.2 Table

An attribute information on each of the monitoring sites in the groundwater level monitoring network. network may be modified or enhanced if deemed necessary

5.2.6 Monitoring Protocols

§352.2 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.
§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.

The Data Quality Objective (DQO) process, which follows the U.S. EPA Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA, 2006), will be used to develop monitoring protocols that assist in meeting measurable objectives and sustainability goals of this Plan. The DQO process is also outlined in the DWR's Beast Management Practices for Monitoring Networks (2016a) and monitoring protocols (2016b). The DQO process helps to ensure a repeatable and robust approach to collecting data with a specific goal in mind.

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; and
7. Develop a plan for obtaining data.

Groundwater level monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, December 2016b). Refer to **Appendix 5-C** 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:

1. SGMA regulations require that groundwater levels be measured to the nearest 0.1 foot. The BMP suggests measurements to the nearest 0.01 foot. This is not practical for many measurement methods. 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, measurements can only be made to the nearest foot.
2. Well sounding equipment has to be decontaminated after use if used in a well with suspected or known contamination or if there are obvious signs of contamination, such as oil.
3. Unique well identifiers will be used for private wells to respect the privacy of the well owner.

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.

Representative monitoring sites will not be utilized in James GSA.

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.

Regulation Requirements:

§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.

James GSA does not plan to use groundwater elevations as a proxy for monitoring other sustainability indicators.

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.

The following includes a description of the different types of data gaps, a summary of existing data gaps, and plans to fill the data gaps. These items will be reevaluated in each 5-year update to this Plan.

5.2.8.2 Identification of Data Gaps

§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:

1. **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.
2. **Spatial**: Insufficient number or density of monitoring sites in a specific area.
3. **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 sometimes poor, making it difficult or impossible to match wells with their well logs.

New monitoring networks will be developed as data gaps are filled, and existing networks enhanced when necessary, using the Data Quality Objective (DQO) process, which follows the U.S. EPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006). The DQO process is also outlined in the DWR's Best Management Practices for monitoring networks (2016a) and monitoring protocols (2016b). The DQO process helps to ensure a repeatable and robust approach to collecting data with a specific goal in mind.

Wells in the monitoring network have been measured regularly in the spring and fall of each year since monitoring began at each respective site. It is anticipated that the measuring agencies will continue to measure the wells and report the data to the CASGEM program as well as the James GSA. However, some wells in the monitoring network have not been measured in the last few years, or perhaps were measured but the data has not been uploaded to CASGEM yet. While data gaps are generally not present in the frequency of groundwater level monitoring, temporal gaps are present in some of the well data.

The existing groundwater-level monitoring network has provided adequate data to prepare groundwater contour maps and identify groundwater level trends over the years. The average density of the monitoring network in the region is adequate for the unconfined aquifer, however there are Townships in the GSA that have sparse coverage. Wells included in the monitoring network have known construction information. Both the unconfined and confined aquifer zones in the GSA are represented by the monitoring network, though not in an even distribution. There is insufficient data available at this time to accurately represent the seasonal trends of the confined aquifer zone within the GSA. Spatial data gaps in the groundwater monitoring network are present both laterally and vertically in the James GSA.

There are wells in the monitoring network that are perforated above and below primary clay layers, called composite wells, that are potentially drawing groundwater from two different aquifer zones. In most cases, the classification of potentially composite wells contains multiple sources of error. Well drillers typically target the sandy zones between the primary clay layers. With the goal of maximizing the well yield within the sand strata, the well casing perforations often begin and end within the primary clay layers. Though scholars have estimated the thicknesses and extent of the primary clays in various publications and maps, these estimations are largely based upon well completion reports and electric logs (e-logs) performed by different individuals with varying experience, subjectivity, and margins of error. The E-clay is most apparent when described as "blue-clay" on boring logs. However, terminology is inconsistent across well logs. E-logs are more definitive in locating the confining clay strata but are seldom publicly available. As a result, the well classifications included in the water level monitoring network are based upon the best available information and may be subject to change as more information becomes available. While composite wells will continue to be monitored, these wells are not considered 'high quality monitoring points' and are not included in the monitoring network. High quality monitoring points are defined as wells with reliable access each spring and fall, construction information with the well depth and perforation intervals, perforations not extending above and below confining clay layers, and sufficient depth to accommodate seasonal fluctuations. Wells that do not meet these guidelines will continue to be monitored as they can still provide useful information for other future trend analysis with their long period of record, but these wells will only be included in the network where additional information is needed. During development of groundwater contours, composite wells will be labeled to assist with the analysis. There are no composite wells in the monitoring network..

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

These data gaps can be filled using the four alternatives below:

- **Collect well completion reports.** Well Completion Reports will provide the needed information. These could be collected from the landowner or the DWR; however, several challenges exist. First, landowners may not have the report or may not be willing to provide them. The GSA participants have found it very difficult to match up Well Completion Reports from DWR with actual wells, since so many have been drilled in the area and location maps in the reports are often poor or erroneous. Fresno County also tracks some well construction data in a GIS database as part of their permitting process. This information could be useful for some recently constructed wells.
- **Perform a video inspection of each well to obtain construction information.** A video inspection can be performed on desired wells to determine the total depth and perforated interval. The cost of each inspection is about $1,500 (2017), but up to $15,000 may also be needed to lift a pump to provide access. Additional costs would also be incurred for administration and outreach to landowners. Permission would be needed from the well owner; however, they may agree since they would obtain a free well assessment.
- **Replace monitoring point with a dedicated monitor well:** Dedicated monitor wells could be installed and used in place of private wells. The construction information would be known and there would be no access issues. Dedicated monitor wells are expensive to construct, and their installation will depend on available funding.
- **Replace monitoring point with another private well.** Private wells without construction information could be replaced with another private well that has well construction information. This may be simpler and less costly than a video inspection. However, replacing monitor well locations is not always desirable, since it is preferred to continue measurements in wells that have a long period of record (i.e., long hydrograph).

The GSA, as part of the Kings Subbasin, has applied for DWR grant funds through the Technical Support Services (TSS) program to initially install one dedicated monitoring well cluster in an identified area with insufficient groundwater elevation data. Several monitoring wells would be included in the cluster to monitor water levels from different aquifer zones. Dedicated monitoring wells are preferred because the construction information is known and there are no conflicting production pumping or access issues. The cluster wells could be used to monitor water levels as well as water quality. However, dedicated monitor wells are expensive to construct, so their installation depends on available funding. Additional requests for funding may be submitted to the TSS program in the future.

Spatial gaps will additionally be filled by video logging wells and trying to acquire additional well completion reports for wells that do not currently have construction information available. However, challenges exist the GSA has found it very difficult to match up Well Completion Reports from DWR with actual wells, since so many have been drilled in the area and location descriptions or maps in the reports provided by well drillers are often poor or erroneous. In other cases, wells have run dry, been abandoned, or been destroyed without proper documentation. The cost of a video inspection is about $1,500, but up to $15,000 may also be needed to pull a pump to provide access. Permission would be needed from the well owner for video inspection and long-term access for future measurements.

The GSA will continue efforts to fill spatial gaps in the monitoring network for the confined aquifer. The effort may include conversion of abandoned composite wells to clustered monitoring wells.

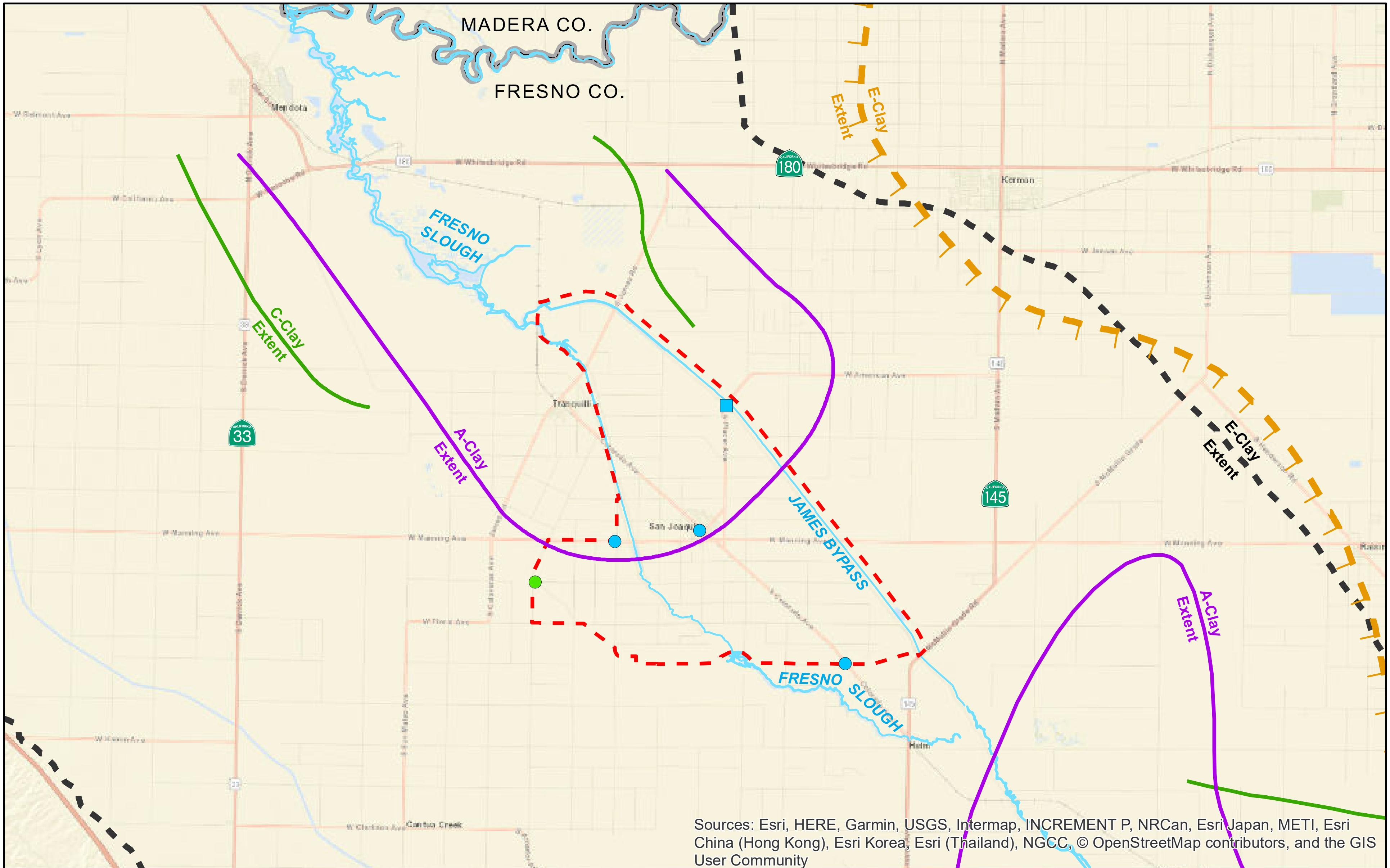
5.2.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

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 Plans to Fill Data Gaps above will address highly variable spatial or temporal conditions currently identified in the monitoring network. Currently James GSA is not experiencing minimum threshold exceedances or adverse impacts to beneficial uses and users of groundwater, nor is it known to be adversely affecting the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin. The criteria are considered adequate to provide the monitoring data 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. Figure 5-2 is a map of the Groundwater Level Monitoring Network. This map identifies the groundwater level indicator wells, actively monitored wells with known construction information, and data gap areas.



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Miles

James GSA
County
A-Clay Extent (1999-H)
C-Clay Extent (1999-H)
E-Clay Eastern Extent (CVHM)

North East Edge of Corcoran Clay

Page and LeBlanc 1969, KDSA Modification

Non-Domestic

Between C and E-Clay

Monitoring Wells

Below E-Clay

Between C and E-Clay

James GSA

Groundwater Level Monitoring Network

Figure 5-2

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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.

Groundwater storage change will be estimated by multiplying local specific yield values by the change in groundwater levels, which are measured on a bi-annual basis.

As part of the Kings Subbasin Coordination Efforts, KDSA (Kenneth D. Schmidt & Associates) and Provost & Pritchard (P&P) conducted a review of available published sources of specific yield data. Additionally, e-logs, geo-logs, and DWR well completion reports were reviewed to complement the available literature. Specific yield values were then estimated for each designated area, usually by 36-square-mile Townships, for depths of 10-50 feet, 50-100 feet, 100-200 feet, and greater than 200 feet below the ground surface. In some areas, specific yield data is limited to one value from 10-300 feet (see **Figure 3.20** in the Hydrogeologic Conceptual Model).

The process for calculating changes in groundwater storage included 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 then 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 ne year to the next.

A multi-year average of the storage change will be evaluated and compared to long-term trends to understand the impact of the implementation of the Plan. A second method of estimating the storage change that was utilized is the water budget analytical model, or the checkbook balance method. It uses inputs from all water sources, consumptive uses, and losses to determine groundwater surplus or overdraft over a given period. The general methodology used in those efforts will continue to be used by the GSA.

Estimated storage change in the lower confined aquifer cannot be calculated at this time due to limited data from confined wells within the GSA.

Please refer to the subsection on Aquifer Characteristics in Chapter 3: Hydrologic Conceptual Model for more information on specific yield values.

The monitoring network for storage change is the same as the water level monitoring network since water level change is an integral part of storage change.

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 will be calculated using local groundwater levels and specific yield values. This methodology has proved adequate in estimating annual change in groundwater storage in other regions of the Kings Basin. Specific yield values for various depths have been determined through an extensive literature search. Groundwater storage calculations are largely dependent on the groundwater level monitoring network, which is being expanded for SGMA. 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. 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

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 Rationale for Site Selection

Regulation Requirements:

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

Change in groundwater storage is based on a calculation involving the specific yield and change in groundwater levels. The groundwater level monitoring sites are discussed above. Specific yield values were acquired from a review of several publications. The specific yield values generally cover 36-square-mile Townships. 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) Each Plan shall describe the following information about the monitoring network:
(2) Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.

The data gathered through the monitoring networks is and will continue to be consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as **Appendix 5-B**.

- Data reporting units (e.g., Water volumes shall be reported in acre-feet, etc.)
- Monitoring site information (e.g., Site identification number, description of site location, etc.)
- Well attribute reporting (e.g., CASGEM well identification number, casing perforations, etc.)
- Map standards (e.g., Data layers, shapefiles, geodatabases shall be submitted in accordance with the procedures described in Article 4, etc.)
- Hydrograph requirements (e.g., Hydrographs shall use the same datum and scaling to the greatest extent practical, 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 GSA. Refer to section 4.3.2. Minimum Thresholds in the Sustainable Management Criteria chapter for the table with the criteria set for each GSA.

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.

5.3.5.1 Map

Figure 5-1 shows the monitoring site locations for the Kings Basin. The monitoring site information in tabular format are included in each GSP within the Kings Basin in section 5.2.5.2. Groundwater Storage monitoring utilizes the groundwater level monitoring network.

5.3.5.2 Table

A table of specific monitoring site information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used is included in **Appendix 5-A**.

5.3.6 Monitoring Protocols

Regulation Requirements:

§352.2 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.
§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, which is the same as the storage change monitoring, will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, 2016b). Refer to **Appendix 5-C** 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:

1. 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.
2. If used in a well suspected of contamination or if there are obvious signs of contamination (such as oil), well sounding equipment will be decontaminated after use.
3. The elevation of the Reference Point (RP) of each well surveyed will be accurate within 0.5 feet.
4. Unique well identifiers will be labeled on all public wells and on private wells if permission is granted.
5. The BMP states that measurements each spring and fall should be taken "preferably within a 1 to 2-week period." This is likely not feasible due to the large number of wells in the GSA, and a 4-week period will be granted for bi-annual monitoring.
6. If a vacuum or pressure release is observed, then water level measurements will be remeasured every 5 minutes until they have stabilized.
7. In the field, water level measurements will be compared to previous records; if there is a significant difference, then the measurement will be verified.

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.

Representative monitoring sites will not be utilized in the Plan Area.

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.

Regulation Requirements:

§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.

James GSA does not plan to use groundwater elevations as a proxy for monitoring other sustainability indicators. 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 chapter includes a description of the different types of data gaps, a summary of existing data gaps in each monitoring network and 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 to consider for monitoring networks:

1. **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.
2. **Spatial**: Insufficient number or density of monitoring sites in a specific area.
3. **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 sometimes poor, making it difficult or impossible to match wells with their well logs.

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

There is no current plan to fill data gaps in the groundwater storage monitoring network.

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 the monitoring data 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 90 miles from the ocean; therefore, seawater intrusion is not an issue in the Plan Area. In addition, there are no saline water lakes in or near the GSA. For these reasons, seawater intrusion is not discussed hereafter in this chapter as allowed by §354.34(j).

5.5 Water 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 James GSA is generally well suited for irrigation and domestic use, although groundwater issues for drinking water may exist in localized areas within the GSA. While some of these chemical concerns are caused by humans, others are natural occurring. Groundwater pollution characterization and mitigation are typically enforced by local agencies and state level programs.

The GSA will review and analyze publicly available routine groundwater monitoring data reported by the community and non-community public supply wells and data from the Groundwater Ambient Monitoring and Assessment Program (GAMA) monitoring wells around the American Avenue Landfill 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.

In order to properly monitor water quality within the Plan Area, an adequate network of monitoring wells is needed. The adequacy of the monitoring network is dependent on existing groundwater quality conditions and the groundwater uses. Within the Plan Area, there are two dominant uses, agricultural irrigation and municipal supply. Two existing water quality monitoring networks will be utilized with each network addressing the needs of each type of use. There are no known contaminant plumes within the Plan Area and a monitoring network to address plume migration is not needed.

James GSA is within the boundary of the Kings River Watershed Coalition Authority, commonly known as the Kings River Water Quality Coalition (KRWQC), which collects some groundwater quality data and prepared a Groundwater Assessment Report (GAR) for the area in November 2014 that focused mainly on nitrates and salts. According to the KRWQC Revised Groundwater Quality Trend Monitoring Workplan (May 2018), groundwater quality will be monitored on an annual basis beginning in 2018. During the summer of each year, the selected trend monitoring wells will be analyzed for nitrate as nitrogen and field parameters will be measured. Every five years, the wells will be analyzed for total dissolved solids (TDS), carbonate, bicarbonate, chloride, sulfate, boron, calcium, sodium, magnesium, and potassium. The specific well locations will not be identified but will be shown as representative for general areas (typically a section). This practice protects the identity of the participating landowner while providing the necessary information to assess groundwater quality. The James GSA will coordinate with the KRWQC when trend monitoring sampling occurs to collect an extra sample bottle for additional analysis on behalf of the GSA when possible, so all constituents of concern are sampled on a routine basis.

The public water supply wells are located within James GSA. Public water systems are required to report to DDW every 3 years, or more frequently if an issue is known or suspected. The list of constituents required may vary by system or well but includes Title 22 constituents at a minimum.

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.

The existing water quality monitoring networks are expected to provide adequate data to prepare water quality maps for the unconfined aquifer. The water quality monitoring network associated with municipal supply uses is considered to be more than adequate as it includes all of the municipal supply wells within the Plan Area. The water quality monitoring network associated with agricultural irrigation is considered to be adequate as it has been approved by the Central Valley Regional Water Quality Control Board and is intended to (1) determine current water quality conditions of groundwater relevant to irrigated agriculture; and (2) develop long-term groundwater quality information that can be used to evaluate the regional effects of irrigated agriculture and its practices, as required by Waste Discharge Requirements General Order No. R5-2013-0120 ("General Order") governing the Tulare Lake Basin area (which includes the Kings Subbasin).

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.

By nature of the selection process for the water quality network, wells have water quality data from several years and are expected to continue to be monitored regularly in the future as part of their respective regulatory programs. Public water systems are required to submit analytical data to DDW every 3 years. KRWQC will report annually on nitrate and every 5 years on other constituents.

The water quality monitoring network associated with municipal supply uses has adequate density as includes all of the municipal supply wells within the Plan Area. The water quality monitoring network associated with agricultural irrigation is adaptive and is evaluated annually to ensure spatial coverage is adequate with respect to the objectives of the General Order.

5.5.4 Monitoring Network Information

5.5.4.1 Scientific Rationale for Site Selection

Regulation Requirements:

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

The scientific rationale for selecting water quality monitoring sites includes:

- Select dedicated monitoring wells over production wells where feasible;
- Select wells with available construction information (i.e. depth, perforated interval);
- Spatial distribution is such that water quality can be defined across the GSA;
- Select sites so that each aquifer is represented (vertical distribution);
- Avoid wells perforated across multiple aquifer zones;
- Preferentially select sites within known contaminated or degraded water quality, unless monitored by responsible parties for regulatory remediation; and
- Consider nearby beneficial uses.

5.5.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

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

The data gathered through the monitoring networks is and will continue to be consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as **Appendix 5-A.**

- Data reporting units and accuracy;
- Monitoring site information;
- Well attribute reporting;

- Map standards;
- Hydrograph requirements;
- Groundwater and surface water models; and
- Availability of input and output files to DWR.

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 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 4.8.

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.

5.5.5.1 Map

A map of the water quality monitoring network is included as **Figure 5-2.**

5.5.5.2 Table

A table of specific monitoring site information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used is included in **Appendix 5-A**.

5.5.6 Monitoring Protocols

Regulation Requirements:

§352.2 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.
§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, December 2016b). Refer to **Appendix 5-C** for a copy of the BMP. The GSA may develop standard monitoring forms in the future if deemed necessary.

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.

Representative monitoring sites will not be utilized in James GSA.

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.

Regulation Requirements:

§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.

James GSA does not plan to use groundwater elevations as a proxy for monitoring other sustainability indicators.

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.

The following includes a summary of existing data gaps and plans to fill the data gaps. These items will be reevaluated in each 5-year update to this Plan.

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.

Public wells in the water quality monitoring network associated with municipal supply uses have been analyzed regularly since monitoring began at each respective site. As long as the well is part of the public water system, data will be required to be collected and reported to DDW. No data gaps have been identified in this monitoring network associated with municipal supply uses.

Water quality monitoring wells associated with agricultural irrigation uses have little or no historical record but will be sampled on a regular basis in the future. The lack of historical data is due to the recent implementation of the monitoring program under the General Order. While this is a historical temporal gap, it will not be a temporal gap going forward.

As discussed earlier, there are no identified spatial data gaps with either water quality monitoring network.

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

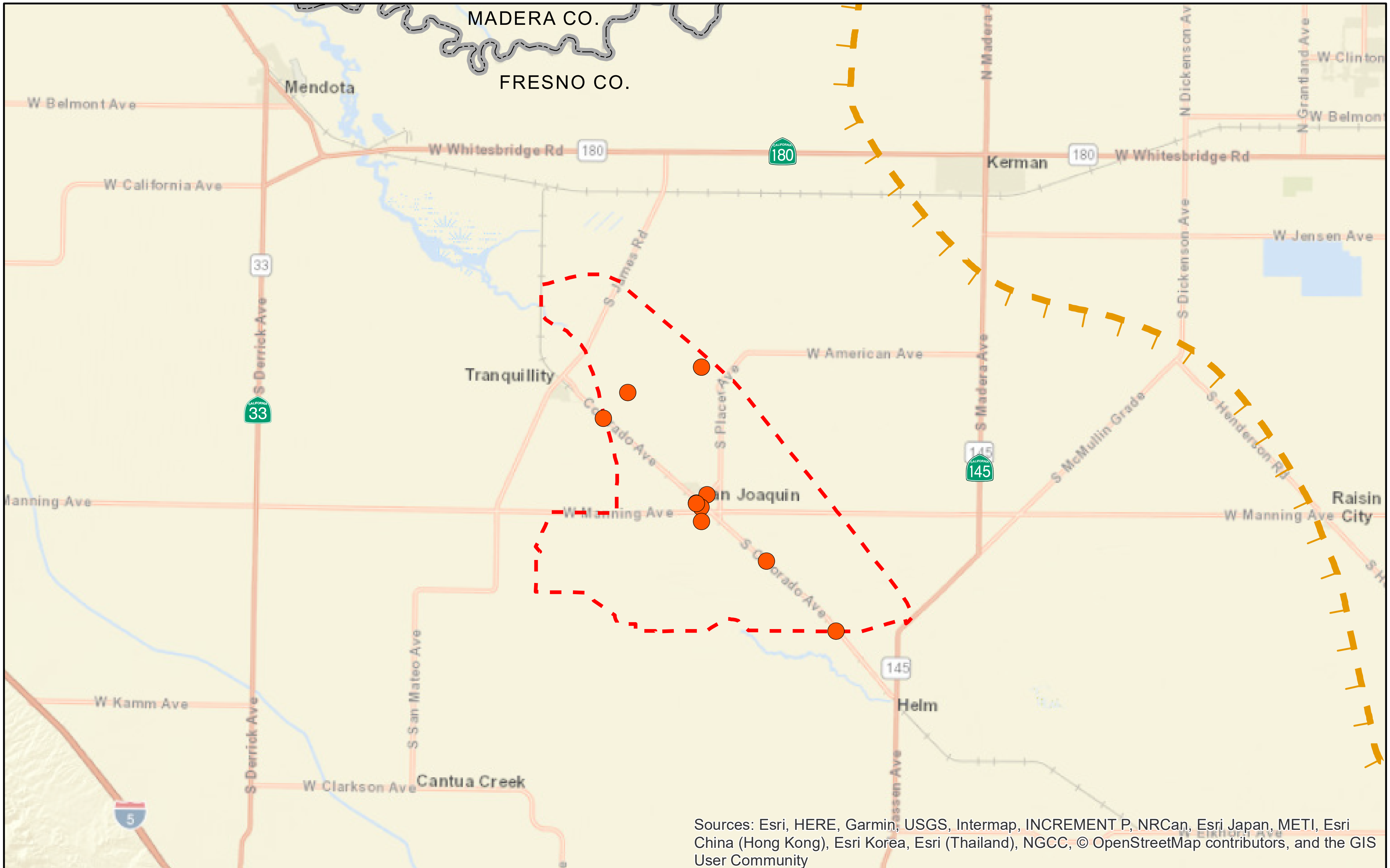
Any lateral and vertical spatial data gaps in the water quality monitoring network that are identified at a later date will be filled through coordination with stakeholders for sampling at existing wells, or through the construction of dedicated monitoring wells. The GSA has applied for a DWR grant through the TSS program to install dedicated nested or clustered monitoring wells in areas with insufficient groundwater elevation data. These wells will also be constructed and used for water quality sampling and monitoring. The construction information will be known and there will be no access issues. However, dedicated monitor wells are expensive to construct, and their installation will depend on available funding.

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 the monitoring data 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



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James GSA

County

Water Quality Monitoring Well

North East Edge of Corcoran Clay

Page and LeBlanc 1969, KDSA Modification

James GSA

Water Quality Monitoring Network

Figure 5-3

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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.

Most land subsidence in the San Joaquin Valley originates from the axial trough of the valley westward, which includes most of the plan area. Areas with the most significant subsidence are underlain by the Corcoran Clay member of the Tulare Formation. **Figure 3-39** shows the land subsidence in the Kings Basin where most of the subsidence can be found west of the Corcoran Clay layer.

Subsidence Monitoring Methods and Technology
Several methods are available for measuring subsidence and are discussed below.

Continuous Global Positioning System. Subsidence can be measured using continuous global positioning system (CGPS) data. Various USGS studies obtain CGPS data from the University NAVSTAR (Navigation Satellite Timing and Ranging) Consortium (UNAVCO) Plate Boundary Observatory (PBO) network of continuously operating GPS stations. The PBO is the geodetic component of UNAVCO, a consortium of research institutions whose focus is measuring vertical and horizontal plate boundary deformation across the western United States using high-precision measurement techniques. CGPS data is measured to one hundredth of a millimeter with a relatively low standard deviation.

Extensometers. Extensometers measure changes in the length of an object. As the surrounding soils move, the distances between reference points change, which allow for continuous measurement of subsidence. Extensometers are costly to install and require frequent maintenance and calibration. In the 1950s and 1960s, the USGS, DWR, and other agencies installed several borehole extensometers in the San Joaquin Valley. There are presently no known extensometers within the James GSA area. Extensometers have a relative accuracy of approximately 1/100th of a foot.

InSAR. During the last decade, the USGS and other groups have been using data from radar emitting satellites in a technique called InSAR (interferometric synthetic-aperture radar). This form of remote sensing compares radar images from each pass of an InSAR satellite over a study area to determine changes in the elevation of the land surface (USGS, 2017). InSAR has a relative accuracy within fractions of an inch.

LiDAR. DWR and USBR utilize Light Detection and Ranging (LiDAR) coupled with land elevation surveys to monitor subsidence. LiDAR utilizes a laser device that is flown above the earth's surface. The accuracy of LiDAR is known to be less than a tenth of a foot as measured in root-mean-square deviation and very similar to that of surveying.

Surveying. In the past, subsidence measurement relied upon optical (spirit level) surveying devices and, later, laser and global positioning satellite (GPS) survey equipment. This type of measurement is still done today, usually along established highways and water conveyance facilities, such as levees and canals. The relative accuracy of GPS surveying is approximately +/- 1 inch.

Subsidence Monitoring Programs
Measurement and monitoring for subsidence is performed by a variety of agencies including USGS, DWR, USBR, KRCD, USACE, University NAVSTAR (Navigation Satellite Timing and Ranging) Consortium (UNAVCO), and various private contractors. Monitoring for subsidence specifically within the boundary of James GSA is currently conducted by NASA, USBR, and KRCD. Some subsidence has been observed

historically, but recent available data suggests subsidence rates accelerated during the recent prolonged drought, particularly in the southwest portion of the GSA.

Continuous Global Positioning System Stations. The CGPS stations provide daily horizontal and vertical data at these locations, with records starting as early as 2004. The Plate Boundary Observatory (PBO) and the Scripps Orbit and Permanent Array Center (SOPAC) upload and process the data from the network of CGPS stations and produce graphs depicting the horizontal and vertical change in a point's location through time. Information on CGPS stations can be found at the following website: https://www.unavco.org/instrumentation/networks/status/pbo/gps

Kings River Conservation District. KRCD has a 7-mile grid that monitors new and existing benchmarks for land subsidence. The KRCD subsidence network includes eleven monitoring points within or on the GSA boundary and ten within a few miles of the GSA boundary (Figure 5-3). Monitoring points in the KRCD network have been surveyed in 2010, 2012, 2013, and 2016.

NASA Monitoring Network. 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. The NASA InSAR data covers the extent of the GSA, with recent subsidence data shown in **Figure 3-39**. More information can be found on their website: https://www.nasa.gov/jpl/nasa-california-drought-causing-valley-land-to-sink

San Joaquin River Restoration Program. Currently, USBR in conjunction with DWR, USGS, and USACE obtain subsidence data twice yearly and have published maps since 2012 of the results in July and December as part of the San Joaquin River Restoration Program (SJRRP). The SJRRP network includes one monitoring point within James GSA and four near the GSA boundary (Figure 5-3). The USBR, as part of the SJRRP, has been monitoring subsidence along the river and bypass levees as part of the restoration effort. More information can be found on their website: http://www.restoresjr.net/monitoring-data/subsidence-monitoring/

USGS Monitoring Network. A subsidence monitoring network consisting of 31 extensometers were installed in the 1950s to quantify the subsidence occurring in the San Joaquin Valley. By the 1980s, the land subsidence monitoring efforts decreased. Since then, a new monitoring network has been developed. The new network includes refurbished extensometers from the old network, CGPS stations, and InSAR. More information can be found on their website: https://ca.water.usgs.gov/land_subsidence/california-subsidence-measuring.html

The land subsidence monitoring network in James GSA will utilize the KRCD benchmarks and will be supplemented with available data from the USBR SJRRP and NASA InSAR land subsidence surveying programs along with any other data that becomes available (e.g. USGS studies). If data from these sources becomes unavailable in the future, a new monitoring network will be established. However, because land subsidence has widespread economic and environmental impacts, the discontinuation of these programs is not anticipated. Recent research on modeling land subsidence using InSAR and Airborne Electromagnetic data will be followed and may be implemented in the future, if proven effective.

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.

The subsidence monitoring network has adequate density to determine land subsidence in the Kings Basin. Within the Kings Basin, the KRCD land subsidence monitoring program has a 7-mile grid to monitor subsidence. INSAR data will also be used to monitor land subsidence in the Kings Basin. INSAR provides complete coverage of the Basin and may be used to fill in the gaps in the KRCD monitoring network.

5.6.3 Monitoring Network Information

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 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.

SJRRP subsidence monitoring has consistently been conducted twice annually since December 2011 and covers the entire Plan Area. Due to the scarcity of measured data points within and adjacent to the Plan Area, it is of limited value in monitoring subsidence within the GSA.

The KRCD monitoring network benchmarks are on an approximate 7-mile grid and have been surveyed one to four times each since 2010. The KRCD monitoring points in the GSA cover the majority of the extents of the C, and E-clays where land subsidence is most likely to occur and will be monitored on an annual basis in the future.

NASA InSAR data is collected periodically and covers the entirety of the James GSA and surrounding area.

5.6.4.1 Scientific Rationale for Site Selection

Regulation Requirements:

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

If additional monitoring locations are added, the following scientific rationale will be used:

- Add sites that can be easily surveyed and tied back to a nearby monument;
- Add sites that are permanent monuments and stable; and
- Add sites in areas that have the greatest potential for subsidence

5.6.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

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

The data gathered through the monitoring networks is and will continue to be consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as **Appendix 5-B**.

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

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.

For the land subsidence sustainability indicator, the quantitative values that will be measured at each monitoring site for the minimum threshold, measurable objective, and interim milestones will be the ground surface elevation. The measurement will be taken in units of feet or meters, depending on the data source. The measurement will be rounded to the nearest hundredth of a measurement unit. The measurements will be converted to a rate of subsidence by comparing it to the most recent prior measurement and calculating the rate of change. The measurement will also be converted to a cumulative change by comparing it to reference ground surface elevations measured within an established time period.

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.

5.6.5.1 Map

Figure 5-3 is a map of the land subsidence monitoring network sites.

5.6.5.2 Table

A table of specific monitoring site information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used is included in **Appendix 5-A.**

5.6.6 Monitoring Protocols

Regulation Requirements:

§352.2 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.
§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, 2016b). Refer to **Appendix 5-C** 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:

1. Identification of land subsidence conditions
2. Monitor regions of suspected subsidence where potential exists
3. GPS surveys must follow surveying standards set out in the California Department of Transportation's Caltrans Surveys Manual
4. Availability of InSAR data is improving and will increase as programs are developed.

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.

Representative monitoring sites will not be utilized in James GSA.

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.

Regulation Requirements:

> **§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.

James GSA does not plan to use groundwater elevations as a proxy for monitoring other sustainability indicators.

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 chapter includes a description of the different types of data gaps, a summary of existing data gaps in each monitoring network and 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.

Land subsidence is often examined as an annual rate. As such, it is ideal to have survey data at monitoring points once per year at a minimum. The KRCD monitoring points have not been surveyed consistently yet but will be collected annually in the future. The NASA data is collected twice or more per year. Taking into consideration all the data, temporal data gaps are not anticipated to occur in the monitoring network in the future.

The KRCD network has an adequate spatial distribution of monitoring points to monitor subsidence in the Plan Area. The NASA InSAR and SJRRP coverage supplement the KRCD data. Laterally, the land subsidence monitoring network does not have data gaps. Vertically, the presence of multiple laterally extensive clay units makes it unclear if subsidence is a result of groundwater extraction from a single or multiple aquifer zones.

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.

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

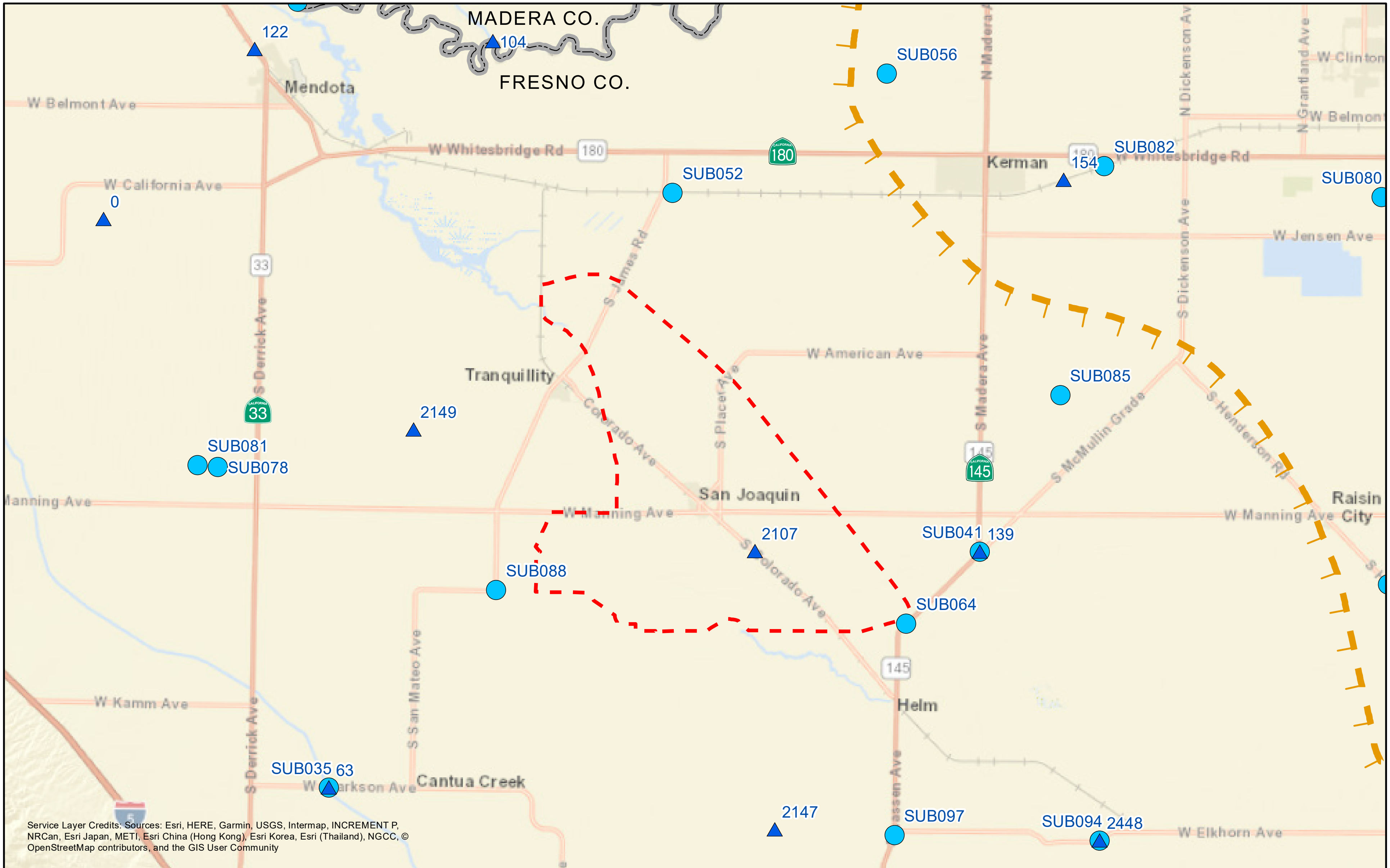
The GSA will rely on other agencies to continue to collect subsidence data. The GSA will coordinate and request a more regular schedule for subsidence monitoring from KRCD. The GSA will also consider installing a multi-depth subsidence monitoring device within the subsidence area in the northwestern portion of the Plan Area and a second device in the southeastern portion of the Plan Area.

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 the monitoring data 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.



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North East Edge of Corcoran Clay

Page and LeBlanc 1969, KDSA Modification

SJRRP Subsidence Monitoring Point

KRCD Subsidence Monitoring Point

James GSA

Land Subsidence Monitoring Network

Figure 5-4

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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.

Regulation Requirements:

§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.

As explained in detail within Section 3.2.7, it is believed that there are no interconnected surface water systems within the Plan Area. Recognizing the importance of gathering additional information to confirm the existence or non-existence of interconnected surface water systems, the James GSA will establish a network of monitoring wells near water bodies that have the potential for groundwater and surface water interconnection.

The monitoring network will consist of shallow monitoring wells constructed or established adjacent to areas along the James Bypass and Fresno Slough that are typically inundated by water levels within the Mendota Pool. The monitoring network will have monitoring wells spaced laterally no greater than one (1) mile apart along and adjacent to natural waterways. The monitoring network will also include monitoring wells sufficiently distant from the adjacent wells to establish water surface elevations and flow gradients. The monitoring network will be installed above the A-clay layer which lies below the entire area containing the waterways. The monitoring network will also include existing or constructed productions or monitoring wells completed below the A-clay layer.

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 monitoring network is expected to provide adequate data to evaluate hydrologic conditions related to interconnected surface water systems. The spacing of the monitoring well locations adjacent to and distant from the waterways will provide adequate data to prepare water surface contour maps and establish lateral flow gradients. The inclusion of monitoring wells below the A-clay layer will allow for the evaluation of horizontal flow and groundwater conditions.

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 density of the monitoring network is considered adequate spatially. A monitoring well spacing adjacent to the waterway of no greater than one (1) mile over an estimated six mile lateral distance combined with corresponding wells distance from the wells adjacent to the waterway will provide sufficient resolution to prepare water surface contour maps and establish lateral flow gradients. An estimated twelve monitoring wells will be employed over an eight square mile area.

5.7.4 Monitoring Network Information

5.7.4.1 Scientific Rationale for Site Selection

Regulation Requirements:

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

The criteria described above that will be used to select monitoring sites is based on the scientific rationale that a monitoring grid consisting of six segments is adequate to characterize the different conditions that are occurring laterally along the waterways. It is anticipated that conditions will along each waterway as it becomes narrower, shallower, and constrained (or channelized) as it extends away from the Mendota Pool.

5.7.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

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

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

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.

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.

5.7.5.1 Map

Figure 5-5 shows a proposed configuration for the interconnected surface water monitoring network. The actual configuration may vary from the proposed configuration due to monitoring site access and availability as well as other factors..

5.7.5.2 Table

A table of information for the interconnected surface water monitoring network sites that are selected will be included in the 5-year update to this Plan.

5.7.6 Monitoring Protocols

Regulation Requirements:

§352.2 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.
§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 for interconnected surface water will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, December 2016b). Refer to **Appendix 5-B** for a copy of the BMP. The GSA will develop standard monitoring forms in the future. Existing monitoring will continue and will be supplemented with additional information to fill data gaps.

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

1. SGMA regulations require that groundwater levels be measured to the nearest 0.1 foot. The BMP suggests measurements to the nearest 0.01 foot. This is not practical for many measurement methods. 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, measurements can only be made to the nearest foot.
2. Well sounding equipment has to be decontaminated after use if used in a well with suspected or known contamination or if there are obvious signs of contamination, such as oil.
3. Unique well identifiers will be used for private wells to respect the privacy of the well owner.

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.

Representative monitoring sites will not be utilized in James GSA.

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.

Regulation Requirements:

§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.

James GSA does not plan to use groundwater elevations as a proxy for monitoring other sustainability indicators.

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.

The following includes a summary of existing data gaps and plans to fill the data gaps. These items will be reevaluated in each 5-year update to this Plan.

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.

The James GSA recognizes a data gap for monitoring related to interconnected surface water systems. The proposed monitoring network should address those data gaps.

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.

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

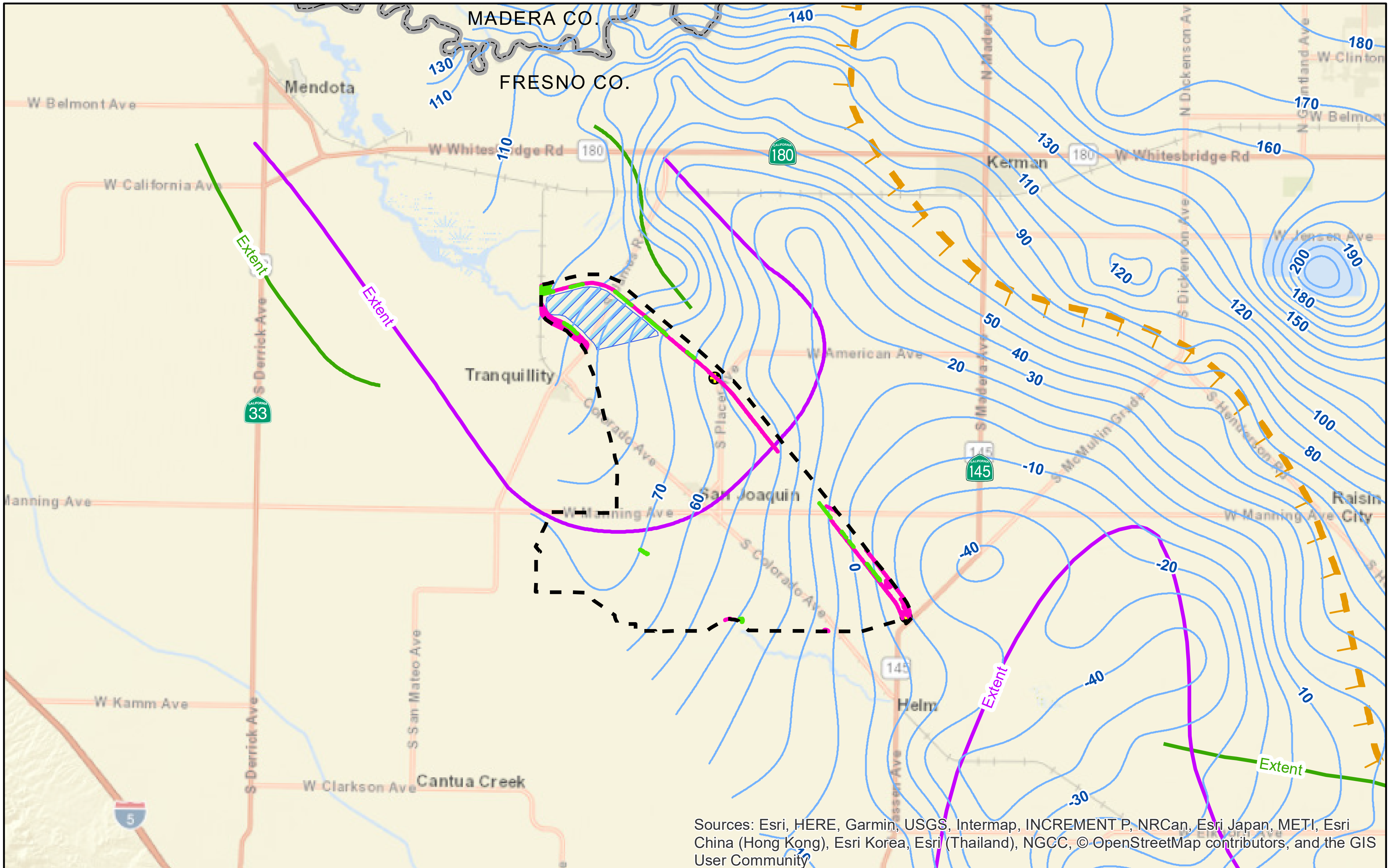
The James GSA plans to address the data gap by implementing the proposed interconnected surface water monitoring network after adoption of the GSP. The James GSA also plans to collect information prior to the five-year evaluation of the GSP sufficient to make a determination about the existence or non-existence of interconnected surface water systems within the Plan Area. If a determination is made that interconnected surface water systems exist within the Plan Area, all aspects of the sustainability indicator will be reviewed as a part of the plan evaluation.

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 the monitoring data 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



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County
A-Clay Extent (1999-H)
C-Clay Extent (1999-H)

North East Edge of Corcoran Clay
Page and LeBlanc 1969, KDSA Modification

Depth To Water, Kings Basin Coordinated Effort
Line of Equal Depth (10ft, Fall 2017)

Proposed Monitoring Location
Proposed Shallow Monitoring Area
GDE Vegetation (TNC i02)
GDE Wetland (TNC i02)

James GSA
Interconnected Surface Water Review
Figure 5-5

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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 Chapter 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 Sections7.4 and 7.5.

6 Projects and Management Actions to Achieve Sustainability

Legal Requirements:

§354.44(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 time-table 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 Overview

An integral component of the groundwater sustainability plan development effort is the development of projects and management actions that will be used to achieve the sustainability goal for the basin. The James GSA has developed a number of projects, programs, and management actions that it will use to achieve sustainability within the Plan Area and the Kings Subbasin. Programs were included as a separate class of actions in this Plan but can be considered to be management actions for the purposes of SGMA compliance and compliance with the GSP regulations. Each of these projects, programs, and management actions will be implemented as discussed in Chapter 7 and as discussed in the implementation plan for each individual project, program, and management action below..

6.2 Projects

The James GSA is proposing twenty-one projects in its GSP. The projects are listed in **Table 6-1**. Each of the projects are in various stages of development and implementation; from projects that are conceptual to projects that have been recently constructed and implemented. Those projects that have been included as constructed and implemented are included in the project list because utilization of the project is an ongoing consideration and subject to a number of factors. Also, the projects included were not constructed or utilized during the analysis of basin conditions used to quantify basin storage change, overdraft, and sustainable yield.

Table 6-1 James GSA Projects

Number	Name
1	K-Basin Groundwater Recharge
2	Basins 1 and 2 Storage and Recharge
3	Basin 3 Floodwater Capture and Recharge
4	Floodway Recharge and Spreading
5	Distribution System Recharge
6	City of San Joaquin Storm Water Pond Recharge
7	McMullin On-Farm Flood Capture and Recharge
8	Southwest Groundwater Banking
9	Carmichael Slough Recharge
10	James Main Canal Spreading
11	Fresno Slough Recharge
12	Mud Dam Spreading and Recharge
13	James Bypass Floodwater Utilization
14	Lassen Avenue Floodwater Utilization
15	McMullin Grade Floodwater Utilization
16	Distributed Recharge Basin
17	McMullin Master Plan
18	James Ranch Recharge Basin
19	Wildlife Habitat Restoration
20	Mendota Pool Water Quality Monitoring
21	Lake Avenue Canal

Each project is described in detail in the following subsections. The section is formatted such that each project begins on a separate page for ease of reference.

6.2.1 K-Basin Groundwater Recharge

6.2.1.1 Project Description

The Lateral K Recharge Basin is a 226-acre basin in the JID used for groundwater recharge and banking. The location of the Lateral K Recharge Basin is shown on the facilities map in **Appendix 6-A.**

6.2.1.2 Expected Benefits

Benefits include managed recharge into the aquifer which will reduce or eliminate long-term overdraft. Benefits will be evaluated by measuring water actually recharged into the aquifer and improvements in sustainability indicators. The 200-acre facility can recharge 0.25 AF per acre per day on a long-term basis. Assuming a 90-day every four years, utilization of the existing project will recharge 1,125 AF on an average annual basis.

6.2.1.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality and depletions of interconnected surface water. The project may incidentally benefit measurable objectives related to subsidence.

6.2.1.4 Water Source and Reliability

Kings River entitlement water provided by James ID will be the primary source of water for the project. James ID receives an average annual entitlement of 18,500 acre-feet of water and this water, after channel losses, is estimated to provide 9,250 acre-feet of diverted water. The deliveries will occur in amounts significantly greater and significantly less than the stated amount depending on fluctuations in annual Kings River watershed hydrology. Kings River flood water is expected to contribute an additional 18,000 acre-feet each year the flows are available. Kings River flood flows are estimated to occur once every four years. Other sources of water may be used including San Joaquin River flood water and purchased water delivered through Central Valley Project facilities; however, these sources are expected to contribute a small percentage of the overall water source for this project.

6.2.1.5 Project Feasibility

The project is already constructed and the project feasibility is related to ongoing operations and maintenance. See Estimated Costs and Financing for additional details.

6.2.1.6 Implementation Plan

The project is already constructed and the facilities have been utilized in prior years. Accordingly, the project has been implemented. Continued implementation will occur on an as-needed basis when economically justifiable.

6.2.1.7 Status and Timeline

This is an ACTIVE project has been COMPLETED.

6.2.1.8 Legal Authority

The project is operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code.

6.2.1.9 Permitting and Regulatory Requirements

There are no known permitting or regulatory requirements for continued implementation of the project.

6.2.1.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $12,000 annually. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased supplies. No financing is required.

6.2.1.11 Public and Agency Notification

All appropriate public and agency notifications were made during construction of the project. No public and agency notifications are required for continued implementation.

6.2.2 Basins 1 and 2 Storage and Recharge

6.2.2.1 Project Description

The project seeks to utilize two existing basins used by James ID for the dual purpose of capturing flood and excess water for later use and to recharge water into the aquifer. Basin 1 is 6.0 acres and holds approximately 100 AF. Basin 2 is 40 acres and holds approximately 900 AF. At currently configured, only 600 AF may be removed from the basins by pumping using permanently installed facilities. The completed project seeks to build out Basin 2 to allow for 300 AF of additional storage and permanent facilities that will allow for the removal of an additional 600 AF from Basin 2. The project will also include modifications to increase the the flow rate conveyed into the basins to allow for the capture of short duration flows in the Kings River.

6.2.2.2 Expected Benefits

Benefits include managed recharge into the aquifer which will reduce or eliminate long-term overdraft. Benefits will be evaluated by measuring water actually recharged into the aquifer and improvements in sustainability indicators. The 46-acre facility can recharge 0.50 AF per acre per day on a long-term basis. Assuming a 90-day every four years, utilization of the existing project will recharge 520 AF of flood water on an average annual basis. Completion of the project will allow for the capture and recovery of 150 AF of flood water on an average annual basis.

6.2.2.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality and depletions of interconnected surface water. The project may incidentally benefit measurable objectives related to subsidence.

6.2.2.4 Water Source and Reliability

Kings River entitlement water provided by James ID will be the primary source of water for the project. James ID receives an average annual entitlement of 18,500 acre-feet of water and this water, after channel losses, is estimated to provide 9,250 acre-feet of diverted water. The deliveries will occur in amounts significantly greater and significantly less than the stated amount depending on fluctuations in annual Kings River watershed hydrology. Kings River flood water is expected to contribute an additional 18,000 acre-feet each year the flows are available. Kings River flood flows are estimated to occur once every four years. Other sources of water may be used including San Joaquin River flood water and purchased water delivered through Central Valley Project facilities; however, these sources are expected to contribute a small percentage of the overall water source for this project.

6.2.2.5 Project Feasibility

The project is an improvement to an already constructed facility. Project feasibility is related to the improvements and ongoing operations and maintenance. See Estimated Costs and Financing for additional details.

6.2.2.6 Implementation Plan

The underlying recharge facility is already constructed and the facilities have been utilized in prior years. Continued implementation of the recharge portion of the project will occur on an as-needed basis when economically justifiable. The feasibility of constructing the improvements to facilitate capture of flood water will be analyzed along with other projects and the analyzed projects will be implemented based on the benefits needed to achieve and maintain measurable objectives and cost. Projects with the lowest implementation costs per unit of benefit will likely be undertaken first.

6.2.2.7 Status and Timeline

This is an ACTIVE project is in the PLANNING phase. The project can designed and constructed within 18 MONTHS.

6.2.2.8 Legal Authority

The project is operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code. Construction of improvements to the existing project would be made under that same authority.

6.2.2.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. The project will also require permits from the County of Fresno for project electrical equipment. The facilities are existing and the improvements are considered incidental to those improvements.

6.2.2.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $36,000 annually. The costs to construct the improvements are estimated to be $100,000. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased water supplies.

6.2.2.11 Public and Agency Notification

All appropriate public and agency notifications were made during construction of the original project. Appropriate notifications will be made for any improvements made to the original project.

6.2.3 Basin 3 Floodwater Capture and Recharge

6.2.3.1 Project Description

The project seeks to utilize an existing basin currently used by James ID for the dual purpose of capturing flood and excess water for later use and to recharge water into the aquifer. Basin 3 is 16.0 acres and holds approximately 240 AF. As currently constructed, water can only be removed from basin 3 and utilized by the district if temporary facilities (pumps) are used. The project seeks to build out Basin 3 to allow for 400 AF of storage and permanent facilities that will allow for the removal of 320 AF from the basin.

6.2.3.2 Expected Benefits

Benefits include managed recharge into the aquifer which will reduce or eliminate long-term overdraft. Benefits will be evaluated by measuring water actually recharged into the aquifer and improvements in sustainability indicators. The 16-acre facility can recharge 0.50 AF per acre per day on a long-term basis. Assuming a 90-day every four years, utilization of the existing project will recharge 180 AF of flood water on an average annual basis. Completion of the project will allow for recovery of 320 AF of captured flood water on an average annual basis.

6.2.3.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality and depletions of interconnected surface water. The project may incidentally benefit measurable objectives related to subsidence.

6.2.3.4 Water Source and Reliability

Kings River entitlement water provided by James ID will be the primary source of water for the project. James ID receives an average annual entitlement of 18,500 acre-feet of water and this water, after channel losses, is estimated to provide 9,250 acre-feet of diverted water. The deliveries will occur in amounts significantly greater and significantly less than the stated amount depending on fluctuations in annual Kings River watershed hydrology. Kings River flood water is expected to contribute an additional 18,000 acre-feet each year the flows are available. Kings River flood flows are estimated to occur once every four years. Other sources of water may be used including San Joaquin River flood water and purchased water delivered through Central Valley Project facilities; however, these sources are expected to contribute a small percentage of the overall water source for this project.

6.2.3.5 Project Feasibility

The project is an improvement to an already constructed facility. Project feasibility is related to the improvements and ongoing operations and maintenance. See Estimated Costs and Financing for additional details.

6.2.3.6 Implementation Plan

The underlying recharge facility is already constructed and the facilities have been utilized in prior years. Continued implementation of the recharge portion of the project will occur on an as-needed basis when economically justifiable. The feasibility of constructing the improvements to facilitate capture of flood water will be analyzed along with other projects and the analyzed projects will be implemented based on the benefits needed to achieve and maintain measurable objectives and cost. Projects with the lowest implementation costs per unit of benefit will likely be undertaken first.

6.2.3.7 Status and Timeline

This is an ACTIVE project is in the PLANNING phase. The project can be designed and constructed within 18 MONTHS.

6.2.3.8 Legal Authority

The project is operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code. Construction of improvements to the existing project would be made under that same authority.

6.2.3.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. The project will also require permits from the County of Fresno for project electrical equipment. The facilities are existing and the improvements are considered incidental to those improvements.

6.2.3.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $18,000 annually. The costs to construct the improvements are estimated to be $250,000. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased water supplies.

6.2.3.11 Public and Agency Notification

All appropriate public and agency notifications were made during construction of the original project. Appropriate notifications will be made for any improvements made to the original project.

6.2.4 Floodway Recharge and Spreading

6.2.4.1 Project Description

The project seeks to utilize the property owned by RD 1606 for spreading and shallow recharge. The project has three hydraulically separate sites. The first site is south of Manning Avenue and is nominally 9,500 feet by 800 feet wide (175 acres). The second site is north of Manning and is nominally 22,800 feet by 800 feet wide (415 acres). The third site is north of Placer Avenue and is nominally 16,800 feet by 800 feet (wide) (305 acres).

6.2.4.2 Expected Benefits

Benefits include managed recharge into the aquifer which will reduce or eliminate long-term overdraft. Benefits will be evaluated by measuring water actually recharged into the aquifer and improvements in sustainability indicators. Each site can recharge an estimated 0.05 AF per acre per day on a long-term basis. Assuming a 90-day every four years, utilization of the sites will recharge 195, 465 and 340 AF of flood water for the respective sites, or a total of 1,000 AF, on an average annual basis.

6.2.4.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality and depletions of interconnected surface water. The project may incidentally benefit measurable objectives related to subsidence.

6.2.4.4 Water Source and Reliability

Kings River entitlement water provided by James ID will be the primary source of water for the project. James ID receives an average annual entitlement of 18,500 acre-feet of water and this water, after channel losses, is estimated to provide 9,250 acre-feet of diverted water. The deliveries will occur in amounts significantly greater and significantly less than the stated amount depending on fluctuations in annual Kings River watershed hydrology. Kings River flood water is expected to contribute an additional 18,000 acre-feet each year the flows are available. Kings River flood flows are estimated to occur once every four years. Other sources of water may be used including San Joaquin River flood water and purchased water delivered through Central Valley Project facilities; however, these sources are expected to contribute a small percentage of the overall water source for this project.

6.2.4.5 Project Feasibility

The project is an improvement to an already constructed facility. Project feasibility is related to the improvements and ongoing operations and maintenance. See Estimated Costs and Financing for additional details.

6.2.4.6 Implementation Plan

The feasibility of constructing the improvements to facilitate the spreading and recharge of flood water will be analyzed along with other projects and the analyzed projects will be implemented based on the benefits needed to achieve and maintain measurable objectives and cost. Projects with the lowest implementation costs per unit of benefit will likely be undertaken first.

6.2.4.7 Status and Timeline

This is an ACTIVE project is in the PLANNING phase. The project can be constructed in segments. The initial segment(s) can designed and constructed within 12 months. All segments can be designed and completed within 24 MONTHS.

6.2.4.8 Legal Authority

The project is operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code. Construction of improvements to the existing project would be made under that same authority.

6.2.4.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. Given the nature of the project, it is anticipated that no other permits will be required at this time. If the final design of the project involves stream issues, the California Department of Fish and Wildlife will be notified and any appropriate permits will be obtained.

6.2.4.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $12,000 annually. The costs to construct the improvements are estimated to be $200,000. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased water supplies.

6.2.4.11 Public and Agency Notification

All appropriate public and agency notifications were made during construction of the original project. Appropriate notifications will be made for any improvements made to the original project.

6.2.5 Distribution System Recharge

6.2.5.1 Project Description

The project consists of the utilization of the James ID water distribution system to recharge additional water into the aquifer by operating laterals and ditches at times when those facilities would not normally be operated.

6.2.5.2 Expected Benefits

Benefits include managed recharge into the aquifer which will reduce or eliminate long-term overdraft. Benefits will be evaluated by measuring water actually recharged into the aquifer and improvements in sustainability indicators. The James ID distribution facilities recharge 1,200 AF per month into the aquifer and the system operates 10 months annually. Recharge rates are higher when the system is initially filled. The expected benefit when the distribution system is operated year round is 2,400 AF annually.

6.2.5.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality and depletions of interconnected surface water. The project may incidentally benefit measurable objectives related to subsidence.

6.2.5.4 Water Source and Reliability

Various water sources provided by James ID will be the primary source of water for the project. These sources include Central Valley Project contract water (35,300 AFY, 40% average allocation), San Joaquin River settlement contract water (9,700 AFY), Kings River entitlement water (9,250 AFY), Kings River flood water, San Joaquin River flood water, and other purchased water. Pumped groundwater will not be used as a source.

6.2.5.5 Project Feasibility

The project is an improvement to an already constructed facility. Project feasibility is related to the improvements and ongoing operations and maintenance. See Estimated Costs and Financing for additional details.

6.2.5.6 Implementation Plan

The project is already constructed and the facilities have been utilized in prior years. Accordingly, the project has been implemented. Continued implementation will occur on an as-needed basis when economically justifiable.

6.2.5.7 Status and Timeline

This is an ACTIVE project has been COMPLETED.

6.2.5.8 Legal Authority

The project is operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code.

6.2.5.9 Permitting and Regulatory Requirements

There are no known permitting or regulatory requirements for continued implementation of the project.

6.2.5.10 Estimated Costs and Financing

The incremental cost to operate and maintain the facility is estimated to be $3,000 annually. There are no capital costs. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased water supplies.

6.2.5.11 Public and Agency Notification

No public or agency notifications are required since this is an active and completed project.

6.2.6 City of San Joaquin Storm Water Pond Recharge

6.2.6.1 Project Description

The project site consists of utilizing two existing storm water basins in the City of San Joaquin for groundwater recharge. The first basin is located on Colorado Avenue and is 2.8 acres. The second basin is located on California Avenue and is 1.8 acres. Both basins are near James ID Lateral H. The basis would be used primarily for storm water capture and disposal through percolation. When basin capacity is not needed for storm water storage, a portion of the basin's capacity would be used for groundwater recharge. The Colorado Avenue basin percolates water well; however, the California Avenue basin does not percolate water well. The cause of the poor percolation is purportedly clay materials that are present at the bottom of the basin. The project, if fully implemented, will remove the clay material exposing native materials and improving percolation.

6.2.6.2 Expected Benefits

Initially, the Colorado Avenue basin is expected to recharge 1.0 AF per day and the California Avenue basin will not be utilized. When fully implemented the California Avenue basin will recharge an additional 0.5 AF per day for a total recharge rate of 1.5 AF per day. The project can reasonably be expected to operate 180 days per year if water is available and would provide 180 AF to 270 AF in an operating season.

6.2.6.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality and depletions of interconnected surface water. The project may incidentally benefit measurable objectives related to subsidence.

6.2.6.4 Water Source and Reliability

Various water sources provided by James ID will be the primary source of water for the project. These sources include Central Valley Project contract water (35,300 AFY, 40% average allocation), San Joaquin River settlement contract water (9,700 AFY), Kings River entitlement water (9,250 AFY), Kings River flood water, San Joaquin River flood water, and other purchased water. Pumped groundwater will not be used as a source.

6.2.6.5 Project Feasibility

The project is already constructed and the project feasibility is related to ongoing operations and maintenance. See Estimated Costs and Financing for additional details.

6.2.6.6 Implementation Plan

This project is being implemented by the City of San Joaquin as a part of their improvements to their storm water system. The project will be implemented regardless of the need for additional recharge to achieve or maintain groundwater sustainability.

6.2.6.7 Status and Timeline

This is an ACTIVE project is in the PLANNING phase. Work at each basin can be can designed and constructed within 12 MONTHS.

6.2.6.8 Legal Authority

The project is operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code and the powers and authorities granted under the California Government Code to the City of San Joaquin, a general law city. Construction of improvements to the existing project would be made under that same authority.

6.2.6.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act and County of Fresno Building Department requirements.

6.2.6.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $1,200 annually. The costs to construct the improvements are estimated to be $200,000 and will be borne by the City of San Joaquin. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased water supplies.

6.2.6.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA compliance.

6.2.7 McMullin On-Farm Flood Capture and Recharge

6.2.7.1 Project Description

The Kings River Conservation District project consists of constructing a 500-cfs turnout on the Kings River to divert flood water through two conveyance canals onto adjacent lands. Terranova Ranches is providing flood easements for their lands and James Irrigation District and Reclamation District No. 1606 are facilitating the project by providing easements for project facilities and coordination of water operations. The project involves two phases, an initial 150 cfs capacity installation and a final 500 cfs buildout.

6.2.7.2 Expected Benefits

Benefits include direct recharge and in-lieu recharge which will reduce or eliminate long-term overdraft. Benefits will be evaluated by measuring water recharged and improvements in sustainability indicators. The first phase is expected to recharge an estimated 6,750 AF on an average annual basis. The second phase is expected to recharge an additional 15,750 AF on an average annual basis. The entire project is expected to recharge an estimated 22,500 AF on an average annual basis. Recharge will occur outside of the James GSA boundaries.

6.2.7.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality, subsidence, and depletions of interconnected surface water.

6.2.7.4 Water Source and Reliability

Kings River flood water will be the primary source of water for the project. Water will be delivered to the project through agreements with the Kings River Water Association and James ID. Kings River flood flows are estimated to occur during a 90 day period once every four years.

6.2.7.5 Project Feasibility

The project is under construction and is expected to be operational prior to adoption of the GSPs within the basin. Landowners in the first phase are obligated to take the flood water through various easements and contracts and the Kings River Conservation District is obligated under agreement with the California Department of Water Resources to divert the flood water to the project. There are no costs incurred by the GSA for this project.

6.2.7.6 Implementation Plan

The project is under construction and will be completed prior to GSP adoption. Accordingly, the project has been implemented. Continued implementation is required under various agreements executed as a part of the project.

6.2.7.7 Status and Timeline

This is an ACTIVE project that is in the CONSTRUCTION phase. The project will be completed within 12 MONTHS.

6.2.7.8 Legal Authority

The project is operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code and the powers and authorities granted to the Kings River Conservation District, a special district governed under the Kings River Conservation District Act (Chapter 931 of the Statutes of 1951).

6.2.7.9 Permitting and Regulatory Requirements

This project is under construction. All permitting and regulatory requirements were addressed prior to construction. There are no known permitting or regulatory approvals required for continued implementation of the project.

6.2.7.10 Estimated Costs and Financing

The costs to operate and maintain the facility vary significantly from year to year and are estimated to be $30,000 annually. The costs to construct the improvements were approximately $7.0 million. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased water supplies.

6.2.7.11 Public and Agency Notification

All appropriate public and agency notifications were made prior to the start of project construction.

6.2.8 Southwest Groundwater Banking

6.2.8.1 Project Description

The project is a joint project of James ID and Fresno ID and consists of three recharge basins totalling 100 acres located in the County of Fresno.

6.2.8.2 Expected Benefits

During wet years, the project is conservatory expected to operate 90 days when the Fresno ID canal system is in operation and assuming an 0.5 AF per acre recharge rate, it will provide 4,500 AF annually in years when it is operated.

6.2.8.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality, subsidence, and depletions of interconnected surface water.

6.2.8.4 Water Source and Reliability

Kings River entitlement water provided by James ID will be the primary source of water for the project. James ID receives an average annual entitlement of 18,500 acre-feet of water and this water, after channel losses, is estimated to provide 9,250 acre-feet of diverted water. The deliveries will occur in amounts significantly greater and significantly less than the stated amount depending on fluctuations in annual Kings River watershed hydrology. Kings River flood water is expected to contribute an additional 18,000 acre-feet each year the flows are available. Kings River flood flows are estimated to occur once every four years. Other sources of water may be used including San Joaquin River flood water and purchased water delivered through Central Valley Project facilities; however, these sources are expected to contribute a small percentage of the overall water source for this project.

6.2.8.5 Project Feasibility

The project is already constructed and the project feasibility is related to ongoing operations and maintenance. See Estimated Costs and Financing for additional details.

6.2.8.6 Implementation Plan

The project is already constructed and the facilities have been utilized in prior years. Accordingly, the project has been implemented. Continued implementation will occur on an as-needed basis when economically justifiable.

6.2.8.7 Status and Timeline

This is an ACTIVE project has been COMPLETED.

6.2.8.8 Legal Authority

The project is operated under the powers and authorities granted to the James Irrigation District and the Fresno Irrigation District, both irrigation districts governed under Division 11 of the California Water Code.

6.2.8.9 Permitting and Regulatory Requirements

This project has been completed. All permitting and regulatory requirements had been addressed.

6.2.8.10 Estimated Costs and Financing

The costs to operate and maintain the facility vary significantly from year to year and are estimated to be $30,000 annually. The costs to construct the improvements were approximately $4.2 million. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased supplies.

6.2.8.11 Public and Agency Notification

All appropriate public and agency notifications were made during construction of the project. No public and agency notifications are required for continued implementation.

6.2.9 Carmichael Slough Recharge

6.2.9.1 Project Description

The project site is the Carmichael Slough and is located between James ID Laterals E and F. The project will introduce flood and excess water into the slough and will utilize the slough for groundwater recharge. The facilities for the project may include structures to introduce water into the slough from Lateral E and allow water exit the slough into Lateral F. The slough is approximately 2,800 feet long and 40 feet wide.

6.2.9.2 Expected Benefits

The project is conservatively expected to recharge 2.6 AF per day into the aquifer. This will amount to 468 AF over a 180 day operating season.

6.2.9.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality and depletions of interconnected surface water. The project may incidentally benefit measurable objectives related to subsidence.

6.2.9.4 Water Source and Reliability

Various water sources provided by James ID will be the primary source of water for the project. These sources include Central Valley Project contract water (35,300 AFY, 40% average allocation), San Joaquin River settlement contract water (9,700 AFY), Kings River entitlement water (9,250 AFY), Kings River flood water, San Joaquin River flood water, and other purchased water. Pumped groundwater will not be used as a source.

6.2.9.5 Project Feasibility

The project is an improvement to an already constructed facility. Project feasibility is related to the improvements and ongoing operations and maintenance. See Estimated Costs and Financing for additional details.

6.2.9.6 Implementation Plan

The feasibility of constructing the improvements to facilitate the spreading and recharge of flood water will be analyzed along with other projects and the analyzed projects will be implemented based on the benefits needed to achieve and maintain measurable objectives and cost. Projects with the lowest implementation costs per unit of benefit will likely be undertaken first.

6.2.9.7 Status and Timeline

This is an INACTIVE project is in the PLANNING phase. The project can be designed and constructed within 18 MONTHS.

6.2.9.8 Legal Authority

The project is operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code. Construction of improvements to the existing project would be made under that same authority.

6.2.9.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. Since the project involves existing facilities and operations and involves minor improvements, certain CEQA exemptions may apply. Given the minor nature of the construction and that the construction will involve water distribution facilities, no permits or regulatory approvals are expected to be required at this time. A final determination on permits and regulatory approvals will be made during the CEQA process.

6.2.9.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $2,400 annually. The costs to construct the improvements are estimated to be $40,000. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased water supplies.

6.2.9.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA compliance.

6.2.10 James Main Canal Spreading

6.2.10.1 Project Description

The project site consists of two linear shallow basins parallel to the James ID Main Canal between its Lateral N and Lateral P. The first basin, Basin O located between Laterals O and P, is 4000 feet by 80 feet (7.35 acres). The second basin, Basin N located between Laterals N and O, is 3900 feet by 50 feet (4.45 acres). The shallow basins will be used for spreading.

6.2.10.2 Expected Benefits

The project is expected to recharge 0.25 AF per acre per day or a total of 90 AF per month into the aquifer. Recharge rates are higher when the system is initially filled.

6.2.10.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality and depletions of interconnected surface water. The project may incidentally benefit measurable objectives related to subsidence.

6.2.10.4 Water Source and Reliability

Various water sources provided by James ID will be the primary source of water for the project. These sources include Central Valley Project contract water (35,300 AFY, 40% average allocation), San Joaquin River settlement contract water (9,700 AFY), Kings River entitlement water (9,250 AFY), Kings River flood water, San Joaquin River flood water, and other purchased water. Pumped groundwater will not be used as a source.

6.2.10.5 Project Feasibility

The project involves the construction of new facilities where the James ID has ownership or site control. Since land acquisition is not required, the overall costs of the project are significantly reduced and the project is considered easily feasible. See Estimated Costs and Financing for additional details.

6.2.10.6 Implementation Plan

The feasibility of constructing the improvements to facilitate the spreading and recharge of flood water will be analyzed along with other projects and the analyzed projects will be implemented based on the benefits needed to achieve and maintain measurable objectives and cost. Projects with the lowest implementation costs per unit of benefit will likely be undertaken first.

6.2.10.7 Status and Timeline

This is an INACTIVE project is in the PLANNING phase. The project can be designed and constructed within 18 MONTHS.

6.2.10.8 Legal Authority

The project is operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code. Construction of improvements to the existing project would be made under that same authority.

6.2.10.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. Since the project involves existing facilities and operations and involves minor improvements, certain CEQA exemptions may apply. Given the minor nature of the construction and that the construction will involve water distribution facilities, no permits or regulatory approvals are expected to be required at this time. A final determination on permits and regulatory approvals will be made during the CEQA process.

6.2.10.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $3,000 annually. The costs to construct the improvements are estimated to be $60,000. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased water supplies.

6.2.10.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA compliance.

6.2.11 Fresno Slough Recharge

6.2.11.1 Project Description

The project will utilize the Fresno Slough to recharge water into the aquifer. A portion of the water delivered into the slough will recharge the aquifer. Water will also be stored and circulated within the slough for later use. The project is expected to inundate an area 10,000 feet by 40 feet (9.18 acres).

6.2.11.2 Expected Benefits

The project is expected to recharge 0.10 AF per acre per day or a total of 27 AF per month into the aquifer. Recharge rates are higher when the system is initially filled.

6.2.11.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality and depletions of interconnected surface water. The project may incidentally benefit measurable objectives related to subsidence.

6.2.11.4 Water Source and Reliability

Various water sources provided by James ID will be the primary source of water for the project. These sources include Central Valley Project contract water (35,300 AFY, 40% average allocation), San Joaquin River settlement contract water (9,700 AFY), Kings River entitlement water (9,250 AFY), Kings River flood water, San Joaquin River flood water, and other purchased water. Pumped groundwater will not be used as a source.

6.2.11.5 Project Feasibility

The project involves the construction of new facilities where the James ID has ownership or site control. Since land acquisition is not required, the overall costs of the project are significantly reduced and the project is considered easily feasible. See Estimated Costs and Financing for additional details.

6.2.11.6 Implementation Plan

The feasibility of constructing the improvements to facilitate the spreading and recharge of flood water will be analyzed along with other projects and the analyzed projects will be implemented based on the benefits needed to achieve and maintain measurable objectives and cost. Projects with the lowest implementation costs per unit of benefit will likely be undertaken first.

6.2.11.7 Status and Timeline

This is an INACTIVE project is in the PLANNING phase. The project can be designed and constructed within 12 MONTHS.

6.2.11.8 Legal Authority

The project is operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code. Construction of improvements to the existing project would be made under that same authority.

6.2.11.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. Since the project involves existing facilities and operations and involves minor improvements, certain CEQA exemptions may apply. Given the minor nature of the construction and that the construction will involve water distribution facilities, no permits or regulatory approvals are expected to be required at this time. A final determination on permits and regulatory approvals will be made during the CEQA process.

6.2.11.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $1,200 annually. The costs to construct the improvements are estimated to be $30,000. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased water supplies.

6.2.11.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA compliance.

6.2.12 Mud Dam Spreading and Recharge

6.2.12.1 Project Description

The project will utilize the small reservoir created by Mud Dam to pool and store water and allow it to be spread over time across conservation easement lands. An estimated 360 acres will be inundated by the project. A portion of the water applied to the conservation easement lands will recharge the aquifer. Minor improvements to existing facilities may be required to facilitate effective long-term use.

6.2.12.2 Expected Benefits

The project is expected to recharge 0.05 AF per acre per day or a total of 540 AF per month into the aquifer. Recharge rates are higher when the system is initially filled.

6.2.12.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality, subsidence, and depletions of interconnected surface water.

6.2.12.4 Water Source and Reliability

Kings River entitlement water provided by James ID will be the primary source of water for the project. James ID receives an average annual entitlement of 18,500 acre-feet of water and this water, after channel losses, is estimated to provide 9,250 acre-feet of diverted water. The deliveries will occur in amounts significantly greater and significantly less than the stated amount depending on fluctuations in annual Kings River watershed hydrology. Kings River flood water is expected to contribute an additional 18,000 acre-feet each year the flows are available. Kings River flood flows are estimated to occur once every four years. Other sources of water may be used including San Joaquin River flood water and purchased water delivered through Central Valley Project facilities; however, these sources are expected to contribute a small percentage of the overall water source for this project.

6.2.12.5 Project Feasibility

The project is an improvement to an already constructed facility. Project feasibility is related to the improvements and ongoing operations and maintenance. See Estimated Costs and Financing for additional details.

6.2.12.6 Implementation Plan

The feasibility of constructing the improvements to facilitate the spreading and recharge of flood water will be analyzed along with other projects and the analyzed projects will be implemented based on the benefits needed to achieve and maintain measurable objectives and cost. Projects with the lowest implementation costs per unit of benefit will likely be undertaken first.

6.2.12.7 Status and Timeline

This is an INACTIVE project is in the PLANNING phase. The project can be designed and constructed within 12 MONTHS.

6.2.12.8 Legal Authority

The project would be operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code. Mud Dam is owned by James

ID and is permitted by the California Department of Water Resources. Legal authorization to improve and use the property outside of James ID would be obtained from the landowner and, if required, the conservation easement holder.

6.2.12.9 Permitting and Regulatory Requirements

The project may require approval by the California Department of Water Resources as Mud Dam is permitted by that agency. Depending on the scope of the project, a Streambed Alteration Agreement with the California Department of Water Resources may be necessary.

6.2.12.10 Estimated Costs and Financing

The incremental cost to operate and maintain the facility is expected to be negligible. The costs to construct the improvements are estimated to be $24,000. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased supplies.

6.2.12.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA compliance.

6.2.13 James Bypass Floodwater Utilization

6.2.13.1 Project Description

The project utilizes existing James ID conveyances within the James Bypass to provide flood water and excess water to landowners in areas that do not have surface water deliveries. At this time, it is estimated that up to 3,840 acres of land can be served by the project.

6.2.13.2 Expected Benefits

The project is expected to decrease groundwater use 1.0 AF per acre of land served each year for an annual total of 3,840 AF. Water is expected to be available to the project in one of every two years for an average annual benefit of 1,920 AF.

6.2.13.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality, subsidence, and depletions of interconnected surface water.

6.2.13.4 Water Source and Reliability

Water that can be purchased or is excess to the immediate needs of James ID will be the primary source of water for the project. These sources include Kings River entitlement water, Kings River flood water, San Joaquin River flood water, and other purchased water. Pumped groundwater will not be used as a source.

6.2.13.5 Project Feasibility

The project involves the construction of new facilities where the James ID has ownership or site control. Since land acquisition is not required, the overall costs of the project are significantly reduced and the project is considered easily feasible. See Estimated Costs and Financing for additional details.

6.2.13.6 Implementation Plan

The costs to operate the project will vary depending on costs associated with the specific source of water used. The project will serve areas outside of the James GSA and operation of the project will occur when feasible for each of the served landowners or entities.

6.2.13.7 Status and Timeline

This is an ACTIVE project and is in the PLANNING phase. The project can be designed and constructed within 18 MONTHS.

6.2.13.8 Legal Authority

The project would be constructed and operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code, and Reclamation District No. 1606, a reclamation district governed under Division 15 of the California Water Code. Legal authorization to improve and use the property outside of control of James ID and RD 1606 would be obtained from the landowner and, if required, any applicable easement holders.

6.2.13.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. Since the project involves new construction in a Designated Floodway, a floodway encroachment permit may be required from the Central Valley Flood Protection Board. If the facility involves a lift station, a building permit would be required from the County of Fresno. Other permits and approvals may be required depending on the design.

6.2.13.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $12,000 annually. The costs to construct the improvements (at full build) are estimated to be $1,000,000. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased supplies.

6.2.13.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA compliance.

6.2.14 Lassen Avenue Floodwater Utilization

6.2.14.1 Project Description

The project utilizes existing James ID conveyances along the Lassen Avenue alignment to provide flood water and excess water to landowners in areas that do not have surface water deliveries. Water will be "backed into" the conveyance and one or more temporary lift stations may be required. At this time, it is estimated that up to 5,120 acres of land can be served by the project.

6.2.14.2 Expected Benefits

The project is expected to decrease groundwater use 1.0 AF per acre of land served each year for an annual total of 5,120 AF. Water is expected to be available to the project in one of every two years for an average annual benefit of 2,560 AF.

6.2.14.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality, subsidence, and depletions of interconnected surface water.

6.2.14.4 Water Source and Reliability

Water that can be purchased or is excess to the immediate needs of James ID will be the primary source of water for the project. These sources include Kings River entitlement water, Kings River flood water, San Joaquin River flood water, and other purchased water. Pumped groundwater will not be used as a source.

6.2.14.5 Project Feasibility

The project involves the construction of new facilities where the James ID has ownership or site control. Since land acquisition is not required, the overall costs of the project are significantly reduced and the project is considered easily feasible. See Estimated Costs and Financing for additional details.

6.2.14.6 Implementation Plan

The costs to operate the project will vary depending on costs associated with the specific source of water used. The project will serve areas outside of the James GSA and operation of the project will occur when feasible for each of the served landowners or entities.

6.2.14.7 Status and Timeline

This is an INACTIVE project and is in the PLANNING phase. The project can be designed and constructed within 18 MONTHS.

6.2.14.8 Legal Authority

The project would be constructed and operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code. Legal authorization to improve and use the property outside of control of James ID and RD 1606 would be obtained from the landowner and, if required, any applicable easement holders.

6.2.14.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. Since the project involves significant improvements to existing facilities (i.e. lift pump stations), a building permit would be required from the County of Fresno. Other permits and approvals may be required depending on the design of the project.

6.2.14.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $24,000 annually. The costs to construct the improvements (at full build) are estimated to be $1,600,000, or $400,000 per lift station with an anticipated four lift stations required. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased water supplies.

6.2.14.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA compliance.

6.2.15 McMullin Grade Floodwater Utilization

6.2.15.1 Project Description

The project utilizes existing James ID conveyances along the McMullin Grade to provide flood water and excess water to landowners in areas that do not have surface water deliveries. Water will either be "backed into" the conveyance using one or more temporary lift stations or routed through the conveyance from Fresno ID. At this time, it is estimated that up to 3,840 acres of land can be served by the project.

6.2.15.2 Expected Benefits

The project is expected to decrease groundwater use 1.0 AF per acre of land served each year for an annual total of 3,840 AF. Water is expected to be available to the project in one of every two years for an average annual benefit of 1,920 AF.

6.2.15.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality, subsidence, and depletions of interconnected surface water.

6.2.15.4 Water Source and Reliability

Water that can be purchased or is excess to the immediate needs of James ID will be the primary source of water for the project. These sources include Kings River entitlement water, Kings River flood water, San Joaquin River flood water, and other purchased water. Pumped groundwater will not be used as a source.

6.2.15.5 Project Feasibility

The project involves the construction of new facilities where the James ID has ownership or site control. Since land acquisition is not required, the overall costs of the project are significantly reduced and the project is considered easily feasible. See Estimated Costs and Financing for additional details.

6.2.15.6 Implementation Plan

The costs to operate the project will vary depending on costs associated with the specific source of water used. The project will serve areas outside of the James GSA and operation of the project will occur when feasible for each of the served landowners or entities.

6.2.15.7 Status and Timeline

This is an INACTIVE project and is in the PLANNING phase. The project can be designed and constructed within 18 MONTHS.

6.2.15.8 Legal Authority

The project would be constructed and operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code. Legal authorization to improve and use the property outside of control of James ID and RD 1606 would be obtained from the landowner and, if required, any applicable easement holders.

6.2.15.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. Since the project involves existing facilities and operations and involves minor improvements, certain CEQA exemptions may apply. Given the minor nature of the construction and that the construction will involve water distribution facilities, no permits or regulatory approvals are expected to be required at this time. A final determination on permits and regulatory approvals will be made during the CEQA process.

6.2.15.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $12,000 annually. The costs to construct the improvements are estimated to be $1,600,000. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased water supplies.

6.2.15.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA compliance.

6.2.16 Distributed Recharge Basins

6.2.16.1 Project Description

The project will construct a number of small recharge basins either adjacent to or near existing district-owned conveyances located outside of the James GSA for the purpose of groundwater recharge. The basins could either be constructed on lands purchased or leased by the James ID or constructed by others and served by the James ID. The basins would either be used for groundwater recharge and, if appropriate, regulation of flood and excess water delivered to areas that normally do not receive surface waters. At this time, it is estimated that up to 60 acres of recharge basins can be constructed by this project.

6.2.16.2 Expected Benefits

The project is expected to recharge 0.50 AF per acre per day or a total of 2,700 AF per month into the aquifer at full build.

6.2.16.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality, subsidence, and depletions of interconnected surface water.

6.2.16.4 Water Source and Reliability

Water that can be purchased or is excess to the immediate needs of James ID will be the primary source of water for the project. These sources include Kings River entitlement water, Kings River flood water, San Joaquin River flood water, and other purchased water. Pumped groundwater will not be used as a source.

6.2.16.5 Project Feasibility

The project involves the construction of new facilities where the James ID may have has site control or where others may have site control and the facility is served by James ID. Each of the basins contemplated by the project can have a unique arrangement. Project feasibility may vary for each of the distributed sites based on the arrangement. See Estimated Costs and Financing for additional details.

6.2.16.6 Implementation Plan

The costs to operate the project will vary depending on costs associated with the specific source of water used. The project will serve areas outside of the James GSA and operation of the project will occur when feasible for each of the served landowners or entities.

6.2.16.7 Status and Timeline

This is an INACTIVE project in the PLANNING phase. The project can be constructed in segments. The initial segment(s) can designed and constructed within 12 months. All segments can be designed and completed within 60 MONTHS.

6.2.16.8 Legal Authority

The project would be constructed and operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code. Legal authorization to improve and use the property outside of control of James ID and RD 1606 would be obtained from the landowner and, if required, any applicable easement holders.

6.2.16.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. Since the project involves new construction and significant improvements to existing facilities (i.e. lift pump stations), a building permit would be required from the County of Fresno. Other permits and approvals may be required depending on the design of the project.

6.2.16.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $12,000 annually. The costs to construct the improvements are estimated to be $4,500,000, or $75,000 per acre. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased supplies.

6.2.16.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA compliance.

6.2.17 McMullin Master Plan

6.2.17.1 Project Description

The project is the preparation of a comprehensive master planning study to implement surface water deliveries in the undistricted area east of the James GSA. The project is analyzed assuming the master plan is implemented (with assumed conditions) and excludes the costs and benefits from other projects listed in this GSP.

6.2.17.2 Expected Benefits

The project is expected to serve 7,680 acres and decrease groundwater use 1.0 AF per acre of land served each year for an annual total of 7,680 AF. Water is expected to be available to the project in one of every four years for an average annual benefit of 1,920 AF.

6.2.17.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality, subsidence, and depletions of interconnected surface water.

6.2.17.4 Water Source and Reliability

Water that can be purchased or is excess to the immediate needs of James ID will be the primary source of water for the project. These sources include Kings River entitlement water, Kings River flood water, San Joaquin River flood water, and other purchased water. Pumped groundwater will not be used as a source.

6.2.17.5 Project Feasibility

The project has unknown feasibility but involves the construction of water conveyance infrastructure to a large geographic area and the establishment of a governing entity to acquire water and operate and maintain the project facilities. The feasibility will be determined after the master plan and study are completed.

6.2.17.6 Implementation Plan

This is a long-term project and, if needed to achieve and maintain sustainability, would likely be implemented by the McMullin Area GSA. If desired by MAGSA, the James GSA could be a cooperating partner in the project and assist in its implementation. It is highly unlikely that James GSA would implement the project without partners.

6.2.17.7 Status and Timeline

This is an INACTIVE project is in the PLANNING phase. The projects (in the Master Plan that will be developed) can designed and constructed within 120 MONTHS.

6.2.17.8 Legal Authority

The project would be constructed and operated under the powers and authorities granted to various agencies overlying the project area including the County of Fresno, the McMullin Area Groundwater Sustainability Agency, and the James Irrigation District.

6.2.17.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. Since the project involves construction of significant infrastructure, approvals from a number of agencies including the California Department of Fish and Wildlife, Caltrans, and the County of Fresno. Consultation with the U.S. Fish and Wildlife Service on protected species may be necessary. A water rights permit may be required from the State Water Resources Control Board if the project involves appropriative water rights.

6.2.17.10 Estimated Costs and Financing

The costs to develop the initial Master Plan is estimated to be $1,500,000. The costs to construct the improvements are estimated to be up to $250,000,000. The costs to operate and maintain the constructed facilities, excluding water costs, is estimated to be 0.5% to 2% of the construction cost, or $1,250,000 to $5,000,000 annually. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased supplies.

6.2.17.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA compliance. In addition, substantial public outreach during the development of the Master Plan would be necessary.

6.2.18 James Ranch Recharge Basin

6.2.18.1 Project Description

The project will construct recharge basins on a large contiguous parcels of land outside of the James GSA. The project is analyzed assuming four 640 acre recharge basins would be constructed in the area east of the James Bypass within the former landholding of the James Ranch. Adjacent or nearby lands may also be used for the project. The basins would be used to capture flood flows for groundwater recharge on a large scale.

6.2.18.2 Expected Benefits

The project is expected to recharge 0.25 AF per acre per day or a total of 19,200 AF per month into the aquifer at full build. Water is expected to be available to the project for a 90-day period in one of every four years for an average annual benefit of 14,400 AF.

6.2.18.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality, subsidence, and depletions of interconnected surface water.

6.2.18.4 Water Source and Reliability

Kings River flood water will be the primary source of water for the project. Water will be delivered to the project through agreements with the Kings River Water Association and James ID. Kings River flood flows are estimated to occur during a 90 day period once every four years.

6.2.18.5 Project Feasibility

The project has unknown feasibility but involves the construction large scale recharge facilities and associated conveyance infrastructure. The project is expected to be less feasible than many other projects. See Estimated Costs and Financing for additional details.

6.2.18.6 Implementation Plan

This project provides substantial benefits but is expected to be less feasible than other projects. The project will be implemented if there is a substantial need for groundwater recharge by the James GSA.

6.2.18.7 Status and Timeline

This is an INACTIVE project is in the CONCEPTUAL phase. The project can be planned, designed and constructed within 24 MONTHS.

6.2.18.8 Legal Authority

The project would be constructed and operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code. Legal authorization to improve and use the property outside of control of James ID would be obtained from the landowner and, if required, any applicable easement holders.

6.2.18.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. Since the project involves construction of basins and facilities requiring electrical service, a grading permit and building permit would be required from the County of Fresno. Given the scope of land disturbance involved in the project, it is expected that consultation with jurisdictional wildlife agencies would be required to address protected species. Other permits and approvals may be required depending on the design of the project.

6.2.18.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $120,000 annually. The costs to construct the improvements are estimated to be $128,000,000, or $50,000 per acre. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased supplies.

6.2.18.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA compliance.

6.2.19 Wildlife Habitat Restoration

6.2.19.1 Project Description

The project provides surface water to conservation easement lands south of the district for wildlife benefit. The water provided will either be recharged into the aquifer or delivered to the lands. A component of the project would store water on the lands and allow recovery of a portion of the stored water.

6.2.19.2 Expected Benefits

The project is expected to deliver up to 10.0 cfs to the conservation easement lands. It is estimated that 75% of the water delivered will percolate into the aquifer and the remaining 25% will be used through evapotranspiration. It is also estimated that he storage component of the project will allow for the recovery of 500 AF of captured flood water. Water is expected to be available to the project for a 90-day period in one of every four years. The project is expected to provide average annual recharge of 335 AF and an average annual floodwater capture of 125 AF.

6.2.19.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also be expected to benefit measurable objectives related to degraded water quality, subsidence, and depletions of interconnected surface water.

6.2.19.4 Water Source and Reliability

Kings River entitlement water provided by James ID will be the primary source of water for the project. James ID receives an average annual entitlement of 18,500 acre-feet of water and this water, after channel losses, is estimated to provide 9,250 acre-feet of diverted water. The deliveries will occur in amounts significantly greater and significantly less than the stated amount depending on fluctuations in annual Kings River watershed hydrology. Kings River flood water is expected to contribute an additional 18,000 acre-feet each year the flows are available. Kings River flood flows are estimated to occur once every four years. Other sources of water may be used including San Joaquin River flood water and purchased water delivered through Central Valley Project facilities; however, these sources are expected to contribute a small percentage of the overall water source for this project.

6.2.19.5 Project Feasibility

The project is an improvement to an already constructed facility. Project feasibility is related to the improvements and ongoing operations and maintenance. See Estimated Costs and Financing for additional details.

6.2.19.6 Implementation Plan

The underlying recharge facility is already constructed and the facilities have been utilized in prior years. Continued implementation of the recharge portion of the project will occur on an as-needed basis when economically justifiable. The feasibility of constructing the improvements to facilitate capture of flood water will be analyzed along with other projects and the analyzed projects will be implemented based on the benefits needed to achieve and maintain measurable objectives and cost. Projects with the lowest implementation costs per unit of benefit will likely be undertaken first.

6.2.19.7 Status and Timeline

This is an INACTIVE project is in the PLANNING phase. The project can designed and constructed within 12 MONTHS.

6.2.19.8 Legal Authority

The project would be operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code. Legal authorization to improve and use the property outside of James ID would be obtained from the landowner and, if required, the conservation easement holder.

6.2.19.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. Since the project involves existing facilities and operations and involves minor improvements, certain CEQA exemptions may apply. Given the minor nature of the construction and that the construction will involve water distribution facilities, no permits or regulatory approvals are expected to be required at this time. A final determination on permits and regulatory approvals will be made during the CEQA process.
Although the project is expected to include only minor improvements, it is expected that consultation with jurisdictional wildlife agencies would be required to address protected species. Other permits and approvals may be required depending on the design.

6.2.19.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $20,000 annually. The costs to construct the improvements are difficult to estimate but could reach an estimated $600,000. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased water supplies.

6.2.19.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA compliance.

6.2.20 Mendota Pool Water Quality Monitoring

6.2.20.1 Project Description

The project will construct a water quality monitoring site on the Fresno Slough approximately two miles downstream of Highway 180 in Fresno County. The site will allow the James ID to monitor the quality of surface water that is eventually delivered to James ID for compliance with contractual water quality standards.

6.2.20.2 Expected Benefits

The project is expected to reduce the salt in surface water delivered to James ID by 25%. The surface water is used to irrigate agricultural lands and to recharge ground water. The reduction in the salt content will improve groundwater quality within the James GSA.

6.2.20.3 Measurable Objectives

This project will substantially benefit measurable objectives related to water quality. Incidental benefits are expected in measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project is not expected to benefit measurable objectives related to subsidence, and depletions of interconnected surface water.

6.2.20.4 Water Source and Reliability

The project involves the improvement of existing Central Valley Project water supply contract and settlement contract supplies to James ID and RD 1606.

6.2.20.5 Project Feasibility

The costs to implement the project are expected to be minimal compared to the financial benefits associated with improved water quality.

6.2.20.6 Implementation Plan

It is expected that this project will be implemented prior to the adoption of the GSP.

6.2.20.7 Status and Timeline

This is an ACTIVE project is in the PLANNING phase. The project can be designed and constructed within 6 MONTHS.

6.2.20.8 Legal Authority

The project would be operated under the powers and authorities granted to Reclamation District No. 1606, a reclamation district governed under Division 15 of the California Water Code. Legal authorization to improve and use the property would be obtained from the California Department of Fish and Wildlife.

6.2.20.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. Approval or some form of agreement related to use of the site would be required from the California Department of Fish and Wildlife.

6.2.20.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $600 annually. The costs to construct the improvements are estimated to be $20,000.

6.2.20.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA compliance.

6.2.21 Lake Avenue Canal

6.2.21.1 Project Description

The project improves existing James ID conveyances within the James Bypass and constructs a new canal tentatively planned along the Lake Avenue alignment to provide flood water and excess water to landowners in areas that do not have surface water deliveries. The project is an extension of the James Bypass Floodwater Utilization project discussed earlier in this chapter. At this time, it is estimated that up to 5,000 acres of land can be served by the project.

6.2.21.2 Expected Benefits

The project is expected to decrease groundwater use 1.5 AF per acre of land served each year of project operations for an annual total of 7,500 AF. Water is expected to be available to the project in one of every two years for an average annual benefit of 3,750 AF. The actual benefits will vary from year to year due to fluctuations in hydrologic and water market conditions.

6.2.21.3 Measurable Objectives

This project will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This project will also expected to benefit measurable objectives related to degraded water quality, subsidence, and depletions of interconnected surface water.

6.2.21.4 Water Source and Reliability

Water that can be purchased or is excess to the immediate needs of James ID will be the primary source of water for the project. These sources include Kings River entitlement water, Kings River flood water, San Joaquin River flood water, and other purchased water. Pumped groundwater will not be used as a source.

6.2.21.5 Project Feasibility

The project involves the improvement of existing facilities where the James ID has ownership or site control. The project also involves the construction of new facilities where the James ID has ownership or site control. Since land acquisition is required, the overall costs of the project are significantly reduced and the project is considered easily feasible. The annualized cost, less any water purchase costs, are estimated to be $214,000 or $57.00 per acre foot. See Estimated Costs and Financing for additional details.

6.2.21.6 Implementation Plan

The costs to operate the project will vary depending on costs associated with the specific source of water used. The project will serve areas outside of the James GSA and operation of the project will occur when feasible for each of the served landowners or entities.

6.2.21.7 Status and Timeline

This is an ACTIVE project and is in the PLANNING phase. The project can be designed and constructed within 24 MONTHS.

6.2.21.8 Legal Authority

The project would be constructed and operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code, and Reclamation District No. 1606, a reclamation district governed under Division 15 of the California Water Code. Legal authorization to improve and use the property outside of control of James ID and RD 1606 would be obtained from the landowner and, if required, any applicable easement holders.

6.2.21.9 Permitting and Regulatory Requirements

The project will require compliance with the California Environmental Quality Act. Since the project involves new construction in a Designated Floodway, a floodway encroachment permit may be required from the Central Valley Flood Protection Board. If the facility involves a lift station, a building permit would be required from the County of Fresno. Other permits and approvals may be required depending on the design.

6.2.21.10 Estimated Costs and Financing

The costs to operate and maintain the facility varies but is estimated to be $12,000 annually. The costs to construct the improvements are estimated to be $3,000,000 or $202,000 annually based on 20-year financing at 3%. The costs for supplying water to the facility is variable and ranges from no cost (for flood waters) to $1,000 per acre-foot and higher for purchased supplies.

6.2.21.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA compliance.

6.3 Programs

The James GSA is proposing three programs in its GSP. The programs are listed in **Table 6-2**. As mentioned previously, programs were included as a separate class of actions in this Plan but can be considered to be management actions for the purposes of SGMA compliance and compliance with the GSP regulations. Each of the programs are in various stages of implementation; from projects that are conceptual to programs that have been implemented. Those programs that have been included as implemented are included in the program list because utilization of the program is an ongoing consideration and subject to a number of factors. Also, the implemented programs included were not implemented during the analysis of basin conditions used to quantify basin storage change, overdraft, and sustainable yield.

Table 6-2 James GSA Programs

Number	Name
1	Fallow Land Recharge
2	Flood and Excess Water
3	Central Valley Project Water Banking

Each program is described in detail in the following subsections. The section is formatted such that each program begins on a separate page for ease of reference.

6.3.1 Fallow Land Recharge

6.3.1.1 Program Description

The program provides incentives to landowners and growers to apply flood and excess water to fallow lands within the James ID. The program was implemented by James ID in 2017 and 2019.

6.3.1.2 Expected Benefits

The program recharged 1,552 AF in 2017. For planning purposes, it is anticipated that the program will yield 500 AF of additional recharge each year it is implemented. It is expected that he program would be implemented once every four years.

6.3.1.3 Measurable Objectives

This program will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This program will also be expected to benefit measurable objectives related to degraded water quality and depletions of interconnected surface water. The program may incidentally benefit measurable objectives related to subsidence.

6.3.1.4 Water Source and Reliability

The program utilizes water that is in excess to the needs to James ID. This excess water is typically Kings River water and is available in wet years but the water may include CVP water or water from other sources.

6.3.1.5 Program Feasibility

The program has been implemented in prior years and has been demonstrated to be feasible. Implementation includes the setting of a payment rate that is both feasible and will generate interest in participating in the program. See Estimated Costs and Financing for additional details.

6.3.1.6 Implementation Plan

The program has been implemented in prior years. The program will be implemented as needed and when feasible to meet measurable objectives and avoid minimum thresholds.

6.3.1.7 Status and Timeline

This is an ACTIVE program that is ONGOING.

6.3.1.8 Legal Authority

The program is operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code.

6.3.1.9 Permitting and Regulatory Requirements

The program is exempt from compliance with the California Environmental Quality Act. There are no applicable regulatory requirements at this time.

6.3.1.10 Estimated Costs and Financing

The cost to implement the program is the volumetric rate paid to growers to apply water to fallowed lands. This rate was $50 in 2017 and $35 in 2019. The costs to administer the program are negligible and are performed as a part of the district's usual water accounting and billing efforts.

6.3.1.11 Public and Agency Notification

No public or agency notifications are required to implement the program. There is an outreach effort to obtain grower participation in the program.

6.3.2 Flood and Excess Water

6.3.2.1 Program Description

The program provides flood water and excess water to landowners and growers that do not normally receive James ID water deliveries. The program was implemented by James ID in 2017.

6.3.2.2 Expected Benefits

The program is expected to provide about 5,000 AF of in-lieu recharge in 2019. It is expected that the program will have the capability of providing significantly more in-lieu recharge in subsequent years. For planning purposes, an expected annual benefit of 5,000 AF is expected in years when the program is implemented. It is expected that the program would be implemented once in every four years.

6.3.2.3 Measurable Objectives

This program will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This program will also be expected to benefit measurable objectives related to degraded water quality, subsidence, and depletions of interconnected surface water.

6.3.2.4 Water Source and Reliability

The program utilizes water that is in excess to the needs to James ID. This excess water is typically Kings River water and is available in wet years but the water may include CVP water or water from other sources.

6.3.2.5 Program Feasibility

The program has been implemented in prior years and has been demonstrated to be feasible. Implementation includes the setting of a payment rate that is both feasible and will generate interest in participating in the program. See Estimated Costs and Financing for additional details.

6.3.2.6 Implementation Plan

The program has been implemented in prior years. The program will be implemented as needed and when feasible to meet measurable objectives and avoid minimum thresholds.

6.3.2.7 Status and Timeline

This is an ACTIVE program that is ONGOING.

6.3.2.8 Legal Authority

The program is operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code.

6.3.2.9 Permitting and Regulatory Requirements

The program is exempt from compliance with the California Environmental Quality Act. There are no applicable regulatory requirements at this time.

6.3.2.10 Estimated Costs and Financing

The cost to implement the program is funded through water sales. There are costs associated with the procurement of water, distribution of water, and administration of the program. The cost to procure and distribute the water are built into the water sales rate. The costs to administer the program are negligible and are performed as a part of the district's usual water accounting and billing efforts.

6.3.2.11 Public and Agency Notification

No public or agency notifications are required to implement the program. There is an outreach effort to obtain grower participation in the program.

6.3.3 Central Valley Project Water Banking

6.3.3.1 Program Description

The program proposes to provide water from the Central Valley Project to lands not normally served by the CVP in times when excess CVP supplies are available. James ID would then return water to the Central Valley Project at a later date under certain conditions. The terms for the delivery and return of water under this conjunctive use program would be such that the subbasin would receive a net gain in supply.

6.3.3.2 Expected Benefits

The conjunctive use program is expected to provide about 1,000 AF of net benefit in years when it is implemented. It is expected that the program would be implemented once in every five years.

6.3.3.3 Measurable Objectives

This program will substantially benefit measurable objectives related to reduction in groundwater storage and chronic lowering of groundwater levels. This program will also be expected to benefit measurable objectives related to degraded water quality, subsidence, and depletions of interconnected surface water.

6.3.3.4 Water Source and Reliability

The program would utilize purchased or transferred CVP water. The water is expected to be imported in years where CVP supplies available for purchase or transfer. This is expected to occur once every five years.

6.3.3.5 Program Feasibility

The program is likely feasible at reduced level of expected benefits. A feasibility study or similar analysis would have to be performed to determine if it is feasible at the expected level of benefit.

6.3.3.6 Implementation Plan

The program is expected to be analyzed as a part of a Water Marketing Study. If the Water Marketing Study is not performed, an abbreviated study may be performed. Any study will identify opportunities and challenges associated with implementation as well as various possible program partners.

6.3.3.7 Status and Timeline

This is an INACTIVE program is in the CONCEPTUAL phase. The program can be implemented within 24 MONTHS.

6.3.3.8 Legal Authority

The program would be operated under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code, and the U.S. Bureau of Reclamation, a federal government entity under the U.S. Department of Interior.

6.3.3.9 Permitting and Regulatory Requirements

The program will require compliance with the California Environmental Quality Act and the National Environmental Protection Act. Additional regulatory requirements may apply and those requirements would be identified as a part of the environmental studies.

6.3.3.10 Estimated Costs and Financing

The cost to implement the program would vary. Conceptually, the cost to implement the program would be negligible and would involve water transfers to and from banking partners. The terms and conditions of the transfers would be adjusted and additional benefits from the program may be derived through payments to water banking partners.

6.3.3.11 Public and Agency Notification

Notices consistent with any permit or regulatory requirements would be required and the scope of noticing would be determined as a part of CEQA and NEPA compliance. Given the scope and nature of the project, public outreach would be conducted.

6.4 Management Actions

The James GSA is proposing four management actions in its GSP. The programs are listed in **Table 6-3**. Each of the management actions are in various stages of implementation; from management actions that have been initiated but not implemented to those that have been fully implemented. Those management actions that have been implemented, specifically Water Management Planning, Metered Agricultural Water Deliveries, and Metered Groundwater Extractions, are included in the management action list because their continued implementation is technically a consideration for the James GSA. Also, these management actions are not commonly employed by irrigation water providers in the Kings Subbasin and their inclusion serves to highlight the proactive actions taken by the entities within the James GSA.

Table 6-3 James GSA Management Actions

Number	Name
1	Water Management Planning
2	Metered Agricultural Water Deliveries
3	Metered Groundwater Extractions
4	Mendota Pool Water Quality Engagement

Each management action is described in detail in the following subsections. The section is formatted such that each management action begins on a separate page for ease of reference.

6.4.1 Water Management Planning

6.4.1.1 Description

The management action consists of implementation of measures identified in water management plans prepared by municipal and irrigation water suppliers.

6.4.1.2 Expected Benefits

The management action is expected to improve the efficiency of agricultural water distribution and promote agricultural water conservation within James ID. It is also expected to improve urban water conservation within the City of San Joaquin. This will reduce groundwater extractions for James ID in most years and the City of San Joaquin in all years.

6.4.1.3 Measurable Objectives

This management action will benefit measurable objectives related to groundwater storage, chronic lowering of groundwater levels. This management action is also expected to provide incidental benefits to subsidence and depletions of interconnected surface water. This management action is not expected to benefit measurable objectives related to water quality.

6.4.1.4 Water Source and Reliability

The management action involves conservation of existing water sources and does not require additional water sources.

6.4.1.5 Program Feasibility

The management action is feasible as demonstrated by its implementation status.

6.4.1.6 Implementation Plan

The management action is ongoing and implementation will continue in future years.

6.4.1.7 Status and Timeline

This management action has been IMPLEMENTED.

6.4.1.8 Legal Authority

The management action is performed under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code.

6.4.1.9 Permitting and Regulatory Requirements

The management action is governed under rules and regulations promulgated by the U.S. Bureau of Reclamation, the State of California, the James ID, and the City of San Joaquin.

6.4.1.10 Estimated Costs and Financing

The cost to implement the management action are covered by the underlying public entities. Certain costs may be passed along to water users but these costs are not considered substantial in relation to the underlying water service.

6.4.1.11 Public and Agency Notification

Public notice is provided when a public entity adopts or modifies their Water Management Plan. The public is also afforded the opportunity to provide comment.

6.4.2 Metered Agricultural Water Deliveries

6.4.2.1 Description

The management action consists of implementation of measures identified in water management plans prepared by municipal and irrigation water suppliers.

6.4.2.2 Expected Benefits

The management action is expected to promote improvements in irrigation efficiency and water utilization by irrigation water users within James ID.

6.4.2.3 Measurable Objectives

This management action will benefit measurable objectives related to groundwater storage, chronic lowering of groundwater levels. This management action is also expected to provide incidental benefits to subsidence and depletions of interconnected surface water. This management action is not expected to benefit measurable objectives related to water quality.

6.4.2.4 Water Source and Reliability

The management action involves conservation of existing water sources and does not require additional water sources.

6.4.2.5 Program Feasibility

The management action is feasible as demonstrated by its implementation status.

6.4.2.6 Implementation Plan

The management action is ongoing and implementation will continue in future years.

6.4.2.7 Status and Timeline

This management action has been IMPLEMENTED.

6.4.2.8 Legal Authority

The management action is performed under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code.

6.4.2.9 Permitting and Regulatory Requirements

The management action is governed under rules and regulations promulgated by the U.S. Bureau of Reclamation, the State of California, and the James ID.

6.4.2.10 Estimated Costs and Financing

There is no upfront cost to implement this management action because James ID has already purchased water meters for all delivery points and has implemented volumetric billing in its water accounting and invoicing systems. There is an ongoing annual cost estimated at $50,000 for replacement water meters, software subscriptions, and additional staff time to administer the management action.

6.4.2.11 Public and Agency Notification

James ID landowners and growers are provided notification upon any changes to rules or metering requirements.

6.4.3 Metered Groundwater Extractions

6.4.3.1 Description

The management action consists of continuing the current practice of measuring groundwater extractions.

6.4.3.2 Expected Benefits

The management action is expected to aid in management of groundwater elevations and reduction in groundwater extractions.

6.4.3.3 Measurable Objectives

This management action will benefit measurable objectives related to groundwater storage, chronic lowering of groundwater levels, water quality, subsidence and depletions of interconnected surface water.

6.4.3.4 Water Source and Reliability

The management action involves conservation of existing water sources and does not require additional water sources.

6.4.3.5 Program Feasibility

The management action is feasible as demonstrated by its implementation status.

6.4.3.6 Implementation Plan

The management action is ongoing and implementation will continue in future years.

6.4.3.7 Status and Timeline

This management action has been IMPLEMENTED by James ID and the City of San Joaquin.

6.4.3.8 Legal Authority

The management action would be performed under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code.

6.4.3.9 Permitting and Regulatory Requirements

The management action is governed under regulations promulgated by the U.S. Bureau of Reclamation and any requirements imposed by the James Groundwater Sustainability Agency.

6.4.3.10 Estimated Costs and Financing

There is no upfront cost to implement this management action because James ID has already purchased water meters for all wells and has implemented recordkeeping in its water accounting system. There is an ongoing annual cost estimated at $20,000 for replacement water meters and additional staff time to administer the management action.

6.4.3.11 Public and Agency Notification

The management action is internal to James Irrigation District and the City of San Joaquin. No public or agency notification is necessary.

6.4.4 Mendota Pool Water Quality Engagement

6.4.4.1 Description

The management action consists of engagement of entities that introduce salts and other constituents into the Mendota Pool in an effort to reduce the diversion of surface water with excess salts and other undesirable constituents.

6.4.4.2 Expected Benefits

The management action is expected to improve groundwater quality within the plan area. A quantitative assessment of expected groundwater improvements has not been conducted to date.

6.4.4.3 Measurable Objectives

This management action will benefit measurable objectives related to water quality. This management action is not expected to benefit measurable objectives related to groundwater storage, chronic lowering of groundwater levels, subsidence, and depletions of interconnected surface water.

6.4.4.4 Water Source and Reliability

The management action involves conservation of existing water sources and does not require additional water sources.

6.4.4.5 Program Feasibility

The management action is considered feasible as described. Implementation of items beyond the scope of outreach such as studies or modeling would require further consideration of feasibility.

6.4.4.6 Implementation Plan

Initial engagement efforts are underway and ongoing engagement will continue. The scope and level of effort towards engagement will by adjusted based on ongoing surface water quality monitoring (which is outside the scope of this GSP) and groundwater quality sustainability indicators.

6.4.4.7 Status and Timeline

This management action has been INITIATED but has not been fully implemented.

6.4.4.8 Legal Authority

The management action would be performed under the powers and authorities granted to the James Irrigation District, an irrigation district governed under Division 11 of the California Water Code. The participation of other entities would be governed under the legal authorities granted to those entities

6.4.4.9 Permitting and Regulatory Requirements

The management action is governed by state law, specifically the Porter-Cologne Water Quality Control Act, and various water quality control plans and policies adopted by the Central Valley Regional Water Quality Control Board.

6.4.4.10 Estimated Costs and Financing

The cost to implement this management action on an ongoing basis is estimated to be $20,000 which includes staff time, travel, and consultant fees.

6.4.4.11 Public and Agency Notification

Most agencies and members of the public that introduce water into the Mendota Pool have been notified as a part of James ID's engagement process. No specific public or general agency notification is anticipated by this management action but related notifications to the public and other agencies concerning agency activities affecting Mendota Pool water quality may be made by James ID and other agencies from time to time.

7 Plan Implementation

This chapter describes the implementation of the James GSA Groundwater Sustainability Plan. An estimate of GSP implementation costs is provided and funding alternatives are identified and explored. A schedule for implementing projects, programs and management actions is provided. The Data Management System used by the James GSA and the Kings Basin coordination group is described and discussed. Lastly, the annual reporting and periodic evaluation are detailed.

7.1 Estimate of GSP Implementation Costs

The cost to implement the Groundwater Sustainability Plan are difficult to estimate for a number of reasons. First, the projects, programs, and management actions that will be implemented depend on weather and hydrology in the coming years. The hydrology in the Kings Subbasin is highly variable and multiple year averages of watershed runoff can vary considerably. Second, plan implementation will also depend on conditions in adjacent plan areas, both within the Kings Subbasin and other basins and subbasins adjoining the Kings Subbasin. Conditions within the McMullin Groundwater Sustainability Agency plan area and the James Groundwater Sustainability Agency plan area will have the most significant influence on groundwater conditions in the James GSA plan area. Third, certain projects, programs, and management actions can be implemented to varying degrees making these approaches highly adaptable and cost efficient but also adding complexity to estimating implementation costs. Fourth, certain projects, programs, and management actions depend on certain resource costs, namely water and power, and these costs are not known and difficult to estimate in future years.

Despite these difficulties, the cost to implement this Groundwater Sustainability Plan has been estimated for each calendar year of plan implementation, from 2020 to 2040, based on the schedule of implementation, which is discussed below, and certain assumptions, projections, and estimates. The costs were broken down into capital costs, operation and maintenance costs, monitoring costs, reporting costs, and administrative costs and details regarding the estimated costs were provided. It should be noted that the actual cost to implement the plan may deviate significantly from the estimated implementation cost because of the factors previously mentioned.

The costs were annualized to 2020 dollars based on a rate of return of 3.0% and a general rate of inflation of 3.0%. These annualized costs are provided in **Table 7-1**. The Implementation Cost Estimate is included in **Appendix 7-A**.

Table 7-1 Estimated Implementation Costs (Annualized)

Task	Cost
Administration	$60,000
Monitoring	37,000
Outreach	12,000
Coordination	50,000
Technical/Legal	86,400
Projects – Construction	250,000
Projects – O & M	283,000
Total	**$778,800**

7.2 Funding Alternatives

Several funding alternatives were considered by the Board of the James Groundwater Sustainability Agency and its underlying member agencies, the James Irrigation District and Reclamation District No. 1606. These funding alternatives considered included funding by underlying districts, contributions by underlying districts, general assessment on acreage by the underlying districts or the James Groundwater Sustainability Agency, and extraction fees. The funding alternatives are discussed and briefly evaluated below.

The Board of the James Groundwater Sustainability Agency has adopted a funding approach, described after the alternatives below, which includes direct funding by the James Irrigation District and the assumption of certain GSA obligations by the James Irrigation District. While a funding approach has been adopted, it is possible that the James GSA and the underlying agencies may adopt different funding approaches as circumstances permit or require for various projects, programs, and management actions.

7.2.1 Funding by Underlying Districts

In this alternative, funding for the James Groundwater Sustainability Agency would be provided by the underlying districts, namely the James Irrigation District and Reclamation District No. 1606. The basis for the cost share between the two districts would be determined through an agreement reached between the two districts and could be based on acreage, water usage, groundwater extractions, revenues, or some other metric. It is expected that the James Irrigation District would be the majority or sole contributor in this alternative because Reclamation District No. 1606 is primarily a flood control district and provides agricultural irrigation water to a small portion (approximately 1%) of the plan area.

7.2.2 Assigned and Assumed Responsibility

In this alternative, funding for the James Groundwater Sustainability Agency would be provided by assigning the responsibility to construct certain project, operate and maintain certain projects, and perform certain tasks such as monitoring, reporting, and agency administration, to one or more of the underlying districts. For example, under the plan the James Irrigation District may be assigned responsibility to construct one or more projects and to secure a water supply for the project when necessary. Similarly, Reclamation District No. 1606 may be required to provide land or water supplies for projects. Another example would be the James Irrigation District being assigned responsibility to perform the monitoring and reporting specified by the plan. The districts would assume these responsibilities upfront or on a case-by-case basis as certain projects require implementation.

The benefits of this approach are avoiding a duplication of services and avoiding redundant costs. The Drawback to this approach would be uncertainty regarding assumption of responsibility for future projects.

7.2.3 General Assessment

In this alternative, the James Groundwater Sustainability Agency would levy a general assessment against lands within the plan area. The assessment could be tailed to land use or to the amount of benefits conferred by the plan to the land. A Proposition 2018 election would be required in order to levy the assessment. The Proposition 218 election would require that a majority of landowners approve the assessment.

The benefit of this approach is having a consistent cash flow that can be used to implement projects, programs, or management actions.

The drawback of this approach is that the funding stream is not easily adaptable to the specific needs of the GSA. The general assessments may result in an over- or under-collection of funds. The approach is also subject to a Proposition 218 majority vote process and future increases in funding are not guaranteed.

7.2.4 Extraction Fees

In this alternative, the James Groundwater Sustainability Agency would charge groundwater extractors a fee to extract groundwater from the plan area. The fee could be tiered and could include a base fee to fund certain fixed costs. The tiered costs could be based on a fixed fee schedule or a fee schedule that varies based on the funding needs to implement groundwater sustainability projects, programs, and management actions within the plan area. A Proposition 218 election would be required to levy the fee. The election would require that a majority of users protest the fee should the users desire to avoid the fee.

The benefit of this approach is that a consistent cash flow that can be used to implement projects, programs, or management actions. In theory, the fee is related to the need to perform projects or implement programs in that it is related to the demand on groundwater. This may not be the case in practice as sustainability for the James GSA is dependent on conditions and extractions outside of the plan area.

The drawbacks of this approach are that extractions can vary significantly from year to year and the approach does not provide a consistent cash flow.

7.2.5 Other Alternatives and Approaches

There are other funding alternatives that could be considered including the issuance of public debt, short-term borrowing, and pooled funding with other Kings Subbasin GSAs. These funding alternatives were considered but not advanced for further consideration. Also, certain alternates could be combined into a hybrid approach.

7.2.6 Selected Alternative

The Board of Directors of the James Groundwater Sustainability Agency, through consultation and agreement with the Board of Directors of the James Irrigation District and Board of Trustees of Reclamation District No. 1606, has determined that it will fund the James Groundwater Sustainability Agency through direct contributions by underlying districts. Initially, the James Irrigation District will fund the entire budget of the James Groundwater Sustainability Agency with the understanding that Reclamation District No. 1606 may be asked to contribute at a future date if land use or groundwater extraction patterns change significantly from present conditions. The boards have also consented to an approach whereby the James Irrigation District will be responsible implementing projects, programs, and management actions to achieve and maintain sustainability as set forth by the plan.

The boards have also consented to an approach whereby the James Irrigation District will be responsible for monitoring and reporting under the plan as well as the administration of the James Groundwater Sustainability Agency. All reports and submittals to the state and other agencies for compliance with the SGMA shall be made through the James GSA.

Resolutions authorizing the expenditures and the funding approach was enacted by the James GSA, the James Irrigation District, and Reclamation District No. 1606. The resolutions are provided in **Appendix 7-B** Schedule for Implementation

7.3 Schedule for Implementation

7.3.1 Overdraft Responsibility

The various GSAs within the Kings subbasin worked together to develop an understanding of groundwater conditions, groundwater flows, water balance, within the subbasin and their respective planning areas. As a result of their efforts several Technical Memorandum were developed to inform the GSAs and provide coordinated direction on the development of Kings Subbasin GSPs. Technical Memo 6 identified a 120,000 acre-foot annual average reduction in groundwater storage for a base year period, from 10/1/96 to 9/30/11. This value reduction in groundwater storage is consistent with work performed by the Kings River Conservation District.

This annual average reduction in groundwater storage was broken down by the planning areas for the various Kings subbasin GSAs and is shown in **Table 7-2**.

Table 7-2 Storage Change Estimation by GSA

GSA	Responsibility (AF)
Central / South	17,000
James	5,000
Kings River East	11,000
McMullin	16,000
North Fork	49,000
North Kings	24,000
Total	122,000

The memo went on to identify alternative methods to allocate responsibility for the decline in storage among the various GSAs. These alternatives were presented in the memo. The conclusion of the memo proposed a method that was acceptable to all of the GSAs. It is understood that the boards of all the Kings subbasin GSAs have adopted or approved the approach. Under the accepted approach, the various Kings subbasin GSAs are responsible for addressing the amounts of annual average reduction in groundwater storage shown in **Table 7-3**.

Table 7-3 Overdraft Responsibility by GSA under Technical Memorandum 6

GSA	Responsibility (AF)
Central / South	7,100
James	-16,700
Kings River East	11,000
McMullin	91,100
North Fork	50,300
North Kings	-20,800
Total	122,000

Technical Memorandum 6 did not address the James ID well field which extracts water under a deeded right from the lands within McMullin Area GSA for importation into lands served by James ID within the James GSA. The amount of water imported from the McMullin Area GSA into the James GSA averaged 18,540 acre-feet on an annual basis for the time period evaluated for the storage change estimation. It is reasonable to expect that this groundwater importation, if occurring within the parameters of the deeded right, should be held against the lands that have ceded their groundwater rights to James ID. However, James ID has taken the position that it will voluntarily contribute 18,540 acre-feet on an annual basis towards the amount of overdraft that the McMullin Area GSA is responsible for remediating. This contribution consists of the 16,700 acre-foot credit provided under Technical Memorandum 6 and an additional 1,840 acre-feet of water that is either recharged directly or through in-lieu methods. Since the aforementioned values are based on estimates of storage change and these estimates will be revised in five years along with the five-year evaluation of the GSP, the values will be reconsidered at that time. The contribution is made with the expectation that groundwater extractions by James ID within the McMullin Area GSA are mitigated and no restrictions will be placed on James ID's operations within the McMullin Area GSA. The allocation of overdraft responsibility under this proposed arrangement is shown in **Table 7-4**

To date, no formal agreement has been reached on this arrangement. Until a formal agreement is reached between the GSAs within the Kings Subbasin, the McMullin Area GSA should still address the entire 91,100 acre-feet of allocated responsibility per Technical Memorandum 6. James ID is committed to this arrangement to avoid conflicts over groundwater extractions and to facilitate cooperative efforts to achieve groundwater sustainability within the McMullin Area GSA and the Kings subbasin.

Table 7-4 Overdraft Responsibility by GSA under Proposed Arrangement

GSA	Responsibility (AF)
Central / South	7,100
James	1,840
Kings River East	11,000
McMullin	72,560
North Fork	50,300
North Kings	-20,800
Total	122,000

7.3.2 Rate of Overdraft Correction

During coordination meetings, the GSAs have considered an approach whereby the rate of overdraft correction will increase over time. This approach, referred to as the "10/20/30/40 Approach" in this Plan, requires that 10% of the correction be accomplished in the first five years, 20% in the next five years, 30% in the next five years, and the remaining 40% in the last five years. This approach, while not formally adopted in the Coordination Agreement, has been basis used in setting the measureable objectives for the relevant sustainability indicators within the entire Kings Subbasin.

7.3.3 Implementation Approach

The James GSA has already implemented certain projects, programs, and management actions after the 15-year baseline period used to determine the annual average reduction in groundwater storage values used for the subbasin and the various plan areas within the subbasin. The effectiveness of these actions will be evaluated formally as a part of the plan's periodic evaluation. All of the projects, programs, and management actions included in the Plan are shown in **Table 7-5**. Those that have been implemented as of September 30, 2019 are indicated in the table.

Table 7-5 Implementation Status of Projects, Programs and Management Actions

Identifier	Name	Implemented	Outside Plan Area
Project 1	Lateral K Groundwater Recharge	Y	N
Project 2	Basins 1 and 2 Storage and Recharge	Y	N
Project 3	Basin 3 Floodwater Capture and Recharge	Y	N
Project 4	Floodway Recharge and Spreading	N	N
Project 5	Distribution System Recharge	Y	N
Project 6	City of San Joaquin Stormwater Pond Recharge	Y	N
Project 7	McMullin On-Farm Flood Capture and Recharge	Y	Y
Project 8	Southwest Groundwater Banking	Y	Y
Project 9	Carmichael Slough Recharge	N	N
Project 10	James Main Canal Spreading	N	N
Project 11	Fresno Slough Recharge	Y	N
Project 12	Mud Dam Spreading and Recharge	Y	Y
Project 13	James Bypass Floodwater Utilization	Y	Y
Project 14	Lassen Avenue Floodwater Utilization	N	Y
Project 15	McMullin Grade Floodwater Utilization	N	Y
Project 16	Distributed Recharge Basin	N	Y
Project 17	McMullin Master Plan	N	Y
Project 18	James Ranch Recharge Basin	N	Y
Project 19	Wildlife Habitat Restoration	Y	Y
Project 20	Mendota Pool Water Quality Monitoring	N	Y
Project 21	Lake Avenue Canal	N	N
Program 1	Fallow Land Recharge	Y	N
Program 2	Flood and Excess Water	Y	Y
Program 3	Central Valley Project Water Banking	N	Y
Management Action 1	Water Management Planning	Y	N
Management Action 2	Metered Agricultural Water Deliveries	Y	N
Management Action 3	Metered Groundwater Extractions	Y	N
Management Action 4	Mendota Pool Water Quality Improvements	N	N

The James GSA will implement the remaining projects, programs, and management actions based on subbasin and Plan Area conditions as well as monitoring of the sustainability indicators established by this plan and other plans covering the subbasin. Each project, program, or management action described in the previous chapter will influence sustainability differently. In general, projects, programs, and management actions will be selected for implementation based on a number of factors including capital cost, operating cost, water supply considerations, and benefits.

For example, the James GSA may implement a groundwater recharge project outside of its plan area if it is seeking to address basin-wide reduction in groundwater storage or low groundwater elevations outside of its plan area and in the area where the basin will be constructed. The James GSA may implement a groundwater recharge project within its plan area if it is seeking to address a reduction in groundwater storage within its plan area or low groundwater elevations in its plan area.

It should be noted that the Plan contemplates projects, programs, and management actions to address conditions within its plan area as well as conditions within the subbasin outside of its plan area. Projects, programs and management actions are indicated in **Table 7-5**. This is necessary because the Plan Area is sustainable or near sustainability and is impacted by adjoining areas within the Subbasin, specifically the McMullin Area GSA and the James GSA, that rely solely or primarily on groundwater and are far from sustainable at the present time. These areas draw considerable subsurface water from the Plan Area and their draw from the Plan Area will continue to increase until 2040. While James ID contributes to extractions in the McMullin Area GSA, the extractions are under deeded right and also equate to the amount of subsurface flow during the evaluation study period. The projects being considered outside of the Plan Area are intended to improve conditions adjacent to the Plan Area which in turn will reduce subsurface flows of groundwater from the Plan Area. The projects will also contribute towards achieving sustainability within the Subbasin which is the ultimate purpose of the GSPs submitted by the subbasin.

While implementation of the Plan is intended to be flexible, the Plan assumes that certain projects will be completed within a twenty year timeframe in order to estimate implementation costs. A list of these projects in included in the implementation cost estimate provided in **Appendix 7-A**.

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, has 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 references 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.**

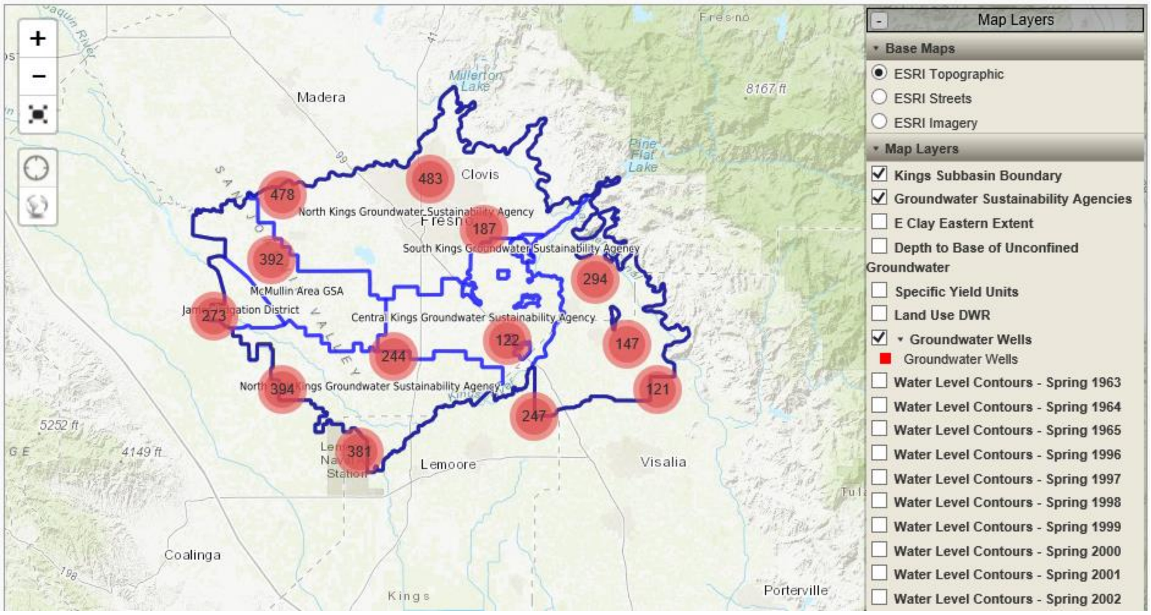

Figure 7-1 Kings Subbasin Data Management System Screenshot

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 7-6** provides a summary of how the DMS addresses each required element of the DMS and annual reporting requirements. The GSA may choose to have their own separate system for additional analysis.

Table 7-6 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 Requirement:

§ 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 Basin Coordinator the required information of groundwater levels, estimated 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 31 – Deadline for GSAs to provide GSA specific information
- Feb 28 – Completion of draft annual report
- Mar 15 – Review by GSA and Board approval
- Apr 1 – Submittal to DWR by Basin Coordinator

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
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; and
- GSA funding status.

7.6 Periodic Evaluations

Regulation Requirement:

§ 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 of changes to the GSP or policy changes in its annual report and submit 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. The GSA will report at least every five years and when the GSP is amended the result of Basin operations and 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.

Appendix 7-A Implementation Cost Estimate

Appendix 7-B Funding Resolutions

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Appendices

Appendix 1 A Kings Basin Coordination Agreement

KINGS SUBBASIN COORDINATION AGREEMENT

THIS KINGS SUBBASIN COORDINATION AGREEMENT ("Coordination Agreement" or "Agreement") is made effective as of the date of execution by the last of the GSA Parties by, between and among the groundwater sustainability agencies ("GSAs") within the Kings Subbasin; namely, the Central Kings GSA, James GSA, Kings River East GSA, McMullin Area GSA, North Fork Kings GSA, North Kings GSA and the South Kings GSA (referred to individually as a "GSA Party," and collectively as the "GSA Parties").

PREAMBLE

The GSA Parties each agree that by executing this Agreement, they are committing to the other GSA Parties to carry out the actions specified in this Coordination Agreement in good faith, and in a manner consistent with their individual responsibilities to comply with the California Sustainable Groundwater Management Act of 2014 ("SGMA");

RECITALS

This Coordination Agreement is made with reference to the following facts:

WHEREAS, each of the GSA Parties is a Groundwater Sustainability Agency ("GSA"), as the same is defined in the SGMA, and collectively, they provide GSA coverage of the entire Tulare Lake Hydrologic Region, San Joaquin Valley Groundwater Basin, Kings Subbasin; identified in California Department of Water Resources ("DWR") Bulletin 118 as Basin Number 5-22.08 ("Subbasin"); and

WHEREAS, the Kings Subbasin includes multiple GSAs that intend to manage the Subbasin through the development and implementation of multiple Groundwater Sustainability Plans ("GSPs"); and

WHEREAS, the SGMA requires GSAs in all basins that are managed by more than one GSP to enter into a Coordination Agreement (Cal. Water Code section 10727(b)(3)) to provide the appropriate coordinated methodologies to allow for the multiple GSPs to successfully manage the Subbasin in a manner compliant with the SGMA; and

WHEREAS, more specifically, consistent with the requirements of SGMA (Cal. Water Code section 10727.6), the Coordination Agreement must contain provisions ensuring that each of the GSPs utilizes the same data and methodologies within the basin for (a) groundwater elevation data; (b) groundwater extraction data; (c) surface water supply; (d) total water use; (e) change in groundwater storage; (f) water budget; and (g) sustainable yield; and

WHEREAS, the California Code of Regulations (Title 23, section 357.4) further specifies that agencies intending to develop multiple GSPs shall enter into a Coordination Agreement to ensure that: (a) the GSPs are developed and implemented utilizing the same data and methodologies; (b) elements of the GSPs necessary to achieve the sustainability goal for the basin are based upon consistent interpretations of the basin setting; and (c) the Coordination Agreement shall be submitted to DWR along with the GSPs for review; and

WHEREAS, in recognition of the need to sustainably manage the groundwater within the Kings Subbasin, the GSA Parties desire to enter into this Coordination Agreement between and among their individual GSAs; and

WHEREAS, the GSA Parties acknowledge that nothing contained in this Coordination Agreement determines or alters surface water rights, including but not limited to existing Pre-1914 and licensed water rights of the Kings River Water Association member units, or groundwater rights under common law or any other provision of law that determines or grants surface water rights, in accordance with California Water Code 10720.5 (b).

NOW, THEREFORE, in consideration of the Recitals, which are deemed true and correct and incorporated herein, and of the mutual promises, covenants, terms and conditions set forth herein, the GSA Parties agree as follows:

SECTION 1 – DEFINITIONS

1.1 "Coordinated Plan Expenses" shall mean any authorized expenses incurred by the Coordination Workgroup or the Plan Manager for the purpose of implementing the Coordination Agreement.

1.2 "Coordination" shall mean the integration and synchronization of the efforts of the individual GSA Parties so as to provide coordinated action in the pursuit of a common basin goals under the enabling SGMA statutes.

1.3 "Coordination Agreement" shall mean this Agreement, which is entered into pursuant to and intended to be consistent with Water Code sections 10721 subdivision (d), 10727.6 and California Code of Regulations, Title 23, section 357.4.

1.4 "Coordination Workgroup" shall mean the Workgroup of GSA Representatives established pursuant to this Coordination Agreement.

1.5 "GSA" shall mean a groundwater sustainability agency as defined by Water Code section 10721, subdivision (j) established in accordance with Water Code sections 10723 *et seq*. and "GSAs" shall mean more than one such groundwater sustainability agency. Each GSA Party is a GSA.

1.6 "GSP" shall mean a groundwater sustainability plan as defined by Water Code section 10721, subdivision (k), and "GSPs" shall mean more than one such plan.

1.7 "GSA Alternate Representative," "Alternate Representative," or "Alternate" and their plural forms shall mean an alternate member of the Coordination Workgroup selected to represent the GSA in accordance with **Exhibit "A"** and Section 4.1.2-4.1.4 of this Coordination Agreement who shall serve in the absence of the respective GSA Representative and shall be entitled to cast the vote for the absent GSA Representative.

1.8 "GSA Party" or "GSA Parties" shall mean a Groundwater Sustainability Agency or in the plural, two or more Groundwater Sustainability Agencies within the Kings Subbasin that is (are) a signatory to this Coordination Agreement.

1.9 "GSA Representative" or "Representative" and their plural forms as appropriate shall mean a member of the Coordination Workgroup selected to represent the GSA in accordance with **Exhibit "A"** and Sections 4.1.2 – 4.1.4 of this Coordination Agreement.

1.10 "Interbasin Agreements" shall mean any voluntary agreement entered into by a GSA, GSAs or a Coordination Workgroup with a GSA, GSAs or a Coordination Workgroup in any adjacent basin in order to better establish understanding regarding fundamental elements of the GSPs of any of the contracting GSA, GSAs, or Coordination Workgroups as the same may relate to enhanced sustainable groundwater management between the basins; all as more specifically set forth at Title 23 Cal. Code Regs section 357.2(a) through (d).

1.11 "Plan Manager" shall mean an entity or individual, appointed at the pleasure of the Coordination Workgroup, or as provided in Section 4.2 of this Coordination Agreement, to perform the role of the Plan Manager to serve as the point of contact to DWR, consistent with Title 23 Cal. Code Regs. section 351, subdivision (z).

1.12 "Service Providers" shall mean engineers, hydrogeologists, hydrologists, economists, technicians, attorneys or other professional service providers hired by the GSA Parties to provide assistance in accordance with this agreement.

1.13 "SGMA" shall mean the California Sustainable Groundwater Management Act of 2014, as amended from time to time, commencing at Water Code section 10720, together with its implementing regulations applicable to Groundwater Sustainability Plans, set forth at California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2.

1.14 "Subbasin" shall mean the Kings Subbasin (Basin Number 5-022.08, DWR Bulletin 118, Interim Update 2016) within the Tulare Lake Hydrologic Region.

1.15 "Technical Memoranda" shall mean the memoranda prepared by and/or for the Coordination Workgroup and includes the data and methodologies for assumptions identified in Water Code section 10727.6 used to prepare the coordinated GSPs. Individually, the memoranda shall be referred to as a "Technical Memorandum."

SECTION 2 – GENERAL OBLIGATIONS AND LIMITATIONS OF AGREEMENT

2.1 Obligation to Coordinate

The GSA Parties to this Coordination Agreement agree to work cooperatively and collaboratively to meet the coordination requirements of the SGMA and this Coordination Agreement. Each GSA Party to this Coordination Agreement is a GSA and acknowledges that it is bound by the terms of this Coordination Agreement as an individual GSA Party. However, it is further understood and agreed that in order to bind or otherwise obligate a GSA Party on any matters affecting its individual rights, responsibilities and obligations under SGMA, or any recommendations received by it arising from the terms and conditions contained in this Agreement (including any proposed future amendments hereto), that GSA Party's governing body must take final action at public meeting(s) and hearing(s) consistent with Water Code section 10728.4 regarding GSPs.

2.1.1 Obligation to Appoint Representatives and Alternatives

Each GSA Party understands its coordination participation, as more fully set forth in Section 4 of this Coordination Agreement, is based on representation through and by its individual designated GSA Representative. It is the responsibility and obligation of each GSA Party under this Coordination Agreement to appoint and authorize its respective GSA Representative and/or its Alternate Representative. Each GSA Party shall appoint and authorize one Representative and one Alternate to participate in coordination functions as described herein, and to facilitate timely and informed input and direction to the Coordination Workgroup and the Plan Manager.

By execution of this Coordination Agreement, each GSA Party confirms the authority of its GSA Representative and Alternate to provide input and direction to the Coordination Workgroup and the Plan Manager on behalf of that GSA Party, and each GSA Party understands that the Coordination Workgroup and the Plan Manager may undertake further consideration or conduct further analysis on the basis of that input and direction.

2.1.2 Non-Entity Status

The GSA Parties acknowledge and agree that this Coordination Agreement is entered into pursuant to the authorities referenced in Section 1.3 hereof, and that execution hereof does not act to create a legal entity separate and apart from the individual GSA Parties; that nothing contained in this Agreement is intended to create the power to sue or be sued, to enter into contract, or to enjoy the benefits or accept the obligations of a legal entity.

2.1.3 Implementation of Individual GSPs

Except as otherwise provided herein, this Coordination Agreement does not in any manner affect each GSA Party's responsibility to develop, approve and implement its respective individual GSP in accordance with the requirements of the SGMA.

2.2 No Adjudication Actions or Alternate Plans in the Subbasin

In accordance with the Title 23, California Code of Regulations section 357.4(f), the GSA Parties acknowledge that, as of the date of this Coordination Agreement, no area of the Subbasin is subject to (1) an adjudication action pursuant to Water Code section 10721(a), or (2) an alternative groundwater management plan submitted pursuant to Water Code section 10733.6.

2.3 No Restrictions on Interbasin Agreements

Nothing in this Coordination Agreement shall prevent any GSA Party or GSA Parties from entering into interbasin agreements with an Agency or individual parties within an adjacent Subbasin, or any other relevant Subbasin, so long as such interbasin agreements are not in direct conflict with or otherwise prevent compliance with this Coordination Agreement or compliance with the SGMA.

SECTION 3 – FINANCIAL MATTERS

3.1 Coordination Expenses

Each GSA Party shall bear its own costs associated with activities performed under this Coordination Agreement. No GSA Party shall incur debts, liabilities or obligations on behalf of any other GSA Party unless provided for in a separate agreement.

3.2 Contracting for Services

The GSA Parties shall contract with all Service Providers, including the Plan Manager, directly in their capacity as individual GSAs. Nothing in this Coordination Agreement shall be construed to create a fiscal agent relationship between the individual GSA Parties or between the GSA Parties and the Plan Manager or any other individuals or entities unless further set forth in a separate written agreement.

3.3 Arrangements for Cost Sharing

When the GSA Parties agree to perform activities that involve a financial obligation under this Coordination Agreement, the GSA Parties may enter into a cost-sharing arrangement or separate cost sharing agreement(s) as a part of approving and undertaking the activity.

3.4 Incorporation of Cost Sharing Agreements

Any cost sharing agreement executed by all of the GSA Parties shall be incorporated into this Coordination Agreement for the purposes of Section 13.1.2. No other cost sharing agreements or arrangements shall be incorporated into the Coordination Agreement for the purposes of Section 13.1.2.

SECTION 4 – RESPONSIBILITIES FOR KEY FUNCTIONS

4.1 Coordination Workgroup

4.1.1 The GSA Parties have established a Coordination Workgroup to provide an informal forum for the GSA Parties to direct the Plan Manager and Service Providers on the development and coordination of data and methodologies to support the technical assumptions and information in each GSP, as provided in the SGMA, and to satisfy the coordination and annual reporting obligation in the years following initial GSP adoption.

4.1.2 The Coordination Workgroup will consist of one GSA Representative identified on **Exhibit "A,"** attached hereto and incorporated herein by this reference, as said **Exhibit "A"** may be modified from time to time. Each GSA Representative shall have one Alternate Representative authorized to participate in the absence of the GSA Representative.

4.1.3 Individuals serving as GSA Representatives and Alternate Representatives shall be selected and appointed by each respective GSA Party in the sole and absolute discretion of the respective GSA Party, and such appointments shall be effective upon providing written notice to the Plan Manager and to each of the other GSA Representatives listed on **Exhibit "A"**.

4.1.4 The Coordination Workgroup will recognize each GSA Representative and GSA Alternate Representative until such time as a GSA Party may provide written notice of removal and replacement of the Representative or Alternate to the Plan Manager and to every other GSA Representative designated on **Exhibit "A."** Each GSA Party shall promptly fill any vacancy created by the removal of such Representative or Alternate Representative so that each GSA Party shall have the number of validly designated Representatives and Alternate Representatives specified on **Exhibit "A".**

4.1.5. Informal meeting notes of the meetings of the Coordination Workgroup will be prepared and maintained as set forth in Section 4.5.3.

4.2. Plan Manager

The Coordination Workgroup shall appoint, by unanimous consent, a Plan Manager, who may be a consultant hired by the GSA Parties pursuant to the Coordination Agreement or a public agency serving as or participating in a GSA that is a GSA Party to this Coordination Agreement. In accordance with the Title 23, California Code of Regulations Section 357.4(b)(1) the Plan Manager shall serve as the point of contact for DWR as specified by the SGMA (section 1.11 above). The Plan Manager has no authority to make policy decisions or represent the Coordination Workgroup without the prior unanimous consent of the Coordination Workgroup. The Plan Manager has no authority to bind or otherwise create legal obligations on behalf of the Coordination Workgroup. The Plan Manager is obligated to disclose all substantive communications he/she transmits and receives in his/her capacity as Plan Manager to the Coordination Workgroup. The Plan Manager serves at the pleasure of the GSA Parties, shall serve until he/she resigns or is otherwise replaced by unanimous consent of the Coordination Workgroup and shall have a separate written agreement with each GSA Party. The Plan Manager is identified in **Exhibit "A"**.

4.3 Coordination Workgroup Role and Limitations

4.3.1 Workgroup Role

In an effort to further the effective coordination of the GSA Parties under this Coordination Agreement, the Coordination Workgroup is convened to research, consider, and otherwise forward unanimous recommendations to each individual GSA Party's Board of Directors, subject to the ultimate formal approval of each said GSA Party's GSA Board of Directors, for the following enumerated items:

(a) Technical Memoranda for the SGMA required GSP elements described in Water Code section 10727.6, subdivisions (a) through (g) and Sections 8 through 10 of this Coordination Agreement, including the technical data and methodologies, as further collectively approved by the individual GSA Parties, in the GSA Parties' respective GSPs.

(b) Following the submittal to and approval of the GSPs and this Coordination Agreement by DWR, recommendations for ongoing review and updating of the Technical Memoranda as needed; for assuring submittal of annual reports; for providing five-year assessments and for any needed revisions to the Coordination Agreement; and for providing review and assistance with coordinated projects and programs.

(c) Review and recommendation for approval of annual estimates of Coordinated Plan Expenses presented by the Plan Manager and any updates to such estimates; provided, that such estimates or updates with supporting documentation shall be circulated to all GSA Parties in advance of the meeting at which the Coordination Workgroup will consider the annual estimate and within an adequate timeframe for GSA Representatives to present to their respective GSA Party Board of Directors for consideration and approval.

(d) Provide input and direction to the Plan Manager in the performance of its duties in conformance with the SGMA.

4.3.2 Limitations

It is the intent of the GSA Parties that every effort be made to achieve a consensus on the items to be recommended by the Coordination Workgroup for individual GSA Board consideration. The Coordination Workgroup shall be limited in scope to this intended result. When the terms of this Coordination Agreement or applicable law require the approval of a GSA Party, that approval shall be evidenced as indicated in Section 5 of this Agreement.

4.4 Ad Hoc Sub-Workgroups

The Coordination Workgroup may informally organize ad hoc sub-workgroups. Such ad hoc sub-workgroups may include qualified individuals possessing the knowledge and expertise to assist the Coordination Workgroup, consistent with the Coordination Agreement, on specific topics identified by the Coordination Workgroup. Individuals participating in ad hoc sub-workgroups need not be GSA Representatives or Alternate Representatives.

4.4.1 Work of Ad Hoc Sub-Workgroups

Tasks assigned to ad hoc sub-workgroups, or staff made available by the GSA Parties, may include more specific technical assistance to the Coordination Workgroup concerning development of recommendations for technical data, supporting information or documentation, and/or recommendations on matters of interest to the Coordination Workgroup, from time to time.

4.5 Coordination Workgroup Meetings

4.5.1 Timing and Notice

Any two GSA Representatives or, more typically, the Plan Manager, may call meetings of the Coordination Workgroup as needed to carry out the activities described in this Coordination Agreement. The Coordination Workgroup may, but is not required to, set a date for regular meetings for the purposes described in this Coordination Agreement. It is agreed and understood that, in the interest of cooperation and overall efficiency, every effort will be made to schedule meetings of the Coordination Workgroup at such times and places as will result in the ability of each GSA Party to have a GSA Representative present at the meeting.

4.5.2 Effective Participation

In order to provide timely and comprehensive consideration in its role as a Coordination Workgroup of items included within its scope, it is agreed that every effort will be made to have at least one of the GSA Representatives from every GSA Party listed on **Exhibit "A"** present for purposes of holding a Coordination Workgroup meeting. It is understood and agreed that the intent of the GSA Parties is to reach a consensus on all matters considered by the Coordination Workgroup for recommendation forward to each GSA Party's Board of Directors for final consideration. The GSA Representatives from every GSA Party listed on **Exhibit "A"** must be present at a meeting, or may provide a written communication in advance of the meeting, of the absent GSA Party's position on the item being considered to the Coordination Workgroup and/or the Plan Manager should the GSA be unable to have their Representative present, for any Coordination Workgroup attempt to reach consensus for a final recommendation on a matter described in section 4.3.1 to take place.

4.5.3 Informal Meeting Notes

The Plan Manager shall keep and prepare informal meeting notes of all Coordination Workgroup meetings. Notes of ad hoc sub-workgroup meetings shall be kept by the Plan Manager or Plan Manager's appointee. All Coordination Workgroup meeting notes and ad hoc sub-workgroup meeting notes shall be maintained by the Plan Manager as Coordination Workgroup records and shall be available to the GSA Parties.

SECTION 5 – APPROVAL BY INDIVIDUAL PARTIES

5.1 Whether by operation of law or by action of the Kings Subbasin under the terms of this Coordination Agreement any recommendation, action, position or agreement of this Subbasin requires separate written approval by each of the GSA Parties, and such approval shall be evidenced to the other GSA Parties, in writing, by providing a copy of the Resolution, Motion, or Minutes of the formal action taken by each of their respective Boards of Directors to the Plan Manager of the Coordination Workgroup.

SECTION 6 – EXCHANGE OF DATA AND INFORMATION

6.1 Exchange of Information

In accordance with Title 23, California Code of Regulations Section 357.4(b)(2) of the GSP Regulations, the GSA Parties acknowledge and recognize that for this Coordination Agreement to be effective in promoting basin-wide groundwater sustainability and compliance with the SGMA and the basin level coordinating and reporting regulations, the GSA Parties will have an affirmative obligation to exchange certain minimally necessary information among and between the other GSA Parties. The GSA Parties agree that they shall only use the information exchanged amongst them for the purposes set forth in this Agreement.

6.2 No Duty of Confidentiality

All Parties are public agencies and each Party acknowledges that any exchanged information is subject to the provisions of the California Public Records Act and a duly issue subpoena or court order. Each GSA Party shall be responsible for determining whether the information minimally necessary from its GSA to comply with the data and methodologies coordination and subsequent annual coordinated reporting of basin level data to DWR, as further set forth in this Coordination Agreement and in **Exhibit "B"** attached hereto, is subject to any non-disclosure or privacy restrictions. It shall be the responsibility of each individual GSA Party to take such steps and employ such measures as it deems necessary to configure the information in a form that satisfies its privacy concerns while otherwise complying with its statutory and regulatory obligations under this Coordination Agreement. This Coordination Agreement imposes no duty or obligation upon any GSA Party, nor its agents, contractors or other professional associates, for the protection of the information provided by other GSA Parties in satisfying the minimal coordination and reporting requirements under the SGMA and the regulations.

6.3 Voluntary Exchange of Information

Nothing in this Coordination Agreement shall be construed to prohibit any GSA Party from voluntarily exchanging information with any other GSA Party by any other mechanism separate from the Coordination Workgroup.

6.4 Public Records Act Requests

The GSA Parties agree that the Coordination Workgroup is not a public agency and shall take all appropriate actions to ensure the non- public agency status of the Coordination Workgroup when receiving any data requests under the Public Records Act or otherwise. As such, the Plan Manager is not authorized to accept or respond to any Public Records Act request, and may, but is not obligated to, refer the requesting party to one or more of the GSA Parties.

SECTION 7 – COORDINATED DATA MANAGEMENT SYSTEM

7.1 In accordance with the Title 23, California Code of Regulations Section 357.4(e), the GSA Parties are developing and will maintain a coordinated data management system that is capable of storing and reporting information relevant to and in compliance with the SGMA reporting requirements, the coordinated monitoring network of the Subbasin and the coordinated implementation of the GSA Parties' GSPs.

7.2 The GSA Parties likewise agree to develop and maintain the data required for the Basin data management system to provide the minimum required annual reporting information, as well as other pertinent information determined necessary by the Coordination Workgroup. Each GSA shall provide data in a format compatible with the Basin Data Management System. After providing the Coordination Workgroup with data from the individual GSPs, the Coordination Workgroup will cause the data to be stored and managed in a coordinated manner among the GSA Parties and reported to DWR periodically, as required. A description of the Data Management System is included in **Exhibit "B"**.

SECTION 8 – METHODOLOGIES AND ASSUMPTIONS

8.1 SGMA Coordination Requirements

Pursuant to the SGMA, this Coordination Agreement must demonstrate that the individual GSAs intending to develop and implement multiple GSPs pursuant to Water Code section 10727(b)(3) have coordinated with the other GSAs preparing a GSP within the Subbasin to ensure that the GSPs utilize the same data and methodologies for the following assumptions used in developing the GSPs: (1) groundwater elevation; (2) groundwater extraction data; (3) surface water supply; (4) total water use; (5) changes in groundwater storage; (6) water budgets; and (7) sustainable yield. (Water Code Section 10727.6.)

8.2 Coordination during GSP Development

During development of the individual GSPs, the GSA Parties have developed common methodologies and assumptions for the required plan elements listed in Water Code section 10727.6. This development was facilitated through research, analysis and discussion within the Coordination Workgroup. Once consensus was achieved at the Coordination Workgroup, the recommendations of the Coordination Workgroup were forwarded to the individual GSA Party's Board of Directors for further consideration and approval as part of their GSPs. The final approved set of data gathering, storage and analysis criteria, along with the approved methodologies associated with each required item specified in Water Code section 10727.6 specified above in section 7.1 of this Agreement, is attached to this Coordination Agreement as **Exhibit "B,"** and incorporated into each GSP and in this Agreement as if originally set out in full. Generally, the basis upon which the methodologies and assumptions were developed includes, but shall not be limited to, collection of existing relevant data/information, consideration of applicable best management practices, methodologies considered as standard accepted practices in the water and groundwater industries and/or best modeled or projected data available and may include consultation with the DWR, as appropriate.

8.3 Description of Data and Methodologies

The data and methodologies for assumptions described in Water Code section 10727.6 and Title 23, California Code of Regulations Section 357.4 for preparation of coordinated plans, in addition to **Exhibit "B"** as set forth above, is further supported by applicable relevant Technical Memoranda prepared by the Coordination Workgroup, and recommended to the individual GSA Parties for each of the elements discussed in Sections 8, 9, and 10 of this Coordination Agreement. The data and methodologies required for coordination are subject to the unanimous consent of the Coordination Workgroup and all GSA Parties' Boards of Directors, and have been incorporated to this Coordination Agreement and incorporated into each GSA Party's GSP, as appropriate. The Technical Memoranda created pursuant to this Agreement have been utilized by the GSA Parties during the development and implementation of their GSPs in order to assure coordination of the GSPs in compliance with the SGMA. The GSA Parties acknowledge that this Coordination Agreement is required to be submitted to DWR along with each GSA's completed GSP to ensure that each GSP has included the information developed in **Exhibit "B".**

SECTION 9 – MONITORING NETWORK

9.1 In accordance with the Title 23, California Code of Regulations Section 357.4(b)(3)(A), the GSA Parties hereby agree to coordinate the development and maintenance of a Subbasin monitoring network through the coordination of the respective GSA monitoring networks established pursuant to the GSA Parties' GSPs. The description of the Subbasin monitoring network includes monitoring objectives, protocols, and data reporting requirements specific to enumerated sustainability indicators. Each GSA Party's network facilitates the collection of data in order to adequately characterize groundwater and related surface water conditions in the Subbasin and reasonably evaluate changing conditions that occur from implementation of the individual GSPs. Each GSA Party's GSP describes the GSA monitoring network's objectives as they relate to the Subbasin as well as their individual GSA area as required by the regulations, including, but not limited to, an explanation of coordinated network development and implementation to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater.

9.2 Each GSA Party has provided and shall continue to provide to the Coordination Workgroup, at a minimum, all relevant required data and information for their respective representative monitoring sites established in accordance with Title 23, California Code of Regulations, Section 354.36, as amended from time to time. A description of the groundwater elevation data and monitoring network has been included in **Exhibit "B"** in accordance with the Title 23, California Code of Regulations Section 357.4(b)(3)(A).

SECTION 10– COORDINATED WATER BUDGET

10.1 In accordance with the Title 23, California Code of Regulations Section 357.4(b)(3)(B), the GSA Parties hereby agree to prepare a single coordinated water budget for the Subbasin for use in the individual GSA Party's GSP. The water budget includes those elements required by Title 23, California Code of Regulations, Section 354.18, including groundwater extraction data, surface water supply, total water use, and change in groundwater in storage.

10.2 In accordance with the Title 23, California Code of Regulations Section 357.4(b)(3)(C), the GSA Parties have utilized and will continue to utilize the coordinated water budget to determine the sustainable yield for the basin. The determination of sustainable yield is supported by a description of the undesirable results for the basin, and an explanation of how the minimum thresholds and measurable objectives defined by each GSP relate to those undesirable results, based on information described in the basin setting. A description of the Coordinated Water Budget is included in **Exhibit "B".**

SECTION 11 – ADOPTION AND USE OF THE COORDINATION AGREEMENT

11.1 Coordination of GSPs

In accordance with the Title 23, California Code of Regulations Section 357.4(c), this section has been included to provide clarification of how the GSPs implemented together satisfy the requirements of SGMA and are substantially compliant with Title 23, California Code of Regulations. Each GSA Party acknowledges that it is responsible to ensure that its own GSP complies with the statutory requirements of the SGMA. The GSA Parties further acknowledge the existence of more than one GSA within the Kings Subbasin and the related requirements of the California Water Code and the California Code of Regulations to coordinate among the multiple GSAs within the Subbasin. It is the intent of the GSA Parties that, through development and execution of this Coordination Agreement and the implementation of their collective GSPs within the Subbasin, that they shall satisfy the requirements of sections 10727.2 and 10727.4 of the Water Code, and that when taken together as a whole, they shall provide a detailed description of how the Subbasin will timely achieve sustainability and be managed sustainably into the future. As described in this Agreement and the Exhibits, the GSA Parties have developed their respective GSPs using common data and methodologies. The GSA Parties have coordinated development of their GSPs prior to GSP submittal. Each GSP within the basin is using the same GSP outline structure, and includes common language describing the basin where appropriate.

11.2 GSP and Coordination Agreement Submission

In accordance with the Title 23, California Code of Regulations Section 357.4(d), the GSA Parties agree to submit this Coordination Agreement and their respective GSPs to DWR through the Coordination Workgroup and Plan Manager, in accordance with all applicable requirements.

SECTION 12 – MODIFICATION AND TERMINATION

12.1 Modification or Amendment of **Exhibit "A"**

The GSA Parties agree that **Exhibit "A,"** except for the withdrawal of GSA Parties to this Agreement, may be updated by written direction from the GSA Parties from time to time. Upon such modification, the updated **Exhibit "A"** shall be attached to this Agreement as a replacement to the previously existing **Exhibit "A."** Upon such attachment, the updated "**Exhibit "A"** shall become a part of this Coordination Agreement without further approval being required. The Plan Manager shall provide notice of such change to all GSA Representatives.

12.2 Modification or Amendment of **Exhibit "B"**

The GSA Parties agree that **Exhibit "B"** may be updated by written direction from the GSA Parties and consensus of the Coordination Workgroup, followed by approval of each individual GSA Party's Board of Directors from time to time without the necessity of amending the main body of the Agreement. Upon such modification, the updated **Exhibit "B"** shall be attached to this Agreement as a replacement to the previously existing **Exhibit "B."** Upon such attachment, the updated "**Exhibit "B"** shall become a part of this Coordination Agreement. The Plan Manager shall provide notice of such change to all GSA Representatives.

12.3 Amendment for Compliance with Law

Should any provision of this Coordination Agreement be determined to be not in compliance with legal requirements under circumstances where amendment of the Agreement to include a provision addressing the legal requirement will cure the non-compliance, the GSA Parties agree to promptly prepare and approve such amendment.

12.4 Modification or Amendment of Coordination Agreement

Except as provided in Sections 12.1 and 12.2, the GSA Parties hereby agree that this Coordination Agreement may be supplemented, amended, or modified only by a writing approved by each individual GSA Party's Board of Directors and signed by the GSA Parties.

SECTION 13 – WITHDRAWAL, TERM, AND TERMINATION

13.1 Withdrawal

13.1.1 Any GSA Party may withdraw from this Coordination Agreement upon providing the Plan Manager and all other remaining GSA Parties with at least one (1) year's written notice of such withdrawal. Such a withdrawal from this Coordination Agreement shall not cause or require termination of this Coordination Agreement.

13.1.2 Any GSA Party who withdraws shall remain obligated for Coordinated Plan Expenses as provided in any then-existing separate cost sharing agreement.

13.2 Term

This Coordination Agreement, as modified from time to time pursuant to Section 12, shall continue for a term that is coterminous with the requirements of the SGMA, as the same may be modified, from time to time.

13.3 Termination

This Coordination Agreement shall terminate if the requirements of SGMA no longer apply to the GSA Parties or if the requirements of SGMA no longer require a Coordination Agreement. This Coordination Agreement may also be terminated upon the unanimous written consent of the GSA Parties.

SECTION 14 – WATER RIGHTS

14.1 Acknowledgement of Water Code Section 10720.5

The GSA Parties acknowledge that pursuant to Water Code Section 10720.5(a), that SGMA does not modify rights or priorities to use or store groundwater consistent with Section 2 of Article X of the California Constitution, except as so provided in said subsection. The GSA Parties further acknowledge that pursuant to Water Code Section 10720.5(b), SGMA does 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. Water rights may be determined in an adjudication action as described in Water Code Section 10720.5(c). Any dispute involving water rights including without limitation as to priority of water rights shall be separately resolved based upon applicable law before a proper judicial, administrative or enforcement forum, and is specifically excluded from the provisions of this Agreement, including without limitation, Section 15 below.

SECTION 15 – RESOLUTION OF CONFLICTS

15.1 Procedure for Resolving Conflicts or Disputes

In accordance with Title 23, California Code of Regulations Section 357.4(b)(2) of the GSP Emergency Regulations, the GSA Parties have identified procedures for resolving conflicts between Parties. In the event that any conflict or dispute arises between or among the GSA Parties relating to the enforcement or interpretation of any term, covenant or condition of this Agreement or the rights and obligations arising from this Agreement ("Dispute"), the aggrieved GSA Party or GSA Parties ("Aggrieved GSA Party") shall provide written notice, sufficiently detailing the basis upon which the Dispute is alleged to exist, to the other GSA Parties. Within fifteen (15) days after such written notice, the GSA Parties shall meet and confer and/or commence an attempt in good faith to resolve the Dispute through informal means. If the GSA Parties cannot agree upon a resolution of the Dispute within thirty (30) days following the provision of written notice specified above, the Dispute shall be submitted to mediation as provided in Section 15.2.

15.2 Mediation

Upon expiration of thirty (30) days as described in Section 15.1, the Aggrieved GSA Party shall initiate mediation by notifying all GSA Parties in writing of the Dispute, the informal attempts to resolve the Dispute pursuant to Section 15.1, and the initiation of mediation. The notice shall be submitted no later than thirty (30) days from the expiration date outlined in Section 15.1. A mediator shall be selected that is mutually agreeable to the GSA Parties. The GSA Parties 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 disputing GSA Parties agree or mediator suggests may be necessary to facilitate effective mediation. Each GSA Party that is a party to the mediation 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 or as otherwise agreed to. Should the GSA Parties be unable to resolve the Dispute through the mediation process, any GSA Party may seek legal or other relief as they may deem appropriate.

SECTION 16 – GENERAL PROVISIONS

16.1 Authority of Signers

The individuals executing this Coordination Agreement represent and warrant that they have the authority to enter into this Coordination Agreement and to legally bind the GSA Party for whom they are signing to the terms and conditions of this Coordination Agreement.

16.2 Governing Law

The validity and interpretation of this Coordination Agreement will be governed by the laws of the State of California.

16.3 Severability

Except as provided for cure by amendment in Section 12.2, if any term, provision, covenant, or condition of this Coordination Agreement is determined to be unenforceable by a court of competent jurisdiction, it is the GSA Parties' intent that the remaining provisions of this Coordination Agreement will remain in full force and effect and will not be affected, impaired, or invalidated by such a determination.

16.4 Counterparts

This Coordination Agreement may be executed in any number of counterparts, each of which will be an original, but all of which will constitute one and the same agreement.

16.5 Good Faith

The Parties agree to exercise their best efforts and utmost good faith to effectuate all the terms and conditions of this Coordination Agreement and to execute such further instruments and documents as are reasonably necessary, appropriate, expedient, or proper to carry out the intent and purposes of this Coordination Agreement.

16.6 Construction and Interpretation.

This Agreement has been developed through negotiation and each of the GSA Parties has had a full and fair opportunity to review and make suggestions to revise the terms of this Agreement. As a result, the normal rule of construction that any ambiguities are to be resolved against the drafting GSA Parties shall not apply in the construction or interpretation of this Agreement.

16.7 Indemnity

No GSA Party, nor any director, officer or employee of a GSA Party, shall be responsible for any damage or liability occurring by reason of anything done or omitted to be done by another GSA Party under or in connection with this Coordination Agreement. The GSA Parties further agree, pursuant to Government Code section 895.4, that each Party shall fully indemnify and hold harmless each other GSA Party and its agents, directors, officers, employees and contractors from and against all claims, damages, losses, judgments, liabilities, expenses and other costs, including litigation costs and attorney fees, arising out of, resulting from, or in connection with any work delegated to or action taken or omitted to be taken by such GSA Party under this Coordination Agreement.

16.8 Entire Agreement

This Agreement constitutes the entire agreement among the GSA Parties and supersedes all prior agreements and understandings, written or oral.

IN WITNESS WHEREOF, the GSA Parties have executed this Agreement as of the date of the last signature hereto.

CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By Phillip G. Desatoff

Date: 11/15/19

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

Date: ______________________________

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

Date: ______________________________

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

Date: ______________________________

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

Date: ______________________________

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

Date: ______________________________

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

Date: ______________________________

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CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By [signature]

STEVEN P. STADLER, EXECUTIVE DIR.

Date: DECEMBER 12, 2019

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

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Date: ______________________________

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

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Date: ______________________________

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

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Date: ______________________________

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

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Date: ______________________________

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

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Date: ______________________________

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By ______________________________

Date: ____________________________

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

Date: ____________________________

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

Date: 11/21/2019

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

Date: ____________________________

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

Date: ____________________________

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

Date: ____________________________

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

Date: ____________________________

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CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

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Date: ______________________________

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By Matt H Hy

MATTHEW H. HURLEY Gen. Mgr.

Date: 11/6/2019

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

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Date: ______________________________

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

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CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: 11-22-2019

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

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CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ____________________________

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ____________________________

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ____________________________

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ____________________________

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ____________________________

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By Gary R. Serrato

____

Date: Oct 24, 2019

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ____________________________

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IN WITNESS WHEREOF, the GSA Parties have executed this Agreement as of the date of the last signature hereto.

CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: ______________________________

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

____

Date: 12/20/2019

EXHIBIT "A"

GSA DESIGNATED REPRESENTATIVES AND SUBBASIN PLAN MANAGER

DATED: _12/20/2019_

CENTRAL KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

Representative: Phil Desatoff

Alternate: Earl Hudson

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

Representative: Steve Stadler

Alternate: Robert Motte

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

Representative: Chad Wegley

Alternate: Jack Brandt

MCMULLIN AREA GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

Representative: Matt Hurley

Alternate: Don Cameron

NORTH FORK KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

Representative: Mark McKean

Alternate: Scott Sills

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

Representative: Gary Serrato

Alternate: Kassy Chauhan

SOUTH KINGS GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

Representative: Karnig Kazarian

Alternate: Sherman Dix

The PLAN MANAGER is:

Name: Ronnie Samuelian

Agency/Entity: Provost & Pritchard

Exhibit "B"
To the Kings Subbasin Coordination Agreement

The GSAs may update and modify the processes described in this exhibit as new preferred methods are identified, additional data is gathered, or reporting requirements change. Updates to the methods or information will be subject to agreement by GSAs under the terms of this agreement and documented in Basin annual reports and GSP updates.

I. Sustainability Goal

The sustainability goal of the Kings Basin and each GSA is to ensure that by 2040 the basin is being managed 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.

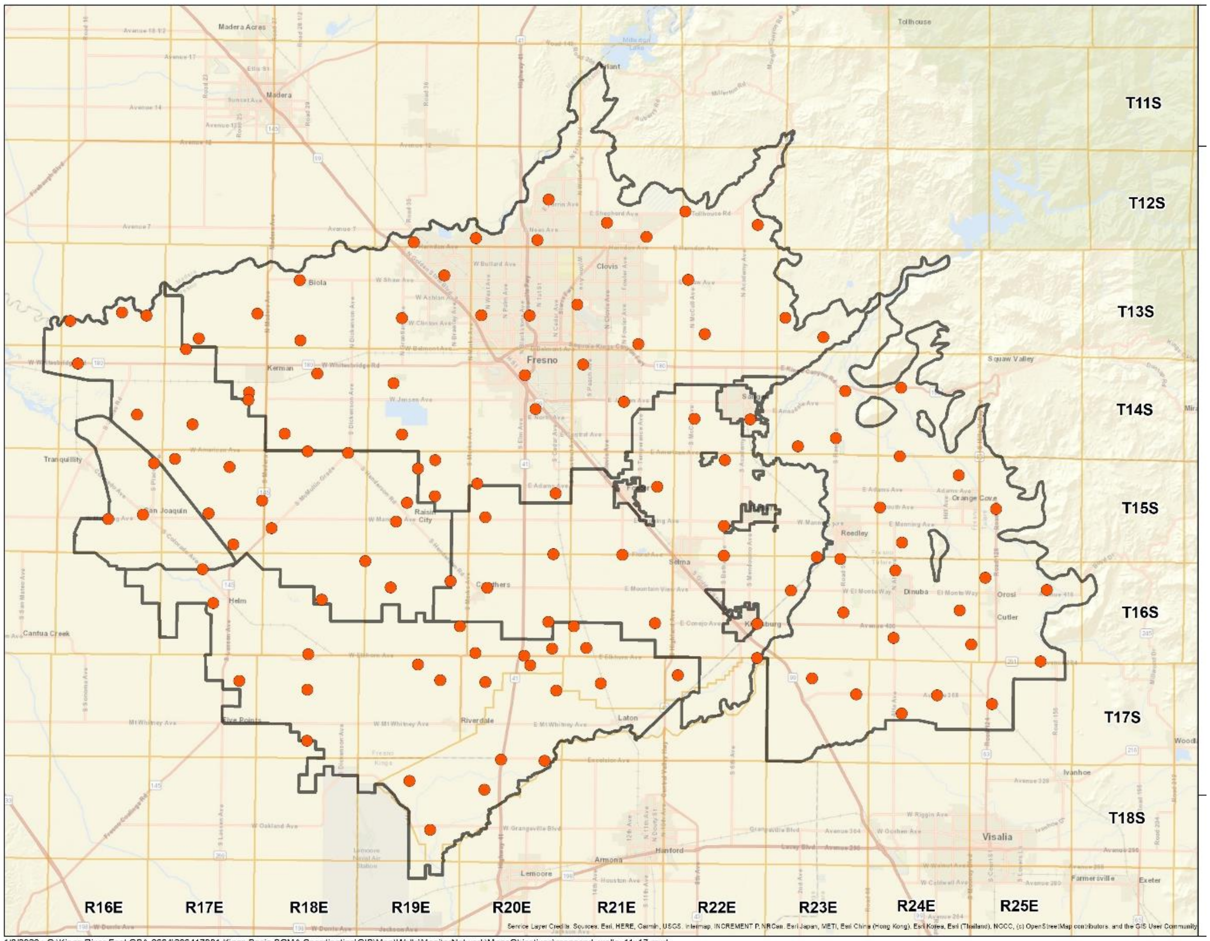
II. Description of Monitoring Networks

The GSAs within the Kings Basin have established three monitoring networks within each GSA for water level, water quality and subsidence.

The objectives of the various monitoring programs include the following:

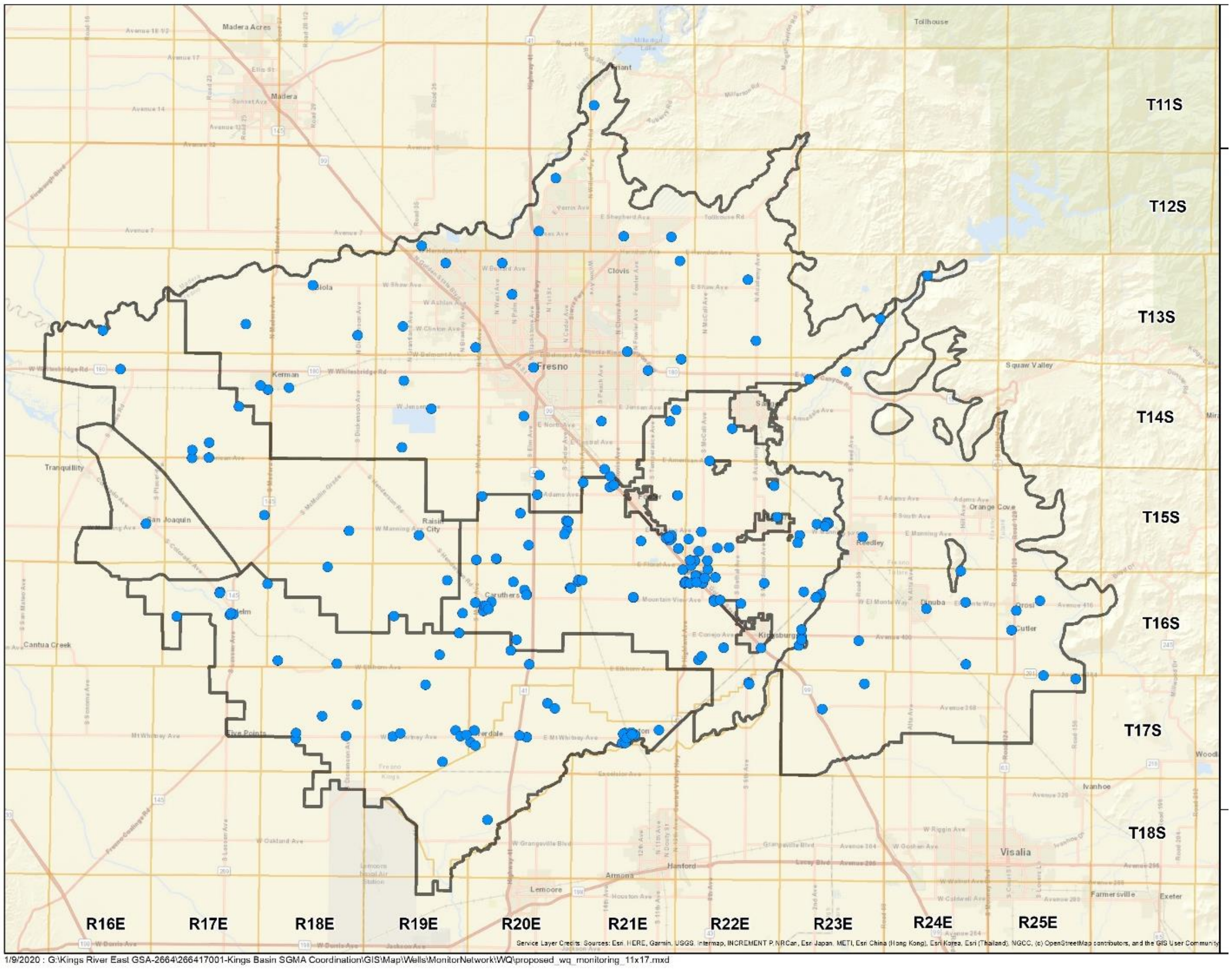
1. Establish a baseline for future monitoring.
2. Provide warning of potential future problems.
3. Use data gathered to generate information for water resources evaluation.
4. Help to quantify annual changes in water budget components.
5. Develop meaningful long-term trends in groundwater characteristics.
6. Provide comparable data from various locales within 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.

The water level monitoring network will utilize existing wells that have been historically monitored for groundwater level. The GSAs are planning to locate additional monitor wells in areas with limited data, and these will be added to the network. Each GSA will discuss their individual monitoring network in their respective GSP. The groundwater elevation measurements will be collected every March and October to provide data on the seasonal high and seasonal low groundwater conditions. Each GSA will provide the water level data to the Plan Manager for the Basin for inclusion in the Data Management System and annual reports. These wells along with additional wells will be used for groundwater storage calculations. A copy of the preliminary water level monitoring network is shown in the figure below.

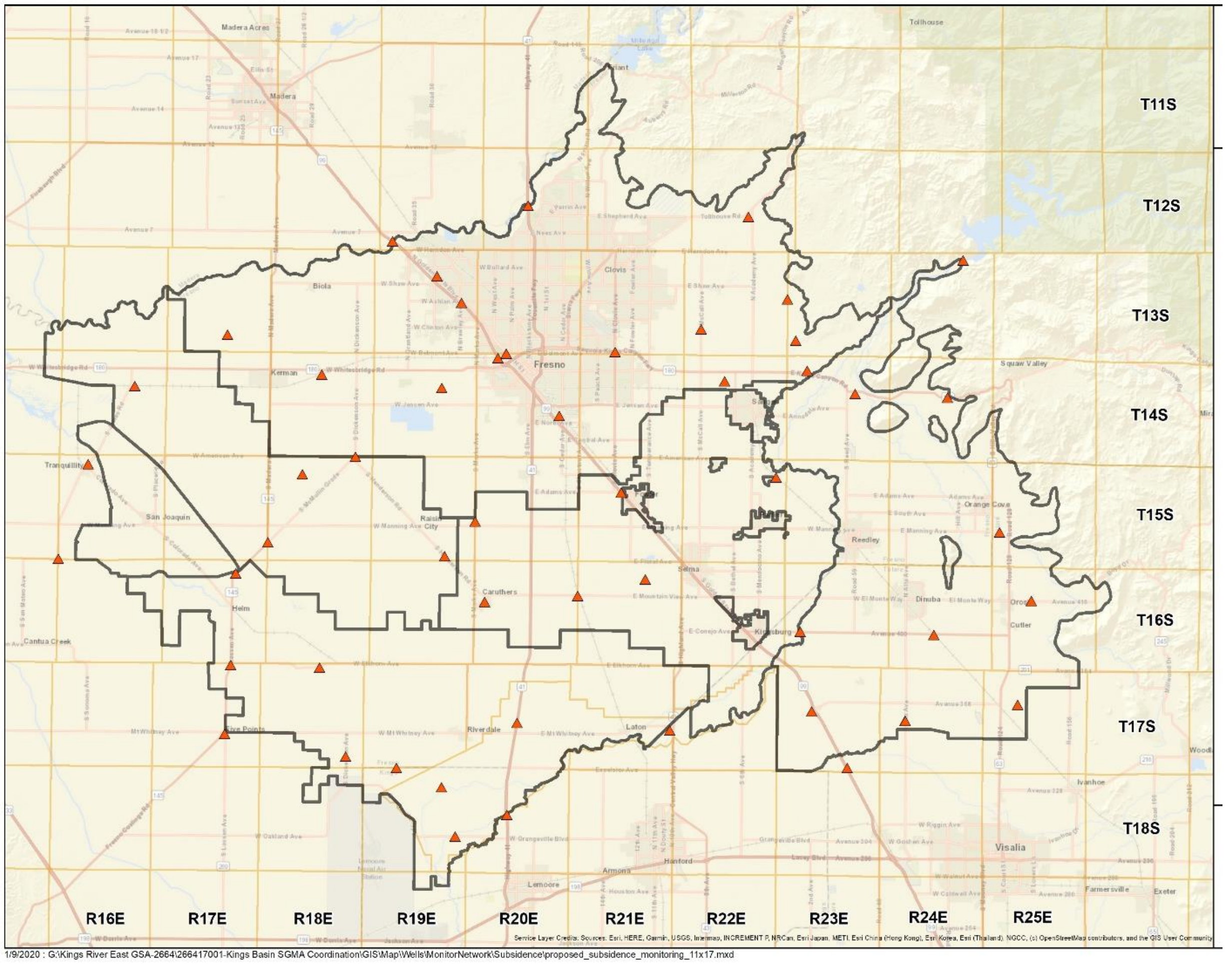


1/9/2020 : G:\Kings River East GSA-2664\266417001-Kings Basin SGMA Coordination\GIS\Map\Wells\MonitorNetwork\MeasObjectives\proposed_wells_11x17.mxd

Groundwater quality reporting by community water systems and non-community public supply wells is a requirement of California Code of Regulations (CCR) Title 22, and the GSAs will rely on this data for groundwater quality monitoring. Community and other public supply wells are 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. Locations were selected to be representative of large and small communities dependent on groundwater and to spatially cover each GSA. The representative groundwater quality monitoring network will be evaluated and revised as needed. A copy of the preliminary groundwater quality monitoring network is shown in the figure below.



Land subsidence is limited primarily to the western portion of the Subbasin.   Land subsidence will be primarily monitored using 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 spatial and temporal network is adequate and designed with the flexibility to increase measurement frequency or decrease benchmark spacing if more data is warranted. NASA InSAR remote sensing data will be used to verify any observed subsidence and fill in gaps between the surveyed benchmarks. The GSAs will also track land subsidence points just outside of their boundaries to see if subsidence is encroaching into the area. A copy of the subsidence monitoring network is shown in the figure below.



III. Description of Coordinated Data Management System

The GSAs 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 will generate the required information for 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, landuse, streets, aerial imagery, geologic information and specific yield information. Additional items may be added to the DMS in the future as needed or required.

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 for quality assurance and will not change once approved. Groundwater storage calculations are performed outside of the DMS in accordance with the method described in the GSPs, then the results of those calculations are 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. A description of how the DMS addresses each required element of a DMS and annual reporting requirements is included in the GSP and listed in the table below. GSAs may choose to have their own separate system for additional analysis.

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

IV. Overdraft Mitigation Responsibility for Each GSA

The GSAs have agreed to an initial target overdraft volume for each GSA to include in their respective GSPs along with projects and management actions to mitigate for that volume. A table showing the total for each GSA is included in below. Although specific values are identified, there is significant margin of error in calculating both storage change and boundary flows. The overdraft estimates are only for the unconfined aquifer and do not include any external boundary flow estimates, from either the unconfined or confined aquifer, as the GSAs will need to further evaluate how these external boundary flows are going to be addressed with the neighboring basin GSAs. The initial values do not consider James pumping in McMullin GSA. The GSAs agree to evaluate and adjust these values regularly in future years as additional information is collected and estimates of storage change are updated.

GSA	Proposed Initial Responsibility (AF)
Central/South	-7,100
James	16,700
Kings River East	-11,000
McMullin	-91,100
North Fork	-50,300
North Kings	20,800
Total	-122,000

V. Description of Kings Subbasin Coordinated Water Budget

As provided for in SGMA, coordinated water budgets were prepared by Kings Subbasin Groundwater Sustainability Agencies (GSA). The water budgets quantify the components of water supply and use along with change in groundwater in storage. The coordinated 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

In developing the initial Groundwater Sustainability Plans (GSP), the Kings Subbasin GSAs have regularly coordinated and have used consistent approaches to groundwater budget development. The methods used in the initial GSPs are described generally below and may vary somewhat depending on what kind of water budget (historical, current or projected) is being discussed. The Kings Subbasin GSAs intend on continuing to coordinate in development of water budgets in the future and will revise this exhibit as necessary to meet future management needs and data availability.

The historical, current and projected water budgets for the Kings Subbasin 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 Susbasin, limited data availability for model development purposes and limited time available for refinement, calibration and validation of a model. The use of an analytical water budget (spreadsheet) 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 which does not explicitly identify the data source or computation method. Overall, the GSAs in the Kings Basin mutually agreed that an analytical water budget would be a more practical and useful tool, at least initially, and therefore offer greater value in managing groundwater. Much of the data developed as part of the analytical water budget will be used as model input if the existing Kings Subbasin numerical model is updated in the future.

The Kings Subbasin Coordinated Water Budgets quantify the following information in accordance with SGMA §354.18 (b):

(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.

The water budget information listed above is described first for the historical 15-year period of Water Years 1996/97-2010/11 (WY 1997-2011). This historical period was selected by the Kings Subbasin based on average surface water delivery amounts during the period compared to long term records, since average surface water deliveries would equate to average groundwater pumping. While a more recent historical period would have been ideal, unfortunately extreme drought conditions between 2012 and 2016 would have made this impractical.

Total Surface Water

During the WY 1997-2011 historical period, records were available for most surface water supplies entering or leaving the Kings Subbasin. Records of the largest surface water amounts (Kings River diversions) from major divertors were summarized for each GSA for the historical period for irrigation and municipal purposes, and for recharge. The Kings River diversion records were headgate diversions, so canal losses were also included. Records of smaller Kings River and San Joaquin River diversions were estimated based on crop acreage amounts and evapotranspiration estimates. Precipitation to each Kings Subbasin GSA was estimated based on available precipitation records, with isohyetal contour maps used to determine average quantifies for specific GSAs. Lesser amounts of surface water derived from minor streams were estimated based on limited available direct measurements and correlations with other small watersheds based on watershed areas and average precipitation amounts.

Groundwater System Inflows

Groundwater system inflows are not directly measured for the most part and were estimated directly (where possible) or based on related parameters. The largest groundwater system inflow in the Kings Subbasin, deep percolation of irrigation water, was quantified based on estimated water use and irrigation efficiencies, with deep percolation computed as the difference between estimated total applied water and evapotranspiration of applied water. Water use for the historical period was estimated based on unit evapotranspiration of applied water and land use interpolated from available DWR crop survey information for the historical period. The unit evapotranspiration of applied water estimates for the historical period were based on DWR estimates of unit water use developed for Detailed Analysis Units as background information for the California Water Plan.

Deep percolation of municipal and industrial water was estimated based on applied water use with reductions for evapotranspiration of applied water and allowance for recharge of treated wastewater. Seepage to groundwater of irrigation conveyance and reservoirs was estimated based on limited investigations of channel seepage in Kings Subbasin irrigation districts, with loss estimates applied to total diversion amounts.

Lesser amounts of groundwater inflows (from precipitation, subsurface inflow, river seepage and minor streams) were all estimated. Groundwater percolation from precipitation was estimated based on total precipitation using procedures from the Department of Water Resources to estimate the portion of total precipitation that results in groundwater recharge. Subsurface inflows to GSAs were determined for the unconfined aquifer based on gradients from groundwater contour maps each year and groundwater transmissivities for boundaries between GSAs and with other Subbasins. Total minor stream flows were reduced by runoff outside of the Subbasin to quantify recharge from that source.

Groundwater System Outflows

The largest quantity of groundwater system outflows in the Kings Subbasin is groundwater pumping. Groundwater pumping for irrigation is not directly measured for the most part and was estimated based on crop consumptive use, crop acreages and irrigation efficiencies, with adjustments for cropland surface water deliveries. The data used for the crop consumptive use estimates was primarily from DWR sources, as described in the Outflows from Groundwater System section of the GSPs. Records of groundwater pumping for municipal uses were obtained from municipal agencies when available and estimates for individual domestic pumpers were estimated based on population and approximate unit use. Unconfined aquifer subsurface outflows from GSAs were estimated using the same procedure previously described for use in estimating unconfined subsurface inflows. Confined aquifer subsurface outflows to adjacent subbasins was estimated in a similar manner as the unconfined aquifer outflows. Insufficient data was available to estimate confined aquifer flows between GSAs within the Kings Subbasin.

Change in Groundwater Storage

Differences in groundwater inflows and outflows result in changes to groundwater storage, either in the unconfined aquifer or the confined aquifer. The larger amount of groundwater storage change in the Kings Subbasin occurs in the unconfined zone. This unconfined groundwater storage change was estimated annually for Kings Subbasin GSAs based on changes in yearly groundwater contour maps and specific yields estimates. Confined groundwater storage change was less common in the Kings Subbasin, occurring only in confined zones on the western side of the subbasin. Confined groundwater storage change was not quantified because of lack of confined groundwater level data, but estimates were made for several GSAs based on surface land subsidence estimates which is equivalent to the volume of water occurring in subsurface clays when groundwater levels fall below historical minimums.

Overdraft

Overdraft is defined as groundwater storage change during a period when groundwater extractions exceed groundwater recharge. An initial estimate of overdraft was based on estimated storage change (unconfined and confined) for the historical WY 1997-2011 period, which had approximately average water supply conditions. In GSAs with changing land use, the computed change in groundwater storage for current conditions can be adjusted upwards or downwards based on current water use estimates.

Water Year Types

Water year types were identified for the Kings Subbasin based on review of historical diversion records for the period 1955 through 2018. Kings River diversions to Kings Subbasin GSAs (which are the primary water supply source to the Kings Subbasin) were tabulated and segregated into three categories – Dry, Normal and Wet. Wet Year types were defined as years when Kings River diversions were greater than 125% of the long-term average and Dry Year Types were defined as years when Kings River diversions were less than 75% of the long-term average. Normal years occurred when Kings River diversions were between 75% and 125% of the long-term average. Water supply parameters for the historical period were grouped into the water year types and 50-year averages summarized in the water budget.

Sustainable Yield

Sustainable yield is a level of groundwater use that results in avoidance of undesirable results for sustainability indicators in the groundwater basin. A water budget resulting in no ongoing storage change under average conditions was used as the basis for determining sustainable yield, in addition to localized review for areas with potential undesirable results. In general, reductions in water use equivalent to estimated groundwater storage change in the current and projected water budgets were used as the basis for determining the sustainable yield. The quantity of groundwater pumping for current and projected conditions can be reduced by the amount of ongoing storage decrease, with adjustment for deep percolation of pumped overdraft quantities.

Current Water Budget

The current water budget was developed to represent groundwater conditions for current levels of water supply and water use on a long-term average basis. For the Kings Subbasin, Kings River water supplies during the historical average period were used as the basis for the current water budget. The water supply estimates for sources with regulatory changes, such as the CVP Friant Kern Canal, were adjusted based on available operations studies. Other water supply amounts were left the same as historical amounts for the current water budget.

The major changes for the current water budget were made to water use. Estimated irrigation and municipal and industrial water use estimates were updated to current levels based on the most recent land use and population estimates. For irrigation water use, unit water use amounts for the historical period obtained from DWR were used together with the 2014 land use to develop an updated current water use estimate. This current irrigation water use estimate was then used to compute related factors, such as deep percolation of irrigation water and groundwater pumping. Municipal and industrial water use was similarly updated based on unit per capita water use rates and more recent population estimates. Other water use parameters were kept the same as for the historical period.

Groundwater storage change for the current water budget was estimated directly through the water budget itself. A computation of actual groundwater storage change for a recent historical period would not correspond to average conditions, and one-year storage change estimates are subject to a greater degree of uncertainty than long-term storage change estimates due to uncertainties in factors such as the time lag for recharge to impact the aquifer.

Projected Water Budget

Projected water budgets for the Kings Subbasin for early future (2040) and late future (2070) were estimated similarly to the current water budget, with additional adjustments to reflect climate change conditions and management practices.

Water supplies for the Kings Subbasin were reviewed for climate change effects on runoff patterns and ultimately most were left unchanged. The climate change projections for Kings River runoff show a very slight increase in total runoff with a relatively large shift in the timing of runoff. Runoff (presumably from rainfall) increased significantly in the winter and early spring and was reduced in late spring and summer. Due to the lack of analytical ability to quantify the effects of these changes, along with the ability of Kings Subbasin water managers to accommodate changes in runoff timing through storage in Pine Flat Reservoir and other management actions, the historical water supplies from the Kings River were assumed to remain consistent into the future.

Water supplies for the Friant Kern Canal were updated for early future and late future climate conditions based on DWR CALSIM projections with climate change, as adjusted by the Friant Water Authority.

No change was made to water supply from precipitation for early future and late future climate conditions. The climate change projections indicate a very slight increase in precipitation during the November through April rainfall season. Based on the slight precipitation increase and the generally negligible effect of precipitation on overall water supply, the historical estimates of precipitation were used for future projections. Other water supply components were similarly left unchanged from historical levels.

The climate change forecasts indicate that the major change for projected water conditions is likely to occur through increased evapotranspiration. Projected evapotranspiration rates from climate change models were estimated for Kings Subbasin

GSAs and showed increases for early future and late future levels. While increased evapotranspiration rates appear to result in direct increases for perennial crops, USBR analyses indicate that for annual crops they result primarily in a shift in crop timing without an overall water use increase. To account for these differences, the increased evapotranspiration rates were used to adjust perennial crop unit water use rates while unit water use rates for annual crops were left constant.

Groundwater storage change for the projected water budgets was determined directly through the water budget. In addition to the historical water use and water supply components, the projected water budgets also include estimates of supply projects and management actions that are planned for implementation by Kings Subbasin GSAs. These anticipated projects and management actions show sustainability for the early future (2040) water budgets as well as sustainability for the late future (2070) water budgets.

Appendix 1 B GSP Checklist

Preparation Checklist for GSP Submittal

GSP Regulations Section	Water Code Section	Requirement	Description	NFKGSA GSP Section(s)
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	5.2, 5.3, 5.5, 5.6, 5.7 5.2.6, 5.3.6, 5.5.6, 5.6.6, 5.7.6
Article 5. Plan Contents, Subarticle 1. Administrative Information				
354.4		General Information	• Executive Summary • List of references and technical studies	ES 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	1.5
354.8(a)	10727.2(a)(4)	Map(s)	• Area covered by GSP • Adjudicated areas, other agencies within the basin, and areas covered by an Alternative • Jurisdictional boundaries of federal or State land • Existing land use designations • Density of wells per square mile	2 (Figure 2-1) 2 (Figure 2-2) 2 (Figure 2-8) 2, 2.1 (Figure 2-4) 2.1 (Figure 2-5)

GSP Regulations Section	Water Code Section	Requirement	Description	NFKGSA GSP Section(s)
354.8(b)		Description of the Plan Area	• Summary of jurisdictional areas and other features	2.1
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	2.2 2.2 2.2 2.2
354.8(f)	10727.2(g)	Land Use Elements or Topic Categories of Applicable	• Summary of general plans and other land use plans	2.3, 2.3.1

GSP Regulations Section	Water Code Section	Requirement	Description	NFKGSA GSP Section(s)
		General 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	2.3.2 2.3.3 2.3.4 2.3.5
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	2.4, 2.4.1 2.4.2 2.4.3 2.4.4 2.4.5 2.4.5 2.4.6 2.4.7, 2.2.1, 2.2.2 2.4.8, 2.2.1

GSP Regulations Section	Water Code Section	Requirement	Description	NFKGSA GSP Section(s)
			• 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	2.4.9 2.4.10 2.4.11
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	2.5, 2.5.1 2.5.1 (Table 2-3) 2.5.3 2.5.3 2.5.4 2.5.4.5

GSP Regulations Section	Water Code Section	Requirement	Description	NFKGSA GSP Section(s)
Article 5. Plan Contents, Subarticle 2. Basin Setting				
354.14		Hydrogeologic Conceptual Model	• Description of the Hydrogeologic Conceptual Model • Two scaled Cross-sections • Map(s) of physical characteristics: topographic information, surficial geology, soil characteristics, surface water bodies, source and point of delivery for imported water supplies	3.1 3.1.7 3.1.4 (Figure 3-15, 3-16) (Figure 3-4, 3-6, 3-7, 3-14, 3-17, 3-18, 3-19, 3-21, 3-22)
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	3.1.12 (Figure 3-23)
	10727.2(d)(4)	Recharge Areas	• Description of how recharge areas identified in the plan substantially contribute to the replenishment of the basin	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	3.2, 3.2.1 3.2.3 3.2.4 3.2.5 3.2.6 3.2.7 3.2.8

GSP Regulations Section	Water Code Section	Requirement	Description	NFKGSA GSP Section(s)
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	3.3, 3.3.3-3.3.7 3.3.11 3.3.13 3.3.5, 3.3.8, 3.3.9, 3.3.10 (Tables 3-17 to 3-21)
	10727.2(d)(5)	Surface Water Supply	• Description of surface water supply used or available for use for groundwater recharge or in-lieu use	3.4, 3.1.10, 3.1.11, 3.1.12
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	3.5
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria				
354.24		Sustainability Goal	• Description of the sustainability goal	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	4.2.1, 4.3.1, 4.5.1, 4.6.1, 4.7.1

GSP Regulations Section	Water Code Section	Requirement	Description	NFKGSA GSP Section(s)
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	4.2.2, 4.3.2, 4.5.2, 4.6.2
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	4.2.3, 4.3.3, 4.5.3, 4.6.3 4.7.2 4.8

GSP Regulations Section	Water Code Section	Requirement	Description	NFKGSA GSP Section(s)
Article 5. Plan Contents, Subarticle 4. Monitoring Networks				
354.34	10727.2(d)(1)	Monitoring	• Description of monitoring network	5.1
			• Description of monitoring network objectives	5.1.1 to 5.2.1
			• 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	5.1.1, 5.2.1, 5.3.1, 5.5.1, 5.6.1, 5.7.1
			• Description of how the monitoring network provides adequate coverage of Sustainability Indicators	
	10727.2(d)(2)	Networks	• Density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends	5.2.3, 5.3.3, 5.5.3, 5.6.4 5.7.3
	10727.2(e)		• Scientific rational (or reason) for site selection	5.2, 5.3, 5.5, 5.6, 5.7
	10727.2(f)		• Consistency with data and reporting standards	
			• Corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone	

GSP Regulations Section	Water Code Section	Requirement	Description	NFKGSA GSP Section(s)
			(Monitoring Networks Continued) • 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	5.2.5 (Figure 5-1) 5.2
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	5.3, 5.3.7 5.3 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	5.2.8, 5.3.8, 5.5.8, 5.6.8 5.7.8 5.2, 5.3, 5.5, 5.6, 5.7 (Figures 5-2, 5-3, 5-4, 5-5)

GSP Regulations Section	Water Code Section	Requirement	Description	NFKGSA GSP Section(s)
Article 5. Plan Contents, Subarticle 5. Projects and Management Actions				
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 • Time-table 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	6.2, 6.3
354.44(b)(2)	10727.2(d)(3)		• Overdraft mitigation projects and management actions	6.2, 6.3

Appendix 2 A James GSA Memorandum of Understanding

MEMORANDUM OF UNDERSTANDING
FOR IMPLEMENTATION OF THE
SUSTAINABLE GROUNDWATER MANAGEMENT ACT

THIS MEMORANDUM OF UNDERSTANDING ("MOU") is made and effective as of December 17, 2015 by and between James Irrigation District (the "James ID") and Reclamation District 1606 (the "RD 1606"). The James ID and RD 1606 are collectively referred to herein as the "Parties" and individually as a "Party." This MOU is made with reference to the following facts:

A. The State of California has enacted the Sustainable Groundwater Management Act (contained in SB 1168, AB 1739 and SB 1319), referred to in this MOU as the "Act", pursuant to which certain local agencies may become a groundwater sustainability agency and adopt a groundwater sustainability plans in order to manage and regulate groundwater in underlying basins.

B. The Act, more specifically California Water Code section 10735.2, provides that the State Water Resources Control Board may designate a basin as probationary after June 30, 2017 if a groundwater sustainability agency ("GSA") or a collection of GSAs has not been formed to develop a groundwater sustainability plan ("GSP") for the entire basin.

C. The Act further provides that the State Water Resources Control Board may designate a basin as probationary after January 31, 2020 if a GSP, or collection of GSPs, is not adopted for the entire basin, but excluding portions of a basin where a GSA is demonstrating compliance with the sustainability goal.

D. The Parties overlie a portion of the Kings Groundwater Sub-basin ("Basin") as defined in the current version of the California Department of Water Resources Bulletin 118.

E. Other local agencies overlying the Kings Groundwater Sub-basin intend to form one or more GSAs and collectively develop one or more GSPs for the entire basin, and it is contemplated the GSA for the Party's collective region will develop a coordination plan or agreement as provided at water Codes Section 10727.6 with the other local agencies overlying the Kings Groundwater Sub-basin..

F. The Parties, in order to coordinate groundwater management activities and to comply with the Act, desire to form a GSA for the region that generally includes the collective jurisdictional boundaries of the Parties.

G. In order to accomplish this desire, the Parties wish to define their respective roles, responsibilities, and obligations.

H. This MOU is intended to be an agreement as authorized by Water Code Section 10723.6(a)(2).

THEREFORE, in consideration of the mutual promises, covenants and conditions set forth in this MOU, the Parties agree as follows:

1. Purpose and Intent. The Parties hereby affirm that they have joined together for the purpose of forming a GSA to comply with the Act. The intent of this MOU is to establish a process by which the Parties may jointly and cooperatively take steps necessary to consider formation of a GSA.

2. Effective Date and Termination. This MOU shall become effective upon its execution by all Parties. Any party may withdraw from this MOU by giving thirty (30) days written notice of its election to withdraw to the other Parties. If not otherwise provided in the notice of termination, a notice of termination shall be effective immediately upon receipt by the other Parties.

3. Roles and Responsibilities. The James ID shall serve as the Coordinator for the Parties acting jointly under the MOU. As Coordinator, James ID shall facilitate meetings among the Parties. Each Party shall appoint a representative and the parties shall meet as required to discuss and coordinate any actions needed to form the GSA. The James ID shall hold a public hearing to consider formation of the GSA as required in California Water Code section 10723. If a decision is made to form the GSA, James ID shall prepare and submit the required notification under CWC section 10723.8.

4. Financial Obligations. Each Party shall bear its own costs associated with activities performed under this MOU. No Party shall incur debts, liabilities or obligations on behalf of any other Party to this MOU.

5. Ongoing Cooperation. The Parties acknowledge that activities under this MOU will require the frequent interaction between them in order to exploit opportunities and resolve issues that arise. The Parties shall work cooperatively and in good faith. Notwithstanding the foregoing, nothing in this MOU shall be interpreted so as to require the Parties to singly or jointly implement any actions contemplated by this MOU, including forming or supporting the formation of a GSA, and each Party reserves the unrestricted authority and right to exercise their lawful discretion in matters pertaining to compliance with the Act.

6. Governance. In order to facilitate the formation of the GSA, the Parties agree that the GSA shall be governed by a board of five directors and the directors shall be appointed by the Parties as follows: four directors shall be appointed by the James ID and one director shall be appointed by Reclamation District 1606. The directors may be elected officials, appointed officials, agency employees, landowners, or residents.

7. Entire Agreement. This MOU constitutes the entire agreement between the Parties with respect to the subject matter hereof. All prior agreements with respect to that subject matter, whether verbal or written, are hereby superseded in their entirety by this MOU and are of no further force or effect. Amendments to this MOU shall be effective only if in writing, and then only when signed by the authorized representatives of the respective Parties.

8. Severability. 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. Ambiguities. This MOU shall be interpreted as if it had been jointly drafted by all of the Parties. Therefore, the normal rule of construction that ambiguities are construed against the drafter is hereby waived.

10. No Third Party Beneficiaries. This MOU does not create, and shall not be construed to create, any rights enforceable by any person, partnership, corporation, joint venture, limited liability company or other form of organization or association of any kind that is not a party to this MOU.

11. Counterparts. This MOU may be executed in counterparts, with all of such executed counterparts together constituting a single, original document. Facsimile and electronic signatures shall be effective for all purposes.

12. Notices. Notices authorized or required to be given under this MOU 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 parties beneath their signatures on this MOU, or to such other address as a Party may provide to the other Parties from time to time.

13. Authority. Each of the individuals signing this MOU on behalf of a Party hereby represents and warrants he or she has the authority to execute this MOU on behalf of such Party and that the governing body of such Party has duly approved the execution of this MOU on behalf of that Party.

14. Governing Law. This MOU shall be governed by and construed according to the laws of the State of California.

IN WITNESS WHEREOF, the Parties have executed this MOU as of the date first above written.

JAMES IRRIGATION DISTRICT

By: ______________________
Steven Stadler, P.E., General Manager

RECLAMATION DISTRICT 1606

By: ______________________
Jerome Salvador, President

Appendix 2 B Outreach Strategy

JAMES GROUNDWATER SUSTAINABILITY AGENCY

BOARD OF DIRECTORS
Riley Chaney, President
William Cory Carvahlo, Vice President
Steven Stadler, Executive Director
Thomas W. Chaney, Director
Robert Motte, Director

8749 Ninth Street
Post Office Box 757
San Joaquin, California 93660-0757

Telephone: (559) 693-4356
Facsimile: (559) 693-4357

DATE: January 18, 2017

TO: James Groundwater Sustainability Agency Directors

FROM: Steven Stadler, P.E., Executive Director

SUBJECT: Outreach Plan

Following is an outline plan of outreach activities that are proposed during the development and implementation of the Groundwater Sustainability Plan (GSP). Certain outreach activities are required under the Sustainable Groundwater Management Act of 2014 and emergency regulations adopted by the Department of Water Resources. Other outreach activities listed below are not mandatory but encouraged.

<u>Interested Parties</u>. The GSA is required to maintain an Interested Party List and provide certain notices and information to interested parties. In addition to these mandatory communications, the GSA will have workshops to inform interested parties and others about the Sustainable Groundwater Management Act (SGMA) and the district's efforts to develop and implement a GSP per that act.

<u>Advisory Committee</u>. The GSA may create an Advisory Committee and appoint members to the committee. It is anticipated that the Advisory Committee would meet quarterly or as frequently as required. The GSA may consider appointing representatives from the County of Fresno and the Kings River Conservation District to the Advisory Committee.

<u>Newsletter</u>. The GSA may create a newsletter and provide it to interested parties and landowners. The newsletter would likely be an annual publication and would be issued between the winter and summer issue of the James Irrigation District newsletters.

<u>Workshops</u>. The GSA will have workshops to inform interested parties and others about the Sustainable Groundwater Management Act (SGMA) and the district's efforts to develop and implement a GSP per that act. The GSA may also hold single-issue workshops to obtain information that will assist in the development and implementation of the GSP. The workshops would be held as frequently as quarterly.

<u>Information Sheet</u>. The GSA will develop a one-page information sheet explaining its role in the implementation of SGMA. The information sheet may define key terms and include responses to frequently asked questions.

<u>Other Activities</u>. This outline plan is not comprehensive and other activities may be undertaken as needs or opportunities arise.

Appendix 2 C SGMA Stakeholders Survey

JAMES GROUNDWATER SUSTAINABILITY AGENCY

BOARD OF DIRECTORS
William Cory Carvalho, President
Micah Combs, Vice President
Robert Motte, Director
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Telephone: (559) 693-4356
Facsimile: (559) 693-4357

DATE: January 27, 2020

TO: James Groundwater Sustainability Agency Directors

FROM: Steven Stadler, P.E., Executive Director

SUBJECT: SGMA Stakeholders Survey

The Groundwater Sustainability Plan ("GSP") adopted by the James Groundwater Sustainability Agency ("James GSA") on December 12, 2019 contained a reference to a SGMA Stakeholders Survey in the Table of Contents. This memorandum is intended to document the absence of the SGMA Stakeholders Survey in the GSP.

The Outreach Strategy and Plan contained in the GSP did not contemplate performing a Stakeholders Survey because sufficient stakeholder engagement was sought and obtained during the development of the draft GSP. The Advisory Committee that was formed contained a number individuals and agencies representing various groundwater users and interests in the James GSA area and the Kings Subbasin. Furthermore, various other interested parties participated in the Advisory Committee meetings and provide their input and opinion directly through that process. Other irrigation and municipal water users were contacted and input was provided through outreach conducted by the James GSA and the James Irrigation District. Lastly, participation by environmental and social justice representatives in these forums was limited and input from these organizations was sought and obtained directly. More specifically, Self-Help Enterprises, the Community Water Center, and the Leadership Counsel for Justice and Accountability were contacted, conditions in the GSA plan area were discussed, and the James GSA received input which was incorporated into the adopted GSP. Given the amount and breadth of stakeholder involvement, it was felt that performing a SGMA Stakeholder Survey would not have provided further meaningful information and the activity was excluded from the Outreach Plan.

Appendix 3 A Kings Subbasin GSA Coordination Efforts Technical Memoranda 1-6

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.

Est. 1972

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).

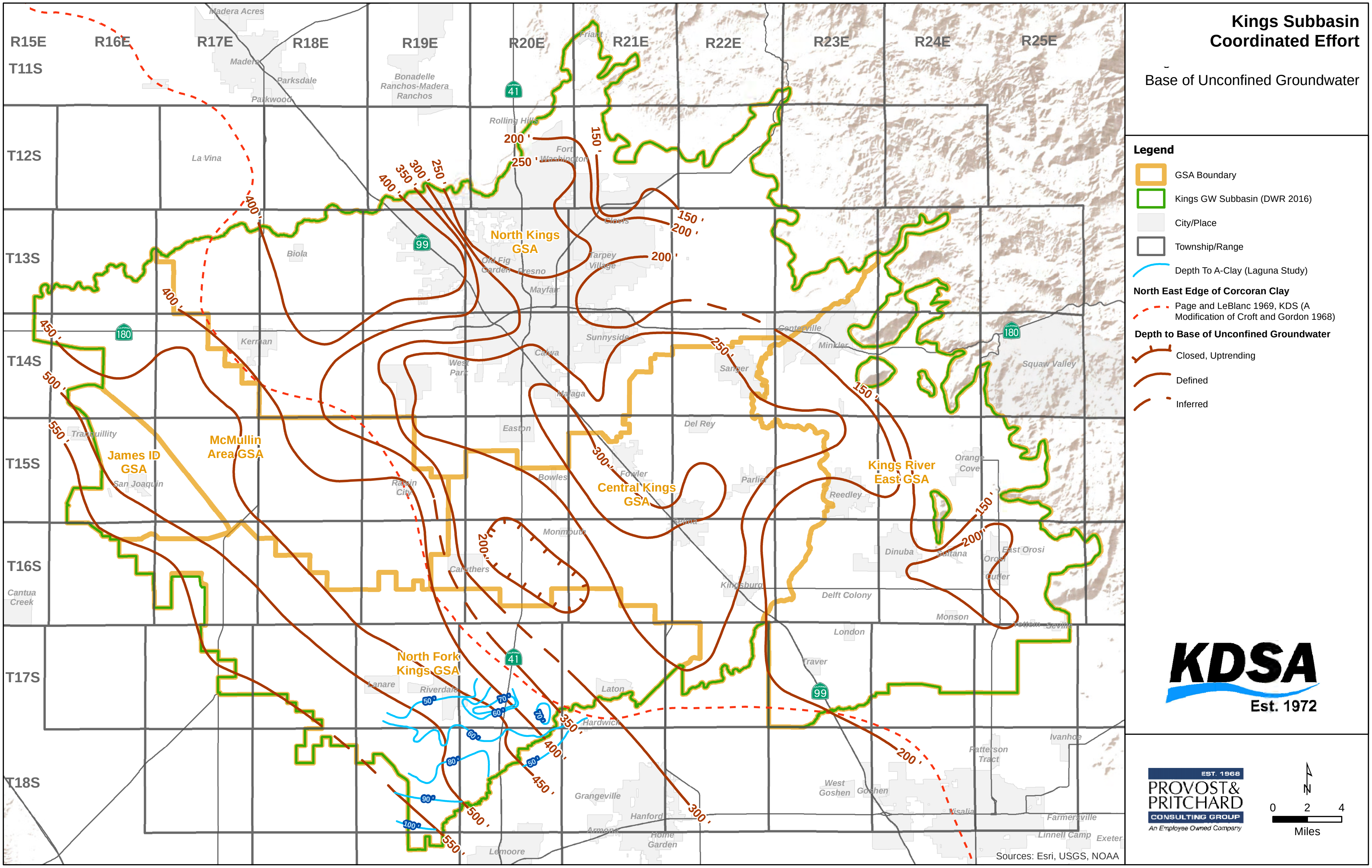
UNCONFINED GROUNDWATER IN THE KINGS SUB-BASIN

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.



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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.

KINGS SUBBASIN GSA COORDINATION EFFORTS

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 Area 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

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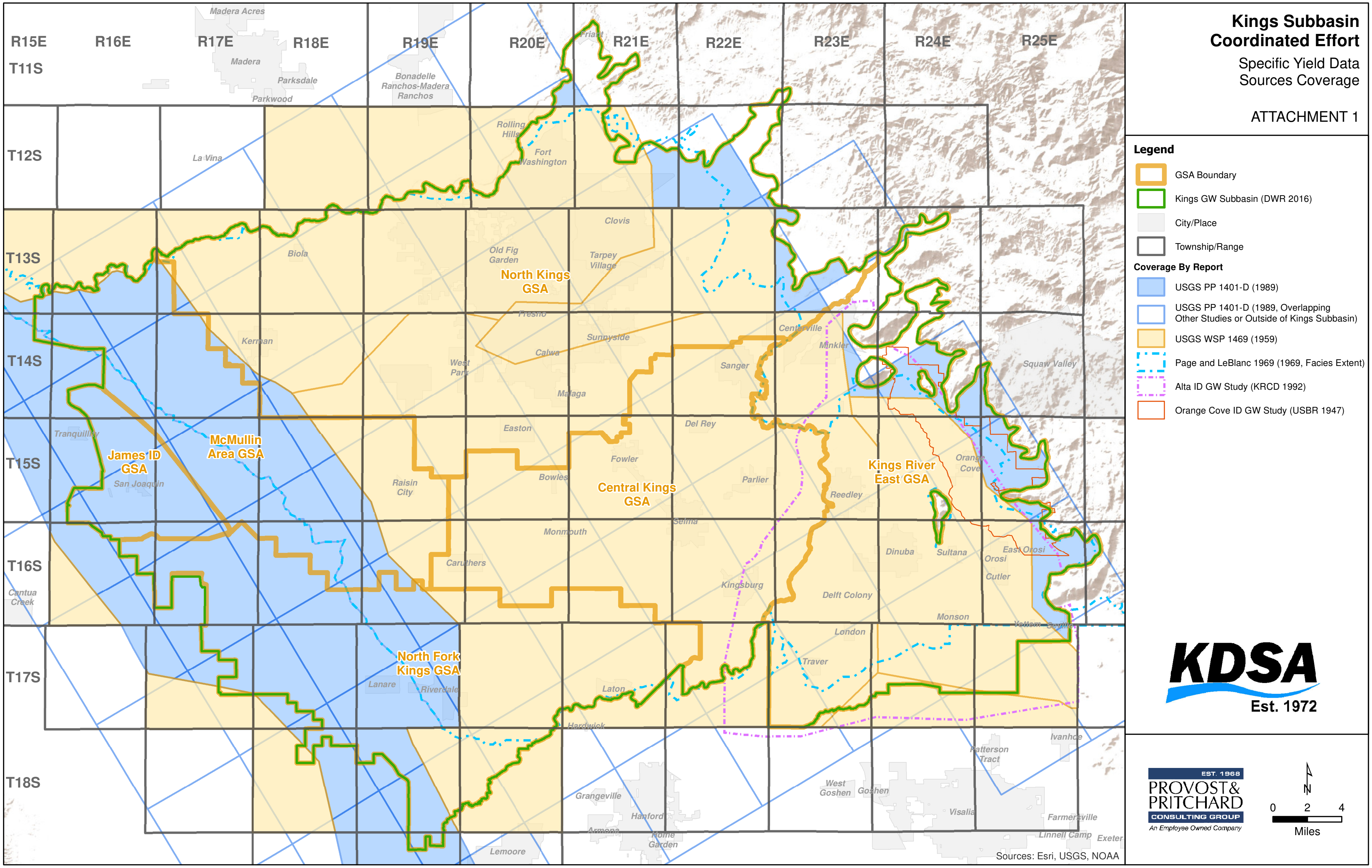
Attachments 1

Kings Basin, Specific Yield Data Sources Coverage



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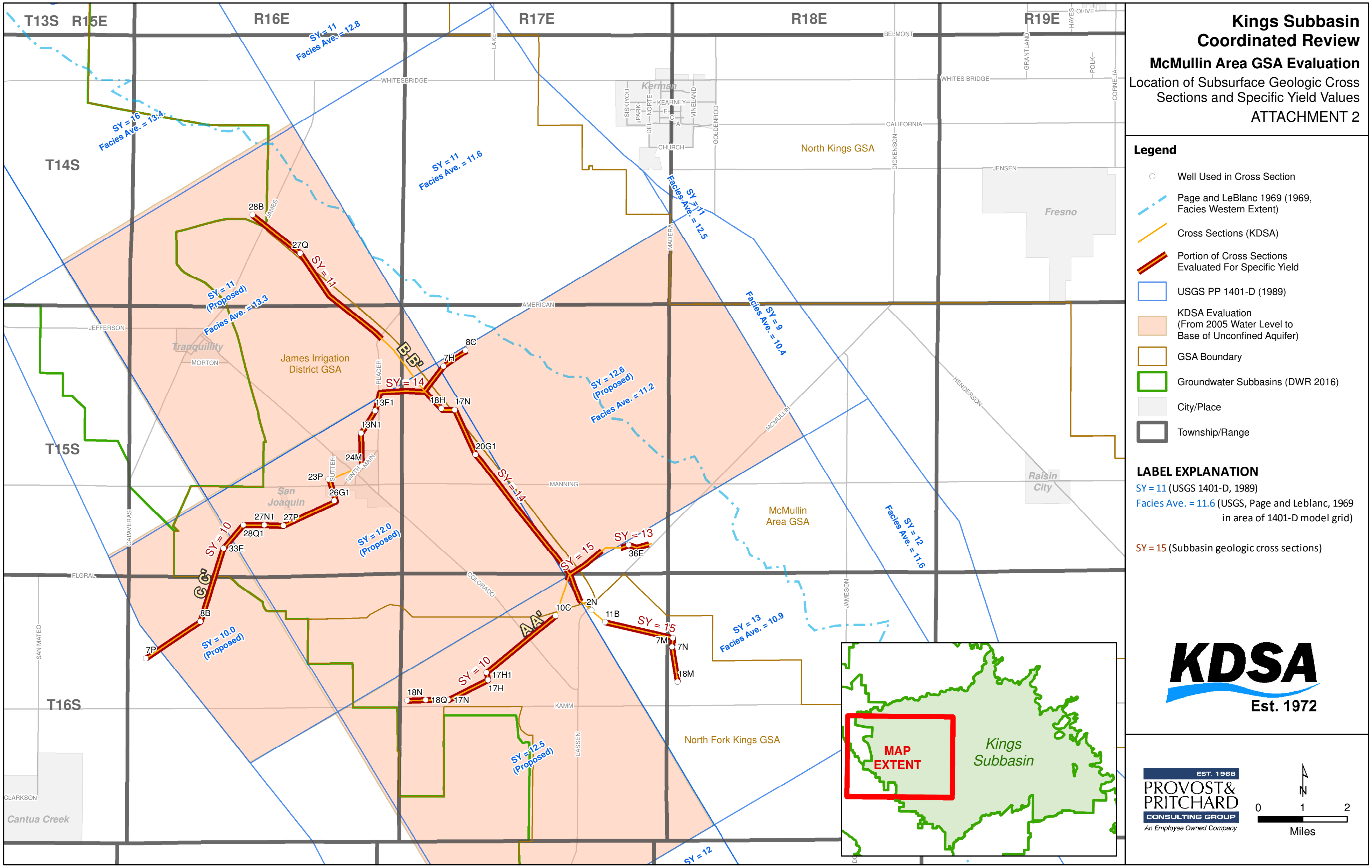
Attachments 2

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.

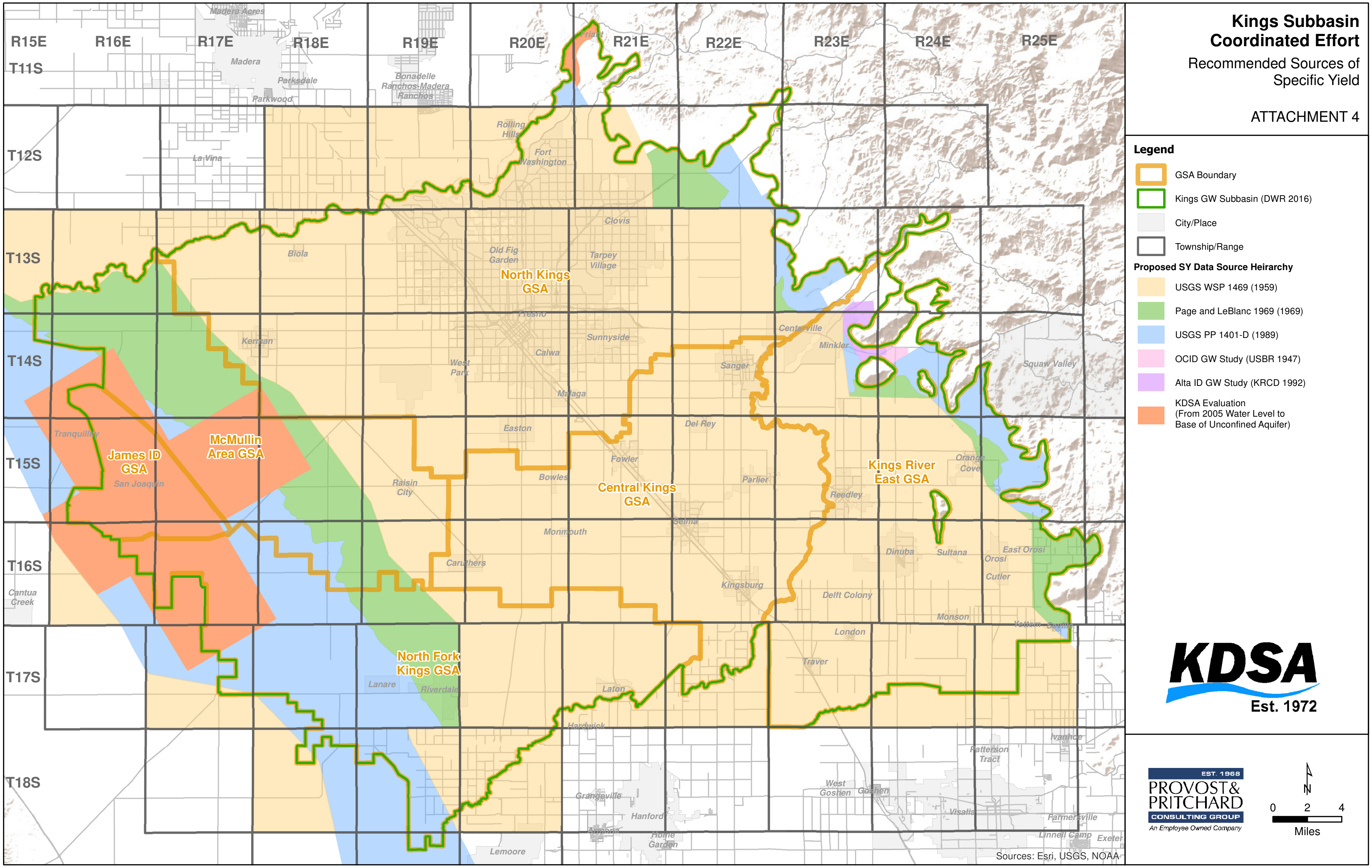
Cross Section B-B′ extends along the Fresno Slough. Fifteen wells with good logs were selected for evaluation. The northwestmost segment evaluated comprised five wells (28B to C-65). Specific yields ranged from 9 to 15 percent and averaged 11 percent. The closest 1401-D T&R values ranged from 10 to 11 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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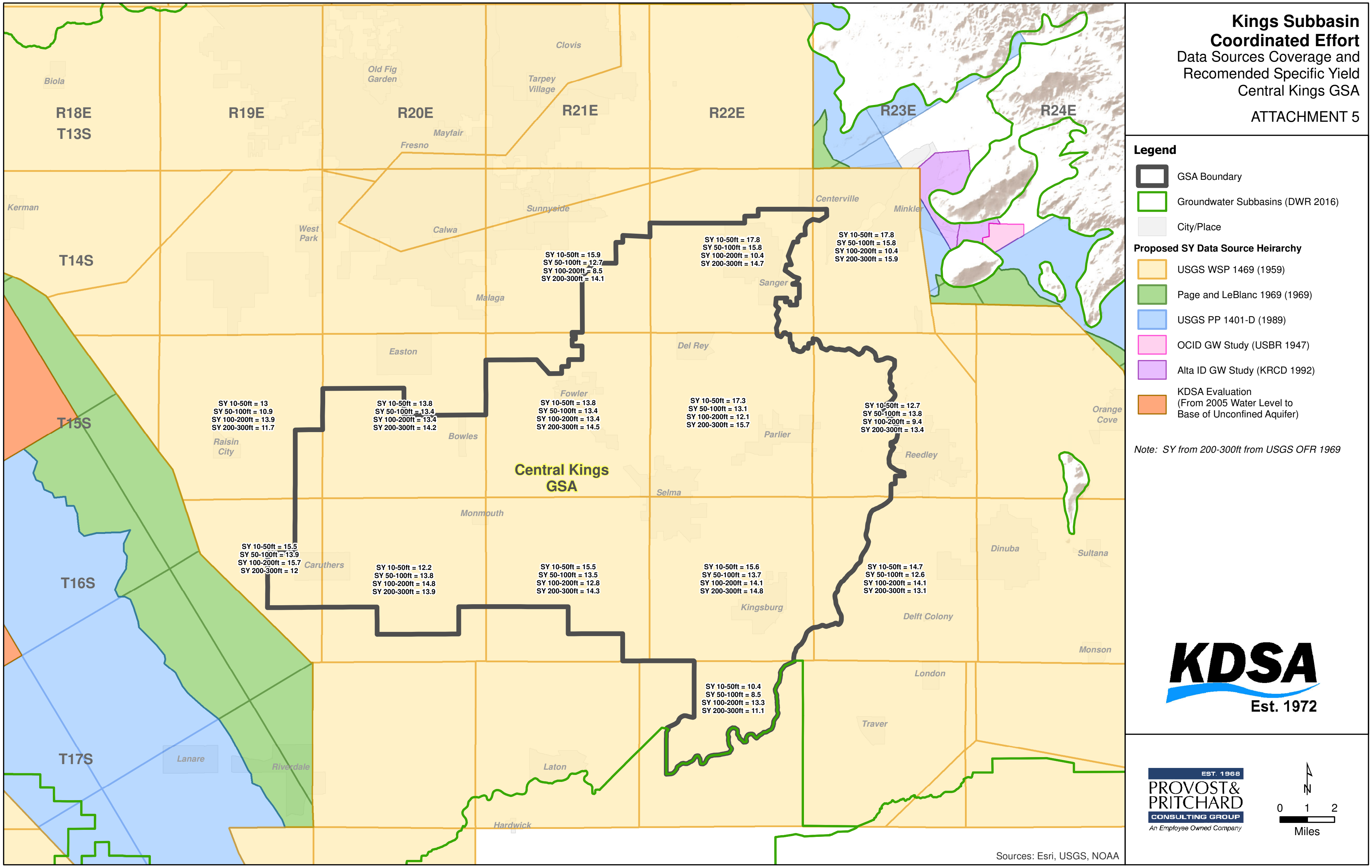
Attachments 5

Central Kings GSA, Data Sources and Recommended Specific Yield



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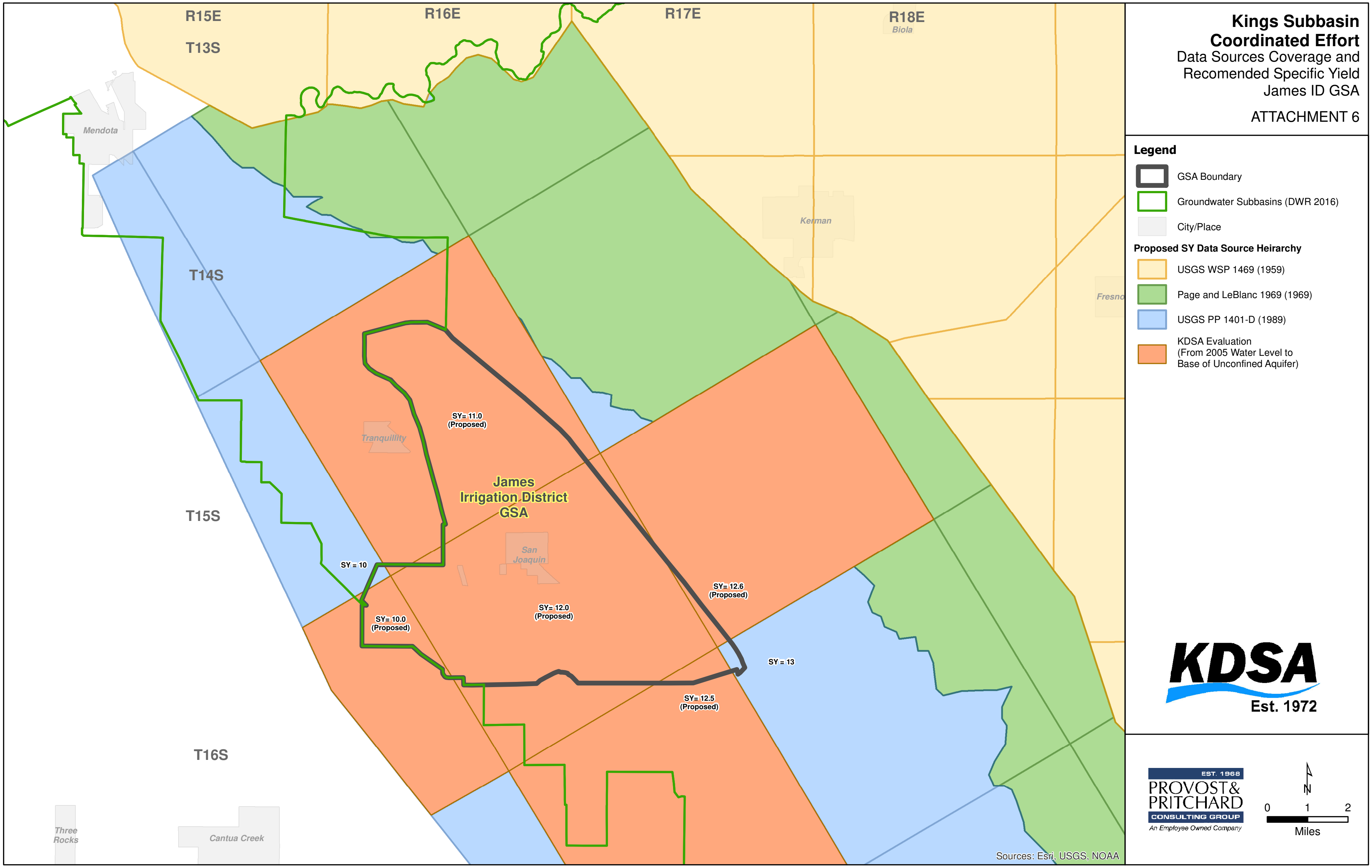
Attachments 6

James ID GSA, Data Sources and Recommended Specific Yield



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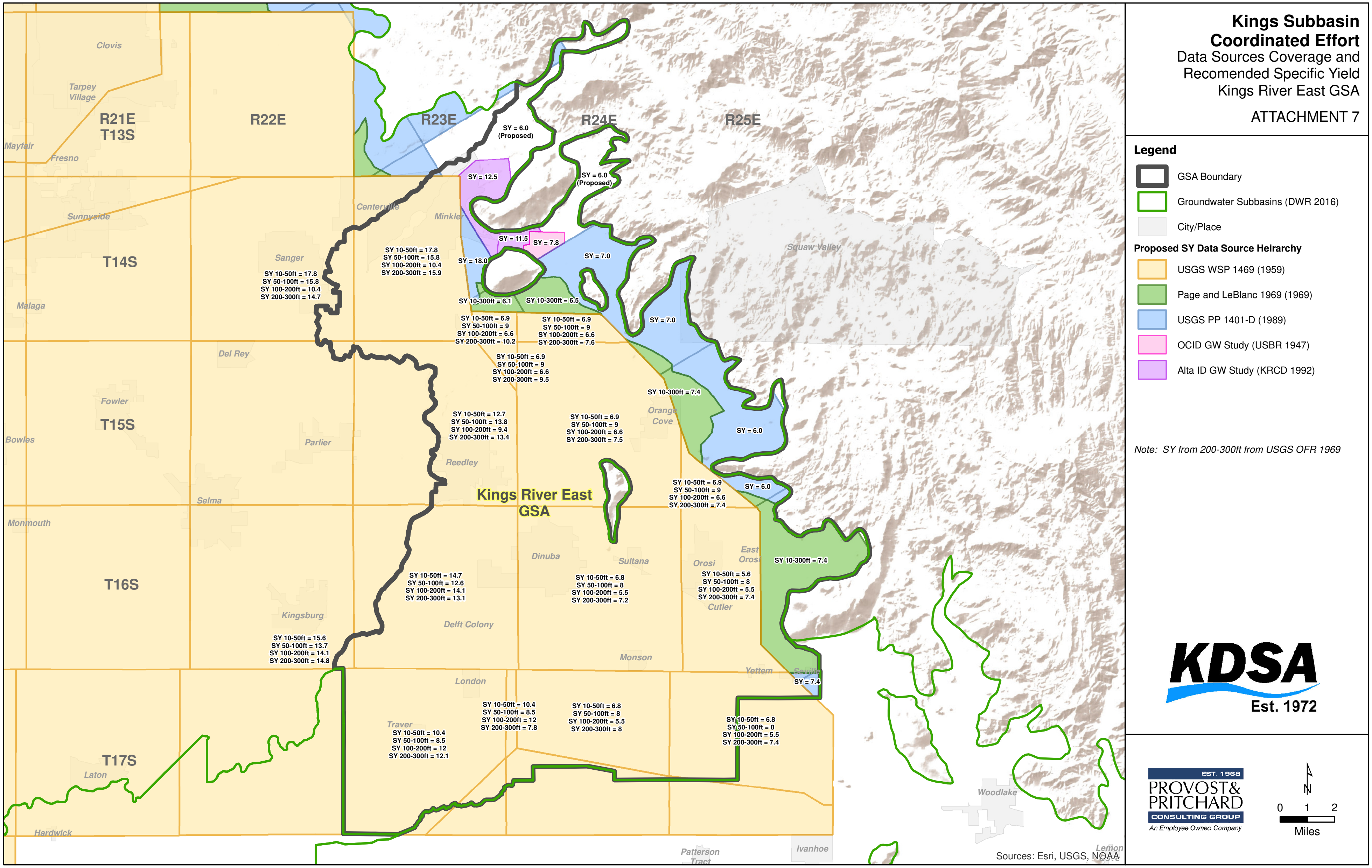
Attachments 7

Kings River east GSA, Data Sources and Recommended Specific Yield



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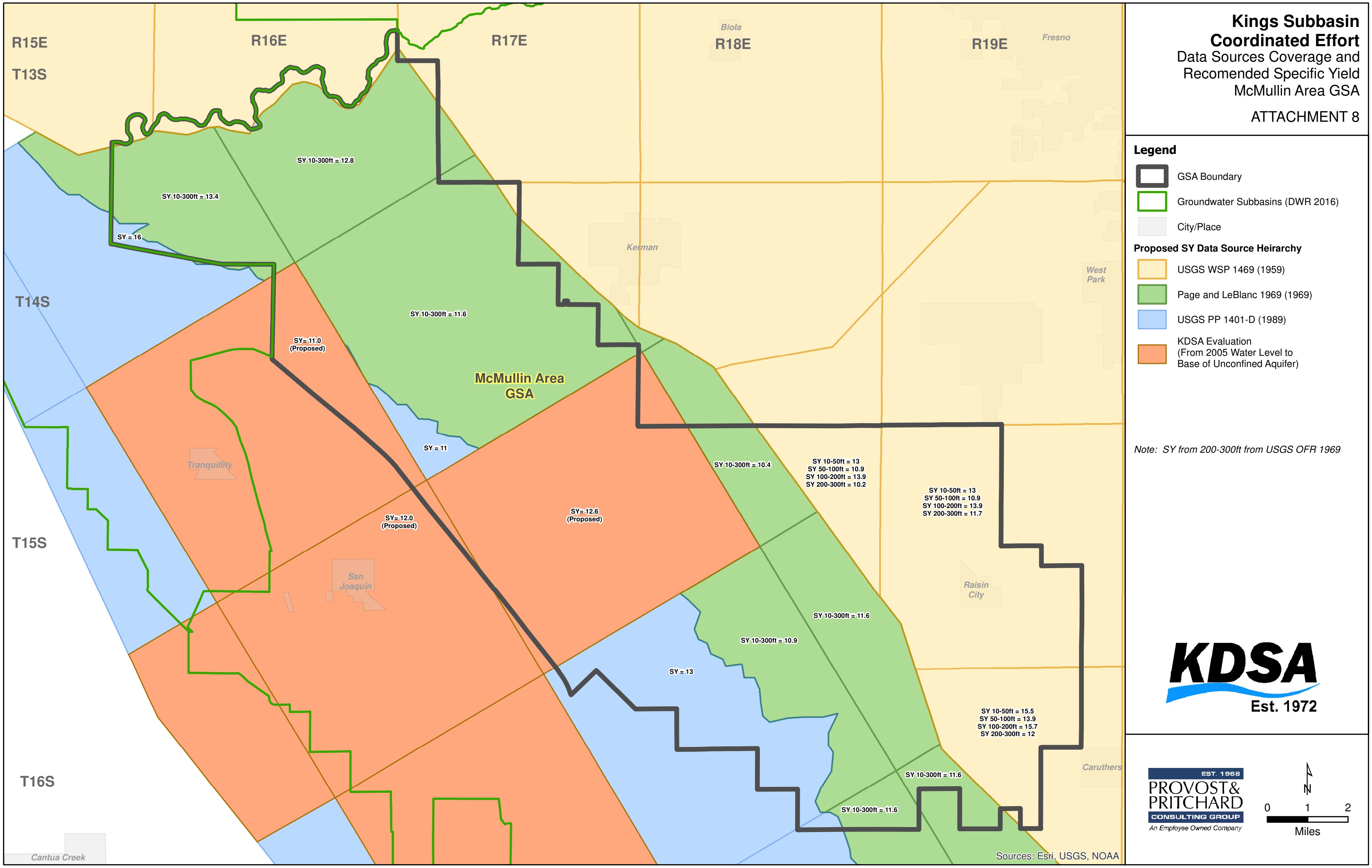
Attachments 8

McMullin Group GSA, Data Sources and Recommended Specific Yield



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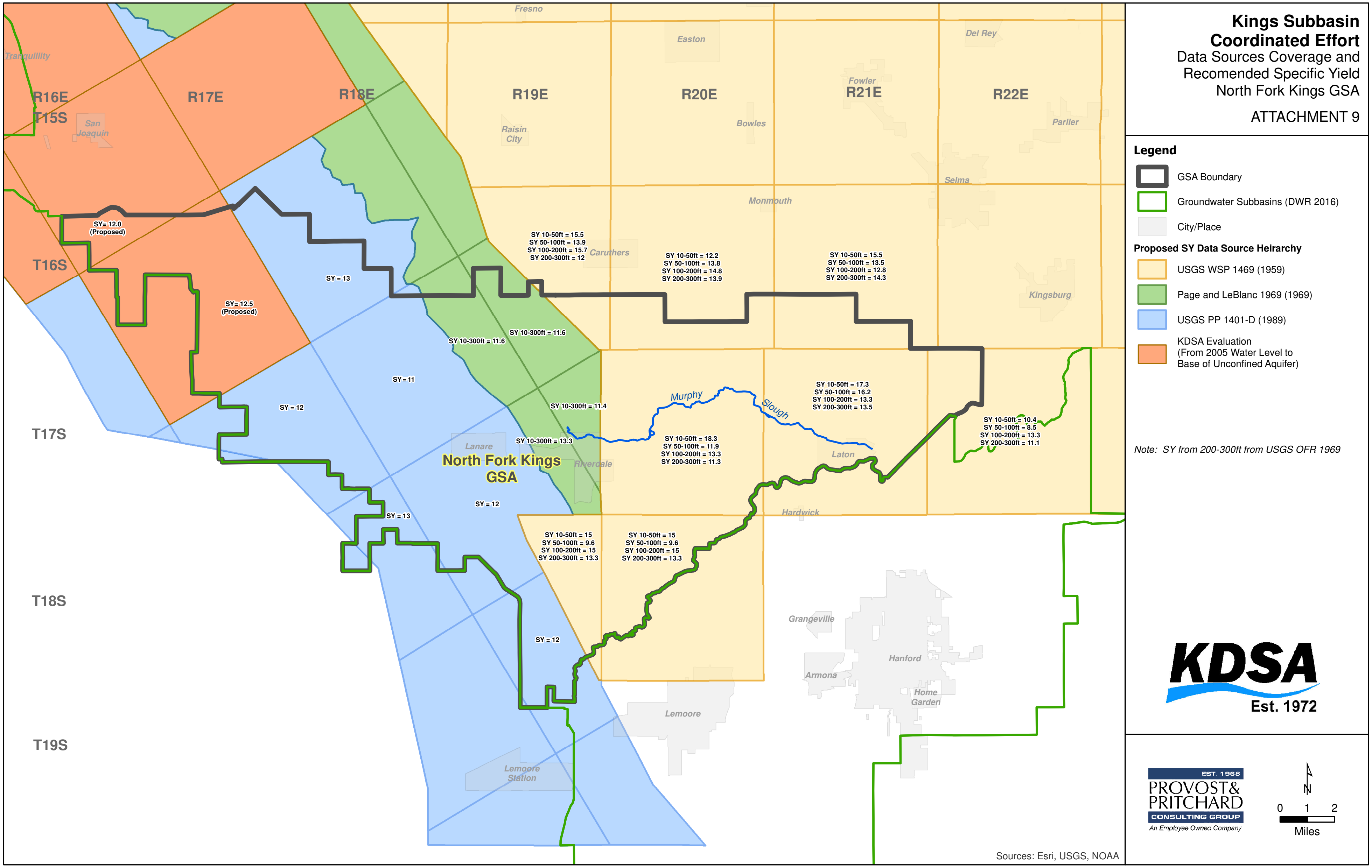
Attachments 9

North Fork Kings GSA, Data Sources and Recommended Specific Yield



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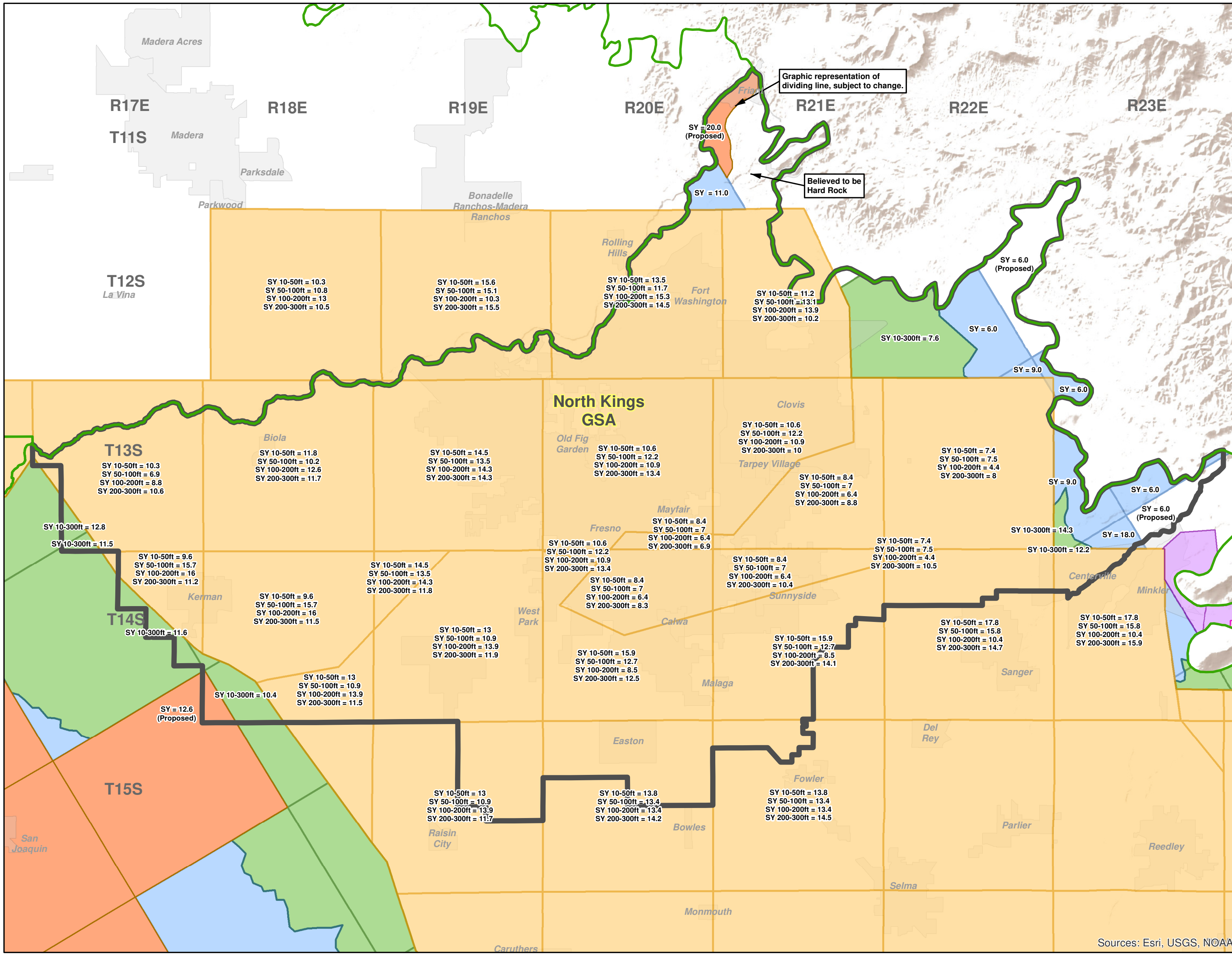
Attachments 10

North Kings GSA, Data Sources and Recommended Specific Yield



Kings Subbasin Coordinated Effort

Data Sources Coverage and Recomended Specific Yield North Kings GSA

ATTACHMENT 10

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)
- KDSA Evaluation (From 2005 Water Level to Base of Unconfined Aquifer)

Note: SY from 200-300ft from USGS OFR 1969

KDSA Est. 1972

EST. 1968 PROVOST& PRITCHARD CONSULTING GROUP An Employee Owned Company

N

0 2 4 Miles

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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.

Technical Memorandum 3
Hydrologic Period

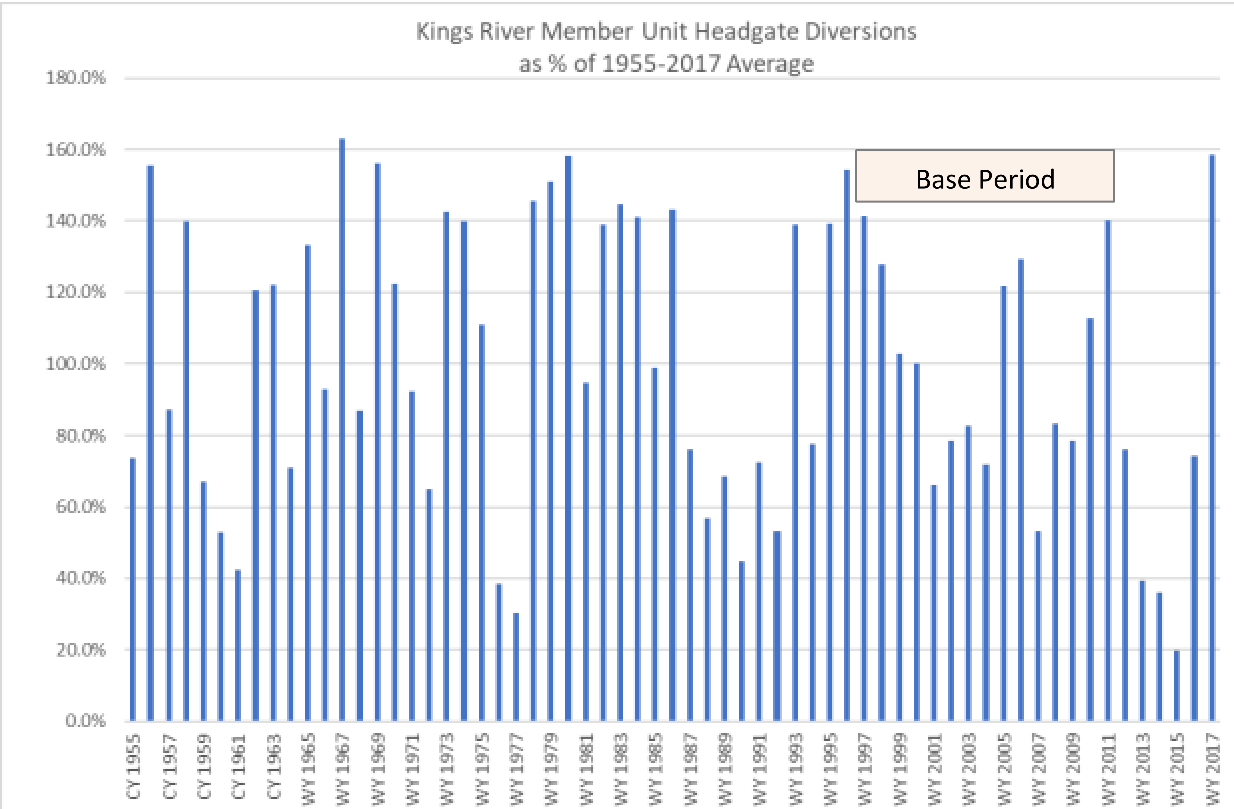
This memo identifies the recommended hydrologic period to utilize as part of the Kings Groundwater Sub-basin (Kings Basin) effort to evaluate historical changes in groundwater storage. Determination of a recent hydrologic period that approximates long-term average conditions is needed to consider the change in groundwater storage over time.

Section 354.18 (b) (5) of DWR's Groundwater Regulations states: "*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*."

Surface water supplies in the Kings Basin come from three primary sources: Kings River, San Joaquin River and local streams. The Kings River is the primary source of surface supply, and typically accounts for nearly 90% of the delivered surface water. Therefore, the analysis to determine the hydrologic period was performed based on Kings River supplies. To determine an average period within the Kings for analysis, the total deliveries of Kings River water into the Kings Subbasin were considered rather than the total runoff of the Kings River (Pre-Project Piedra), which would include water delivered to the Tulare Subbasin as well as periodic flood releases that leave the KRWA service area. Actual deliveries into the Kings Subbasin can further vary significantly on a percent of average basis each year as compared to the total watershed runoff of the Kings because of the entitlement schedule and ability to store water for coordinated water runs. This is especially true in dry years during which portions of the Kings basin receives considerably more surface water than other areas within the KRWA service area.

Surface water diversions from the Kings River are measured at the head gates for each canal by the Kings River Water Association (KRWA) and then aggregated to head gate diversions for each KRWA member unit. Historic annual water year head gate diversions for each member unit in each GSA were obtained from the KRWA Watermaster Reports through 2009 and from the KRWA database through 2017. The water year on the Kings River occurs from October to September. Attachment 1 shows that the average annual head gate diversions for the member units in each GSA from 1955 through 2017 was approximately 1,088,696 AF. Included in Attachment 1 is the water year total for diversions into the Kings Basin as a percentage of the 1955-2017 average, as well as for comparison the water year Pre-Project Piedra (PPP) total runoff percentage and the April-July runoff of the Kings River for each year. To determine an appropriate average base period, 10, 15, and 20 year rolling averages of water year totals were calculated as a percentage of the 1955-2017 average, with the 15-year period for water years 1997 through 2011 representing a normal period for surface water deliveries, and hence an expected normal period for groundwater pumping. The average Kings River diversions during this base period for each GSA is also shown in Attachment 1.

The graph below shows each water year as a percentage of the 1955-2017 average.



Recommendation

Although this effort is not directly associated with the Water Budget requirements of the SGMA regulations, Section 354.18 (c) (2) (A), requires that the water budget start with the most recently available information and extend back a minimum of 10 years. A 10-year period was considered as a minimum number of years to establish average water conditions.

The desired outcome was to find a minimum 10-year period that approximates close to 100% of the long-term average. It is recommended to consider as recent a period as practical to represent surface water use in meeting more recent demands based on current cropping patterns in the basin, as well as changes in facilities and water use that are different from 30 to 40 years ago. In reviewing the rolling averages, the period from water year 1997-2011 is recommended as the base period. This 15 year period is approximately 99.4% of the 1955-2017 average. This range of years includes a few above average years, as well as some dry years.

Groundwater level readings used for the storage change analysis will cover this base period. Fall readings are not available for all areas in the basin, so the recommended water level readings for the storage calculation will be Spring 1997 and Spring 2012. This is also consistent with SGMA guidelines that require groundwater storage calculations to be based on seasonal high-water levels in the Spring.

Other Surface Water Supplies

Data was collected for other surface water sources delivered into the subbasin, including CVP deliveries from the Friant Kern Canal and Delta-Mendota Canal, along with Kings River floodwater diversions that were added to the Kings River diversions. A listing of annual diversions from each source for each GSA is included as Attachment 2.

Total Surface Water Supplies

A summary of Kings River diversions and other surface water supplies for each GSA during the base period is shown in the table below.

Kings Subbasin GSA Surface Water Deliveries

	Kings River SW Deliveries into each GSA			
	Historical Member Unit Diversions from KRWA Records	Base Period	Other Surface Water Supplies	Total Surface Water Supplies during Base Period
GSA	**1955-2016/2017 Average**	**WY 1996/1997-2010/2011**		
Central Kings	277,669	275,366	0	275,366
James	5,691	2,064	32,458	34,522
Kings River East	206,343	210,862	36,063	246,925
McMullin Area	0	0	1,874	1,874
North Fork Kings	152,559	163,671	162	163,833
North Kings	446,807	429,737	64,608	494,345
Total	1,089,069	1,081,700	135,165	1,216,865
% of Long-term Avg		99%		

Notes:

1) Base period selected based on member unit head gate diversions from canal headgate diversions. Data from KRWA Watermaster Reports or KRWA database.
2) Central Kings includes Consolidated ID and Lone Tree Kings River head gate diversions.
3) James ID includes James Kings River head gate diversions plus other CVP water to James ID.
4) Kings River East includes Kings River head gate diversions to Alta ID and Kings River WD ; other includes CVP Friant-Kern Canal water to Hills Valley ID, City of Orange Cove, Orange Cove ID and Tri-Valley WD.
5) McMullin Area other includes KR floodwater to Mid-Valley WD and Terranova, plus CVP to Mid-Valley WD
6) North Fork Kings includes Kings River head gate diversions to Burrel Ditch Company, Clark's Fork RD, Crescent Canal Company, Laguna ID, Liberty Canal Company, Murphy Slough Association, Stinson Canal & Irrigation, and Upper San Jose Water Company. Other includes CVP Section 215 water.
7) North Kings includes Kings River head gate diversions to Fresno ID, other includes CVP FKC water to City of Fresno, Fresno ID, Garfield WD, and International WD.

Attachment 1

Historical Kings River Member Unit Headgate, AF Diversions

Kings Basin GSAs surface water data for Coordinated Kings effort **ATTACHMENT 1**

Historical Kings River Member Unit Headgate Diversions in Acre-Feet

					CENTRAL KINGS GSA		JAMES ID GSA	KINGS RIVER EAST GSA		NORTH FORK KINGS GSA								NORTH KINGS GSA		
	WY PPP	% WY	Apr-Jul	% A-J	Consolidated ID	Lone Tree Channel	James ID	Alta ID	Kings River WD	Burrel Ditch Company	Clark's Fork Recl District	Crescent Canal Co	Laguna ID	Liberty Canal Co	Murphy Slough Assoc	Stinson Canal & Irrigation	Upper San Jose Water Co	Fresno ID	Total	% 1955-2017
CY 1955	1,119,176	65.9%	861,924	70.0%	143,904		-	109,983	56,080	4,903	748	7,156	30,397	1,777	25,153	6,408	1,704	414,866	803,079	73.7%
CY 1956	2,600,733	153.1%	1,599,859	129.9%	433,041	-	22,441	276,019	55,320	19,319	1,558	24,222	111,743	18,121	93,189	35,016	3,065	598,825	1,691,879	155.4%
CY 1957	1,251,497	73.7%	1,011,180	82.1%	185,048	24,427	-	180,157	53,856	6,050	1,577	12,396	46,219	5,146	36,173	-	3,164	398,079	952,292	87.4%
CY 1958	2,545,394	149.8%	2,016,761	163.8%	397,891	23,821	29,397	247,027	54,490	10,423	1,180	27,148	84,051	15,513	99,828	16,487	2,458	514,123	1,523,837	139.9%
CY 1959	806,803	47.5%	528,285	42.9%	104,217	28,390	4,068	101,498	57,583	-	617	8,651	29,701	2,650	27,108	5,452	2,082	360,388	732,405	67.3%
CY 1960	722,629	42.5%	542,217	44.0%	86,133	28,193	-	71,097	54,217	-	484	-	14,533	-	1,016	-	76	321,819	577,568	53.0%
CY 1961	568,993	33.5%	403,682	32.8%	58,759	18,122	-	46,225	56,448	-	-	-	11,304	-	11,041	-	-	258,249	460,148	42.3%
CY 1962	1,900,229	111.8%	1,499,752	121.8%	305,618	27,282	-	234,915	60,425	9,586	1,457	18,793	69,282	13,796	65,069	7,210	4,108	494,469	1,312,010	120.5%
CY 1963	1,939,139	114.1%	1,435,163	116.6%	357,135	24,456	-	213,984	52,619	9,959	1,177	15,997	75,684	12,292	56,973	12,002	3,356	492,825	1,328,459	122.0%
CY 1964	911,642	53.7%	645,306	52.4%	114,760	29,332	-	125,441	53,241	3,724	652	7,017	39,167	-	30,632	1,488	1,047	368,184	774,685	71.1%
WY 1964 - 1965	2,013,721	118.5%	1,336,183	108.5%	347,131	28,789	10,515	239,474	58,779	9,067	895	21,745	82,232	11,459	62,859	12,435	4,590	561,469	1,451,438	133.3%
WY 1965 - 1966	1,215,778	71.6%	833,554	67.7%	239,546	29,185	-	112,724	61,980	2,922	617	9,596	46,681	5,337	46,376	4,669	1,107	450,217	1,010,957	92.8%
WY 1966 - 1967	3,374,398	198.6%	2,367,938	192.3%	525,136	33,580	6,754	281,538	53,862	2,992	1,706	24,493	111,549	20,598	94,440	19,000	3,019	595,359	1,774,026	162.9%
WY 1967 - 1968	843,204	49.6%	565,657	45.9%	198,681	30,295	637	94,645	59,731	4,300	817	10,873	36,466	-	37,245	6,834	1,260	466,696	948,479	87.1%
WY 1968 - 1969	4,386,300	258.2%	3,140,519	255.1%	536,275	27,269	28,979	258,016	46,091	3,009	1,059	24,039	104,176	21,119	100,810	18,067	766	530,991	1,700,665	156.2%
WY 1969 - 1970	1,330,595	78.3%	886,438	72.0%	334,162	40,462	1,720	169,439	54,284	1,339	1,139	18,809	57,422	7,702	57,983	7,348	2,448	578,030	1,332,285	122.3%
WY 1970 - 1971	1,174,952	69.2%	822,353	66.8%	161,959	24,772	-	138,093	55,018	3,604	956	8,912	38,890	5,163	35,325	3,426	1,799	525,411	1,003,329	92.1%
WY 1971 - 1972	859,583	50.6%	548,352	44.5%	99,349	26,904	-	86,774	60,628	1,204	871	1,211	19,815	-	18,896	-	438	392,176	708,266	65.0%
WY 1972 - 1973	2,135,442	125.7%	1,673,187	135.9%	490,632	23,528	99	208,240	50,817	7,950	1,182	17,531	88,313	17,078	70,398	4,993	2,398	568,445	1,551,605	142.5%
WY 1973 - 1974	2,095,945	123.4%	1,540,003	125.1%	422,996	39,667	17,024	205,604	51,492	8,545	1,577	26,111	92,482	14,220	81,243	8,307	2,069	551,006	1,522,343	139.8%
WY 1974 - 1975	1,583,365	93.2%	1,276,059	103.6%	210,603	34,655	-	184,035	55,435	6,000	1,882	16,695	64,790	4,278	55,883	8,426	3,340	559,379	1,205,401	110.7%
WY 1975 - 1976	540,664	31.8%	305,499	24.8%	-	13,894	-	43,381	50,288	-	865	3,965	18,890	-	25,315	5,576	1,353	255,148	418,674	38.4%
WY 1976 - 1977	395,994	23.3%	280,318	22.8%	153	15,597	-	38,722	47,798	-	474	-	-	-	6,815	-	666	220,962	331,187	30.4%
WY 1977 - 1978	3,453,853	203.3%	2,412,444	195.9%	520,937	35,483	12,607	217,628	45,422	889	1,978	21,493	94,298	16,265	84,582	18,340	4,522	511,505	1,585,949	145.6%
WY 1978 - 1979	1,729,846	101.8%	1,267,726	103.0%	469,458	40,473	7,543	210,624	53,096	14,493	1,747	25,321	86,127	14,678	79,010	28,374	2,682	609,539	1,643,166	150.9%
WY 1979 - 1980	3,046,952	179.3%	1,989,470	161.6%	499,664	48,305	26,627	253,273	50,375	8,634	1,989	30,329	106,448	22,609	104,457	31,173	5,586	531,727	1,721,195	158.0%
WY 1980 - 1981	1,040,415	61.2%	799,848	65.0%	181,711	26,674	-	145,400	53,271	6,773	1,097	23,969	23,969	5,717	47,292	15,974	2,563	496,327	1,030,737	94.6%
WY 1981 - 1982	3,111,011	183.1%	2,230,771	181.2%	413,642	15,571	19,442	231,137	49,468	13,339	1,995	32,853	86,911	17,121	100,577	20,753	3,515	507,629	1,513,954	139.0%
WY 1982 - 1983	4,476,391	263.5%	2,728,596	221.6%	514,494	19,042	32,829	222,733	39,442	3,610	1,543	33,662	70,947	17,614	109,059	28,368	4,873	475,370	1,573,586	144.5%
WY 1983 - 1984	1,971,145	116.0%	1,139,961	92.6%	379,581	22,029	11,159	217,919	46,803	18,105	1,890	35,404	72,343	13,179	75,821	26,001	2,517	611,124	1,533,875	140.8%
WY 1984 - 1985	1,252,501	73.7%	908,459	73.8%	187,617	29,268	-	170,827	45,184	2,838	1,141	10,875	51,723	5,584	38,839	10,720	2,608	516,841	1,074,064	98.6%
WY 1985 - 1986	3,262,497	192.0%	2,086,612	169.5%	390,452	26,131	31,181	227,708	44,660	11,937	2,095	38,882	97,124	18,603	118,027	25,203	4,205	523,704	1,559,911	143.2%
WY 1986 - 1987	779,051	45.9%	569,580	46.3%	158,999	19,751	-	121,323	43,395	3,481	2,037	9,945	34,207	2,181	29,590	12,570	2,493	390,539	830,511	76.3%
WY 1987 - 1988	827,211	48.7%	539,687	43.8%	72,086	19,967	-	59,348	42,280	149	1,172	-	-	743	13,274	-	768	410,916	620,703	57.0%
WY 1988 - 1989	905,624	53.3%	639,909	52.0%	114,136	23,618	-	89,636	48,491	298	-	-	28,788	1,190	15,870	-	-	424,943	746,970	68.6%
WY 1989 - 1990	662,989	39.0%	493,197	40.1%	61,775	18,964	-	58,283	43,885	-	-	-	-	-	7,728	-	-	297,670	488,305	44.8%
WY 1990 - 1991	1,075,608	63.3%	859,308	69.8%	147,523	19,470	-	107,230	39,315	3,400	434	6,367	30,878	3,567	23,228	4,054	730	405,293	791,489	72.7%
WY 1991 - 1992	705,247	41.5%	500,401	40.6%	74,649	17,373	-	66,816	43,230	-	-	-	-	337	9,072	-	-	368,478	579,956	53.3%
WY 1992 - 1993	2,553,114	150.3%	1,884,141	153.0%	338,183	30,540	-	246,845	47,784	11,405	2,733	35,642	111,502	21,013	87,214	25,462	3,935	549,368	1,511,627	138.8%
WY 1993 - 1994	861,045	50.7%	632,612	51.4%	167,122	21,220	-	123,895	44,159	4,439	1,204	5,629	29,754	2,896	21,499	3,808	647	418,821	845,093	77.6%
WY 1994 - 1995	3,460,047	203.6%	2,398,607	194.8%	436,102	24,626	-	235,529	38,652	4,835	3,168	39,293	101,064	18,814	115,610	26,156	4,566	467,790	1,516,205	139.2%
WY 1995 - 1996	2,095,921	123.4%	1,509,461	122.6%	437,416	32,512	-	221,624	51,087	17,542	4,524	43,357	88,446	12,778	102,051	26,577	4,360	636,275	1,678,550	154.1%
WY 1996 - 1997	2,652,070	156.1%	1,344,730	109.2%	382,346	33,149	-	214,341	51,664	16,497	2,955	32,831	91,680	18,487	103,457	27,575	5,835	558,018	1,538,836	141.3%
WY 1997 - 1998	3,104,062	182.7%	2,300,989	186.9%	392,186	23,197	30,847	172,176	40,504	4,860	2,337	31,777	75,124	15,701	118,028	26,097	2,914	455,173	1,390,921	127.7%
WY 1998 - 1999	1,261,024	74.2%	890,467	72.3%	262,680	28,511	111	155,463	46,821	10,324	2,331	20,833	59,994	8,887	52,034	18,574	2,609	449,068	1,118,240	102.7%
WY 1999 - 2000	1,534,654	90.3%	1,157,277	94.0%	261,592	25,978	-	166,411	50,622	8,180	1,726	15,194	61,822	6,681	54,010	12,218	3,572	419,477	1,087,483	99.9%
WY 2000 - 2001	1,010,201	59.5%	781,979	63.5%	118,242	18,708	-	124,465	48,403	6,050	1,452	13,095	30,672	3,745	32,567	7,720	1,628	313,330	720,077	66.1%
WY 2001 - 2002	1,141,149	67.2%	839,385	68.2%	179,455	21,609	-	133,219	49,903	1,363	1,032	7,087	33,868	3,172	24,220	2,894	1,543	396,707	856,072	78.6%

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Kings Basin GSAs surface water data for Coordinated Kings effort **ATTACHMENT 1**

Historical Kings River Member Unit Headgate Diversions in Acre-Feet

					CENTRAL KINGS GSA		JAMES ID GSA	KINGS RIVER EAST GSA		NORTH FORK KINGS GSA								NORTH KINGS GSA		
	WY PPP	% WY	Apr-Jul	% A-J	Consolidated ID	Lone Tree Channel	James ID	Alta ID	Kings River WD	Burrel Ditch Company	Clark's Fork Recl District	Crescent Canal Co	Laguna ID	Liberty Canal Co	Murphy Slough Assoc	Stinson Canal & Irrigation	Upper San Jose Water Co	Fresno ID	Total	% 1955-2017
WY 2002 - 2003	1,426,170	83.9%	1,038,245	84.3%	178,511	21,407	-	137,603	47,403	6,119	1,351	6,910	42,222	4,114	39,240	4,810	1,535	409,908	901,133	82.7%
WY 2003 - 2004	1,050,714	61.8%	698,583	56.7%	135,600	25,320	-	128,426	59,580	396	4	3,881	18,102	2,632	18,235	1,601	807	389,044	783,628	72.0%
WY 2004 - 2005	2,531,327	149.0%	1,917,065	155.7%	328,331	22,135	-	212,052	46,836	9,868	1,978	26,768	76,070	12,972	81,162	18,181	4,751	483,028	1,324,132	121.6%
WY 2005 - 2006	2,948,677	173.5%	2,352,852	191.1%	397,176	10,779	-	211,646	44,436	4,634	2,921	29,816	81,189	10,733	103,461	27,500	3,873	477,848	1,406,012	129.1%
WY 2006 - 2007	679,047	40.0%	436,295	35.4%	49,801	15,733	-	76,225	53,289	1,785	801	3,429	15,285	595	14,860	3,916	436	344,190	580,345	53.3%
WY 2007 - 2008	1,216,651	71.6%	915,185	74.3%	216,719	16,776	-	131,685	52,261	2,578	660	5,018	27,310	2,390	25,869	5,506	908	421,157	908,837	83.5%
WY 2008 - 2009	1,348,201	79.3%	1,006,920	81.8%	147,690	22,298	-	150,834	48,229	4,126	329	6,496	31,351	1,494	35,385	2,487	698	405,715	857,132	78.7%
WY 2009 - 2010	2,062,001	121.4%	1,576,537	128.0%	311,141	24,970	-	220,277	43,008	11,017	1,359	13,740	65,517	6,920	67,543	7,963	4,646	449,830	1,227,931	112.8%
WY 2010 - 2011	3,319,830	195.4%	2,295,580	186.4%	431,959	26,492	-	**208,331**	**36,816**	11,732	**2,388**	38,178	96,959	15,383	119,436	59,671	3,810	473,562	1,524,717	140.0%
WY 2011 - 2012	825,683	48.6%	543,009	44.1%	165,460	18,632	-	**127,137**	**42,530**	482	**820**	2,981	27,856	1,716	27,749	536	1,760	411,320	828,979	76.1%
WY 2012 - 2013	691,301	40.7%	430,191	34.9%	13,722	8,692	-	**35,730**	**44,856**	-	-	-	**6,807**	-	**5,365**	-	-	314,036	429,208	39.4%
WY 2013 - 2014	536,924	31.6%	405,903	33.0%	50,234	5,795	-	**25,791**	**44,924**	-	-	-	**2,029**	-	**7,603**	-	-	255,211	391,587	36.0%
WY 2014 - 2015	360,979	21.2%	208,480	16.9%	**11,858**	-	-	-	**42,770**	-	**597**	**115**	**4,413**	-	**1,503**	-	-	**153,802**	215,058	19.7%
WY 2015 - 2016	1,253,961	73.8%	880,495	71.5%	**137,298**	**20,104**	-	**130,613**	**40,630**	**1,962**	-	-	**12,153**	**3,941**	**14,335**	**343**	**329**	**449,317**	811,025	74.5%
WY 2016 - 2017	4,096,148	241.1%	2,700,109	219.3%	**519,137**	**5,891**	**64,577**	**241,182**	**35,218**	**9,918**	**1,863**	**43,589**	**106,913**	**22,060**	**142,975**	**38,885**	**5,294**	**488,110**	1,725,612	158.4%
Min	360,979	21%	208,480	17%	-	-	-	-	35,218	-	-	-	-	-	1,016	-	-	153,802	215,058	
Max	4,476,391	263%	3,140,519	255%	536,275	48,305	64,577	281,538	61,980	19,319	4,524	43,589	111,743	22,609	142,975	59,671	5,835	636,275	1,774,026	
Avg	1,724,403	101%	1,213,195	99%	254,124	23,545	5,691	157,118	49,225	5,602	1,288	15,875	53,264	8,139	54,152	11,955	2,283	446,807	1,089,069	
GSA Average					277,669		5,691	206,343		152,559								446,807		

Average 1996/97-2010/11					*252,895*	*22,471*	*2,064*	*162,877*	*47,985*	*6,635*	*1,575*	*17,004*	*53,811*	*7,594*	*59,300*	*15,114*	*2,638*	*429,737*	*1,081,700*	*99%*
GSA Average					*275,366*		*2,064*	*210,862*		*163,671*								*429,737*		

Data from KRWA Watermaster Reports

Bold numbers from KRWA database

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Attachment 2

Kings Basin GSA surface water data, AF

Kings Basin GSAs surface water data for Coordinated Kings effort **ATTACHMENT 2**

All data in Acre-Feet

		WY 1996 - 1997	WY 1997 - 1998	WY 1998 - 1999	WY 1999 - 2000	WY 2000 - 2001	WY 2001 - 2002	WY 2002 - 2003	WY 2003 - 2004	WY 2004 - 2005	WY 2005 - 2006	WY 2006 - 2007	WY 2007 - 2008	WY 2008 - 2009	WY 2009 - 2010	WY 2010 - 2011	Average 1997 - 2011
CENTRAL KINGS GSA																	275,366
Kings River Diversions	Consolidated ID Head Gate Diversions	382,346	392,187	262,680	261,592	118,242	179,455	178,511	135,600	328,331	397,176	49,801	216,719	147,690	311,141	431,959	252,895
	Lone Tree Channel Head Gate Diversions	33,149	23,197	28,511	25,978	18,708	21,609	21,407	25,320	22,135	10,779	15,733	16,776	22,298	24,970	26,492	22,471
Subtotal		415,495	415,384	291,191	287,570	136,950	201,064	199,918	160,920	350,466	407,955	65,534	233,495	169,988	336,111	458,451	275,366
Other surface water supplies	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JAMES ID GSA																	34,522
Kings River Diversions	James ID Head Gate Diversions	-	*30,847*	111	-	-	-	-	-	-	-	-	-	-	-	-	2,064
Other surface water supplies	CVP - JID	44,142	13,219	43,304	33,242	29,051	33,280	38,336	38,216	38,669	44,175	38,502	20,147	14,198	24,672	33,710	32,458
KINGS RIVER EAST GSA																	246,925
Kings River Diversions	Alta ID Head Gate Diversions	214,341	172,176	155,463	166,411	124,465	133,219	137,603	128,426	212,052	211,646	76,225	131,685	150,834	220,277	208,331	162,877
Kings River Diversions	Kings River WD Head Gate Diversions	51,664	40,504	46,821	50,622	48,403	49,903	47,403	59,580	46,836	44,436	53,289	52,261	48,229	43,008	36,816	47,985
Subtotal		266,005	212,680	202,284	217,033	172,868	183,122	185,006	188,006	258,888	256,082	129,514	183,946	199,063	263,285	245,147	210,862
Other surface water supplies	FKC - Hills Valley Irrigation District	4,084	2,546	3,507	3,887	3,642	4,895	4,225	5,121	3,901	4,649	5,538	4,888	5,778	5,551	4,770	4,465
	FKC - City of Orange Cove	1,464	923	1,218	1,398	1,442	1,580	1,582	1,899	1,971	2,078	2,099	2,334	2,063	1,921	1,793	1,718
	FKC - Orange Cove Irrigation Distric	35,215	22,167	28,742	28,204	29,772	30,056	29,393	34,401	26,014	29,774	29,313	25,864	26,697	31,251	25,981	28,856
	FKC - Tri-Valley Water District	878	594	874	1,098	1,040	1,493	1,416	1,640	1,040	930	826	860	991	1,015	653	1,023
Subtotal		41,641	26,230	34,341	34,587	35,896	38,024	36,616	43,061	32,926	37,431	37,776	33,946	35,529	39,738	33,197	36,063
McMullin GSA																	1,874
Other surface water supplies	Kings River Floodwater - MVWD	-	7,298	459	-	-	-	-	-	-	3,648	-	-	-	-	-	760
	CVP - MVWD	2,986	1,830	1,343	275	17	2	368	-	849	3,980	-	-	-	-	2,899	970
	Kings River Floodwater - Terranove Ranch	-	-	-	-	-	-	-	-	-	2,162	-	-	-	-	-	144
Subtotal		2,986	9,128	1,802	275	17	2	368	-	849	9,790	-	-	-	-	2,899	1,874
NORTH FORK KINGS GSA																	163,833
Kings River Diversions	Burrel Ditch Company Head Gate Div	16,497	4,860	10,324	8,180	6,050	1,363	6,119	396	9,868	4,634	1,785	2,578	4,126	11,017	11,732	6,635
Kings River Diversions	Clark's Fork Recl District Head Gate Div	2,955	2,337	2,331	1,726	1,452	1,032	1,351	4	1,978	2,921	801	660	329	1,359	2,388	1,575
Kings River Diversions	Crescent Canal Company Head Gate Div	32,831	31,777	20,833	15,194	13,095	7,087	6,910	3,881	26,768	29,816	3,429	5,018	6,496	13,740	38,178	17,004
Kings River Diversions	Laguna Irrigation District Head Gate Div	91,680	75,124	59,994	61,822	30,672	33,868	42,222	18,102	76,070	81,189	15,285	27,310	31,351	65,517	96,959	53,811
Kings River Diversions	Liberty Canal Company Head Gate Div	18,487	15,701	8,887	6,681	3,745	3,172	4,114	2,632	12,972	10,733	595	2,390	1,494	6,920	15,383	7,594
Kings River Diversions	Murphy Slough Association Head Gate Div	103,457	118,028	52,034	54,010	32,567	24,220	39,240	18,235	81,162	103,461	14,860	25,869	35,385	67,543	119,436	59,300
Kings River Diversions	Stinson Canal & Irrigation Head Gate Div	27,575	26,097	18,574	12,218	7,720	2,894	4,810	1,601	18,181	27,500	3,916	5,506	2,487	7,963	59,671	15,114
Kings River Diversions	Upper San Jose Water Company HG Div	5,835	2,914	2,609	3,572	1,628	1,543	1,535	807	4,751	3,873	436	908	698	4,646	3,810	2,638
Subtotal		299,317	276,838	175,586	163,403	96,929	75,179	106,301	45,658	231,750	264,127	41,107	70,239	82,366	178,705	347,557	163,671
Other surface water supplies	FKC Section 215 water		-	-	-	-	-	1,906	-	200	-	-	-	-	-		162
NORTH KINGS GSA																	494,345
Kings River Diversions	Fresno ID Head Gate Diversions	558,018	455,173	449,068	419,477	313,330	396,707	409,908	389,044	483,028	477,848	344,190	421,157	405,715	449,830	473,562	429,737
Other surface water supplies	FKC - City of Fresno	60,000	25,333	74,686	38,618	58,000	60,595	59,689	56,226	60,130	54,704	42,692	59,303	7,743	20,530	50,649	48,593
	FKC - Fresno Irrigation District	20,587	1,978	26,129	57,555	1,805	6,418	3,887	11,606	7,711	3,090	4,462	558	23,288	8,778	3,731	12,106
	FKC - Garfield Water District	3,806	2,017	3,216	2,949	2,680	2,797	2,564	2,841	1,988	2,490	2,023	2,238	2,127	1,808	1,552	2,473
	FKC - International Water District	1,533	1,325	1,310	1,498	1,413	1,548	1,423	1,584	1,751	1,589	1,091	1,034	1,713	1,106	1,622	1,436
Subtotal		**85,926**	**30,653**	**105,341**	**100,620**	**63,898**	**71,358**	**67,563**	**72,257**	**71,580**	**61,873**	**50,268**	**63,133**	**34,871**	**32,222**	**57,554**	**64,608**

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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.

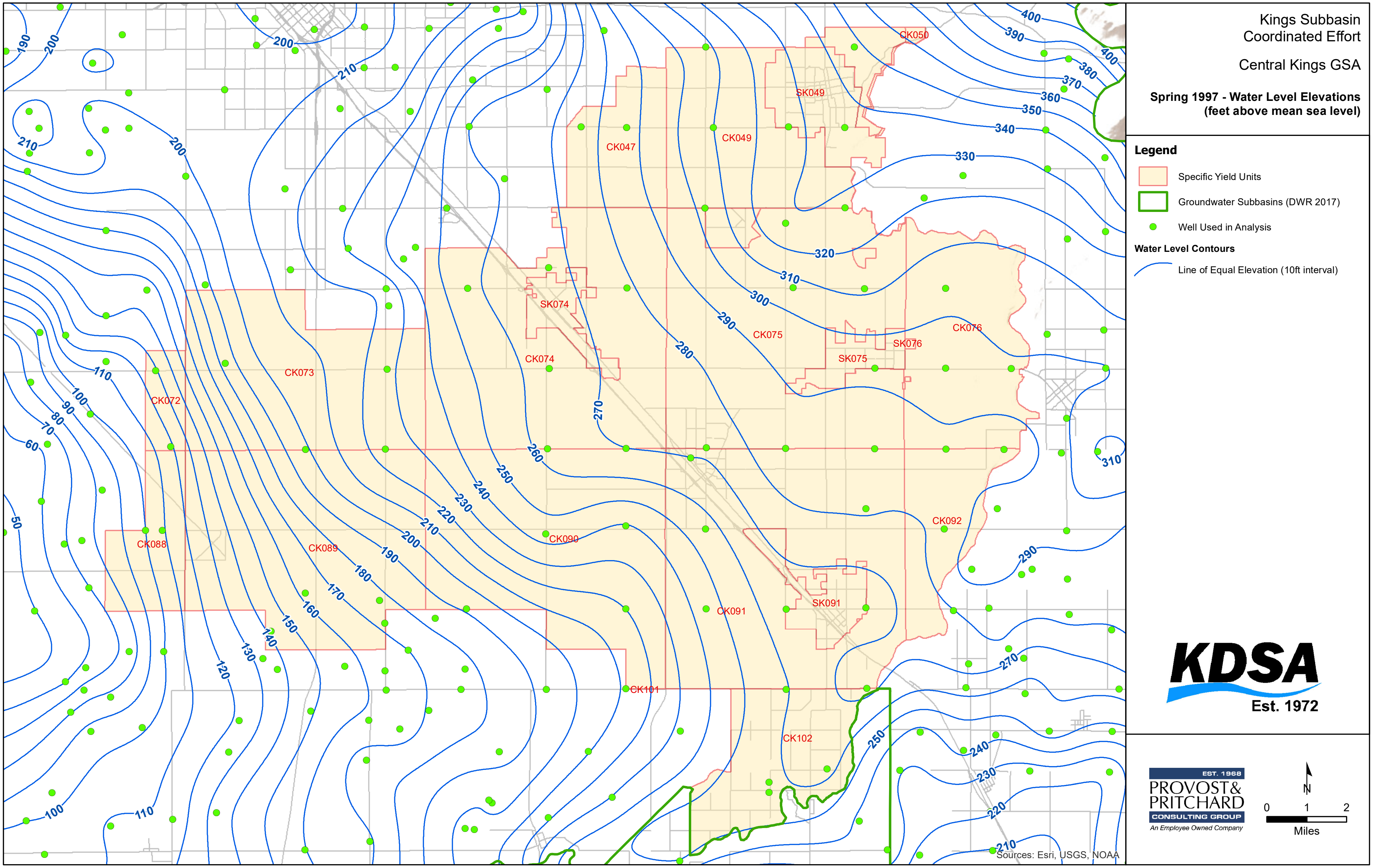
Results of Initial Estimation

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



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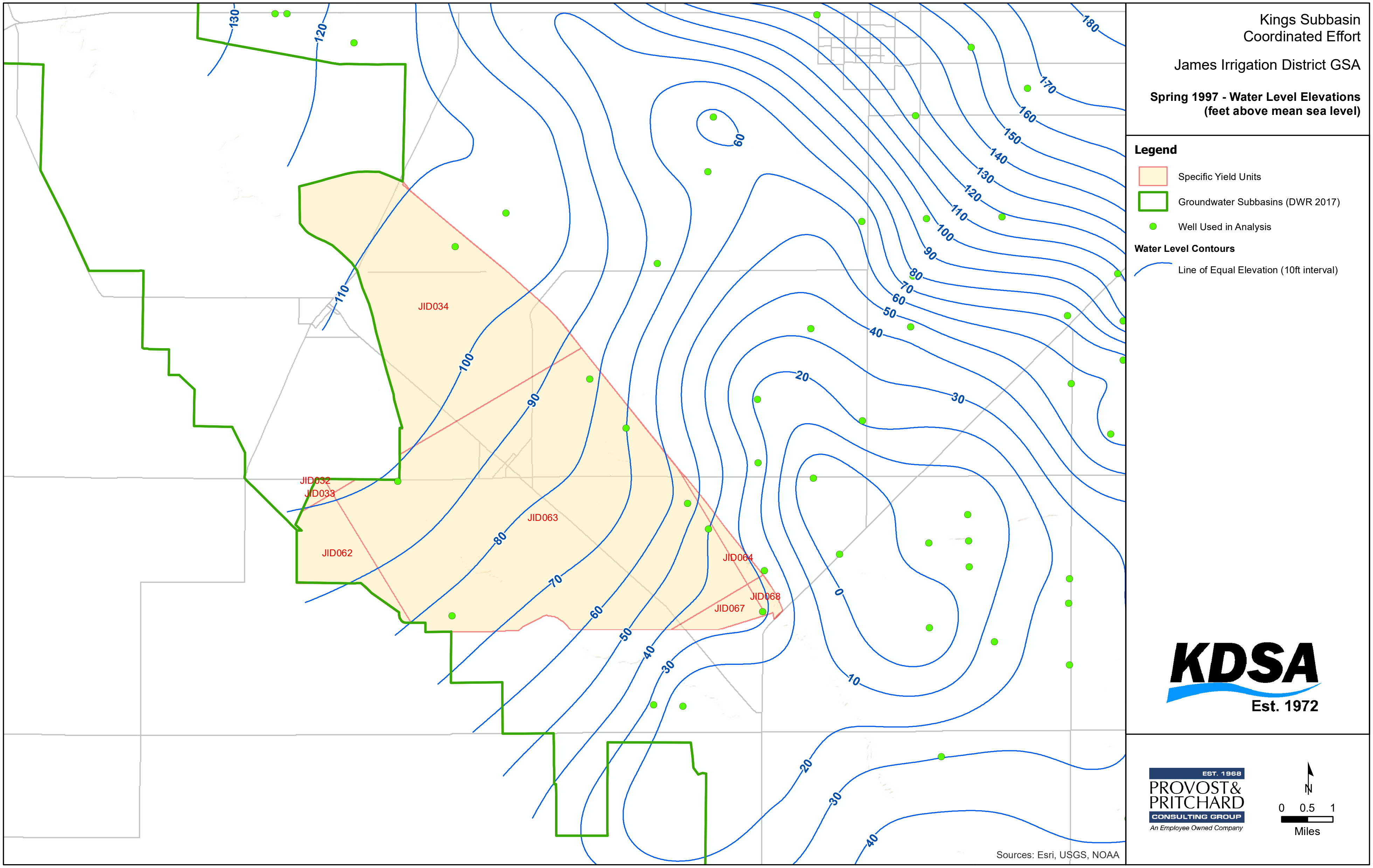

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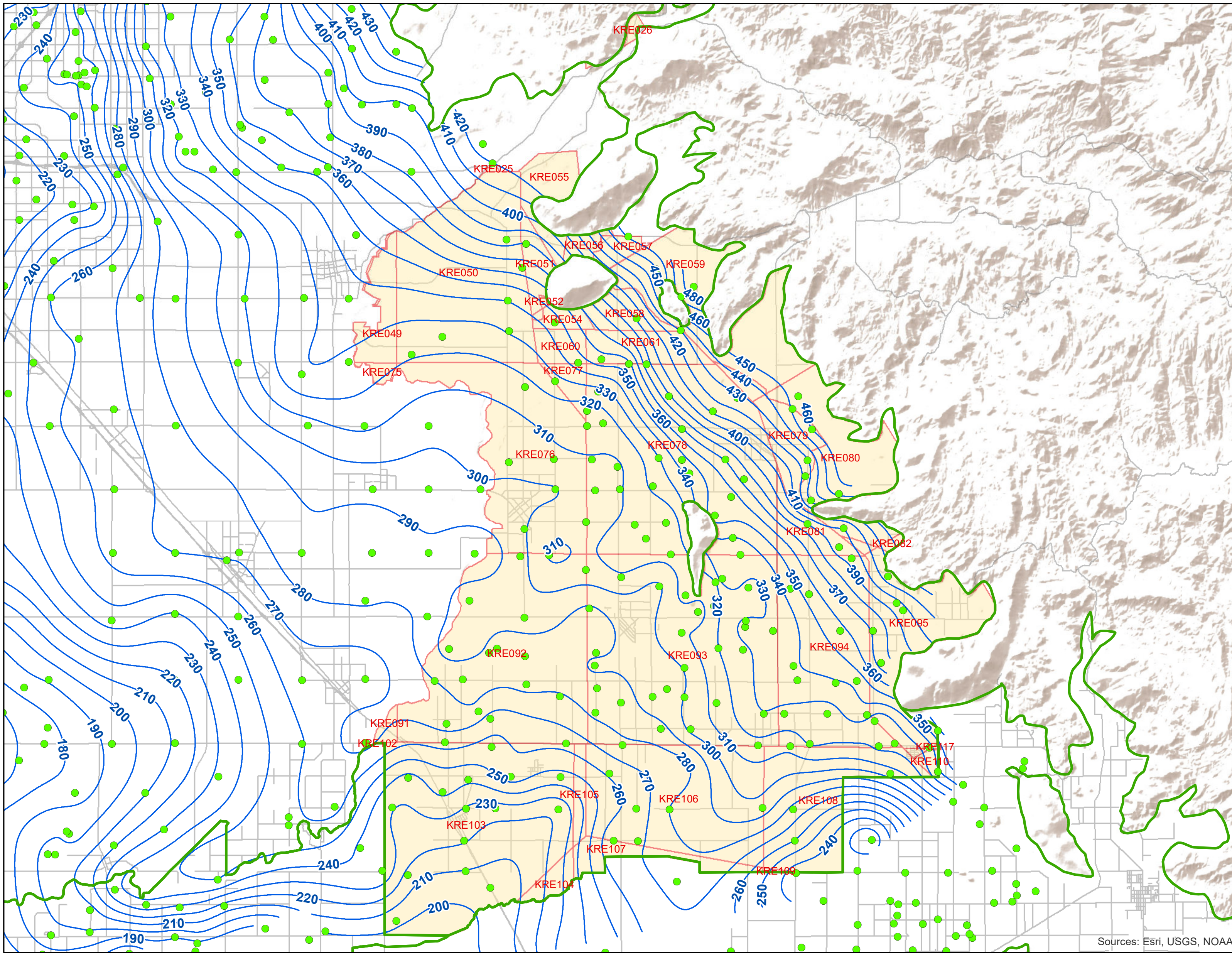

Kings Subbasin Coordinated Effort

Kings River East 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

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0 1 2 3 Miles

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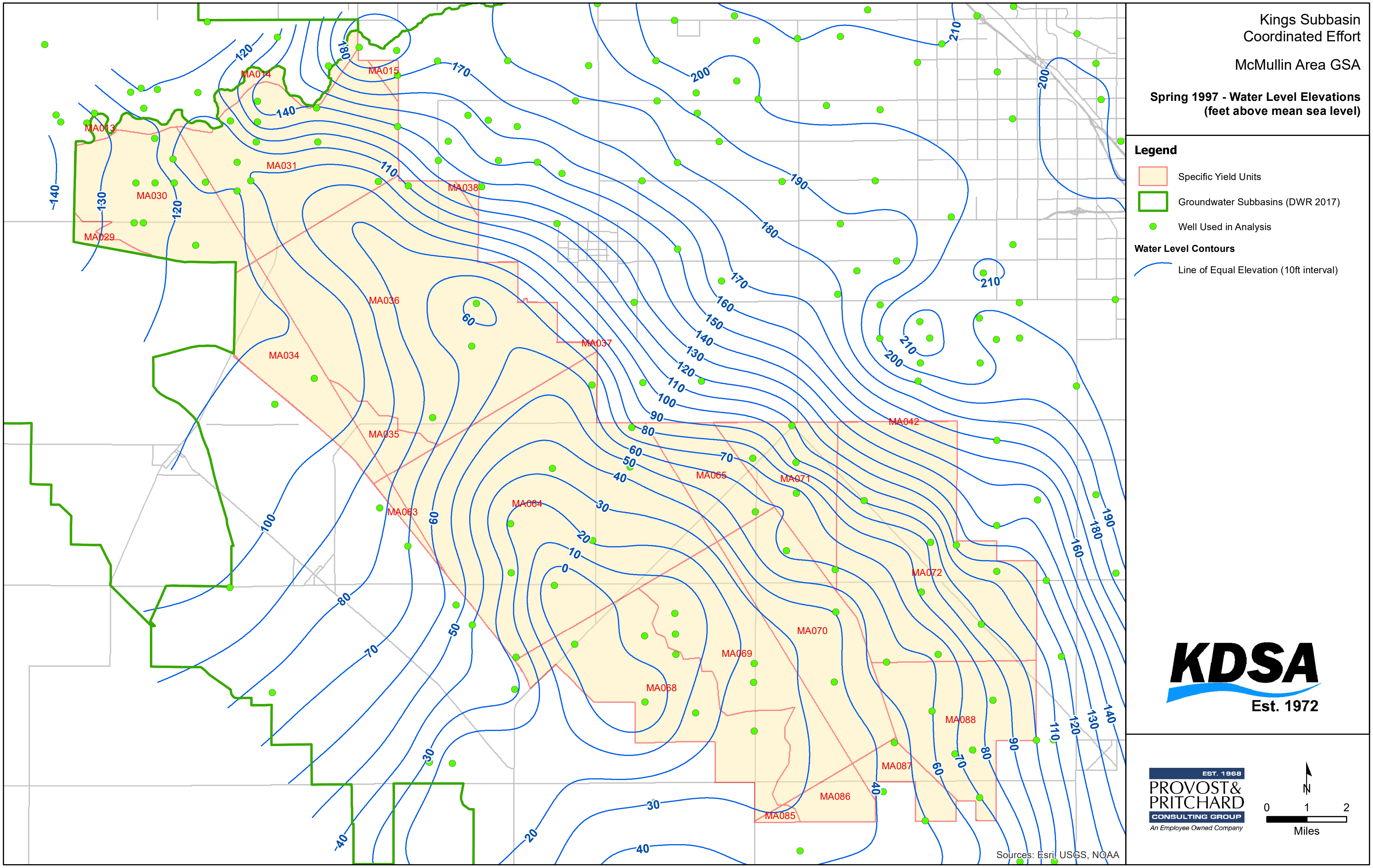

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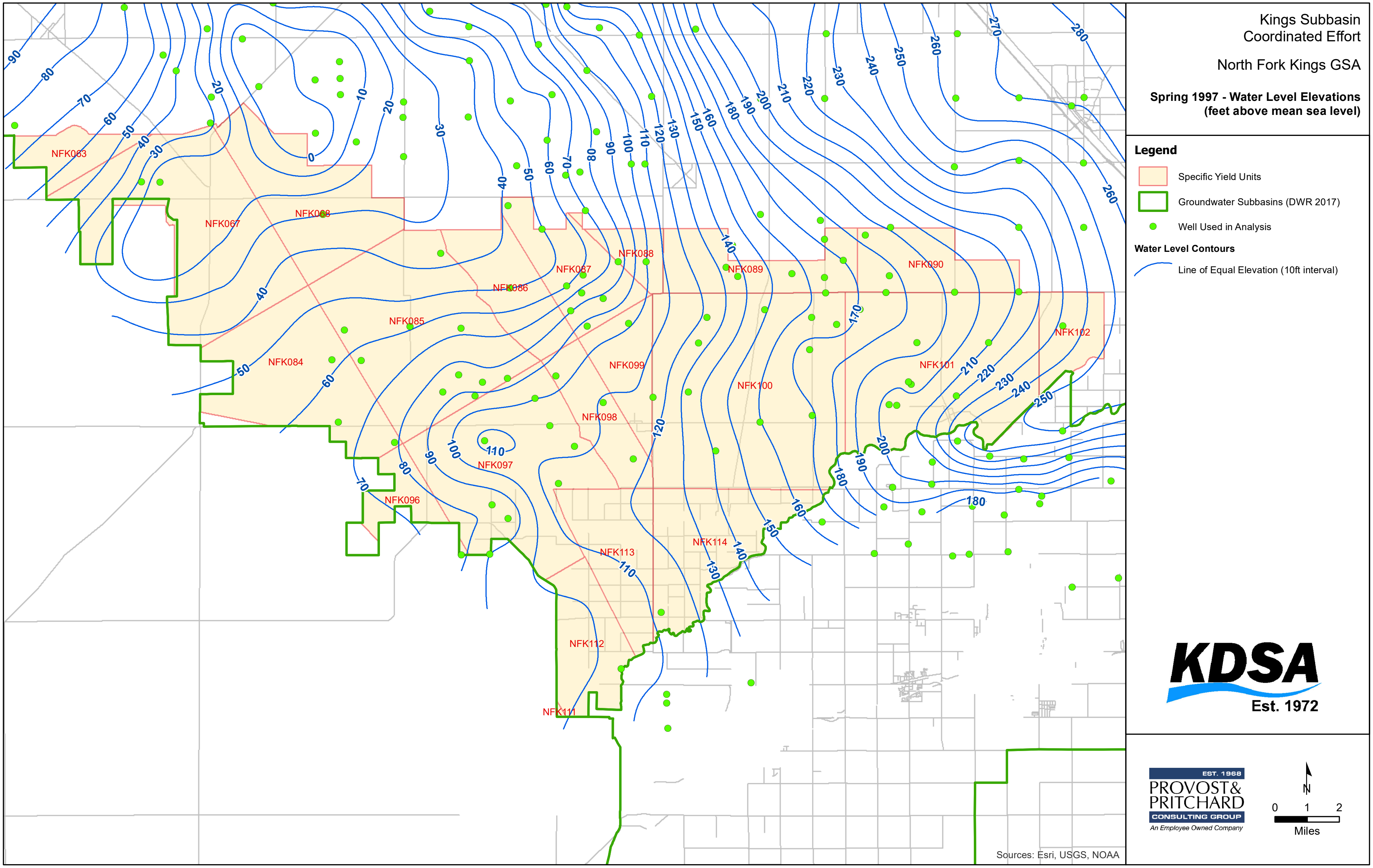

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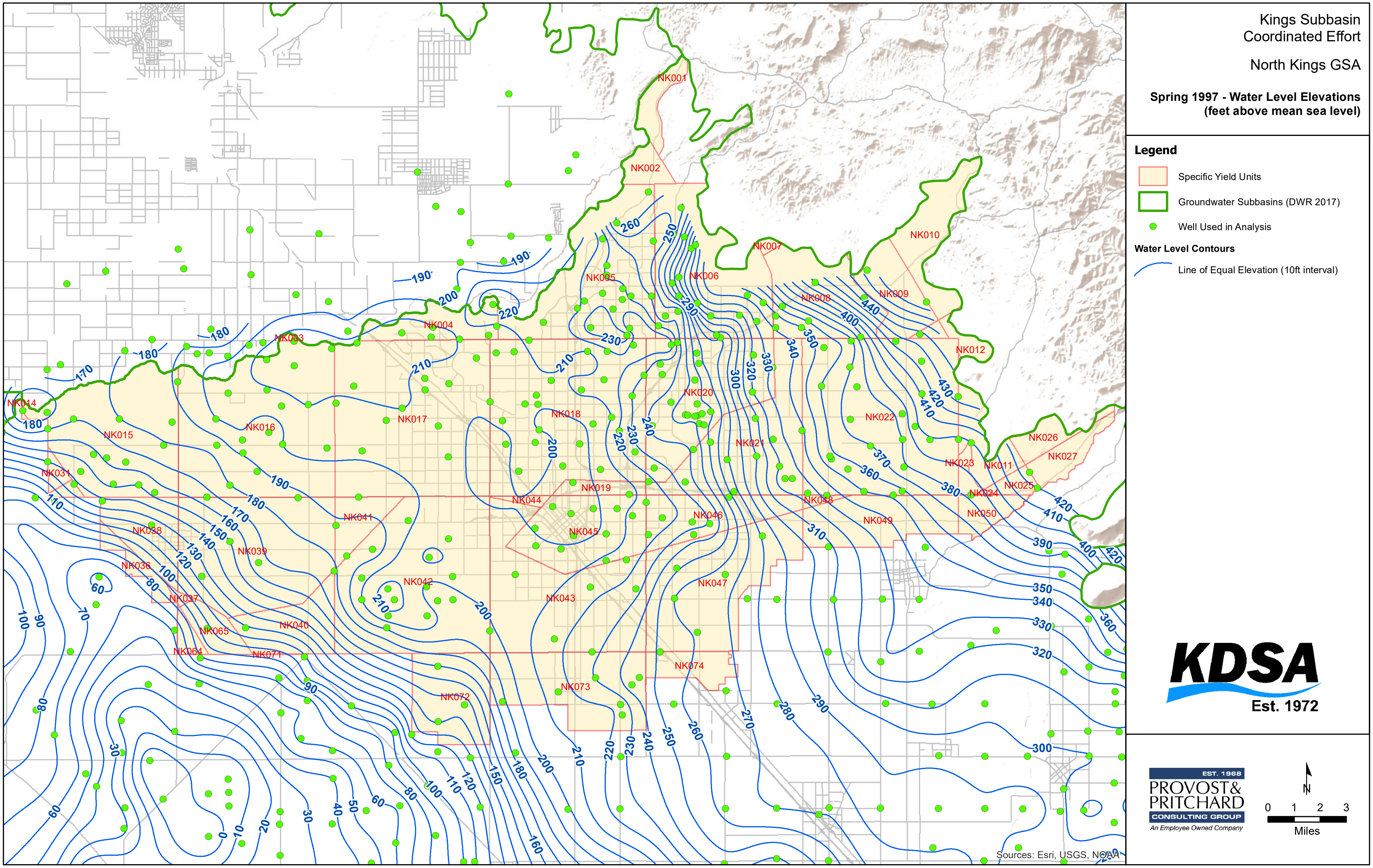

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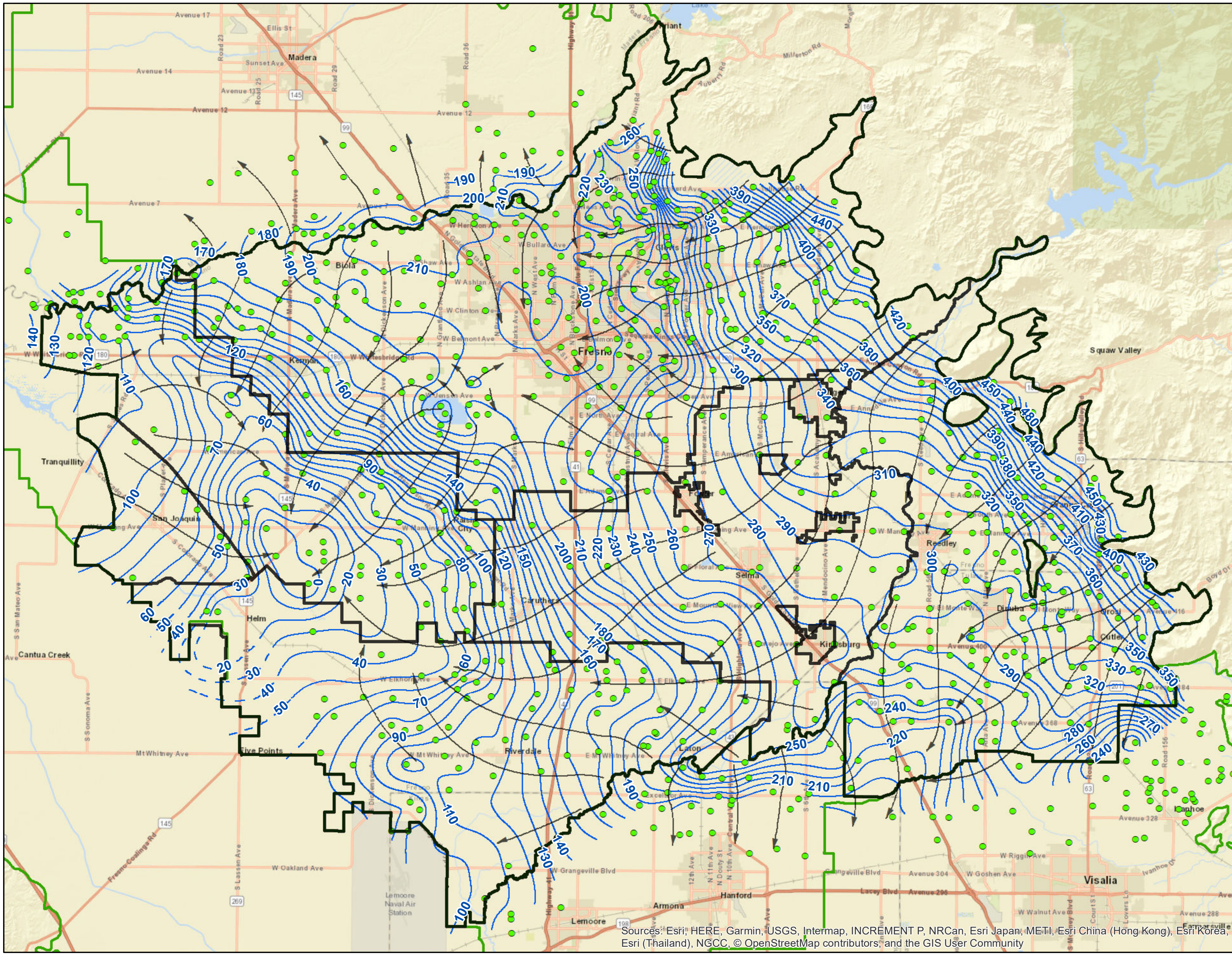
Kings Subbasin
Coordinated Effort

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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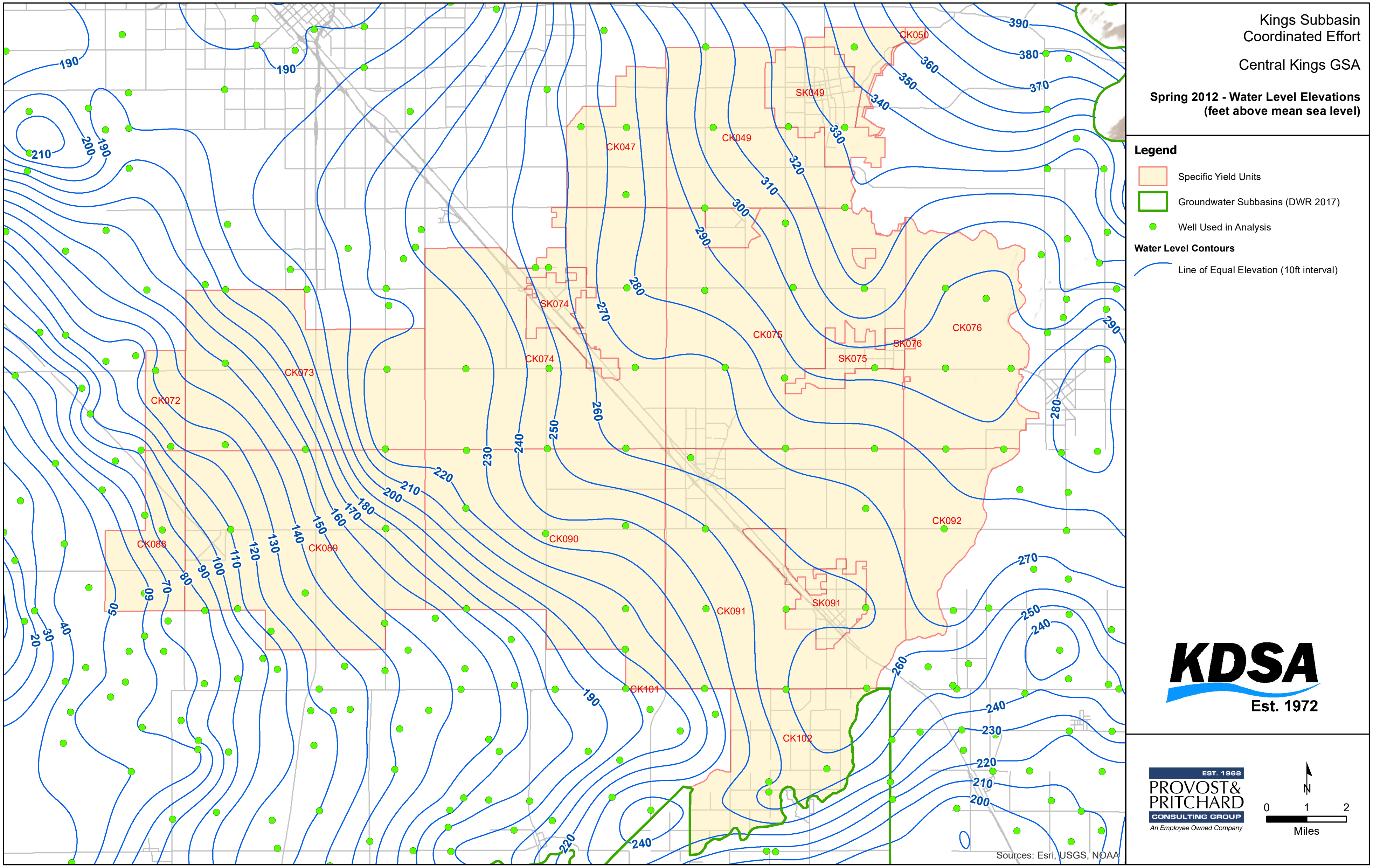

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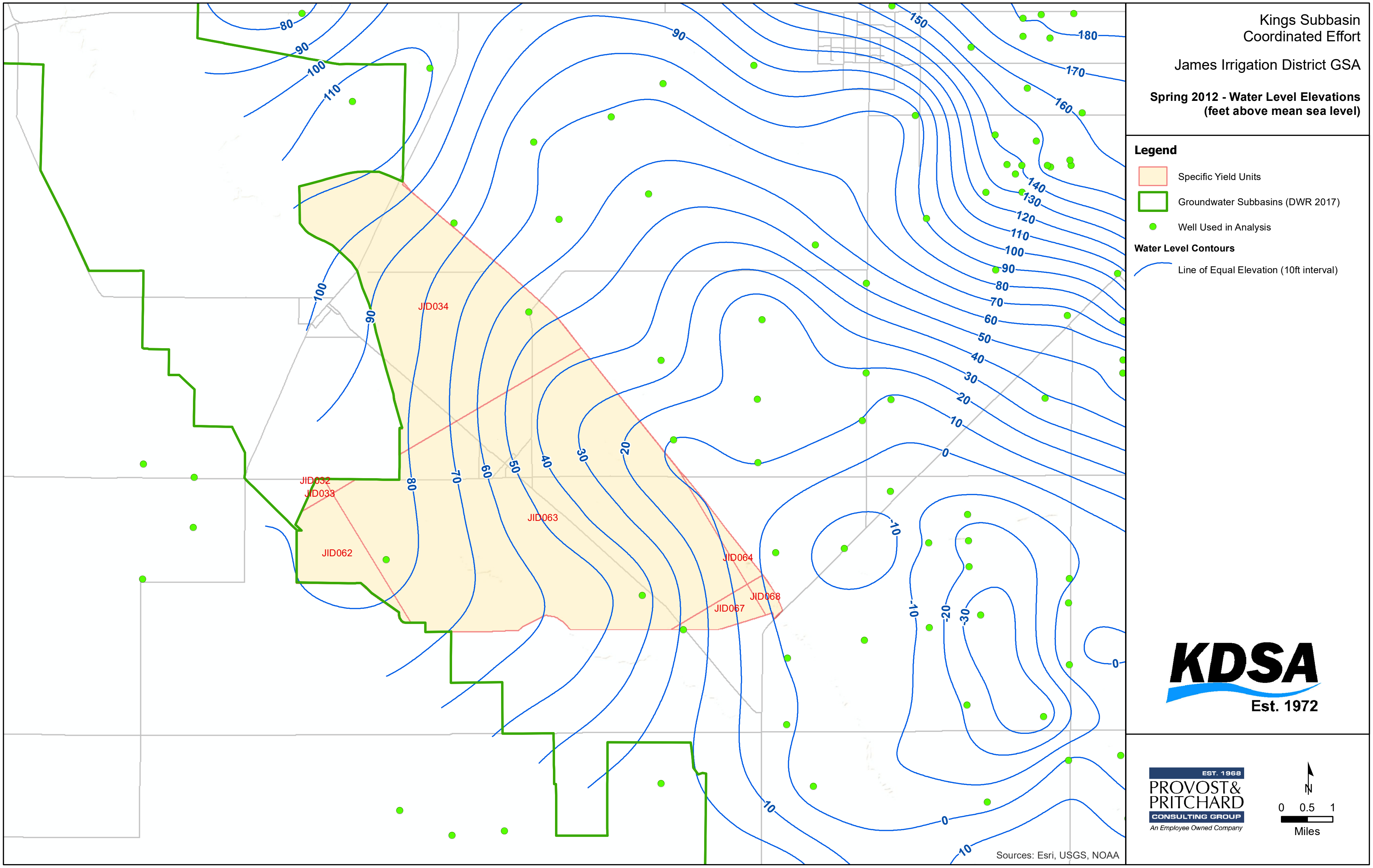

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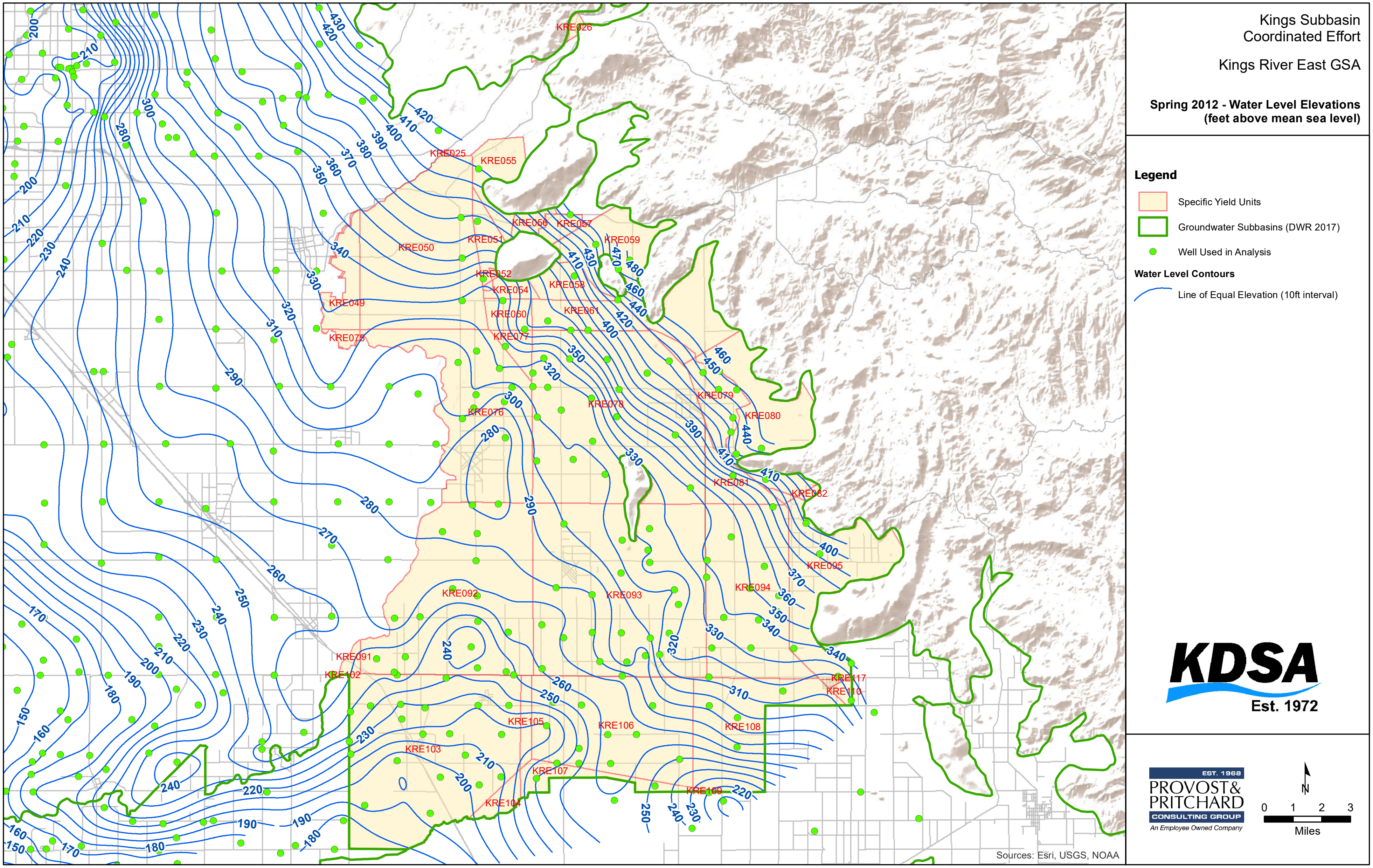

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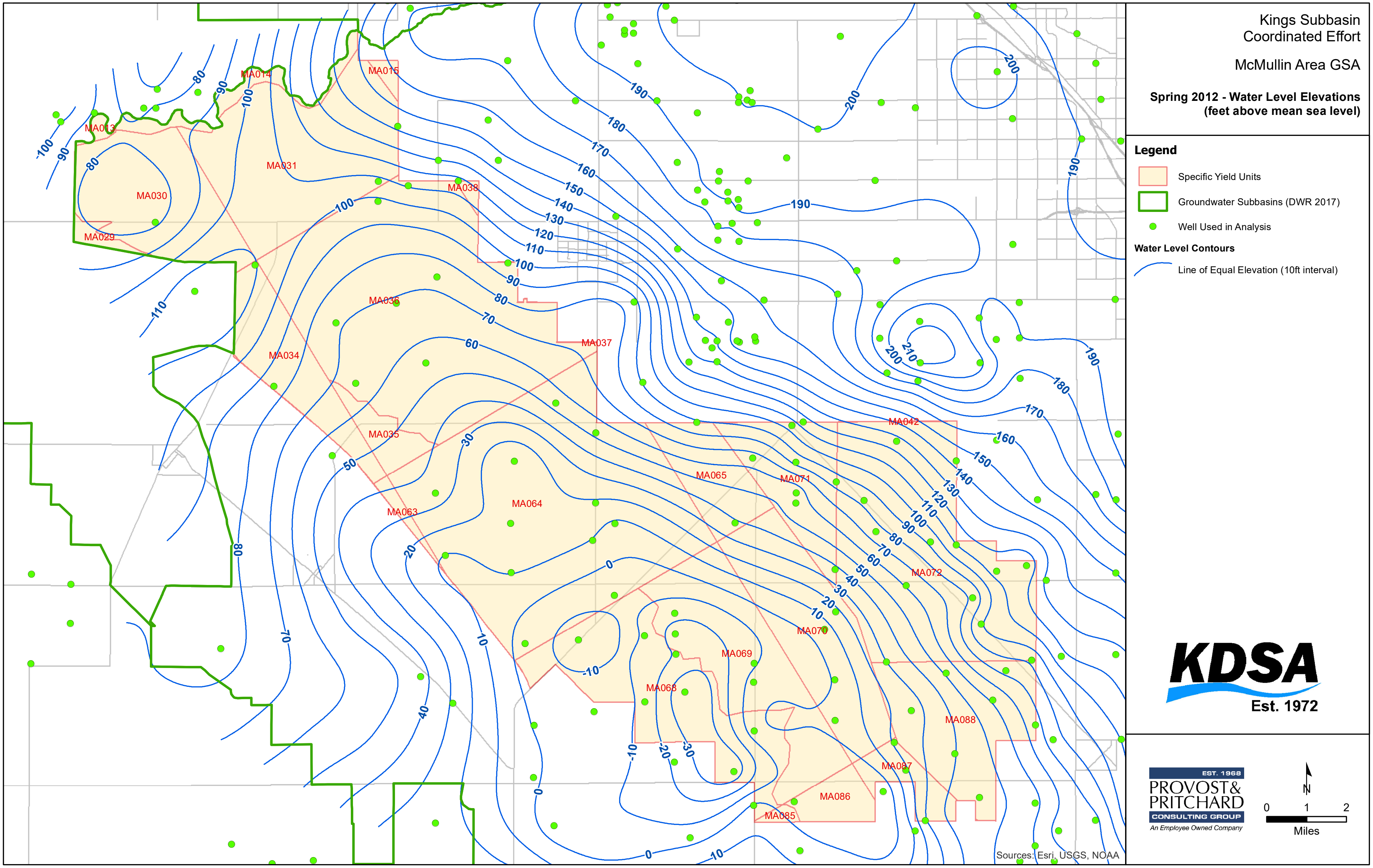

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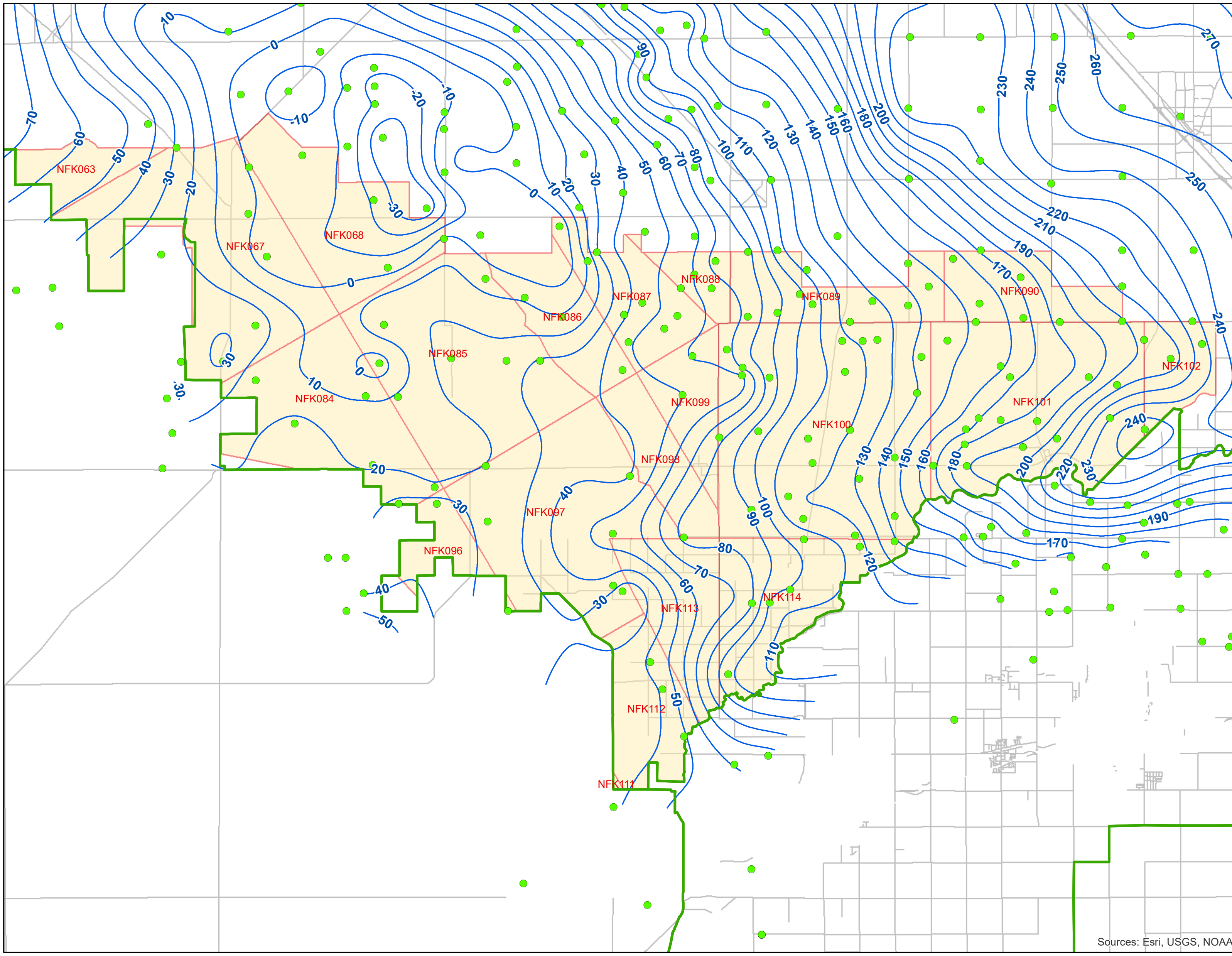
Kings Subbasin
Coordinated Effort

North Fork Kings GSA

Spring 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 An Employee Owned Company

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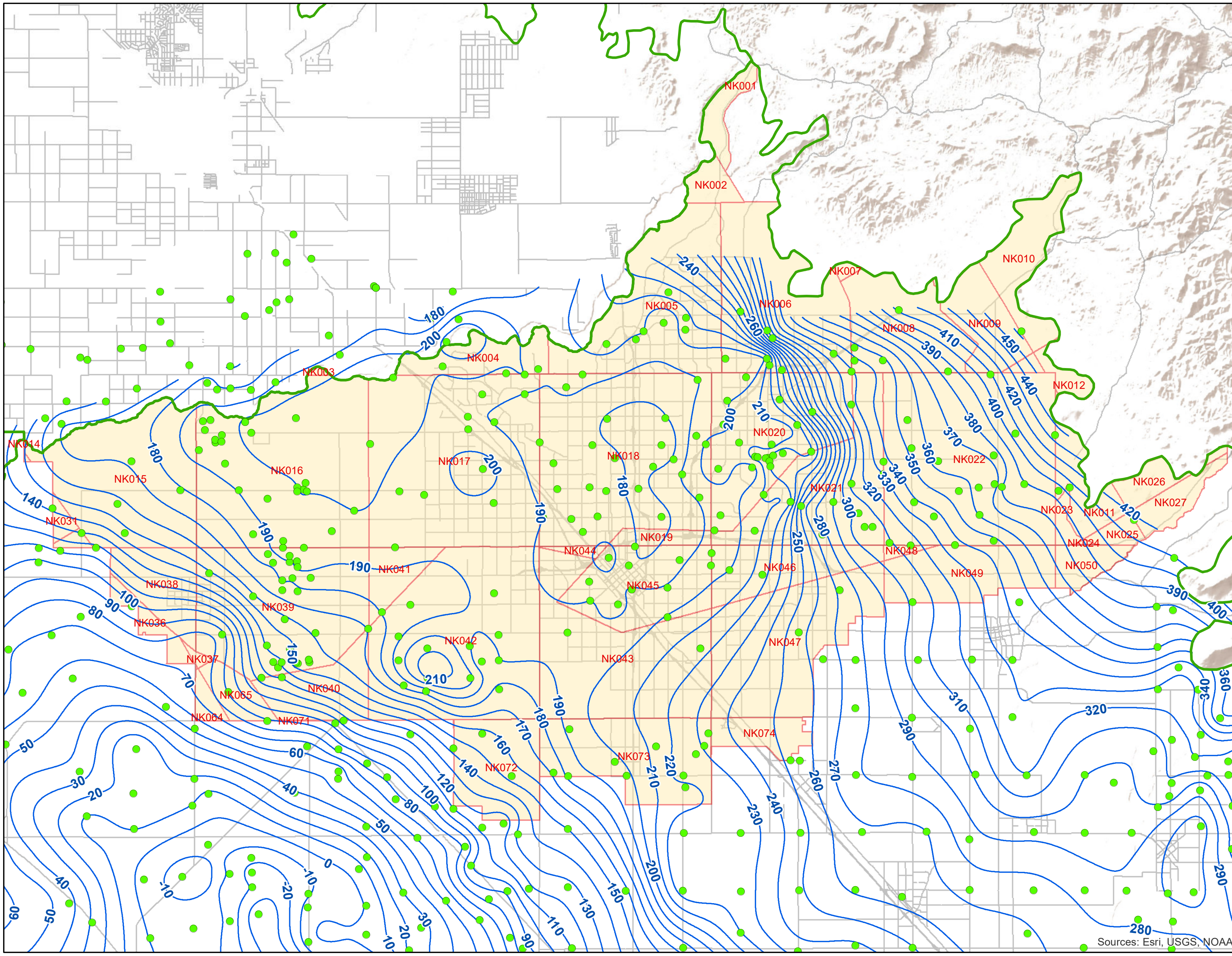
Kings Subbasin
Coordinated Effort

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
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company

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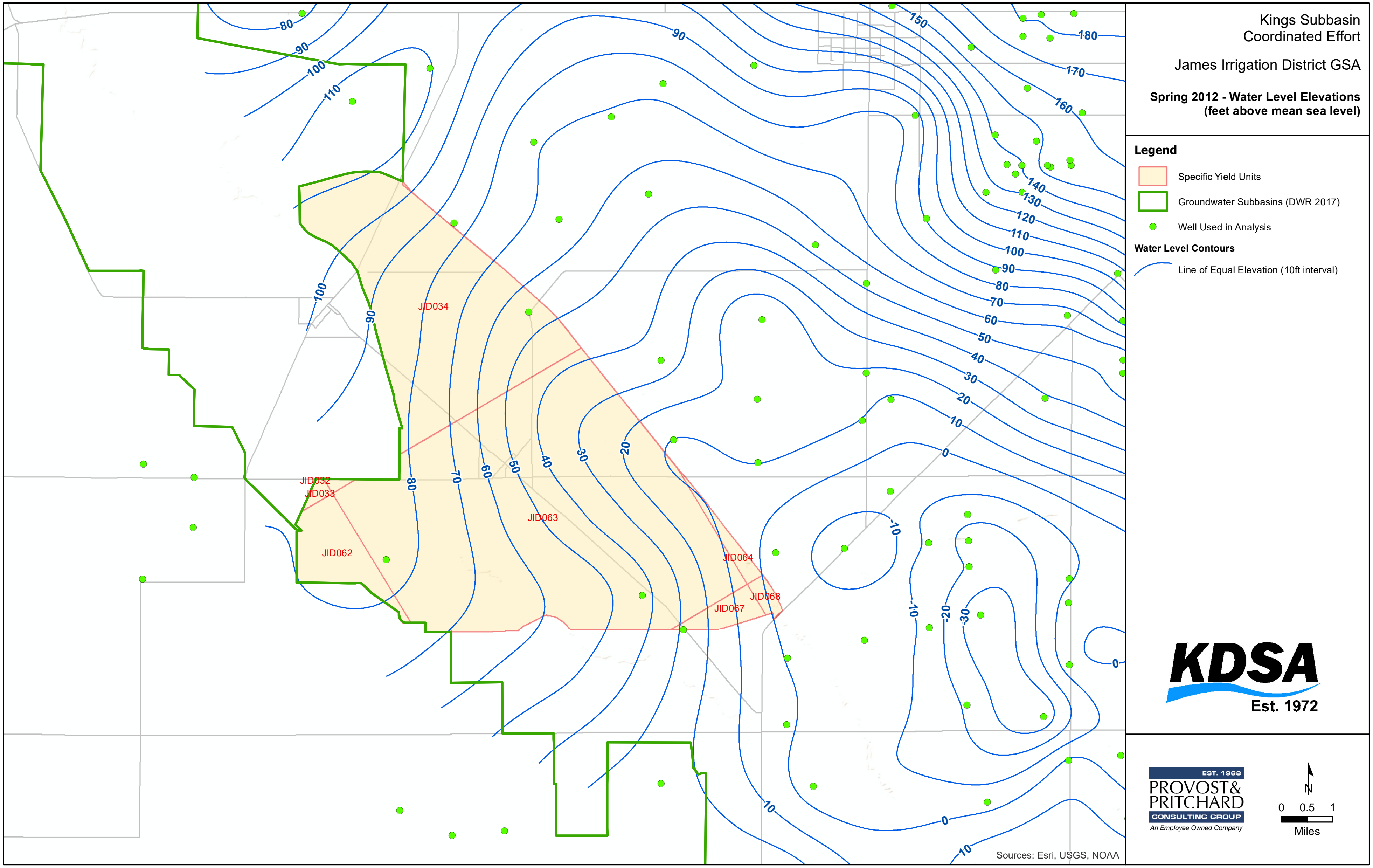

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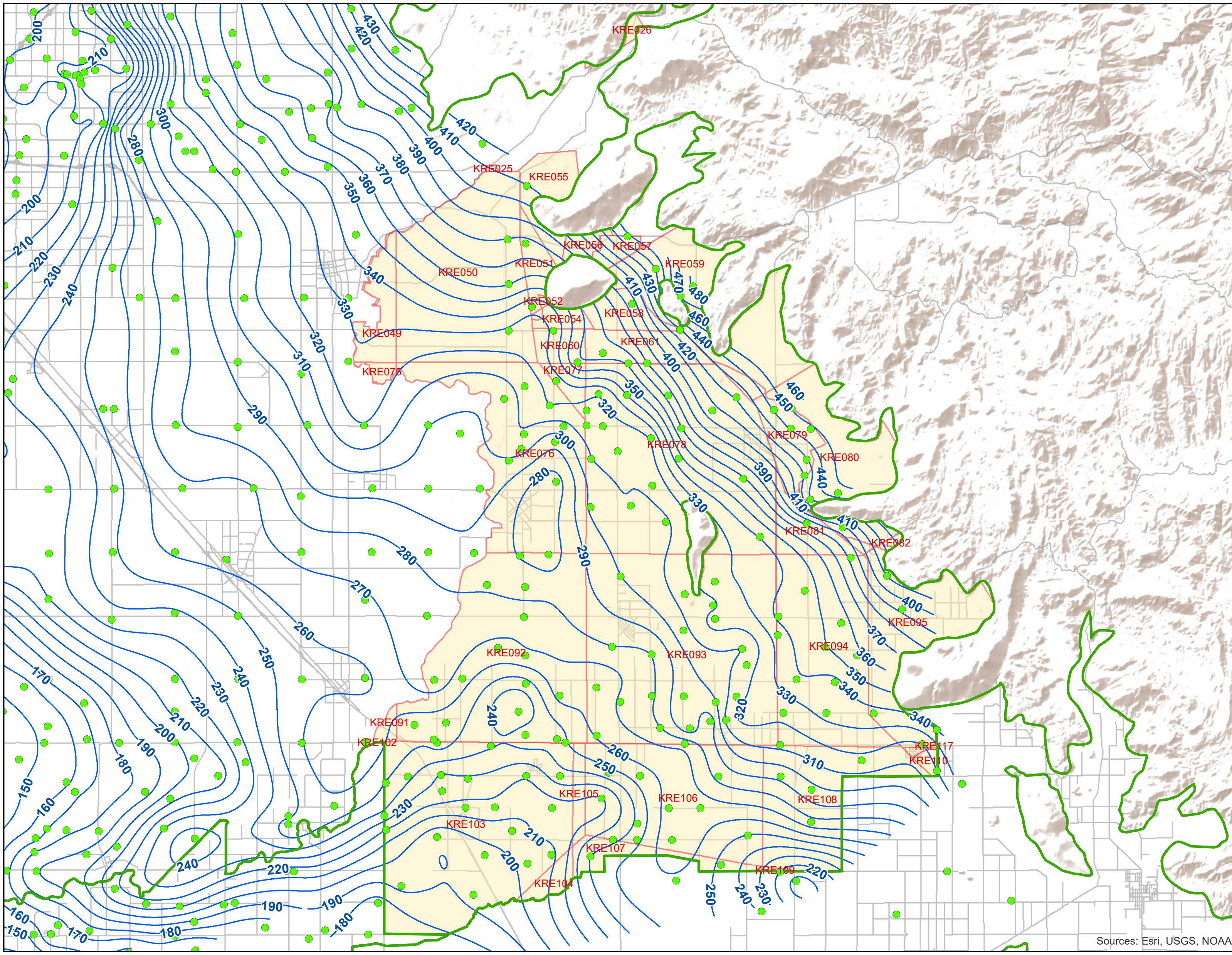

Kings Subbasin
Coordinated Effort

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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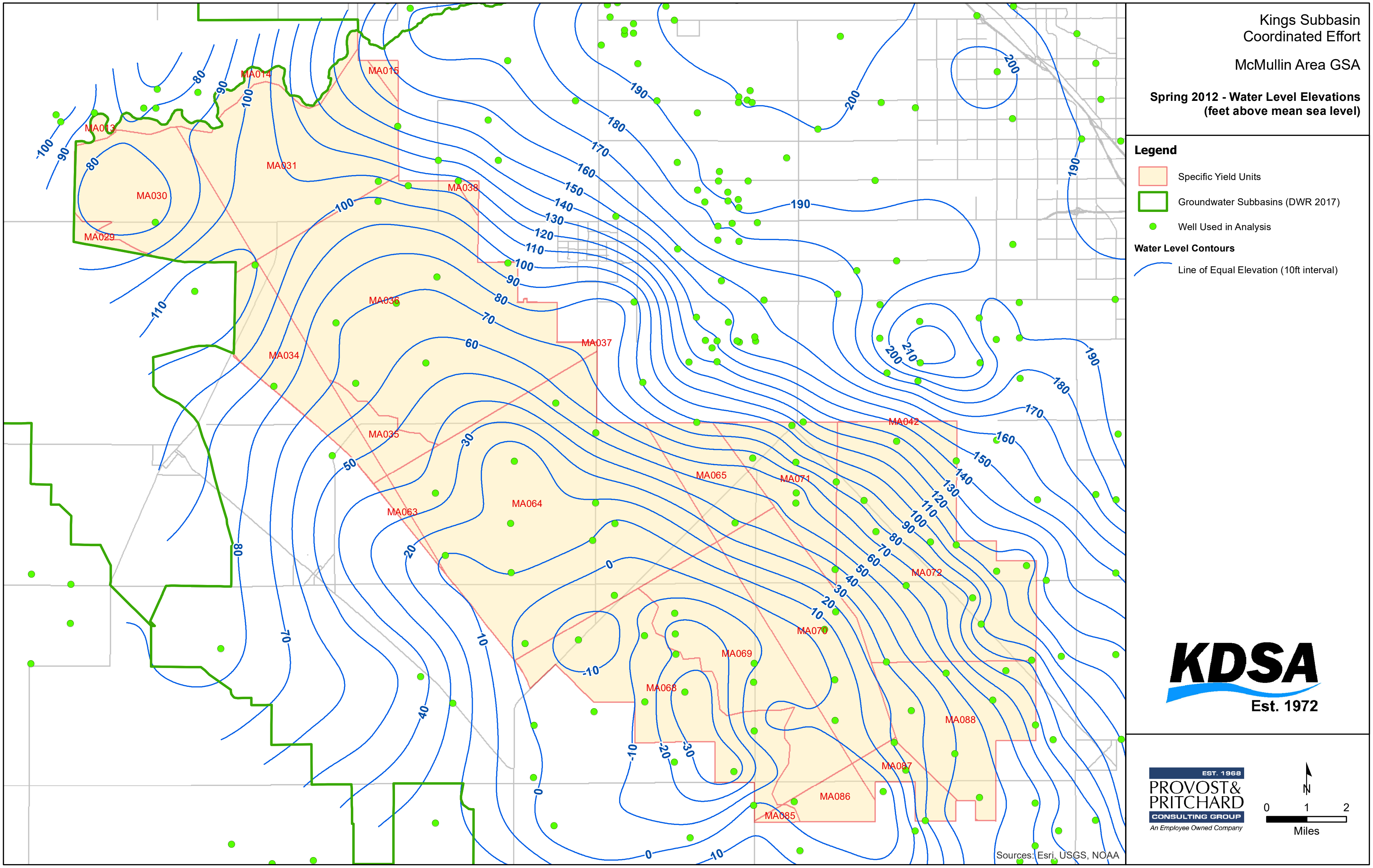
Kings Subbasin
Coordinated Effort
McMullin Area GSA
Spring 2012 - Water Level Elevations
(feet above mean sea level)
Legend
Specific Yield Units
Groundwater Subbasins (DWR 2017)
Well Used in Analysis
Water Level Contours
Line of Equal Elevation (10ft interval)
KDSA
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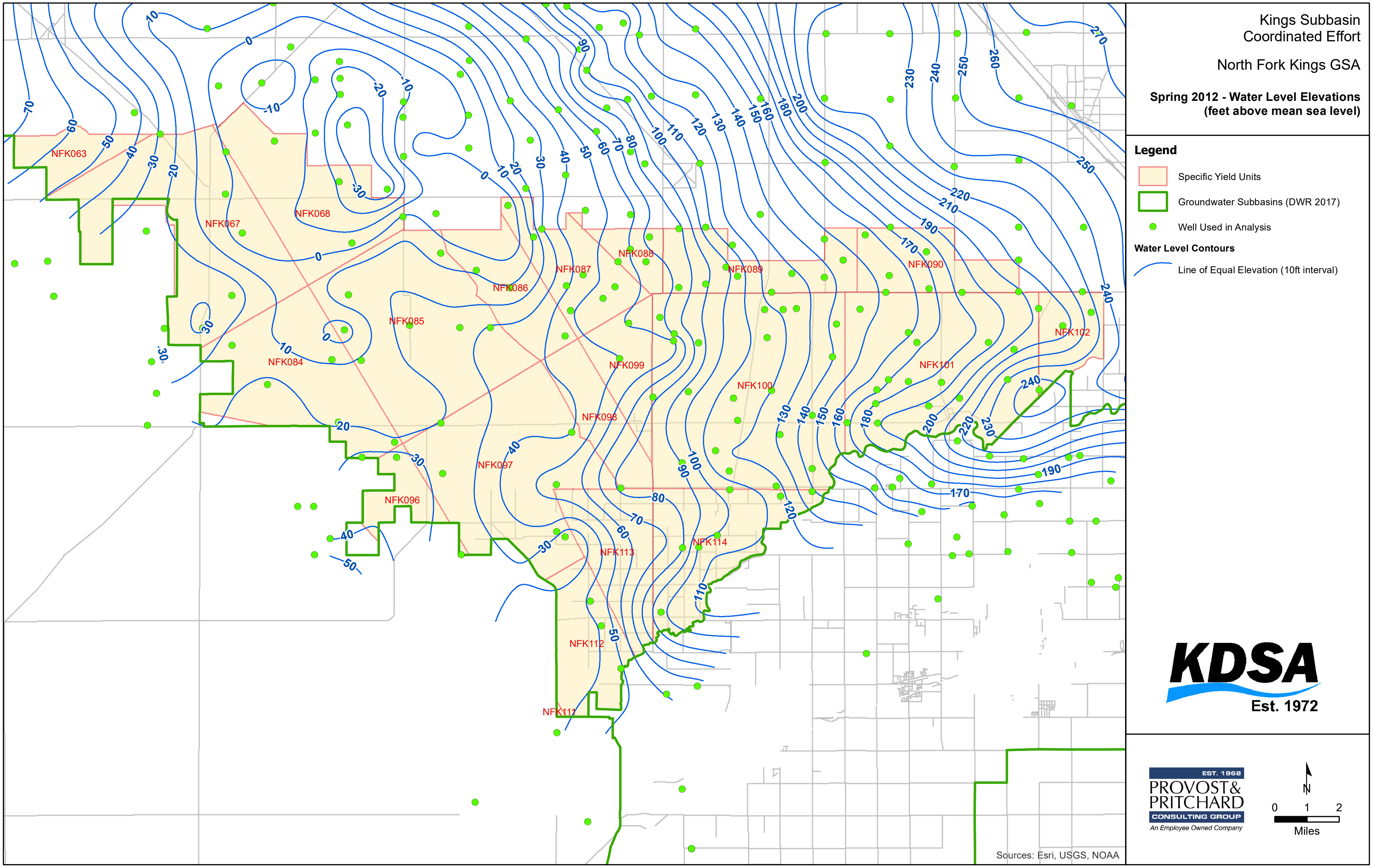
Sources: Esri, USGS, NOAA
10/18/2018 : G:\Kings River East GSA-2664\266417001-Kings Basin SGMA Coordination\GIS\Map\Wells\WSE\11x17\Contours\ByGSA\spr12_wse_mcmullin_11x17.mxd



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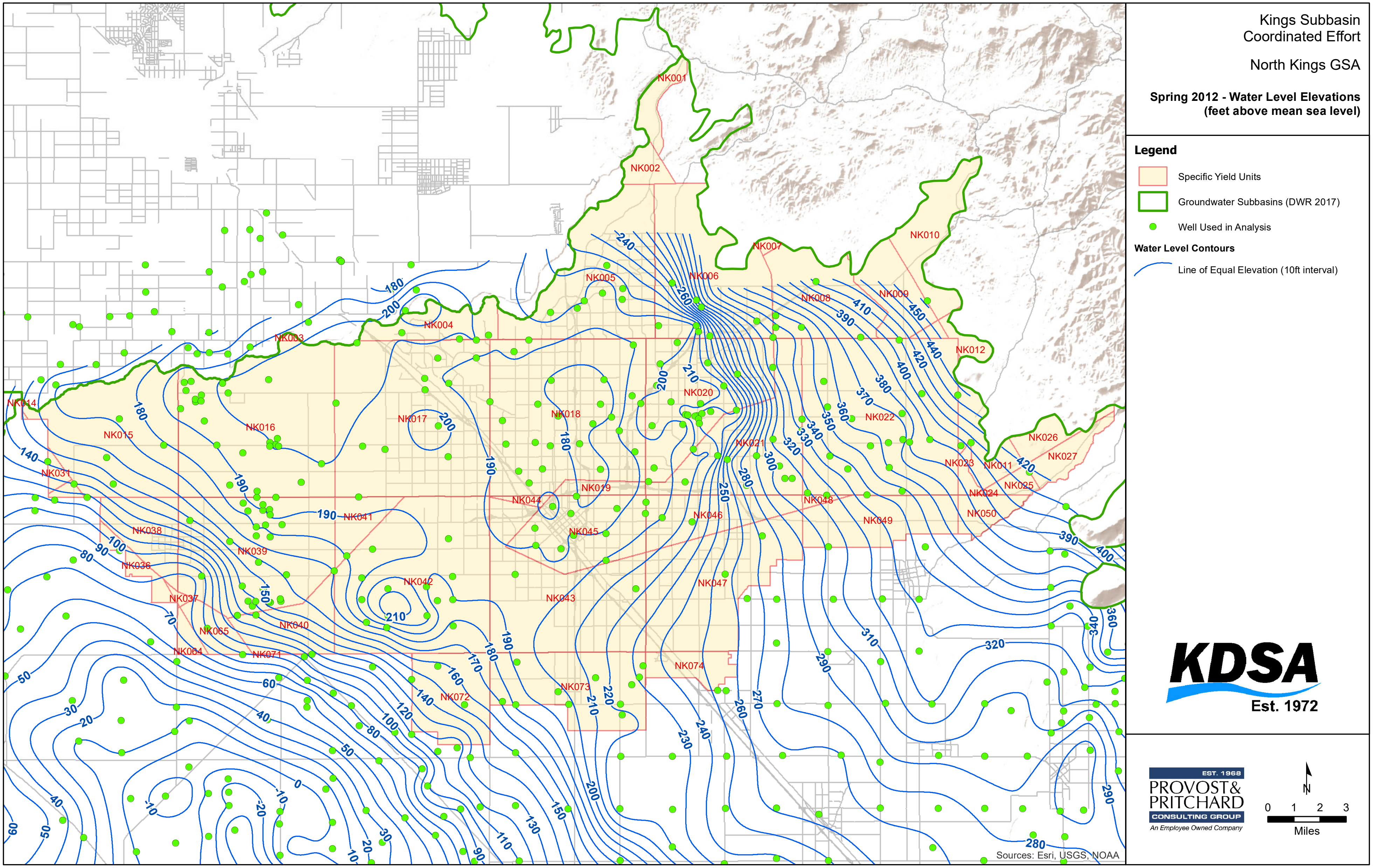
Kings Subbasin
Coordinated Effort
North Kings GSA
Spring 2012 - Water Level Elevations (feet above mean sea level)
Legend
Specific Yield Units
Groundwater Subbasins (DWR 2017)
Well Used in Analysis
Water Level Contours
Line of Equal Elevation (10ft interval)
KDSA
Est. 1972
EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company
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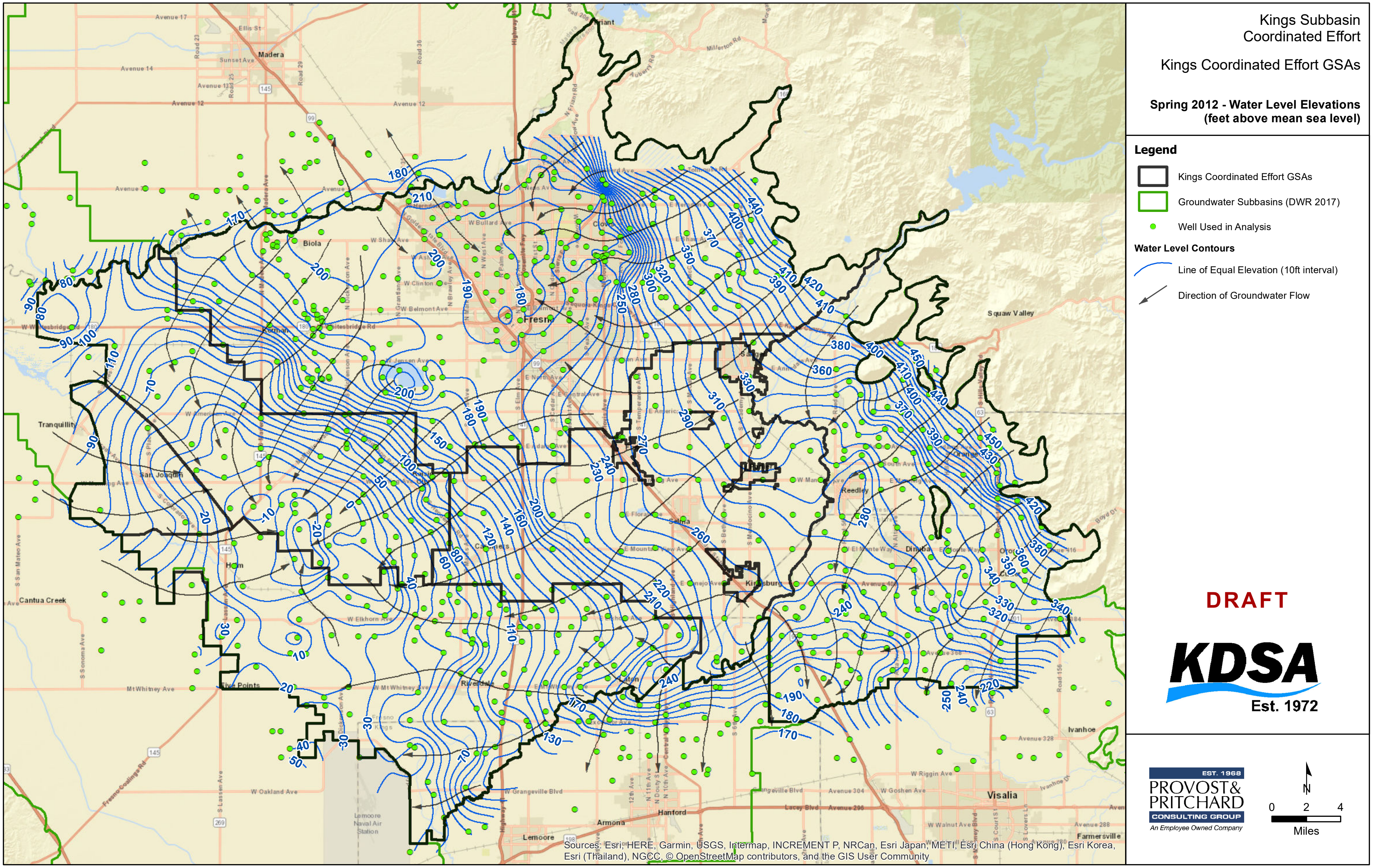
Sources: Esri, USGS, NOAA



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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	
JID063	DWR	JID	366022N1202260W004	T15S R16E 28	171.1	72.8		98.3	
JID063	DWR	JID	365808N1202249W001	T15S R16E 33	172.6		89.6		83.0
JID063	JID	JID	15S17E18B001MX	T15S R17E 18	173.0	90.6	103.3	82.4	69.7
JID063	JID	JID	15S17E20C001MX	T15S R17E 20	176.0	105.8	121.0	70.2	55.0
JID063	DWR	JID	365960N1201241W001	T15S R17E 28	181.6	127.1		54.5	
JID063	DWR	JID	365813N1201460W002	T15S R17E 32	177.7	16.1		161.6	
JID063	DWR	JID	365888N1201168W001	T15S R17E 33	181.1	140.9		40.2	
JID063	DWR	JID	365642N1202068W001	T16S R16E 02	178.2	101.8		76.4	
JID063	DWR	JID	365700N1201400W001	T16S R17E 05	174.5		131.2		43.3
JID067	DWR	JID	365655N1200977W001	T16S R17E 03	186.7	155.2		31.5	
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

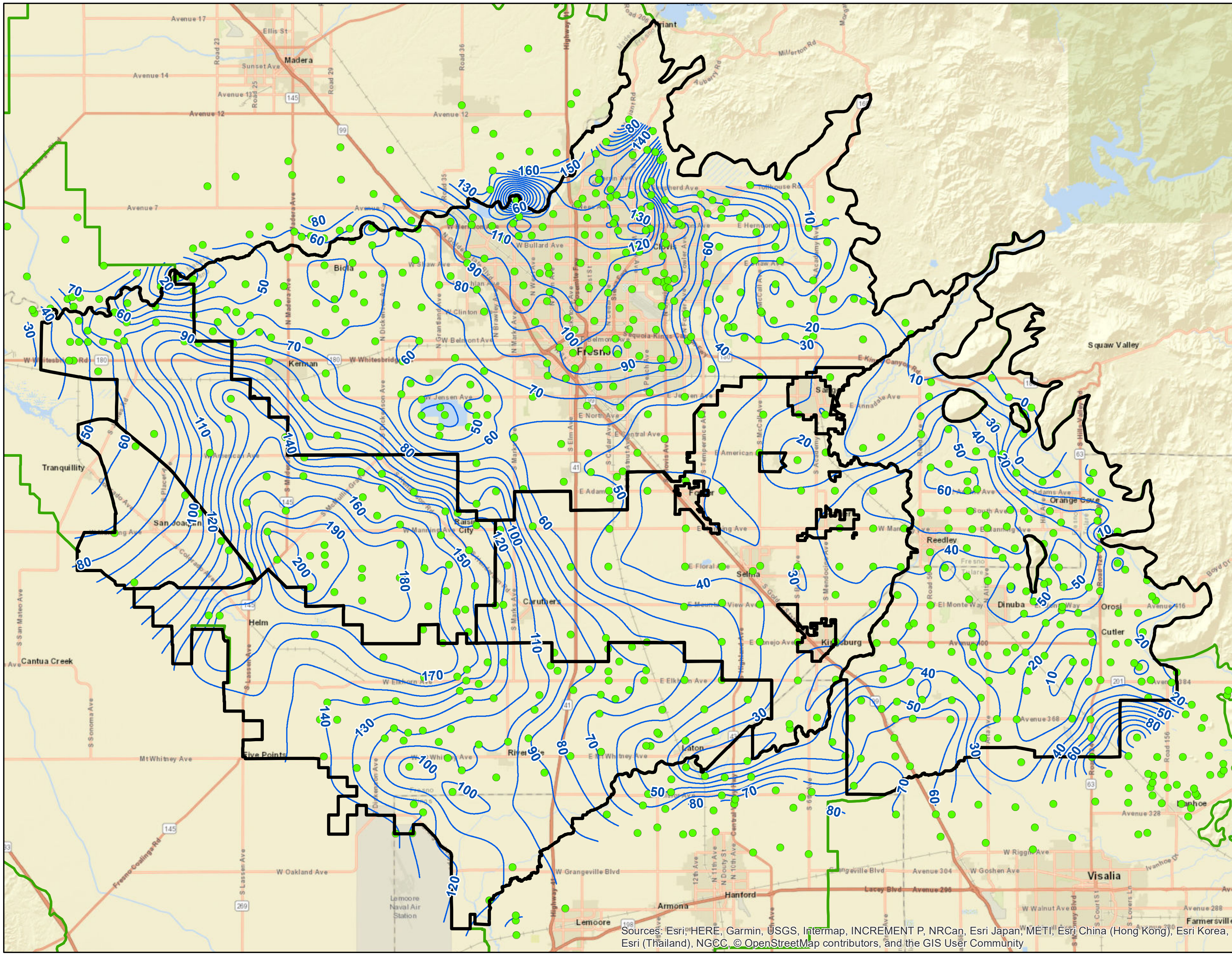
SY Unit	AGENCY	GSA	Well ID	TRS	GSE	Spring 1997 DTW	Spring 2012 DTW	Spring 1997 WSE	Spring 2012 WSE
Outside of Study Area	DWR	Outside of Study Area	364044N1195963W001	T17S R22E 33	268.7	81.5	94.0	187.2	174.7
Outside of Study Area	DWR	Outside of Study Area	364031N1195624W001	T17S R22E 35	268.7	67.5	86.4	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

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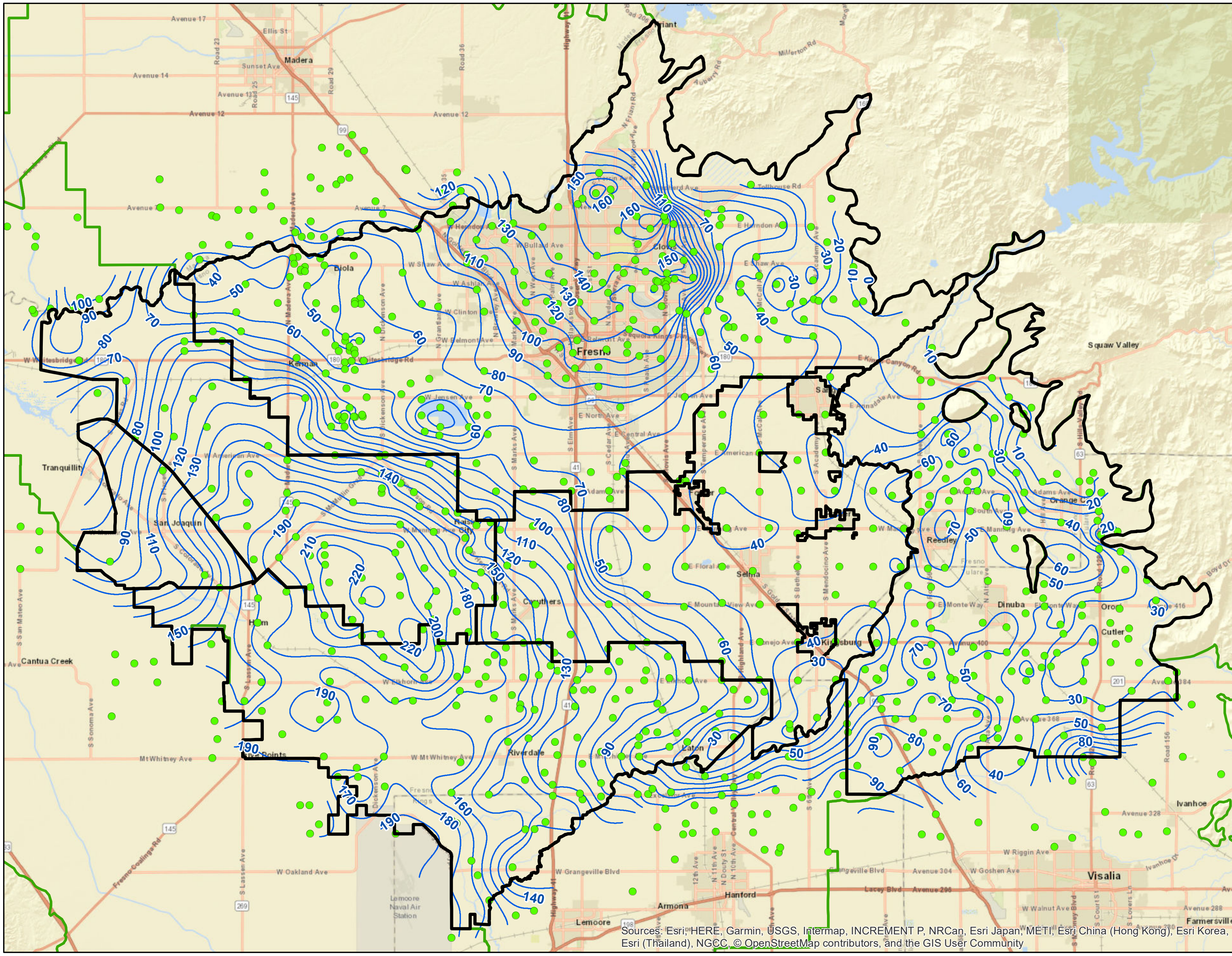

Kings Subbasin
Coordinated Effort

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

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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)	SPR 1997 to SPR 2012 Change (AF)
CK047	USGS WSP 1469	0.159	0.127	0.085	0.141	4,747	42	143,269	53	135,675	-7,595
CK049	USGS WSP 1469	0.178	0.158	0.104	0.147	10,333	30	377,428	37	365,539	-11,889
CK050	USGS WSP 1469	0.178	0.158	0.104	0.159	115	25	4,448	24	4,469	21
CK072	USGS WSP 1469	0.130	0.109	0.139	0.117	1,598	118	36,828	119	36,685	-143
CK073	USGS WSP 1469	0.138	0.134	0.134	0.142	13,442	62	438,946	82	403,341	-35,605
CK074	USGS WSP 1469	0.138	0.134	0.134	0.145	19,177	38	694,167	51	662,143	-32,024
CK075	USGS WSP 1469	0.173	0.131	0.121	0.157	20,186	35	745,232	40	729,729	-15,503
CK076	USGS WSP 1469	0.127	0.138	0.094	0.134	9,895	47	297,769	50	294,019	-3,749
CK088	USGS WSP 1469	0.155	0.139	0.157	0.120	3,844	135	85,493	157	72,182	-13,311
CK089	USGS WSP 1469	0.122	0.138	0.148	0.000	17,282	86	289,935	113	223,728	-66,207
CK090	USGS WSP 1469	0.155	0.135	0.128	0.143	17,929	52	601,268	61	579,657	-21,611
CK091	USGS WSP 1469	0.156	0.137	0.141	0.148	20,442	35	779,805	43	754,025	-25,780
CK092	USGS WSP 1469	0.147	0.126	0.141	0.131	4,850	32	174,998	40	169,924	-5,073
CK102	USGS WSP 1469	0.104	0.085	0.133	0.111	7,060	23	222,369	32	215,450	-6,918
						150,902		4,891,955		4,646,566	-245,389

Notes: 1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.

Total Change in Storage (AF) =	-245,389
Years in Range =	15
Average Change per Year (AF) =	-16,359
Average Change per Year (AF, Rounded 1,000s) =	-16,000

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
Years in Range =	15
Average Change per Year (AF) =	-4,615
Average Change per Year (AF, Rounded 1,000s) =	-5,000

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
Years in Range =	15
Average Change per Year (AF) =	-11,486
Average Change per Year (AF, Rounded 1,000s) =	-11,000

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

Notes: 1) Specific Yield values zeroed and storage volume not calculated for areas below base of unconfined aquifer.

Total Change in Storage (AF) =	-238,767
Years in Range =	15
Average Change per Year (AF) =	-15,918
Average Change per Year (AF, Rounded 1,000s) =	-16,000

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
Average Change per Year (AF) =	-48,651
Average Change per Year (AF, Rounded 1,000s) =	-49,000

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
Years in Range =	15
Average Change per Year (AF) =	-24,135
Average Change per Year (AF, Rounded 1,000s) =	-24,000

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
Average Change per Year (AF) =	-651
Average Change per Year (AF, Rounded 1,000s) =	-1,000

Technical Memorandum 5
Estimation of Groundwater Flows at Boundaries

This Technical Memorandum (TM) summarizes the process used to estimate the groundwater flows at internal Kings Subbasin GSA boundaries and between the neighboring groundwater basins. The flow estimates are for the unconfined groundwater of the Kings Subbasin and for the spring of years 1925 and 1997 to 2012 with the exception of 2010 (hereafter 1997 to 2012). Groundwater Contours were not generated in 2010 due to a significant data gap in Central Kings that year. This TM does not evaluate the unconfined boundary flow between the Central and South Kings GSAs. Excluding the South and Central boundaries, there are 9 unique internal boundaries between Kings Subbasin GSAs as shown in Attachment 1. There are 12 external boundaries between Kings Subbasin GSAs and GSAs in the neighboring groundwater basins. The internal boundaries between the Kings Subbasin GSAs were split into 86 flow segments (segment numbers 0 to 85) where groundwater flows were estimated between the Kings Subbasin GSAs, Attachment 2. The external boundaries were split into 83 external flow segments (segment numbers 100 through 182) as shown in Attachment 2.

Groundwater flows across segments along the Kings and San Joaquin Rivers are, at this time, assumed to be zero, and while estimates of transmissivity and changes in aquifer thickness are provided for the flow segments along the rivers where data is available, these flows are assigned a zero value in the tabulated data.

Groundwater flow was estimated across these segments, excluding the flow segments along the rivers, for springs of 1925, and 1997 to 2012, as discussed below and shown in Attachment 3. The estimated flows by segment were then grouped by shared GSA boundaries and direction of flow. The tables showing the grouped data are included as Attachment 4. The estimated unconfined flows from spring 1925, and the average flows from 1997 to 2012 for Kings Subbasin GSAs with shared boundaries were summarized as shown in Table 1. Table 1 also provides summaries of estimated unconfined flows between the Kings Subbasin and the neighboring groundwater basins.

<u>Flow Segments</u>

The internal flow segments primarily follow the boundaries between the basin's GSAs and generally are aligned along GSA boundaries (Attachment 2). In a few areas where a boundary changes direction multiple times over a short distance, the flow segments were simplified by making a straight line across the boundary, e.g. segments 6, 23, 62, 63 are some of the simplified flow segments. Where the Kings River or the San Joaquin River are the boundary between GSA's (both internal and external), flow segments were assigned based on reaches of the river that generally trend in the same direction. Transmissivity values were estimated for the segments. Changes in estimated transmissivity were used to refine the boundaries into the 86 internal flow segments and KDSA provided estimates of transmissivity along the external flow segments. See Attachment 2 for the groundwater contour maps, and Attachment 3 for the tabulated data.

Groundwater Flow

Darcy's law

Darcy's Law is commonly used to calculate groundwater flows. For lateral groundwater flows, the equation used is:

$$Q = TIL$$

where: $Q\ is$ 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 estimated from specific capacity (pumping rate divided by drawdown) values. 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 to use to estimate groundwater flows,
- The aquifer is relatively homogenous and isotropic

The following discusses the components of Darcy's Law and describes the methods and data sources used to estimate the flow equation components in the Kings Subbasin and along the Subbasin boundaries. It is important to note that groundwater flow estimates under this effort are only being done for the unconfined groundwater and for the springs of 1925, and 1997 to 2012. The base of the unconfined aquifer was developed in TM 1. Groundwater flow was estimated across the flow segments and then the flows across the segments were grouped to develop estimated groundwater flows between the Kings Subbasin GSAs and between the Kings Subbasin GSAs and GSAs in the neighboring groundwater basins.

Transmissivity Estimates (T)

Both drawdown and recovery water-level measurements are normally made for aquifer tests. Pumping rates and pumpage are normally measured with a totalizing flowmeter. The aquifer tests for large capacity wells tapping alluvial deposits commonly comprise pumping at a constant rate (constant discharge test) for periods ranging from about 8 to 24 hours. Drawdown and recovery water-level measurements are commonly plotted on a semi-logarithmic scale (depth to water on an arithmetic scale versus time on a log scale). For tests where the pumping level doesn't stabilize, a corrected recovery plot is prepared. Such aquifer tests are commonly done on new wells, to help design the optimum pump for the well. Drawdown measurements are affected by well losses, and thus recovery plots are normally given more weight in determining the transmissivity.

Transmissivity values are available for dozens of tests on wells tapping the shallow unconfined groundwater and for dozens of other tests on wells tapping the deeper confined groundwater.

Transmissivity values derived from aquifer tests in much of the Kings Basin range from as low as about 10,000 gpd per foot to as high as about 300,000 gpd per foot.

Specific Capacity

In the absence of aquifer test results, the specific capacities can be used to estimate transmissivities. Specific capacity is the pumping rate divided by the drawdown. Davis, Lofgren, and Mack (1964) in U.S. Geological Survey Water-Supply Paper 1618 (WSP 1618) provided specific capacity values by township and range for much of the San Joaquin Valley, including the Kings Subbasin. These values were collected during 1955-56, and were presented in Table 3 of that paper. An important factor is that as of that time, most of the wells that were evaluated in the Kings Subbasin had been drilled by the cable-tool method and tapped the shallow unconfined groundwater. Most of these were open-bottom wells, consisting of a blank (non-perforated) steel well casing, with a large open hole below the bottom of the casing. Such wells were highly efficient, meaning the well losses were small or insignificant. Well losses are primarily due to turbulent flow as the groundwater nears the perforations in a well, and possibly within the gravel pack, for gravel packed wells. Most large capacity wells drilled since 1965 in the Kings Subbasin were drilled by the reverse rotary method and have perforated casings and gravel packs. Such wells usually have significant well losses, which reduces the specific capacities compared to the transmissivities.

Thomasson et al. (1960) developed conversion factors between specific capacity and transmissivity in U.S. Geological Survey Water-Supply Paper 1464. A conversion factor of 1,500 has commonly been used to multiply times the specific capacity to estimate the transmissivity for unconfined aquifers in the San Joaquin Valley. A value of 2,000 is commonly used for confined aquifers in the valley. Specific capacities in Table 3 in WSP 1618 for townships in the Kings Subbasin usually ranged from about 40 to 90 gpm per foot. Using a conversion factor of 1,500, this would indicate a range in transmissivity from about 60,000 to 135,000 gpd per foot. Lower specific capacities (10 to 30 gpm per foot) are common in the eastern part of the Kings Basin in the interfan area. Some of the highest specific capacities for wells tapping the shallow unconfined groundwater in the Kings Basin were in the north part of the Fresno Urban Area. Carollo Engineers and Harshbarger and Associates (1969) indicated specific capacities exceeding 100 gpm per foot over a large area within several miles of the San Joaquin River. They determined transmissivities from two aquifer tests in northwest Fresno and by converting specific capacity values for wells elsewhere in Fresno. Transmissivities in the Fresno Urban Area as of 1969 ranged from 60,000 gpd per foot in part of the area southwest of Highway 99 to 300,000 gpd per foot near the San Joaquin River. The higher values aren't indicated by specific capacity values averaged over whole townships, because they generally are found only in part of a particular township.

The internal estimated flows presented in Attachment 3 are based primarily on transmissivities estimated from specific capacity values in WSP 1618 with some refinements where KDSA had aquifer test results (shown in italicized text) or additional data was provided (also italicized). KDSA provided estimates of transmissivity for the majority of the external flow segments (also italicized). Pump tests were provided by the following entities; Fresno Irrigation District, James Irrigation District, Kings River Conservation District, Fowler Packing, City of Kingsburg, City of Fowler, City of Fresno, and the City of Sanger. These data were used to refine estimates of transmissivity. The resultant recommended transmissivity values incorporate estimates of transmissivity from the more recent pump test data, pump tests data from KDSA, and the data from USGS 1618.

Transmissivity Adjustments for Aquifer Thickness Changes

As mentioned above, transmissivity is equal to the thickness of water-producing strata multiplied by the hydraulic conductivity of these strata, therefore the estimates of transmissivity were adjusted for changing aquifer thickness over time. The general approach was to assume that the spring 1925 water level map is a reasonable representation of the pre-development saturated thickness of the Kings Subbasin aquifer. The difference between the base of unconfined groundwater and the water level contours was assumed to represent the thickness of the unconfined aquifer for a given year or set of years. Estimates of transmissivity from the various sources were adjusted as follows;

- WSP 1618 – the spring 1962 Department of Water Resources (DWR), Lines of Equal Elevation of Water in Wells, was assumed to reasonably represent aquifer thickness from when WSP 1618 was published in 1964. Therefore, the aquifer thickness from 1962 was used to decrease the WSP 1618 estimated transmissivity values for use in the spring 1997 to spring 2012 flow calculations. The percent change from 1962 to the 1997-2012 time period was based on the average of the 1962 to 1999 percent change and the 1962 to 2011 percent change. Conversely, the WSP 1618 estimated transmissivities were adjusted up, i.e., the aquifer was thicker, for the 1925 flow calculations.
- Recent Estimates of Transmissivity – Both KDSA estimated transmissivities and estimates from supplied pump test data are thought to be reasonable estimates for use in the spring 1997 to spring 2012 flow calculations as this is more recent data. However, these estimates of transmissivity were increased for the 1925 flow calculations by an amount commensurate with the average percent thickness change from 1925 to 1999 and 1925 to 2011.

<u>Hydraulic Gradient (I)</u>

The hydraulic gradient or water-level slope (slope) at each segment was estimated from groundwater elevation surfaces and flow lines showing the direction of groundwater flow for the years discussed in TM4. ArcGIS provided an average slope across each flow segment using the continuous groundwater elevation surfaces which has a 200 by 200-foot grid cell size. ArcGIS was also used to determine the direction of flow, which is used to estimate the flow segment length (L) perpendicular to flow direction, as discussed below.

<u>Flow Segment Length (L)</u>

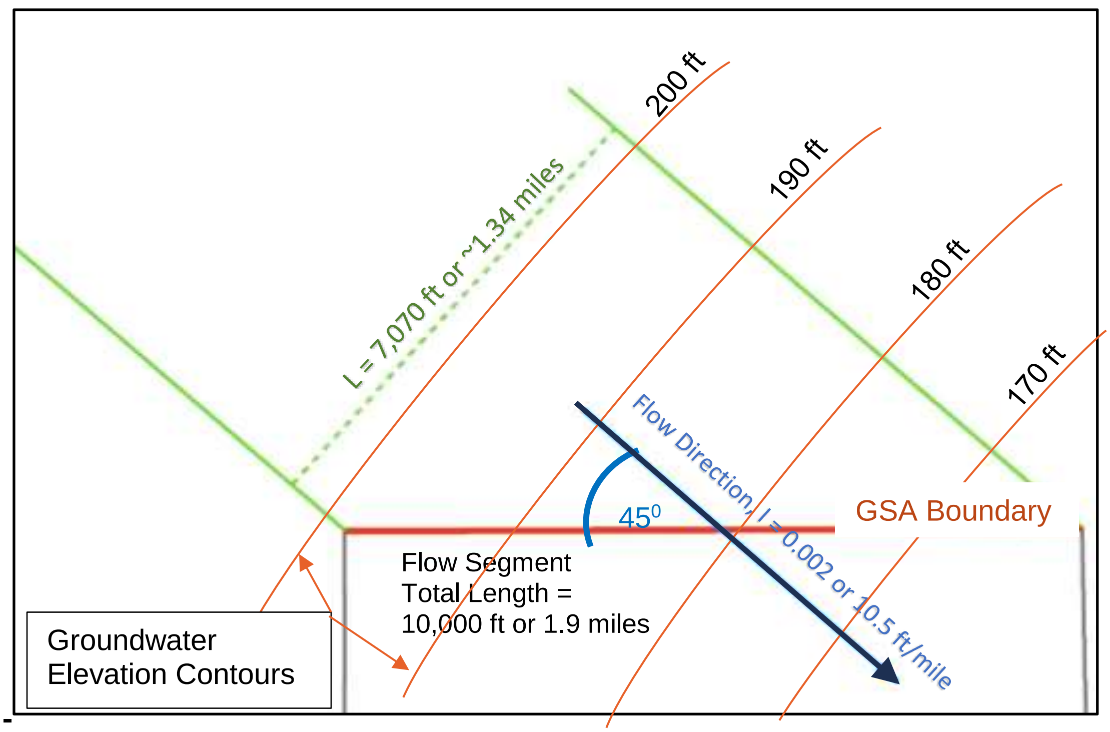
Groundwater flows are calculated in the direction of maximum water slope (perpendicular to water-level contours). With very few exceptions, if any, the direction of groundwater flow was not perpendicular to the flow segment. Therefore, the length of the flow segment perpendicular to maximum slope was calculated based on the angle between the flow segment and the direction of maximum slope. For example, assume a 10,000-foot-long flow segment that is oriented east to west, and a maximum slope direction across it to the southeast. This results in a 45-degree (45°) angle between the orientation of the flow segment and the maximum slope direction. An example of how the resultant length (L) perpendicular to flow is calculated is as follows:

Flow segment length perpendicular to flow (L) = sine 45° X Flow Segment Length (10,000 feet)
Therefore,

L = 0.707 X 10,000 feet = **7,070 feet**.

Method of Flow Calculation

Figure 1, below, illustrates the visual components of groundwater flow for a hypothetical scenario in which flow is at a 45° angle to the flow segment, the gradient is 0.002 or 10.5 feet per mile, and the total length of the flow segment is 10,000 feet or about 1.9 miles. This example calculation uses a transmissivity value of 80,000 gpd/ft.



As discussed and shown above the length perpendicular to flow in this scenario is 7,070 feet. Therefore, the annual groundwater flow (Q) using Darcy's Law would be calculated as follows

Q = TIL

Where Q is the estimated annual flow across the flow segment,

Transmissivity (T) = 80,000 gpd/ft

Hydraulic Gradient (I) = 0.002 or 10.5 ft/mile,

Flow Segment Length (L) = 7,070 ft or 1.34 miles.

Therefore,

Q = 80,000 gpd/ft X 10.5 ft/mile X 1.34 miles, which equals about 1,125,600 gallons per day (gpd). This value is then converted to acre-feet per year (AF/year) using the following conversion

$$\frac{1{,}125{,}600 \text{ gallons/day X } 365 \text{ days/year}}{325{,}851 \text{ gallons/acre-foot}} = \mathbf{1{,}260\ AF/year}.$$

While this is a hypothetical example, the values used, and the resulting estimated flow are within the ranges of flow listed in Attachment 3. The first column in Attachment 3 list the GSA from which flow originates and the second column is the GSA receiving the flow. Attachment 4 groups the data by flows across boundaries, and Table 1, below, provides the net estimated flow between Kings Subbasin GSAs and between the Kings Subbasin and the neighboring basins.

Years Analyzed

Boundary flow estimates were done for the following years based on the spring groundwater elevation contours;

- 1997 to 2012 because these are the years in the hydrologic base period developed in TM 3-hydrologic period and used in TM 4-storage change.
- 1925 because historical flow was credited to the GSA receiving that flow between the Kings Subbasin GSAs.

Groundwater elevation contour maps from spring data are available for years 1925 and 1997 to 2011 as developed in TM 4. The groundwater elevation contours and the wells used in a given year's groundwater contours are shown on the maps along with flow segments, Attachment 2.

Data Gaps

In addition to the lack of estimated groundwater contours in 2010, data gaps are mainly from the lack of complete groundwater contour coverage on the 1925 Department of Public Works and 1962 DWR maps (both years maps referred to as DWR). The main impact of the data gaps on the 1925 and 1962 DWR maps is that flows could not be estimated along these segments in 1925 nor could transmissivity values be adjusted for changes in aquifer thickness. On the 1925 DWR map, groundwater contours do not extend to the San Joaquin River as well they do not cover the area, with a few exceptions, on the west side of the Subbasin. In addition, the contours do not cover a few segments along the Kings and San Joaquin Rivers near the foothills. As flows are estimated to be zero along the rivers, this does not appear to affect the estimated flows between the Kings Subbasin and the Madera Subbasin on the north. The lack of coverage along the west side of the basin did not allow for complete estimate of flows in 1925 there, however unconfined water level slopes at that time in that part of the valley were probably fairly flat and flows to or from the Kings Subbasin in the west were likely small. It should be noted that the main reason for estimating flows in 1925 was to give credit to the internal GSAs for historical flows, as discussed in TM 4. There is a lack of coverage on the 1962 DWR map mainly on the southwest part of the Subbasin and along the upper reaches of the Kings and San Joaquin Rivers. Estimates of flows from 1962 are not included here therefore the main impact to the data was lack of coverage to completely estimate changes in aquifer thickness. There is also a data gap in the area south and east of Helm in 1997. Contour maps from DWR around this time and the maps prepared for this effort were reviewed to provide reasonable estimates of groundwater contours in this area around this time. The resultant contours appear to be representative of groundwater conditions in this area in spring 1997. In general, groundwater level data was relatively sparse in JID GSA for most years and in the Laguna area until 2011.

Results

Table 1, below, shows the estimated net internal and external unconfined groundwater flows, based on available data, for Kings Subbasin GSAs for 1925 and the average from 1997 to 2012.

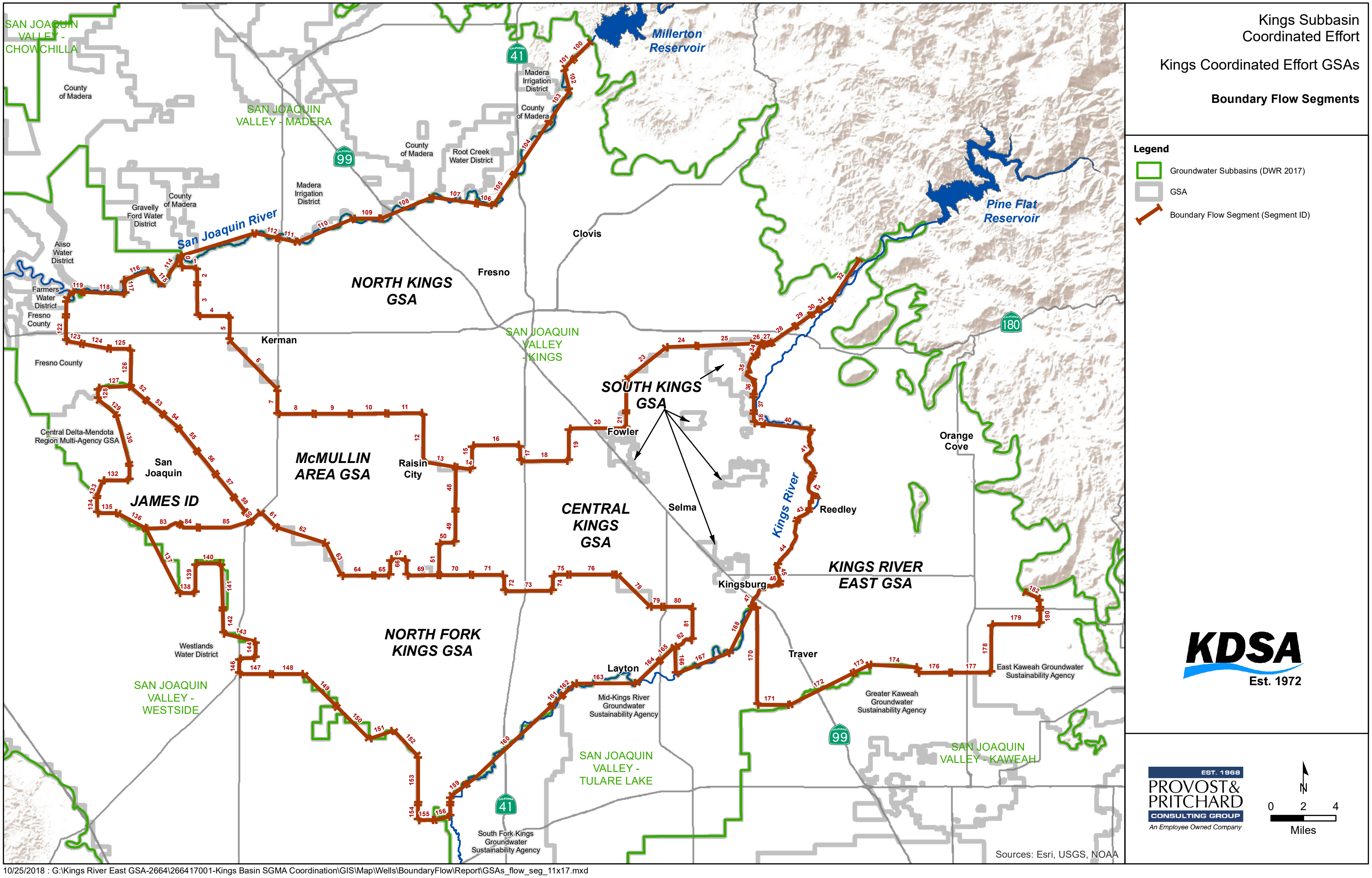
As well, Table 1 has estimates of internal and external flows between the Kings Subbasin and the neighboring basins for 1925 and the average from 1997 to 2012. Flows between South Kings GSA and Central Kings GSA were not estimated as work under this contract is being done for the six initial GSAs. The flow estimates below, and the estimated flows by segment (Attachment 3) and by groups (Attachment 4), are likely within about +- 30%. It is important to note that flows in the deeper confined groundwater are not included in the net flows below. Estimates of the deep groundwater flows, were data is available, are being prepared as a separate TM.

Table 1 - Kings Subbasin, Estimated Net Flows for Kings Subbasin GSAs and between the Kings Subbasin and neighboring basins.

GSA	Average Internal (Kings GSAs to Kings GSAs) Boundary Flows Spring 1997 to Spring 2012 (AF)	1/Average External (Kings Subbasin to Neighboring Basins) Boundary Flows Spring 1997 to Spring 2012 (AF)	Average Internal (Kings GSAs to Kings GSAs) Boundary Flows Spring 1925 (AF)	1/Average External (Kings Subbasin to Neighboring Basins) Boundary Flows Spring 1925 (AF)
Central/South	-20,400	400	-10,500	-600
James	-19,200	7,700	2,500	0
Kings River East	0	-2,100	0	0
McMullin	91,700	6,300	16,600	-300
North Fork Kings	14,900	1,400	13,600	500
North Kings	-67,000	0	-22,200	0
1/ - External Flow Estimates are draft as of 10-24-19				

Attachment 1

Kings Subbasin and Boundary Flow Segments


Kings Subbasin
Coordinated Effort
Kings Coordinated Effort GSAs
Boundary Flow Segments
Legend
Groundwater Subbasins (DWR 2017)
GSA
Boundary Flow Segment (Segment ID)
NORTH KINGS GSA
McMULLIN AREA GSA
JAMES ID
SOUTH KINGS GSA
CENTRAL KINGS GSA
KINGS RIVER EAST GSA
NORTH FORK KINGS GSA
SAN JOAQUIN VALLEY - CHOWCHILLA
SAN JOAQUIN VALLEY - MADERA
SAN JOAQUIN VALLEY - KINGS
SAN JOAQUIN VALLEY - WESTSIDE
SAN JOAQUIN VALLEY - TULARE LAKE
SAN JOAQUIN VALLEY - KAWEAH
Millerton Reservoir
Pine Flat Reservoir
San Joaquin River
Kings River
Clovis
Fresno
Kerman
Fowler
Selma
Kingsburg
Reedley
Orange Cove
Traver
Layton
Raisin City
San Joaquin
County of Madera
Madera Irrigation District
Root Creek Water District
Gravelly Ford Water District
Aliso Water District
Farmers Water District
Fresno County
Central Delta-Mendota Region Multi-Agency GSA
Westlands Water District
Mid-Kings River Groundwater Sustainability Agency
South Fork Kings Groundwater Sustainability Agency
Greater Kaweah Groundwater Sustainability Agency
East Kaweah Groundwater Sustainability Agency
KDSA
Est. 1972
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CONSULTING GROUP
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Sources: Esri, USGS, NOAA
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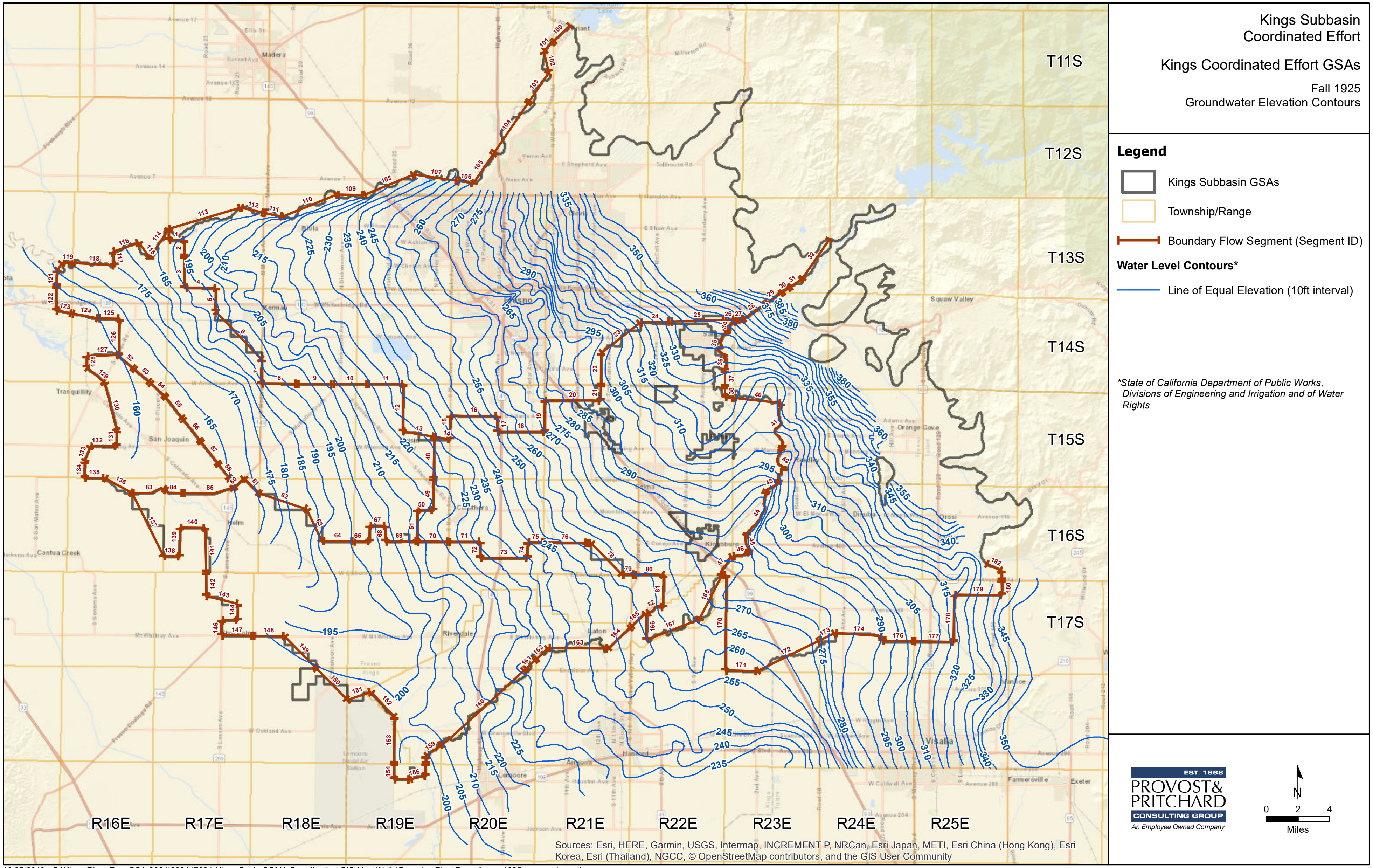
Attachment 2

Groundwater Elevation Contour Maps
(With Flow Segments)



Kings Subbasin Coordinated Effort
Kings Coordinated Effort GSAs
Fall 1925
Groundwater Elevation Contours
Legend
Kings Subbasin GSAs
Township/Range
Boundary Flow Segment (Segment ID)
Water Level Contours*
Line of Equal Elevation (10ft interval)
*State of California Department of Public Works, Divisions of Engineering and Irrigation and of Water Rights
T11S
T12S
T13S
T14S
T15S
T16S
T17S
R16E
R17E
R18E
R19E
R20E
R21E
R22E
R23E
R24E
R25E
EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company
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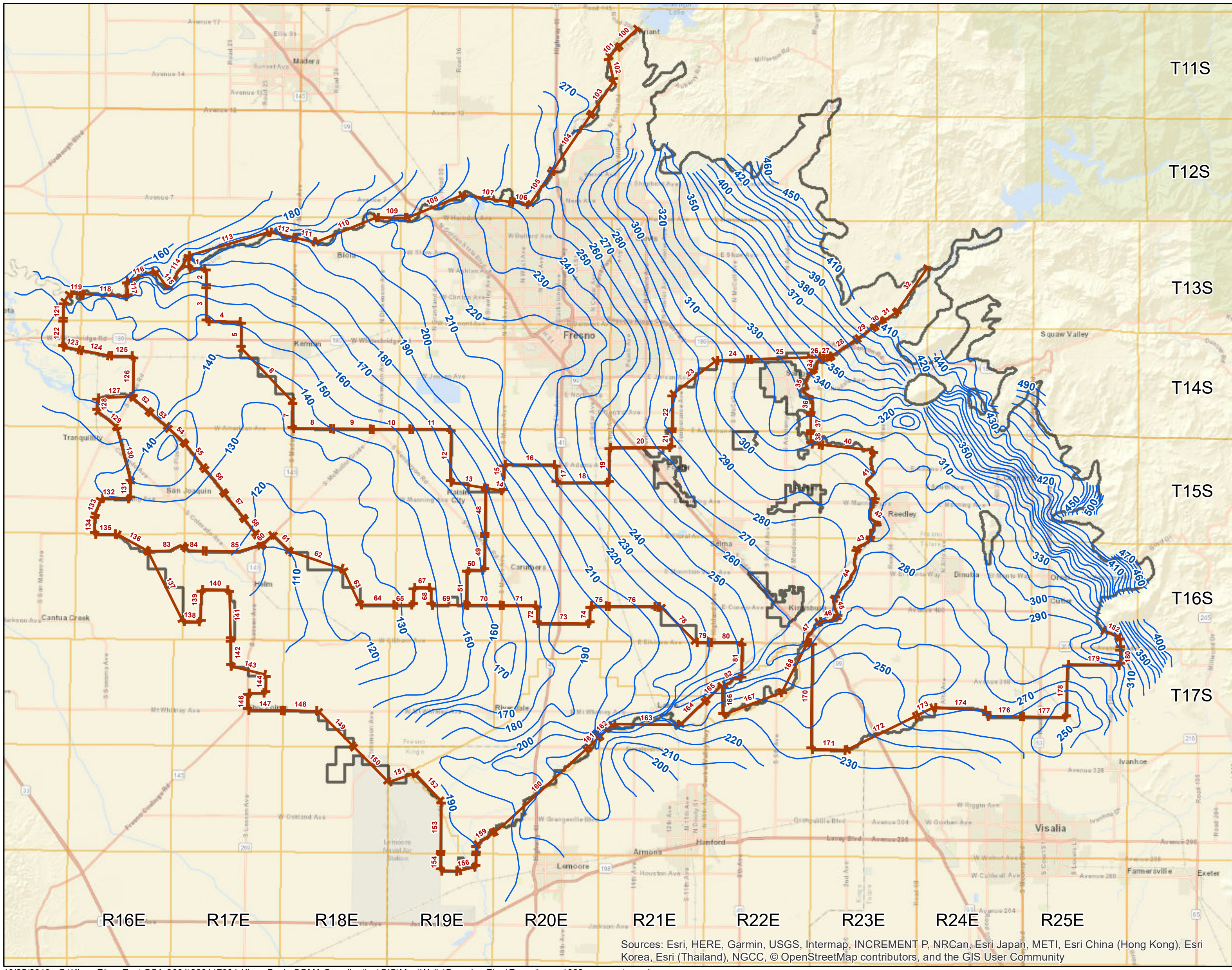
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 1962
Groundwater Elevation Contours



Legend

Kings Subbasin GSAs

Township/Range

Boundary Flow Segment (Segment ID)

Water Level Contours*

Line of Equal Elevation (10ft interval)

**California Department of Water Resources, Lines of Equal Elevation of Water in Wells, San Joaquin Valley*

EST. 1968 PROVOST& PRITCHARD CONSULTING GROUP *An Employee Owned Company*

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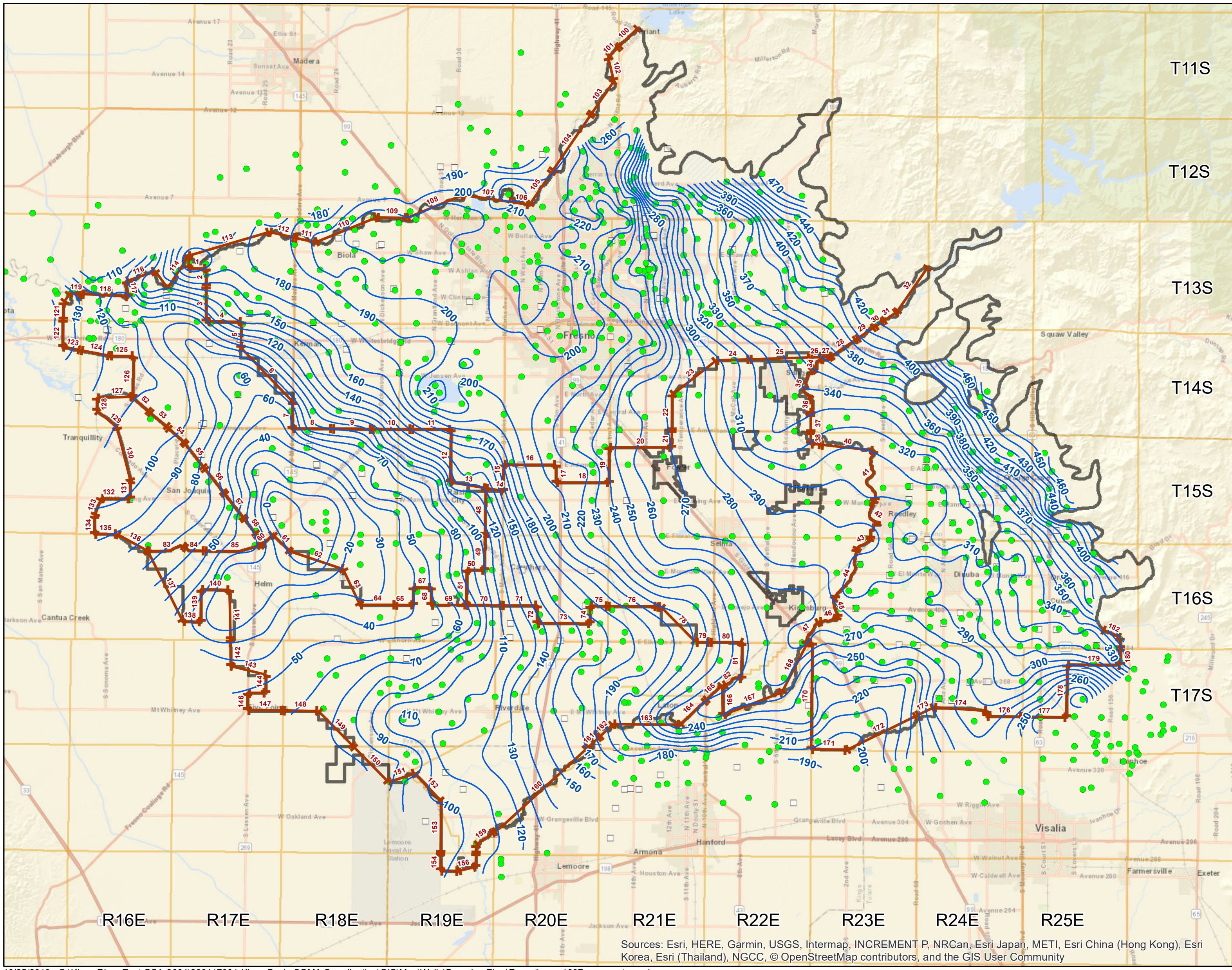

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 1997
Groundwater Elevation Contours

Legend

- Kings Subbasin GSAs
- Township/Range
- Well - Data Used
- Well - Data Not Used
- Boundary Flow Segment (Segment ID)

Water Level Contours

- Line of Equal Elevation (10ft interval)

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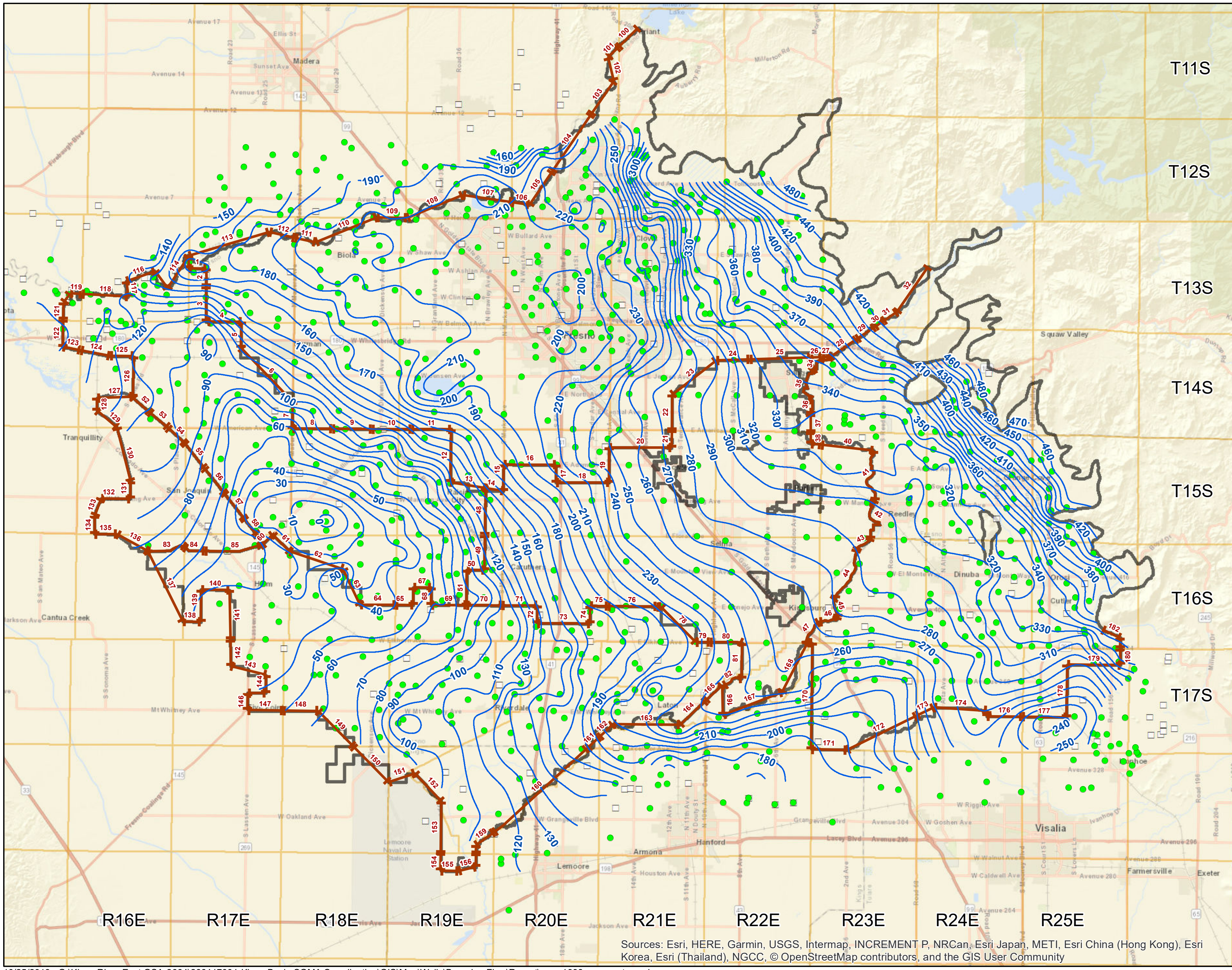
Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 1998
Groundwater Elevation Contours



Legend

- Kings Subbasin GSAs
- Township/Range
- Well - Data Used
- Well - Data Not Used
- Boundary Flow Segment (Segment ID)

Water Level Contours

- Line of Equal Elevation (10ft interval)

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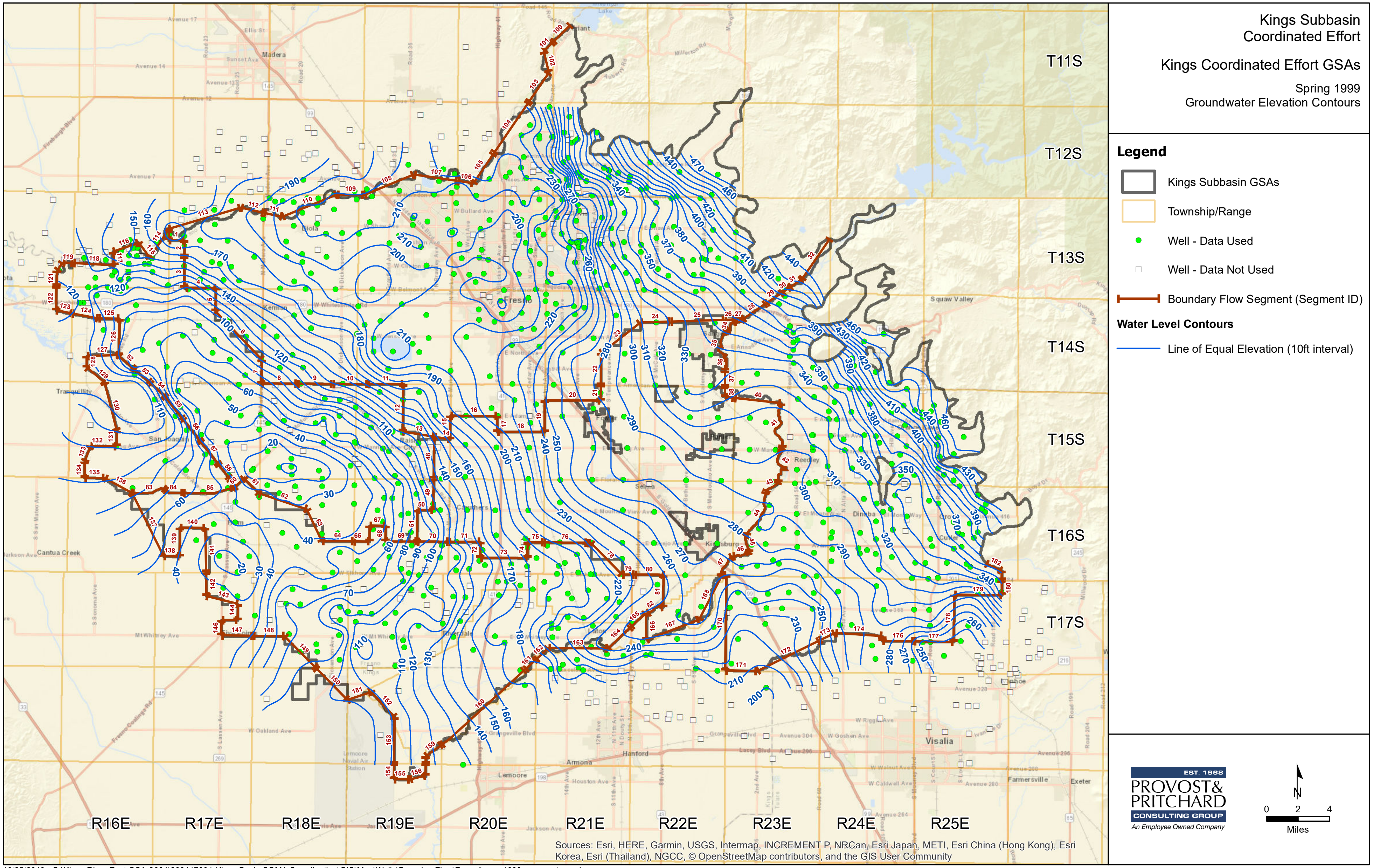

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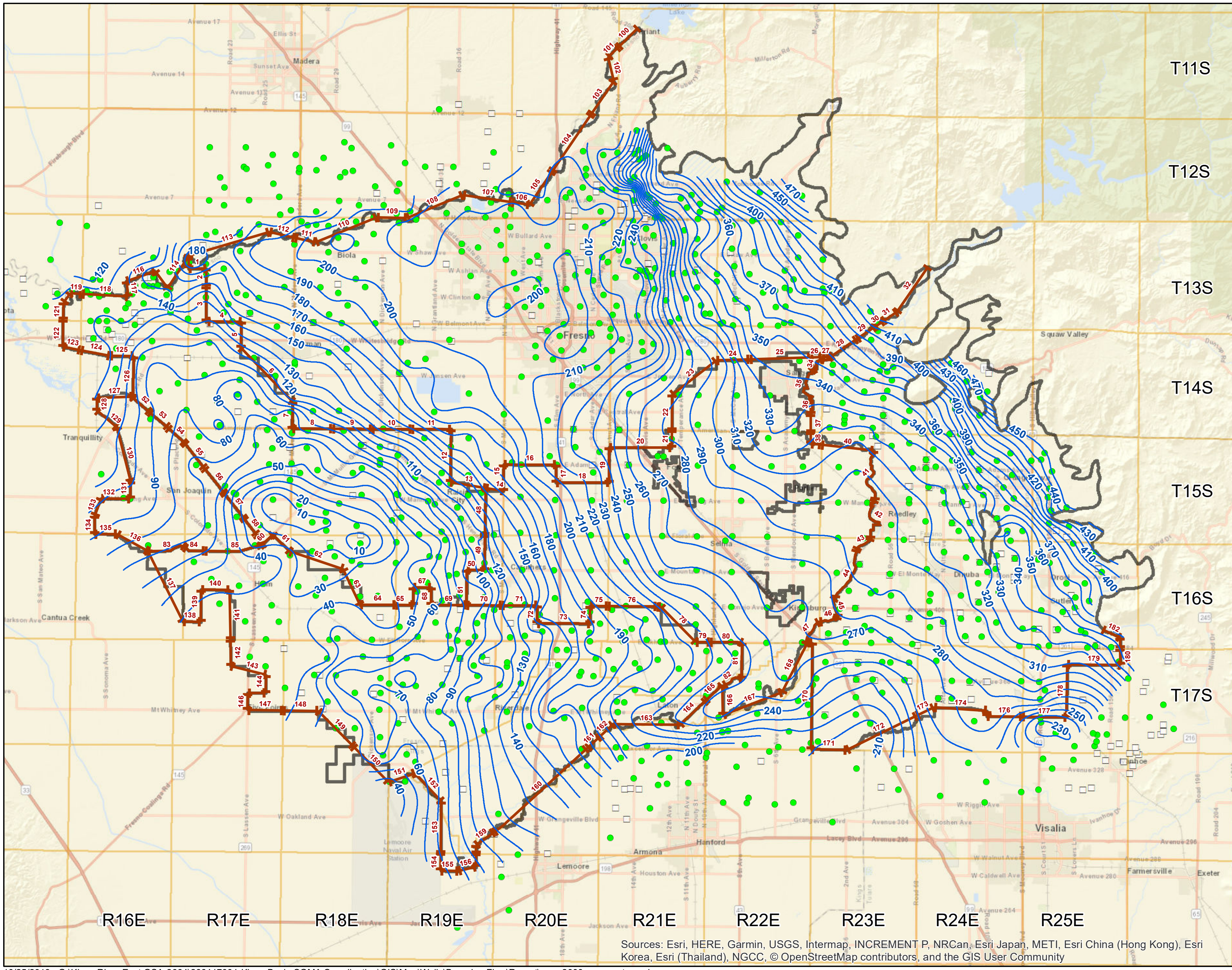


Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2000
Groundwater Elevation Contours

Legend

Kings Subbasin GSAs

Township/Range

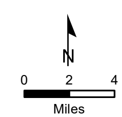
Well - Data Used

Well - Data Not Used

Boundary Flow Segment (Segment ID)

Water Level Contours

Line of Equal Elevation (10ft interval)



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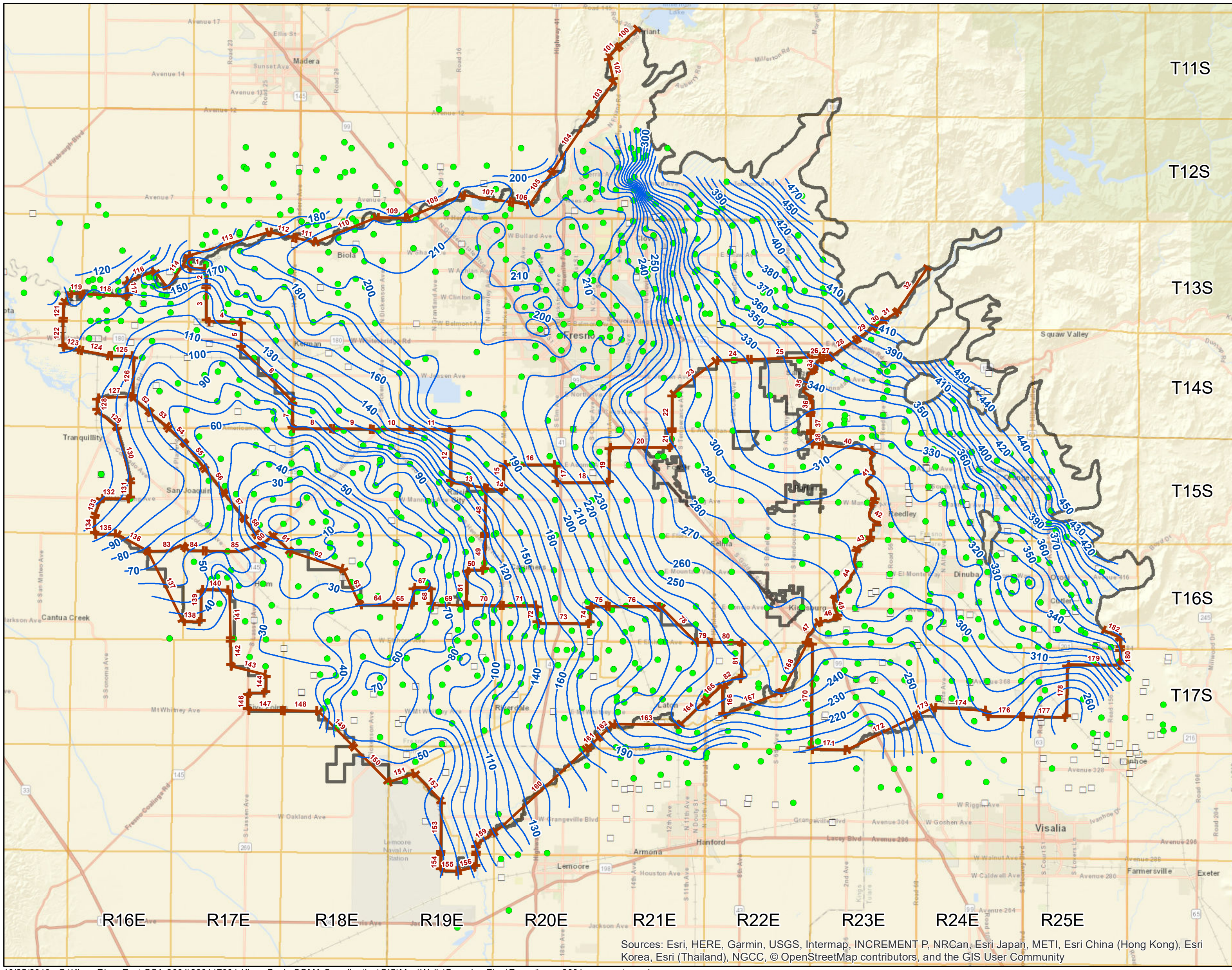

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2001
Groundwater Elevation Contours

Legend

Kings Subbasin GSAs

Township/Range

Well - Data Used

Well - Data Not Used

Boundary Flow Segment (Segment ID)

Water Level Contours

Line of Equal Elevation (10ft interval)

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PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company

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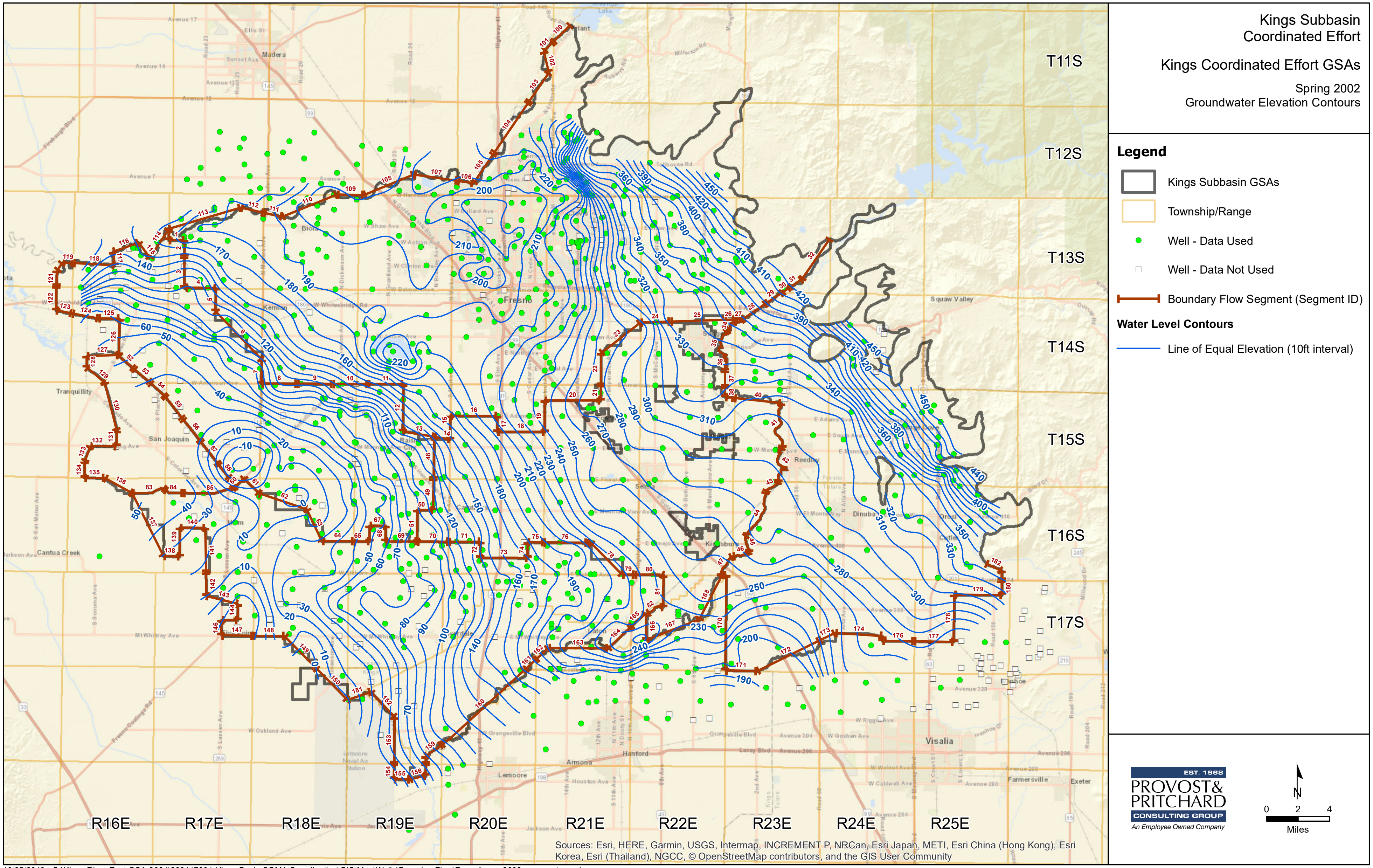

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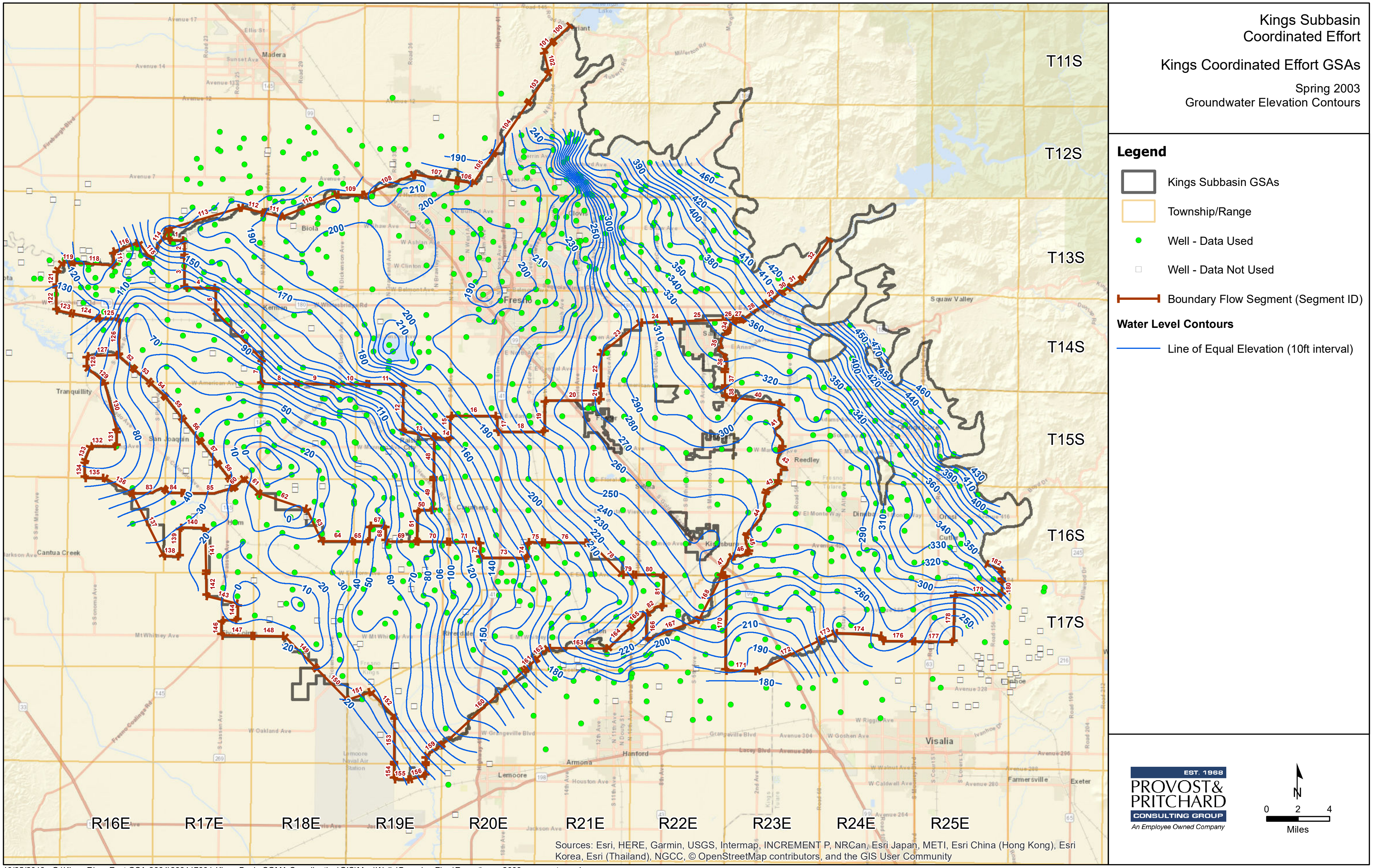

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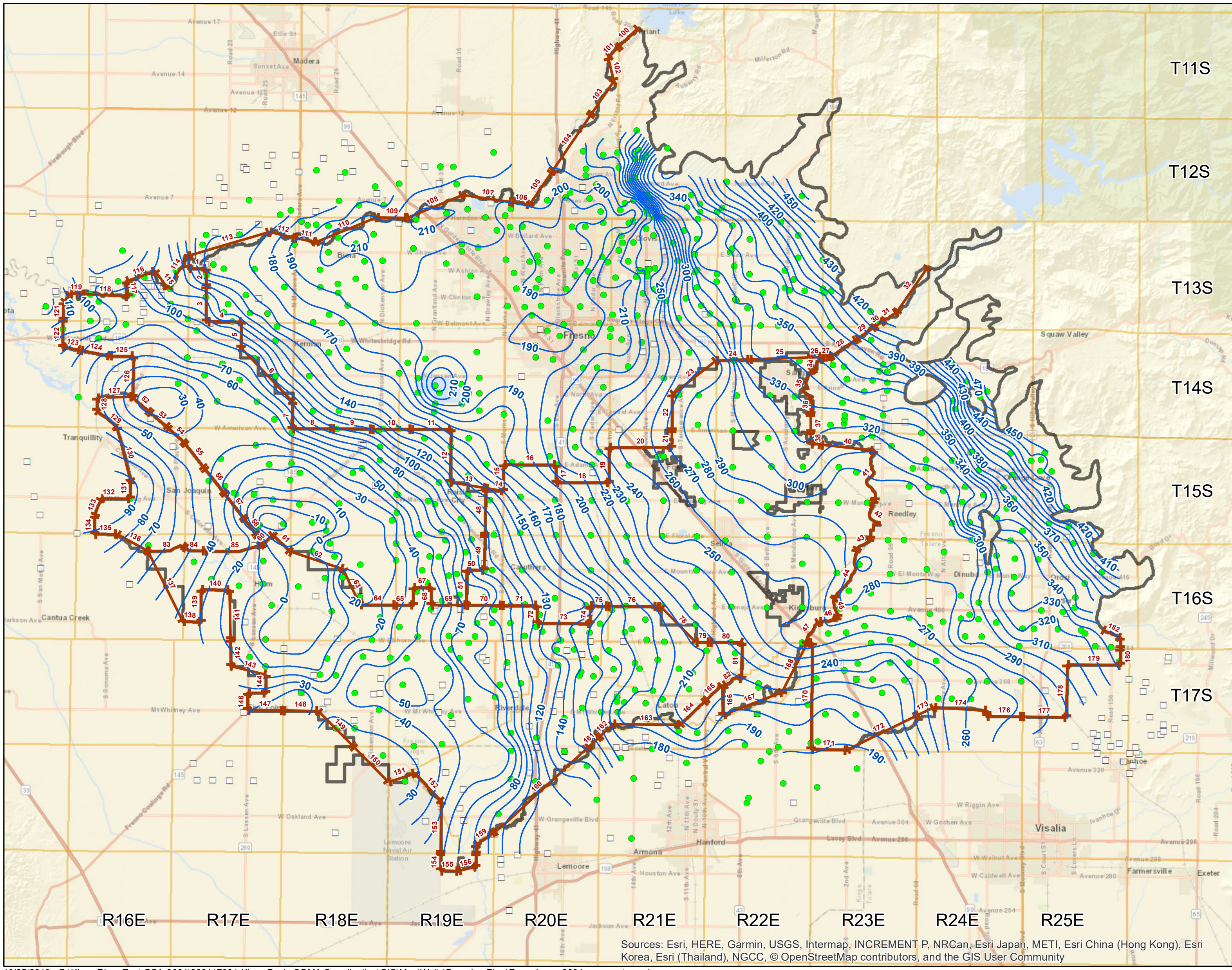

Kings Subbasin Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2004
Groundwater Elevation Contours

Legend

- Kings Subbasin GSAs
- Township/Range
- Well - Data Used
- Well - Data Not Used
- Boundary Flow Segment (Segment ID)

Water Level Contours

- Line of Equal Elevation (10ft interval)

EST. 1968 PROVOST&PRITCHARD CONSULTING GROUP An Employee Owned Company

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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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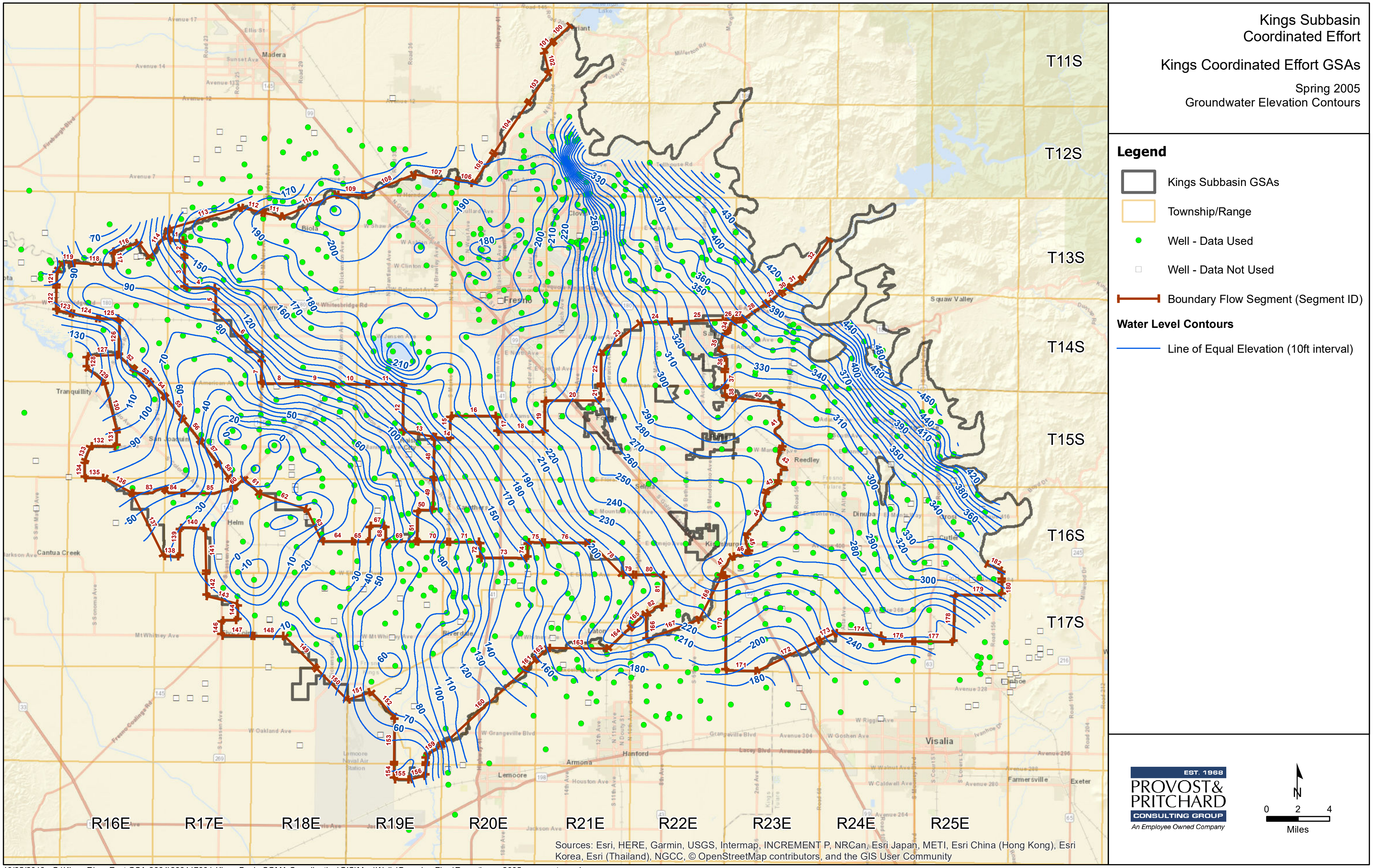

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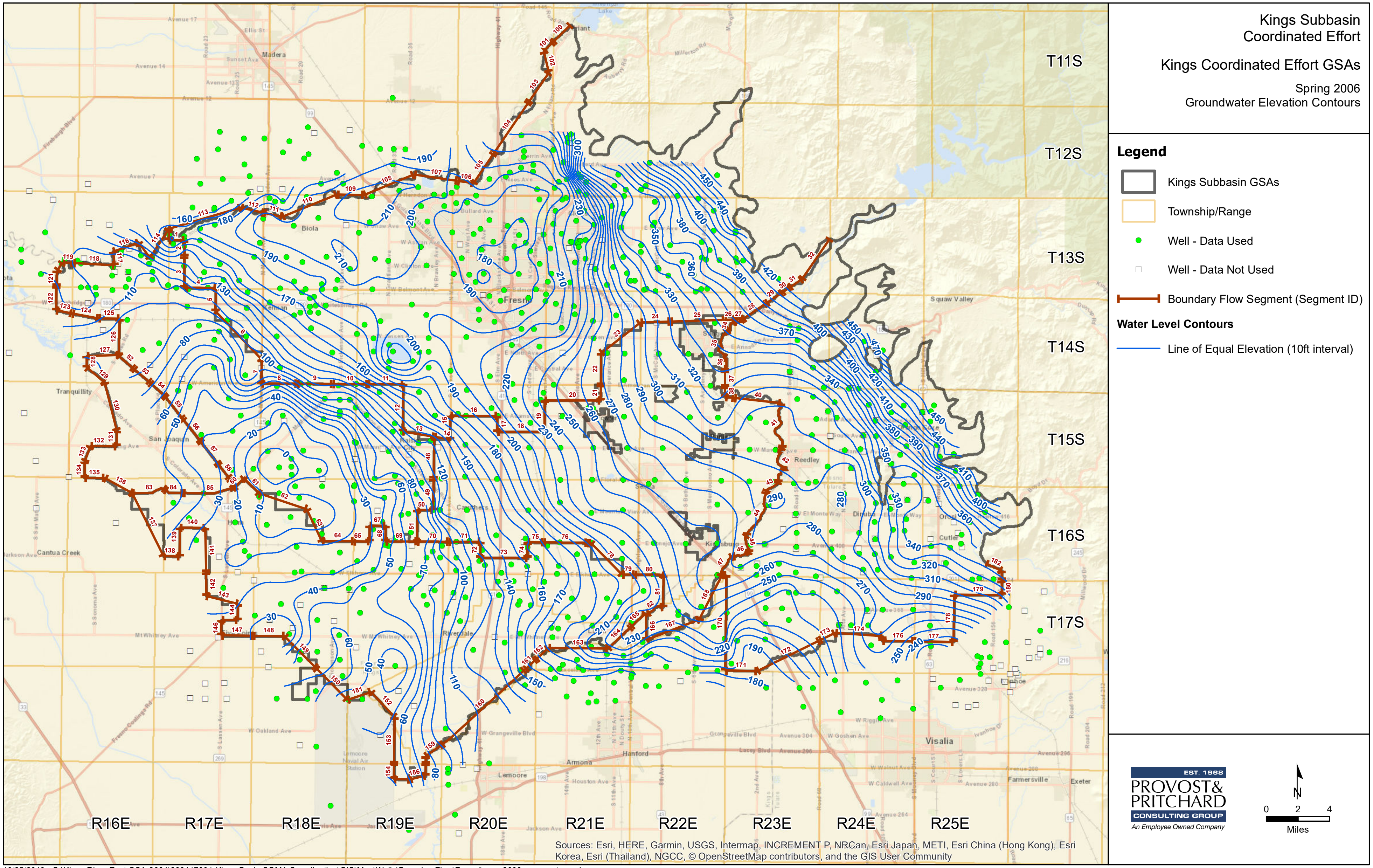

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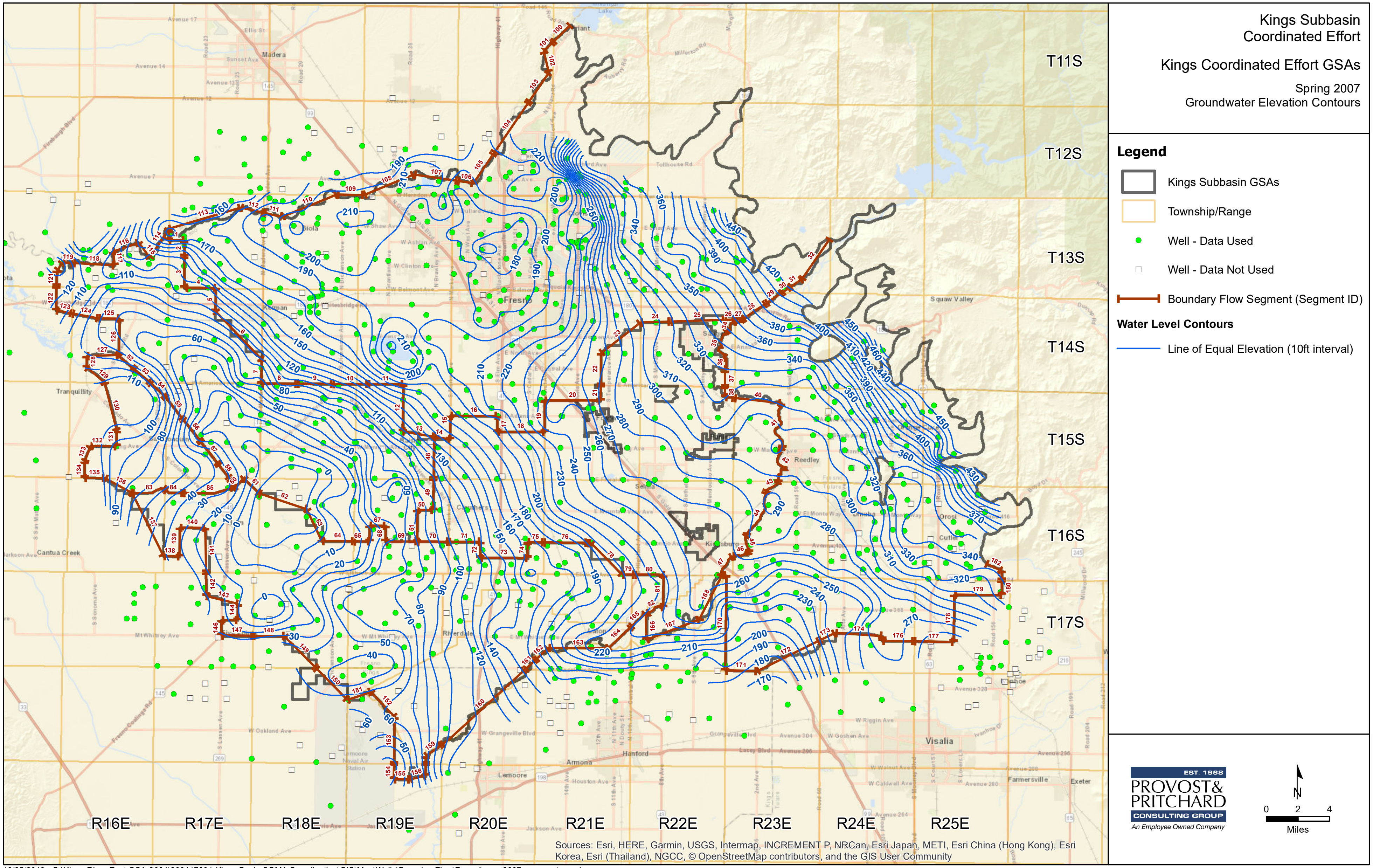

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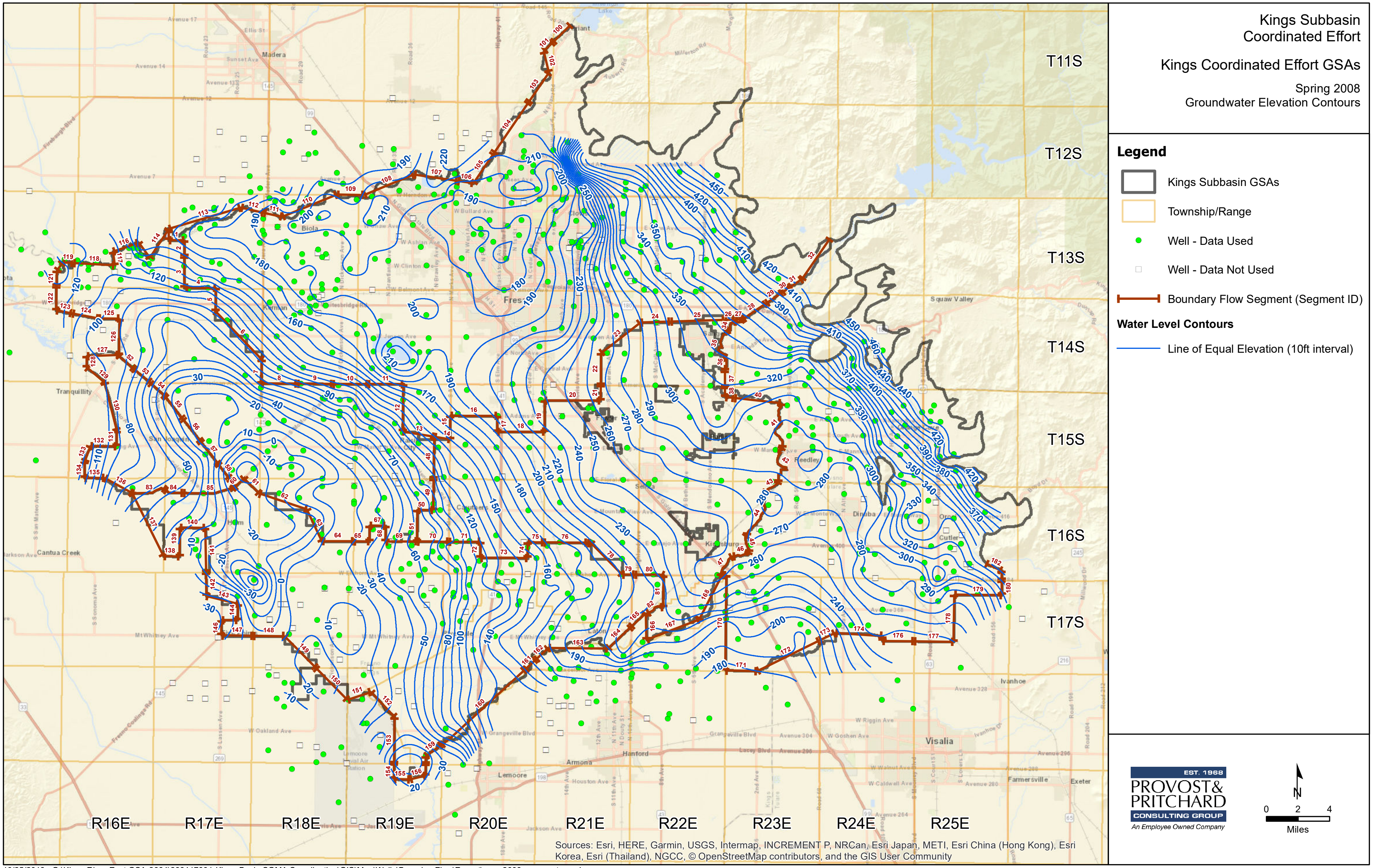

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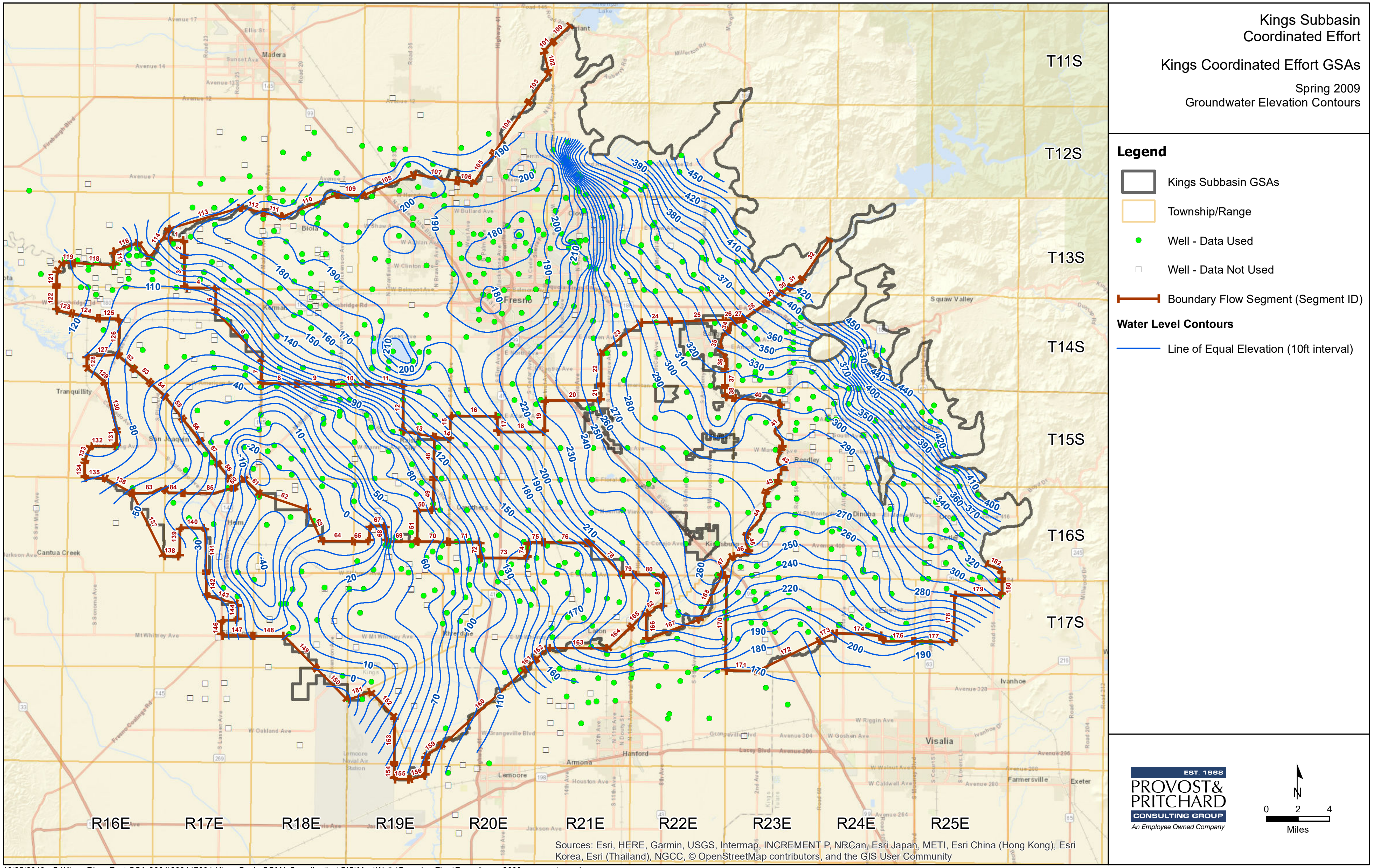

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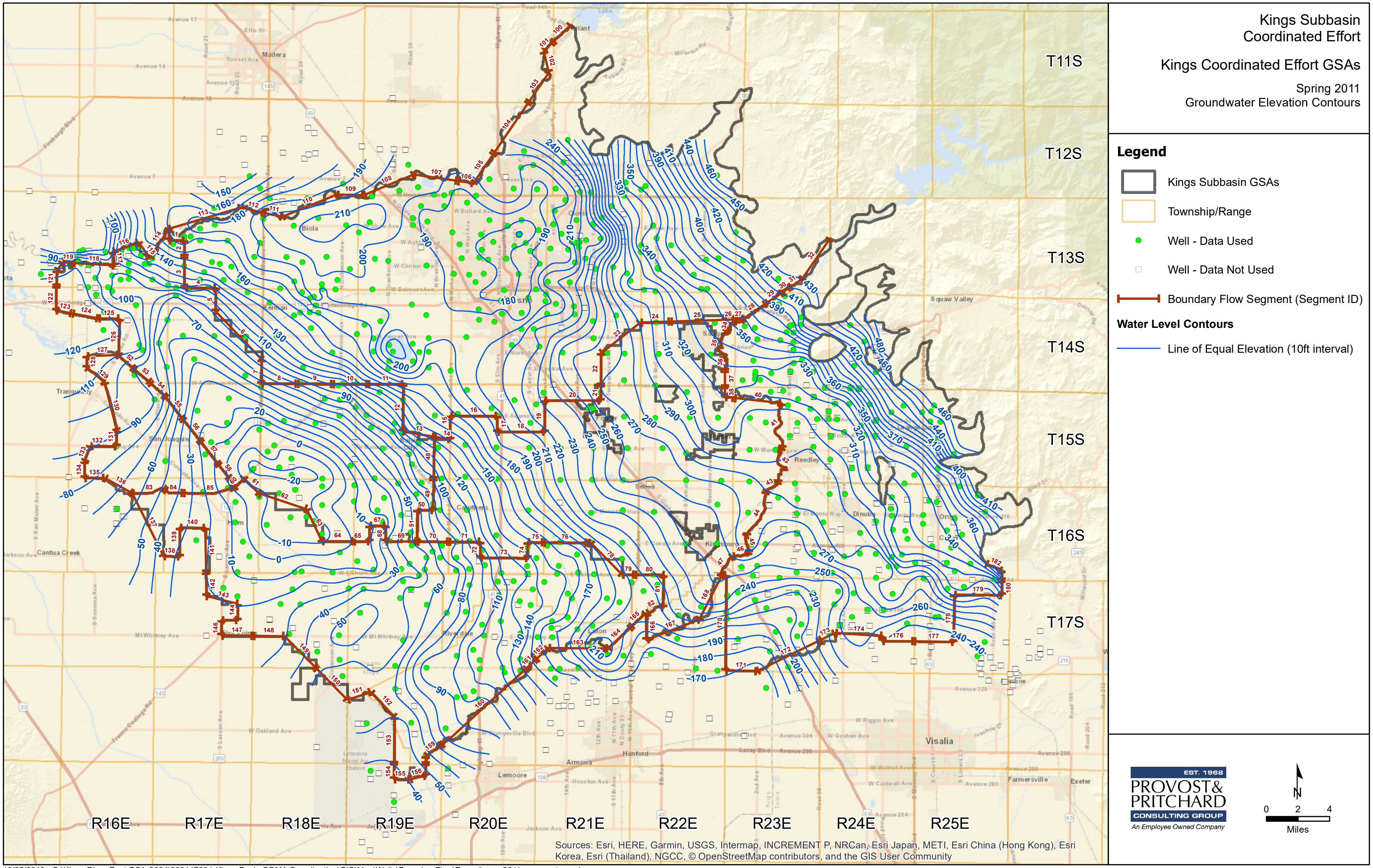

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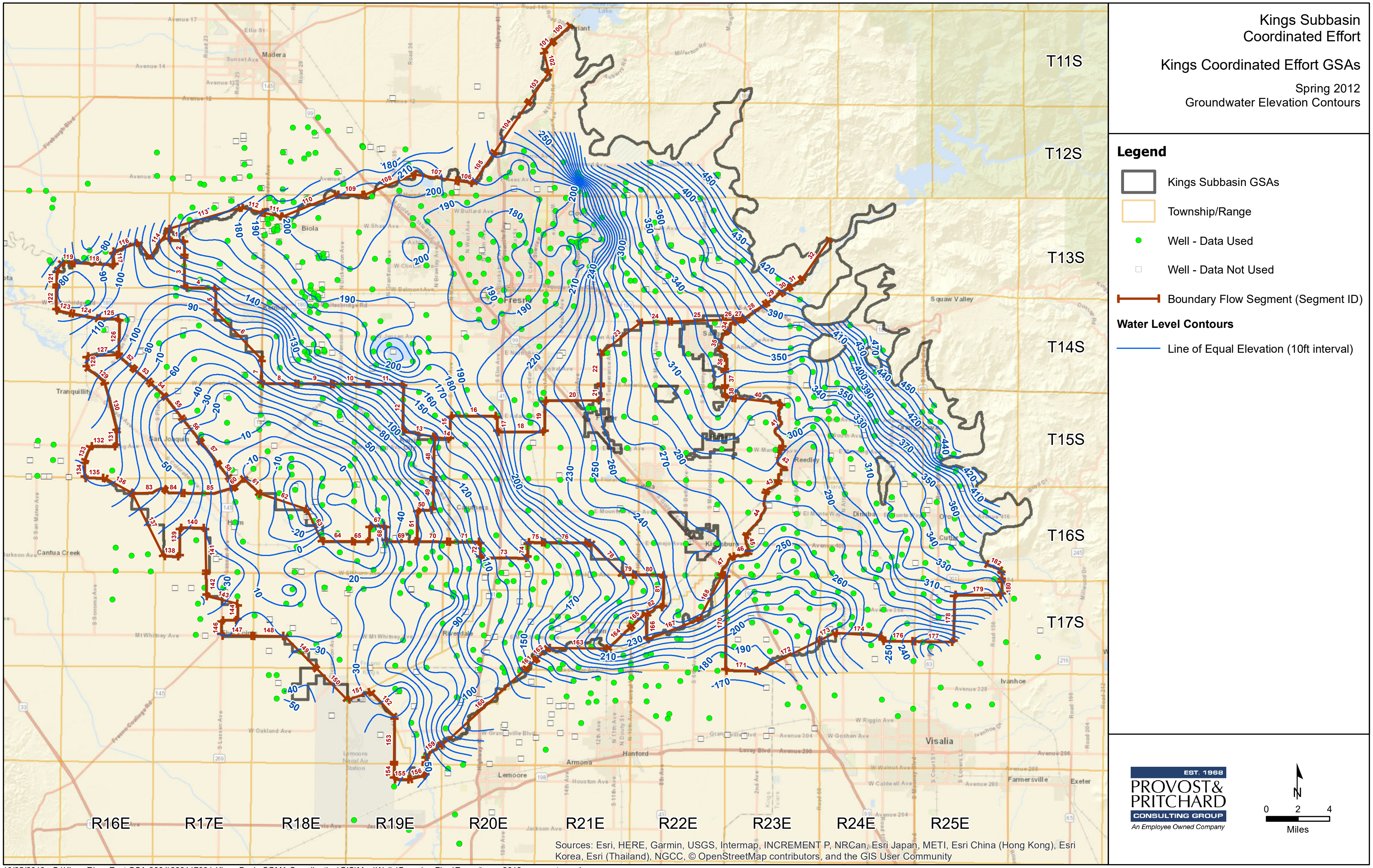

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Attachment 3

Estimated Flows
by Flow Segment

Internal

Attachment 3 - 1925 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Percent Thickness Change (1925-1962)	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3,958	N/A	N/A	N/A	180.1	N/A	0.1	N/A	N/A	N/A	N/A	0.0
McMullin	North Kings	1	96,000	0%	96,000	5,250	0.0014	7.2	326.5	90.6	146.5	90.6	55.9	0.97	4,345	569407	638
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0009	4.7	306.2	180.0	126.2	0.0	53.8	0.94	4,291	370329	415
North Kings	McMullin	3	96,000	9%	104,664	10,532	0.0012	6.2	252.4	180.1	72.4	0.1	72.3	1.26	10,034	1241269	1,390
North Kings	McMullin	4	97,000	11%	107,882	11,871	0.0012	6.5	222.8	90.9	42.8	90.9	48.1	0.84	8,837	1175417	1,317
North Kings	McMullin	5	98,000	12%	110,151	7,744	0.0013	6.7	242.9	181.4	62.9	1.4	61.6	1.07	6,810	952896	1,067
North Kings	McMullin	6	98,000	14%	111,980	22,487	0.0015	7.9	231.8	136.3	51.8	136.3	84.5	1.47	22,382	3744207	4,194
North Kings	McMullin	7	***120,000***	30%	156,443	8,027	0.0019	10.0	241.1	180.7	61.1	0.7	60.3	1.05	6,972	2069735	2,318
North Kings	McMullin	8	120,000	15%	138,005	11,936	0.0010	5.3	222.9	90.3	42.9	90.3	47.4	0.83	8,789	1226468	1,374
North Kings	McMullin	9	120,000	17%	140,615	11,887	0.0012	6.2	228.9	90.6	48.9	90.6	41.7	0.73	7,910	1308078	1,465
North Kings	McMullin	10	120,000	20%	144,000	11,937	0.0012	6.3	234.0	90.0	54.0	90.0	36.0	0.63	7,024	1201798	1,346
North Kings	McMullin	11	***182,000***	24%	225,600	11,909	0.0012	6.1	243.5	90.2	63.5	90.2	26.7	0.47	5,356	1389608	1,557
North Kings	McMullin	12	***115,000***	33%	152,561	15,873	0.0009	5.0	228.2	180.9	48.2	0.9	47.3	0.82	11,658	1670316	1,871
North Kings	McMullin	13	98,000	17%	115,047	10,744	0.0010	5.4	228.9	279.5	48.9	99.5	50.6	0.88	8,303	972610	1,089
North Kings	Central Kings	14	98,000	18%	115,693	5,348	0.0012	6.4	236.7	279.5	56.7	99.5	42.9	0.75	3,637	507031	568
Central Kings	North Kings	15	91,000	18%	107,133	7,944	0.0012	6.3	234.8	0.9	54.8	0.9	53.9	0.94	6,415	819893	918
North Kings	Central Kings	16	83,000	14%	94,379	15,707	0.0014	7.4	233.5	90.3	53.5	90.3	36.8	0.64	9,413	1248892	1,399
North Kings	Central Kings	17	83,000	12%	92,826	5,303	0.0015	8.1	224.7	179.9	44.7	179.9	44.8	0.78	3,736	534360	599
North Kings	Central Kings	18	83,000	11%	91,882	15,829	0.0014	7.3	252.0	90.2	72.0	90.2	18.2	0.32	4,931	622616	697
Central Kings	North Kings	19	89,000	7%	95,598	10,569	0.0012	6.1	241.0	0.5	61.0	0.5	60.5	1.06	9,202	1019562	1,142
North Kings	Central Kings	20	95,000	7%	101,874	18,685	0.0012	6.1	251.2	90.3	71.2	90.3	19.1	0.33	6,119	721644	808
Central Kings	North Kings	21	95,000	7%	101,616	5,292	0.0010	5.2	235.3	1.1	55.3	1.1	54.1	0.94	4,288	431034	483
Central Kings	North Kings	22	111,000	8%	119,488	10,632	0.0011	5.6	269.4	0.3	89.4	0.3	89.1	1.56	10,631	1352421	1,515
Central Kings	North Kings	23	111,000	8%	119,421	16,792	0.0016	8.5	265.2	232.2	85.2	52.2	33.1	0.58	9,160	1759125	1,970
North Kings	Central Kings	24	80,000	9%	87,321	9,989	0.0019	10.2	226.3	268.3	46.3	88.3	41.9	0.73	6,677	1129040	1,265
North Kings	Central Kings	25	***100,000***	2%	102,287	18,219	0.0017	8.9	204.7	268.3	24.7	88.3	63.6	1.11	16,316	2825881	3,165
North Kings	Central Kings	26	***95,000***	-3%	92,232	3,430	0.0020	10.6	212.1	268.3	32.1	88.3	56.2	0.98	2,850	529778	593
North Kings	Central Kings	27	***95,000***	-3%	92,589	2,653	0.0020	10.8	226.6	268.3	46.6	88.3	41.7	0.73	1,765	332924	373
North Kings	Kings River East	28	***95,000***	-4%	91,321	9,490	0.0022	11.8	222.6	235.8	42.6	55.8	13.2	0.23	2,166	442939	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0033	17.4	205.9	235.8	25.9	55.8	29.9	0.52	3,198	622060	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
North Kings	Kings River East	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	-2%	92,845	2,895	0.0021	10.9	227.9	255.3	47.9	75.3	27.4	0.48	1,332	255048	0
Kings River East	Central Kings	34	***95,000***	-3%	91,935	4,909	0.0021	11.2	213.9	220.0	33.9	40.0	6.1	0.11	521	101401	0
Kings River East	Central Kings	35	80,000	1%	80,552	13,736	0.0012	6.1	183.5	189.4	3.5	9.4	5.9	0.10	1,402	130069	0
Kings River East	Central Kings	36	80,000	2%	81,498	5,888	0.0012	6.6	181.9	349.5	1.9	169.5	12.4	0.22	1,268	128321	0
Central Kings	Kings River East	37	80,000	3%	82,083	5,428	0.0008	4.0	153.7	360.0	153.7	180.0	26.3	0.46	2,405	150486	0
Central Kings	Kings River East	38	95,000	4%	98,979	3,460	0.0005	2.7	140.3	360.0	140.3	180.0	39.6	0.69	2,207	112193	0
Kings River East	Central Kings	39	95,000	5%	99,803	3,116	0.0005	2.8	140.5	96.4	140.5	96.4	44.0	0.77	2,166	113758	0
Central Kings	Kings River East	40	90,000	4%	93,718	15,843	0.0010	5.1	110.7	96.4	110.7	96.4	14.3	0.25	3,907	350528	0
Kings River East	Central Kings	41	90,000	5%	94,773	17,844	0.0018	9.3	220.6	178.6	40.6	178.6	41.9	0.73	11,926	1987904	0
Kings River East	Central Kings	42	90,000	5%	94,373	17,872	0.0011	6.1	231.8	186.7	51.8	6.7	45.2	0.79	12,678	1373464	0
Kings River East	Central Kings	43	78,000	1%	78,710	5,653	0.0021	11.0	245.4	229.9	65.4	49.9	15.5	0.27	1,510	247516	0
Central Kings	Kings River East	44	78,000	0%	78,304	16,793	0.0010	5.2	302.6	203.7	122.6	23.7	81.1	1.42	16,592	1281838	0
Central Kings	Kings River East	45	***120,000***	3%	123,231	6,008	0.0004	2.3	248.9	173.3	68.9	173.3	75.6	1.32	5,819	318502	0
Central Kings	Kings River East	46	***120,000***	6%	126,794	6,400	0.0008	4.1	228.9	254.6	48.9	74.6	25.7	0.45	2,773	275970	0
Kings River East	Central Kings	47	***120,000***	8%	129,202	7,877	0.0004	2.2	216.7	211.1	36.7	31.1	5.6	0.10	771	42127	0
Central Kings	McMullin	48	98,000	17%	114,926	14,924	0.0012	6.4	240.6	180.8	60.6	0.8	59.8	1.04	12,897	1791906	2,007
Central Kings	McMullin	49	75,000	17%	87,722	10,541	0.0009	4.5	258.4	180.8	78.4	0.8	77.6	1.35	10,294	768314	861
Central Kings	McMullin	50	75,000	17%	87,420	5,264	0.0009	4.7	294.5	270.3	114.5	90.3	24.2	0.42	2,157	169038	189
Central Kings	McMullin	51	75,000	16%	87,132	10,654	0.0013	6.7	267.2	180.7	87.2	0.7	86.5	1.51	10,634	1183332	1,326
McMullin	James	52	128,000	4%	133,710	6,877	0.0004	2.2	241.2	132.3	61.2	132.3	71.1	1.24	6,507	363723	407
McMullin	James	53	128,000	5%	134,092	7,174	0.0004	2.3	242.3	130.2	62.3	130.2	68.0	1.19	6,651	384523	431
McMullin	James	54	107,000	3%	110,724	6,829	0.0003	1.8	242.3	132.7	62.3	132.7	70.5	1.23	6,435	242034	271
McMullin	James	55	***112,000***	21%	135,327	9,572	0.0003	1.4	237.7	141.8	57.7	141.8	84.1	1.47	9,521	347849	390
McMullin	James	56	***112,000***	27%	142,029	9,617	0.0002	1.1	241.2	141.6	61.2	141.6	80.4	1.40	9,483	274696	308
McMullin	James	57	128,000	9%	139,602	9,585	0.0002	0.9	257.2	142.0	77.2	142.0	64.7	1.13	8,669	211710	237
McMullin	James	58	128,000	10%	140,734	6,153	0.0002	0.9	254.0	142.2	74.0	142.2	68.2	1.19	5,714	136907	153
McMullin	James	59	125,000	11%	138,859	3,455	0.0003	1.7	257.1	152.8	77.1	152.8	75.7	1.32	3,348	151369	170
North Fork Kings	McMullin	60	125,000	12%	140,121	4,656	0.0007	3.9	257.3	227.4	77.3	47.4	29.9	0.52	2,319	240225	269
McMullin	North Fork Kings	61	125,000	13%	141,375	7,115	0.0008	4.0	253.0	315.0	73.0	135.0	62.0	1.08	6,283	677352	759
McMullin	North Fork Kings	62	123,000	14%	140,276	16,815	0.0009	4.8	252.5	288.4	72.5	108.4	35.8	0.63	9,844	1253467	1,404
McMullin	North Fork Kings	63	123,000	14%	140,645	11,841	0.0010	5.2	277.4	334.5	97.4	154.5	57.0	1.00	9,935	1373126	1,538
North Fork Kings	McMullin	64	123,000	16%	142,135	10,574	0.0005	2.5	270.5	270.1	90.5	90.1	0.4	0.01	67	4555	5
McMullin	North Fork Kings	65	75,000	16%	86,909	5,349	0.0006	2.9	261.5	270.8	81.5	90.8	9.3	0.16	866	41608	47
North Fork Kings	McMullin	66	75,000	16%	86,946	5,277	0.0006	3.1	260.9	180.5	80.9	0.5	80.4	1.40	5,203	267577	300

Attachment 3 - 1925 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Percent Thickness Change (1925 1962)	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	16%	87,073	5,354	0.0009	4.8	258.1	270.1	78.1	90.1	12.0	0.21	1,111	88642	99
McMullin	North Fork Kings	68	75,000	16%	86,992	5,258	0.0010	5.4	256.5	0.8	76.5	0.8	75.7	1.32	5,095	450261	504
McMullin	North Fork Kings	69	75,000	16%	86,884	10,633	0.0010	5.5	249.5	270.2	69.5	90.2	20.7	0.36	3,754	340563	381
Central Kings	North Fork Kings	70	75,000	17%	87,409	10,594	0.0009	4.9	243.6	270.3	63.6	90.3	26.6	0.46	4,745	382966	429
Central Kings	North Fork Kings	71	73,000	20%	87,739	10,677	0.0011	5.6	235.8	270.4	55.8	90.4	34.6	0.60	6,057	559450	627
Central Kings	North Fork Kings	72	73,000	19%	86,969	5,277	0.0009	5.0	228.1	0.5	48.1	0.5	47.6	0.83	3,895	321289	360
Central Kings	North Fork Kings	73	73,000	19%	86,689	15,835	0.0007	3.9	214.2	270.4	34.2	90.4	56.2	0.98	13,161	848581	951
North Fork Kings	Central Kings	74	73,000	22%	88,999	5,273	0.0010	5.1	206.3	180.4	26.3	0.4	25.9	0.45	2,305	198812	223
Central Kings	North Fork Kings	75	73,000	23%	89,753	5,321	0.0019	10.1	218.7	270.3	38.7	90.3	51.6	0.90	4,172	718679	805
Central Kings	North Fork Kings	76	93,000	21%	112,496	14,584	0.0015	7.7	211.2	270.7	31.2	90.7	59.5	1.04	12,565	2053186	2,300
Central Kings	North Fork Kings	77	93,000	16%	107,744	1,334	0.0010	5.4	213.6	270.8	33.6	90.8	57.1	1.00	1,121	122532	137
Central Kings	North Fork Kings	78	93,000	15%	107,255	14,877	0.0010	5.4	226.4	315.4	46.4	135.4	89.0	1.55	14,874	1631268	1,827
Central Kings	North Fork Kings	79	***118,000***	19%	140,762	4,185	0.0009	5.0	213.1	270.3	33.1	90.3	57.1	1.00	3,516	468448	525
Central Kings	North Fork Kings	80	***118,000***	15%	135,230	9,772	0.0006	3.0	214.1	271.5	34.1	91.5	57.3	1.00	8,224	626251	701
Central Kings	North Fork Kings	81	***118,000***	12%	132,353	10,682	0.0007	3.5	253.2	0.7	73.2	0.7	72.5	1.26	10,186	902845	1,011
Central Kings	North Fork Kings	82	***118,000***	13%	133,503	6,290	0.0007	3.5	256.1	68.3	76.1	68.3	7.8	0.14	852	75603	85
North Fork Kings	James	83	86,000	0%	86,000	11,628	N/A	N/A	N/A	263.5	N/A	83.5	N/A	N/A	N/A	N/A	N/A
North Fork Kings	James	84	87,000	0%	87,000	6,538	0.0001	0.7	291.0	281.3	111.0	101.3	9.7	0.17	1,106	12224	14
North Fork Kings	James	85	87,000	0%	87,000	18,139	0.0002	0.8	273.8	263.8	93.8	83.8	10.0	0.17	3,139	42613	48

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 1997 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	N/A	96,000	3958	0.0033	17.6	261.9	180.1	81.9	0.1	81.8	1.43	3,918	1257021	1,408
North Kings	McMullin	1	96,000	N/A	96,000	5,250	0.0044	23.2	167.7	90.6	167.7	90.6	77.1	1.35	5,118	2154387	2,413
McMullin	North Kings	2	96,000	N/A	96,000	5,317	0.0045	23.8	166.0	180.0	166.0	0.0	14.0	0.24	1,286	555493	622
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0053	28.2	203.4	180.1	23.4	0.1	23.3	0.41	4,162	2003096	2,244
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0053	28.1	213.0	90.9	33.0	90.9	57.9	1.01	10,060	4712580	5,279
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0059	31.3	197.5	181.4	17.5	1.4	16.1	0.28	2,151	1125398	1,261
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0051	27.0	215.7	136.3	35.7	136.3	79.5	1.39	22,108	9751615	10,923
North Kings	McMullin	7	***120,000***	16%	120,000	8,027	0.0052	27.5	245.0	180.7	65.0	0.7	64.3	1.12	7,232	4521414	5,065
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0050	26.5	215.1	90.3	35.1	90.3	55.2	0.96	9,800	4882441	5,469
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0054	28.4	198.9	90.6	18.9	90.6	71.7	1.25	11,286	6316432	7,075
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0056	29.3	223.0	90.0	43.0	90.0	47.0	0.82	8,730	5285521	5,921
North Kings	McMullin	11	***182,000***	4%	182,000	11,909	0.0051	27.0	204.5	90.2	24.5	90.2	65.7	1.15	10,854	10089509	11,302
North Kings	McMullin	12	***115,000***	13%	115,000	15,873	0.0050	26.4	226.1	180.9	46.1	0.9	45.2	0.79	11,256	6477158	7,255
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0044	23.0	209.4	279.5	29.4	99.5	70.1	1.22	10,104	3546861	3,973
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0054	28.7	242.0	279.5	62.0	99.5	37.5	0.65	3,254	1431639	1,604
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0064	33.6	252.4	0.9	72.4	0.9	71.5	1.25	7,534	3763330	4,215
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0030	15.6	246.5	90.3	66.5	90.3	23.7	0.41	6,320	1376280	1,542
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0012	6.3	224.2	179.9	44.2	179.9	44.3	0.77	3,702	329849	369
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0019	9.8	255.9	90.2	75.9	90.2	14.3	0.25	3,907	548352	614
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0027	14.4	257.9	0.5	77.9	0.5	77.4	1.35	10,314	2358987	2,642
Central Kings	North Kings	20	95,000	4%	91,507	18,685	0.0013	6.8	276.9	90.3	96.9	90.3	6.6	0.12	2,161	256388	287
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0015	7.8	260.6	1.1	80.6	1.1	79.4	1.39	5,202	718279	805
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0016	8.6	270.9	0.3	90.9	0.3	89.4	1.56	10,632	1873515	2,099
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0020	10.3	267.8	232.2	87.8	52.2	35.6	0.62	9,786	2063972	2,312
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0026	13.5	235.0	268.3	55.0	88.3	33.3	0.58	5,481	1144257	1,282
North Kings	Central Kings	25	***100,000***	-4%	100,000	18,219	0.0023	12.0	233.5	268.3	53.5	88.3	34.8	0.61	10,394	2352754	2,635
North Kings	Central Kings	26	***95,000***	-3%	95,000	3,430	0.0024	12.5	217.6	268.3	37.6	88.3	50.7	0.88	2,654	598362	670
North Kings	Central Kings	27	***95,000***	-3%	95,000	2,653	0.0026	13.7	216.5	268.3	36.5	88.3	51.8	0.90	2,084	514309	576
North Kings	Kings River East	28	***95,000***	-5%	95,000	9,490	0.0034	17.9	224.9	235.8	44.9	55.8	10.8	0.19	1,782	573275	0
North Kings	Kings River East	29	59,000	N/A	59,000	6,424	0.0032	17.1	217.2	235.8	37.2	55.8	18.6	0.32	2,046	390576	0
North Kings	Kings River East	30	30,000	N/A	30,000	3,027	0.0028	14.6	206.5	235.8	26.5	55.8	29.3	0.51	1,481	122463	0
North Kings	Kings River East	31	30,000	N/A	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	N/A	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	-3%	95,000	2,895	0.0026	13.9	215.8	255.3	35.8	75.3	39.5	0.69	1,841	459428	0
Kings River East	Central Kings	34	***95,000***	-3%	95,000	4,909	0.0023	12.0	211.2	220.0	31.2	40.0	8.8	0.15	752	162140	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0015	7.7	197.7	189.4	17.7	9.4	8.4	0.15	1,995	240983	0
Central Kings	Kings River East	36	80,000	-3%	82,432	5,888	0.0013	7.1	161.3	349.5	161.3	169.5	8.2	0.14	843	93236	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0015	7.7	148.3	360.0	148.3	180.0	31.7	0.55	2,853	343553	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0016	8.2	142.5	360.0	142.5	180.0	37.5	0.65	2,104	325107	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0016	8.4	141.5	96.4	141.5	96.4	45.1	0.79	2,206	348722	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0015	7.8	171.2	96.4	171.2	96.4	74.7	1.30	15,283	2098747	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0008	4.2	197.9	178.6	17.9	178.6	19.3	0.34	5,891	424510	0
Kings River East	Central Kings	42	90,000	-3%	92,338	17,872	0.0014	7.2	211.5	186.7	31.5	6.7	24.8	0.43	7,505	941402	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0012	6.2	327.4	229.9	147.4	49.9	82.4	1.44	5,603	518619	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0018	9.7	292.3	203.7	112.3	23.7	88.6	1.55	16,788	2436669	0
Kings River East	Central Kings	45	***120,000***	3%	120,000	6,008	0.0018	9.3	233.3	173.3	53.3	173.3	60.0	1.05	5,203	1100660	0
Central Kings	Kings River East	46	***120,000***	6%	120,000	6,400	0.0010	5.5	237.3	254.6	57.3	74.6	17.3	0.30	1,905	237430	0
Central Kings	Kings River East	47	***120,000***	8%	120,000	7,877	0.0010	5.2	122.8	211.1	122.8	31.1	88.3	1.54	7,873	926685	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0038	19.8	238.0	180.8	58.0	0.8	57.1	1.00	12,534	3570579	4,000
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0035	18.7	255.7	180.8	75.7	0.8	74.9	1.31	10,175	1974534	2,212
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0031	16.1	265.0	270.3	85.0	90.3	5.3	0.09	490	82333	92
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0031	16.4	249.3	180.7	69.3	0.7	68.6	1.20	9,920	1709511	1,915
McMullin	James	52	128,000	11%	114,224	6,877	0.0005	2.8	160.4	132.3	160.4	132.3	28.1	0.49	3,235	194435	218
McMullin	James	53	128,000	11%	114,064	7,174	0.0009	5.0	184.9	130.2	4.9	130.2	54.6	0.95	5,849	633106	709
McMullin	James	54	107,000	13%	92,969	6,829	0.0015	7.8	144.5	132.7	144.5	132.7	11.8	0.21	1,401	191422	214
James	McMullin	55	***112,000***	16%	112,000	9,572	0.0024	12.5	112.4	141.8	112.4	141.8	29.4	0.51	4,693	1246176	1,396
James	McMullin	56	***112,000***	19%	112,000	9,617	0.0032	16.8	85.1	141.6	85.1	141.6	56.5	0.99	8,018	2852430	3,195
James	McMullin	57	128,000	22%	99,217	9,585	0.0040	20.9	93.3	142.0	93.3	142.0	48.7	0.85	7,203	2834470	3,175
James	McMullin	58	128,000	24%	97,258	6,153	0.0032	16.9	69.9	142.2	69.9	142.2	72.3	1.26	5,863	1827985	2,048
James	McMullin	59	125,000	24%	95,517	3,455	0.0039	20.7	79.4	152.8	79.4	152.8	73.3	1.28	3,310	1239130	1,388
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0045	23.5	77.7	227.4	77.7	47.4	30.4	0.53	2,353	976114	1,093
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0031	16.6	65.3	315.0	65.3	135.0	69.7	1.22	6,674	1922778	2,154
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0025	13.3	340.7	288.4	160.7	108.4	52.3	0.91	13,310	2941939	3,295
North Fork Kings	McMullin	63	123,000	31%	85,245	11,841	0.0011	5.9	357.4	334.5	177.4	154.5	23.0	0.40	4,621	437790	490
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0010	5.2	343.9	270.1	163.9	90.1	73.8	1.29	10,151	864757	969
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0010	5.5	290.9	270.8	110.9	90.8	20.1	0.35	1,838	100153	112
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0015	7.9	271.3	180.5	91.3	0.5	89.3	1.56	5,277	408083	457

Attachment 3 - 1997 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0021	10.9	265.9	270.1	85.9	90.1	4.2	0.07	390	41208	46
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0022	11.4	253.0	0.8	73.0	0.8	72.2	1.26	5,007	563671	631
McMullin	North Fork Kings	69	75,000	26%	55,265	10,633	0.0025	13.3	240.1	270.2	60.1	90.2	30.0	0.52	5,324	742075	831
Central Kings	North Fork Kings	70	75,000	26%	55,396	10,594	0.0042	22.2	249.6	270.3	69.6	90.3	20.7	0.36	3,737	870986	976
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0032	17.1	251.0	270.4	71.0	90.4	19.4	0.34	3,544	626868	702
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0032	16.8	240.3	0.5	60.3	0.5	59.8	1.04	4,559	797983	894
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0023	12.4	233.8	270.4	53.8	90.4	36.6	0.64	9,434	1208779	1,354
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0022	11.7	220.8	180.4	40.8	0.4	40.4	0.70	3,415	423473	474
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0026	13.5	217.9	270.3	37.9	90.3	52.4	0.91	4,217	631676	708
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0031	16.3	211.0	270.7	31.0	90.7	59.7	1.04	12,591	3126797	3,502
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0033	17.5	203.6	270.8	23.6	90.8	67.1	1.17	1,229	356922	400
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0021	11.1	232.0	315.4	52.0	135.4	83.4	1.46	14,778	2726280	3,054
North Fork Kings	Central Kings	79	***118,000***	6%	118,000	4,185	0.0026	13.6	271.0	270.3	91.0	90.3	0.7	0.01	53	16217	18
Central Kings	North Fork Kings	80	***118,000***	4%	118,000	9,772	0.0025	13.0	267.6	271.5	87.6	91.5	3.9	0.07	664	193640	217
Central Kings	North Fork Kings	81	***118,000***	6%	118,000	10,682	0.0021	11.0	284.5	0.7	104.5	0.7	76.2	1.33	10,374	2541646	2,847
Central Kings	North Fork Kings	82	***118,000***	14%	118,000	6,290	0.0022	11.7	312.7	68.3	132.7	68.3	64.3	1.12	5,670	1488492	1,667
James	North Fork Kings	83	86,000	N/A	86,000	11,628	0.0015	8.2	138.5	263.5	138.5	83.5	55.0	0.96	9,524	1265315	1,417
James	North Fork Kings	84	87,000	N/A	87,000	6,538	0.0022	11.8	132.3	281.3	132.3	101.3	31.0	0.54	3,368	652821	731
James	North Fork Kings	85	87,000	N/A	87,000	18,139	0.0029	15.6	136.0	263.8	136.0	83.8	52.2	0.91	14,336	3676999	4,119

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 1998 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	N/A	96,000	3958	0.0027	14.2	302.15	180.1	122.2	0.1	58.0	1.01	3,356	865828	970
North Kings	McMullin	1	96,000	N/A	96,000	5,250	0.0012	6.5	163.15	90.6	163.1	90.6	72.5	1.27	5,008	588078	659
McMullin	North Kings	2	96,000	N/A	96,000	5,317	0.0043	22.6	163.50	180.0	163.5	0.0	16.5	0.29	1,510	619424	694
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0057	30.0	188.50	180.1	8.5	0.1	8.4	0.15	1,534	785783	880
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0067	35.4	209.57	90.9	29.6	90.9	61.4	1.07	10,419	6156622	6,896
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0051	26.7	227.20	181.4	47.2	1.4	45.8	0.80	5,554	2479168	2,777
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0037	19.3	218.27	136.3	38.3	136.3	82.0	1.43	22,268	7027006	7,871
North Kings	McMullin	7	***120,000***	16%	120,000	8,027	0.0052	27.3	199.79	180.7	19.8	0.7	19.0	0.33	2,618	1626785	1,822
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0039	20.8	234.72	90.3	54.7	90.3	35.6	0.62	6,941	2718959	3,046
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0035	18.3	208.18	90.6	28.2	90.6	62.4	1.09	10,537	3812183	4,270
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0055	29.2	195.96	90.0	16.0	90.0	74.1	1.29	11,480	6933657	7,767
North Kings	McMullin	11	***182,000***	4%	182,000	11,909	0.0041	21.8	202.71	90.2	22.7	90.2	67.5	1.18	11,002	8275757	9,270
North Kings	McMullin	12	***115,000***	13%	115,000	15,873	0.0042	22.1	227.57	180.9	47.6	0.9	46.7	0.81	11,543	5548421	6,215
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0038	20.2	235.78	279.5	55.8	99.5	43.8	0.76	7,430	2293536	2,569
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0042	22.2	226.08	279.5	46.1	99.5	53.4	0.93	4,296	1465560	1,642
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0031	16.6	226.40	0.9	46.4	0.9	45.5	0.79	5,664	1396590	1,564
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0025	13.3	240.40	90.3	60.4	90.3	29.9	0.52	7,825	1454213	1,629
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0028	15.0	228.61	179.9	48.6	179.9	48.7	0.85	3,984	850948	953
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0026	13.9	232.47	90.2	52.5	90.2	37.7	0.66	9,677	1926237	2,158
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0024	12.5	239.34	0.5	59.3	0.5	58.8	1.03	9,043	1794541	2,010
Central Kings	North Kings	20	95,000	4%	91,507	18,685	0.0013	6.8	270.25	90.3	90.2	90.3	0.0	0.00	15	1801	2
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0015	7.7	259.00	1.1	79.0	1.1	77.9	1.36	5,174	705010	790
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0016	8.2	274.20	0.3	94.2	0.3	86.1	1.50	10,608	1787625	2,002
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0018	9.3	284.46	232.2	104.5	52.2	52.3	0.91	13,284	2518255	2,821
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0041	21.5	242.65	268.3	62.6	88.3	25.6	0.45	4,321	1437882	1,611
North Kings	Central Kings	25	***100,000***	-4%	100,000	18,219	0.0017	9.0	224.24	268.3	44.2	88.3	44.0	0.77	12,665	2168132	2,429
North Kings	Central Kings	26	***95,000***	-3%	95,000	3,430	0.0023	12.2	203.10	268.3	23.1	88.3	65.2	1.14	3,113	683914	766
North Kings	Central Kings	27	***95,000***	-3%	95,000	2,653	0.0029	15.3	211.64	268.3	31.6	88.3	56.6	0.99	2,216	608933	682
North Kings	Kings River East	28	***95,000***	-5%	95,000	9,490	0.0038	19.9	225.49	235.8	45.5	55.8	10.3	0.18	1,691	604970	0
North Kings	Kings River East	29	59,000	N/A	59,000	6,424	0.0033	17.4	223.36	235.8	43.4	55.8	12.4	0.22	1,379	268792	0
North Kings	Kings River East	30	30,000	N/A	30,000	3,027	0.0026	14.0	222.44	235.8	42.4	55.8	13.3	0.23	697	55436	0
Kings River East	North Kings	31	30,000	N/A	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	N/A	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	-3%	95,000	2,895	0.0028	14.9	211.22	255.3	31.2	75.3	44.1	0.77	2,015	541909	0
Kings River East	Central Kings	34	***95,000***	-3%	95,000	4,909	0.0020	10.4	201.00	220.0	21.0	40.0	19.0	0.33	1,596	299165	0
Central Kings	Kings River East	35	80,000	-3%	82,389	13,736	0.0011	5.7	188.16	189.4	8.2	9.4	1.2	0.02	286	25264	0
Central Kings	Kings River East	36	80,000	-3%	82,432	5,888	0.0011	6.0	159.00	349.5	159.0	169.5	10.5	0.18	1,071	101009	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0012	6.4	142.00	360.0	142.0	180.0	38.0	0.66	3,339	336028	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0010	5.5	152.58	360.0	152.6	180.0	27.4	0.48	1,591	163086	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0006	3.1	188.41	96.4	8.4	96.4	88.0	1.54	3,114	181197	0
Central Kings	Kings River East	40	90,000	-3%	93,041	15,843	0.0004	2.2	353.55	96.4	173.5	96.4	77.1	1.35	15,444	595692	0
Central Kings	Kings River East	41	90,000	-2%	91,624	17,844	0.0015	8.1	171.92	178.6	171.9	178.6	6.7	0.12	2,080	293864	0
Kings River East	Central Kings	42	90,000	-3%	92,338	17,872	0.0013	6.7	237.33	186.7	57.3	6.7	50.7	0.88	13,824	1615335	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0007	3.8	260.29	229.9	80.3	49.9	30.4	0.53	2,863	165385	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0011	5.7	261.54	203.7	81.5	23.7	57.8	1.01	14,210	1221199	0
Kings River East	Central Kings	45	***120,000***	3%	120,000	6,008	0.0013	6.7	243.06	173.3	63.1	173.3	69.7	1.22	5,636	852424	0
Central Kings	Kings River East	46	***120,000***	6%	120,000	6,400	0.0014	7.1	226.81	254.6	46.8	74.6	27.8	0.49	2,985	483937	0
Kings River East	Central Kings	47	***120,000***	8%	120,000	7,877	0.0011	5.7	234.51	211.1	54.5	31.1	23.4	0.41	3,133	408205	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0040	20.9	236.61	180.8	56.6	0.8	55.8	0.97	12,340	3701926	4,147
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0041	21.7	246.96	180.8	67.0	0.8	66.1	1.15	9,641	2178401	2,440
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0038	20.1	250.80	270.3	70.8	90.3	19.5	0.34	1,761	369178	414
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0020	10.3	254.47	180.7	74.5	0.7	73.8	1.29	10,230	1107702	1,241
James	McMullin	52	128,000	11%	114,224	6,877	0.0012	6.3	125.10	132.3	125.1	132.3	7.2	0.13	862	117216	131
James	McMullin	53	128,000	11%	114,064	7,174	0.0011	5.9	124.27	130.2	124.3	130.2	6.0	0.10	747	95866	107
James	McMullin	54	107,000	13%	92,969	6,829	0.0012	6.5	77.74	132.7	77.7	132.7	55.0	0.96	5,591	641901	719
James	McMullin	55	***112,000***	16%	112,000	9,572	0.0027	14.2	101.03	141.8	101.0	141.8	40.7	0.71	6,247	1879275	2,105
James	McMullin	56	***112,000***	19%	112,000	9,617	0.0027	14.3	98.13	141.6	98.1	141.6	43.5	0.76	6,621	2014600	2,257
James	McMullin	57	128,000	22%	99,217	9,585	0.0038	20.0	96.20	142.0	96.2	142.0	45.8	0.80	6,869	2583044	2,893
James	McMullin	58	128,000	24%	97,258	6,153	0.0048	25.4	49.14	142.2	49.1	142.2	87.0	1.52	6,145	2876168	3,222
James	McMullin	59	125,000	24%	95,517	3,455	0.0044	23.0	45.79	152.8	45.8	152.8	73.0	1.27	3,304	1373142	1,538
North Fork Kings	McMullin	60	125,000	25%	93,183	4,656	0.0036	18.9	40.93	227.4	40.9	47.4	6.5	0.11	524	174373	195
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0035	18.4	35.07	315.0	35.1	135.0	80.1	1.40	7,008	2229125	2,497
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0042	22.0	11.97	288.4	12.0	108.4	83.6	1.46	16,710	6090185	6,822
North Fork Kings	McMullin	63	123,000	31%	85,245	11,841	0.0048	25.1	47.59	334.5	47.6	154.5	73.1	1.28	11,330	4589643	5,141
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0012	6.5	347.19	270.1	167.2	90.1	77.1	1.34	10,305	1106564	1,240
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0013	7.1	296.39	270.8	116.4	90.8	25.6	0.45	2,309	162547	182
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0012	6.6	329.54	180.5	149.5	0.5	31.0	0.54	2,717	175464	197

Attachment 3 - 1998 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Fork Kings	McMullin	67	75,000	32%	51,283	5,354	0.0013	7.0	285.19	270.1	105.2	90.1	15.1	0.26	1,392	94387	106
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0028	14.8	309.40	0.8	129.4	0.8	51.4	0.90	4,107	603002	675
McMullin	North Fork Kings	69	75,000	26%	55,265	10,633	0.0025	13.1	299.86	270.2	119.9	90.2	29.7	0.52	5,264	721017	808
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0027	14.4	294.46	270.3	114.5	90.3	24.2	0.42	4,343	653974	733
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0040	21.3	255.81	270.4	75.8	90.4	14.6	0.25	2,687	591944	663
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0042	22.1	254.67	0.5	74.7	0.5	74.1	1.29	5,076	1168456	1,309
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0026	13.8	240.14	270.4	60.1	90.4	30.3	0.53	7,979	1140433	1,277
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0016	8.7	197.20	180.4	17.2	0.4	16.8	0.29	1,522	141127	158
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0026	13.7	206.00	270.3	26.0	90.3	64.3	1.12	4,795	729514	817
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0034	18.1	211.26	270.7	31.3	90.7	59.4	1.04	12,554	3449707	3,864
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0042	22.2	219.56	270.8	39.6	90.8	51.2	0.89	1,040	383195	429
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0028	14.9	231.08	315.4	51.1	135.4	84.3	1.47	14,804	3660550	4,100
Central Kings	North Fork Kings	79	***118,000***	6%	118,000	4,185	0.0027	14.0	266.33	270.3	86.3	90.3	3.9	0.07	287	90059	101
Central Kings	North Fork Kings	80	***118,000***	4%	118,000	9,772	0.0022	11.8	260.00	271.5	80.0	91.5	11.5	0.20	1,940	513751	575
Central Kings	North Fork Kings	81	***118,000***	6%	118,000	10,682	0.0016	8.3	273.48	0.7	93.5	0.7	87.2	1.52	10,670	1986808	2,226
Central Kings	North Fork Kings	82	***118,000***	14%	118,000	6,290	0.0014	7.6	302.28	68.3	122.3	68.3	53.9	0.94	5,085	867032	971
James	North Fork Kings	83	86,000	N/A	86,000	11,628	0.0015	8.1	139.00	263.5	139.0	83.5	55.5	0.97	9,585	1260036	1,411
James	North Fork Kings	84	87,000	N/A	87,000	6,538	0.0018	9.7	126.90	281.3	126.9	101.3	25.6	0.45	2,828	454359	509
North Fork Kings	James	85	87,000	N/A	87,000	18,139	0.0012	6.3	80.49	263.8	80.5	83.8	3.3	0.06	1,042	108207	121

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 1999 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0030	15.8	253.17	180.1	73.2	0.1	73.1	1.28	3,787	1089757	1,221
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0033	17.3	174.83	90.6	174.8	90.6	84.2	1.47	5,223	1639707	1,837
McMullin	North Kings	2	96,000	0%	96,000	5,317	0.0035	18.4	170.96	180.0	171.0	0.0	9.0	0.16	836	279235	313
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0047	24.7	179.53	180.1	179.5	0.1	0.6	0.01	109	46063	52
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0053	28.1	198.70	90.9	18.7	90.9	72.2	1.26	11,305	5295062	5,931
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0050	26.6	213.29	181.4	33.3	1.4	31.9	0.56	4,094	1819049	2,038
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0042	22.4	224.35	136.3	44.3	136.3	88.1	1.54	22,474	8228178	9,217
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0042	22.0	211.70	180.7	31.7	0.7	31.0	0.54	4,128	2062020	2,310
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0039	20.5	219.09	90.3	39.1	90.3	51.2	0.89	9,300	3584478	4,015
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0035	18.5	214.03	90.6	34.0	90.6	56.6	0.99	9,921	3628515	4,064
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0048	25.1	202.96	90.0	23.0	90.0	67.1	1.17	10,995	5696548	6,381
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0054	28.6	193.61	90.2	13.6	90.2	76.6	1.34	11,584	11410834	12,782
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0036	18.9	188.86	180.9	8.9	0.9	7.9	0.14	2,194	903144	1,012
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0038	20.2	223.40	279.5	43.4	99.5	56.1	0.98	8,921	2746798	3,077
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0045	23.9	232.85	279.5	52.9	99.5	46.7	0.81	3,891	1428497	1,600
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0038	20.1	222.50	0.9	42.5	0.9	41.6	0.73	5,272	1576839	1,766
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0028	14.8	221.70	90.3	41.7	90.3	48.6	0.85	11,778	2441165	2,734
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0025	13.1	215.67	179.9	35.7	179.9	35.8	0.62	3,099	578218	648
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0026	13.6	239.08	90.2	59.1	90.2	31.1	0.54	8,169	1593519	1,785
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0025	13.2	258.41	0.5	78.4	0.5	77.9	1.36	10,334	2168883	2,429
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0018	9.3	252.56	90.3	72.6	90.3	17.7	0.31	5,691	921109	1,032
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0017	8.8	249.83	1.1	69.8	1.1	68.7	1.20	4,930	774934	868
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0017	9.0	285.66	0.3	105.7	0.3	74.6	1.30	10,252	1877937	2,104
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0027	14.4	277.89	232.2	97.9	52.2	45.7	0.80	12,021	3526569	3,950
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0015	7.9	280.25	268.3	100.3	88.3	12.0	0.21	2,072	252718	283
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0020	10.8	240.40	268.3	60.4	88.3	27.9	0.49	8,520	1740194	1,949
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0017	9.0	212.18	268.3	32.2	88.3	56.1	0.98	2,847	460774	*516*
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0021	10.9	207.55	268.3	27.5	88.3	60.7	1.06	2,314	455512	*510*
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0030	15.7	210.03	235.8	30.0	55.8	25.7	0.45	4,119	1159977	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0047	25.0	203.35	235.8	23.4	55.8	32.4	0.57	3,442	961761	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0048	25.3	192.31	235.8	12.3	55.8	43.4	0.76	2,082	299326	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	0.0029	15.3	193.27	235.8	13.3	55.8	42.5	0.74	3,426	297534	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	0.0020	10.4	242.34	34.6	62.3	34.6	27.7	0.48	7,678	454655	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0021	11.0	205.76	255.3	25.8	75.3	49.6	0.87	2,203	435203	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0017	9.2	200.35	220.0	20.3	40.0	19.6	0.34	1,648	273814	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0016	8.6	196.97	189.4	17.0	9.4	7.6	0.13	1,822	245719	0
Central Kings	Kings River East	36	80,000	-3%	82,432	5,888	0.0011	5.8	170.80	349.5	170.8	169.5	1.3	0.02	135	12169	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0012	6.5	140.85	360.0	140.8	180.0	39.1	0.68	3,424	350822	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0017	9.1	143.57	360.0	143.6	180.0	36.4	0.64	2,052	352363	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0017	9.0	149.87	96.4	149.9	96.4	53.4	0.93	2,503	422149	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0013	7.1	172.38	96.4	172.4	96.4	75.9	1.33	15,369	1915796	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0008	4.4	199.32	178.6	19.3	178.6	20.7	0.36	6,311	481843	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0005	2.4	152.06	186.7	152.1	6.7	34.6	0.60	10,149	433965	0
Central Kings	Kings River East	43	78,000	-2%	79,423	5,653	0.0009	4.6	177.74	229.9	177.7	49.9	52.1	0.91	4,462	309143	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0010	5.0	251.23	203.7	71.2	23.7	47.5	0.83	12,378	933122	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0013	6.8	200.97	173.3	21.0	173.3	27.6	0.48	2,787	428076	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0005	2.8	198.91	254.6	18.9	74.6	55.7	0.97	5,287	336448	0
Central Kings	Kings River East	47	***120,000***	0%	120,000	7,877	0.0015	7.9	190.74	211.1	10.7	31.1	20.3	0.35	2,736	492712	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0042	22.1	245.87	180.8	65.9	0.8	65.0	1.14	13,530	4297932	4,814
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0040	21.1	251.77	180.8	71.8	0.8	71.0	1.24	9,964	2189172	2,452
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0043	22.8	259.62	270.3	79.6	90.3	10.7	0.19	979	233110	261
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0024	12.6	294.55	180.7	114.6	0.7	66.1	1.15	9,744	1289887	1,445
James	McMullin	52	128,000	11%	114,224	6,877	0.0051	26.8	56.57	132.3	56.6	132.3	75.7	1.32	6,665	3862859	4,327
James	McMullin	53	128,000	11%	114,064	7,174	0.0080	42.5	25.63	130.2	25.6	130.2	75.4	1.32	6,941	6373256	7,139
James	McMullin	54	107,000	13%	92,969	6,829	0.0075	39.8	56.80	132.7	56.8	132.7	75.9	1.32	6,623	4637493	5,195
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0079	41.7	55.40	141.8	55.4	141.8	86.4	1.51	9,553	8440025	9,454
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0074	39.0	72.69	141.6	72.7	141.6	68.9	1.20	8,975	7418327	8,310
James	McMullin	57	128,000	22%	99,217	9,585	0.0046	24.3	66.77	142.0	66.8	142.0	75.2	1.31	9,268	4223395	4,731
James	McMullin	58	128,000	24%	97,258	6,153	0.0027	14.0	52.05	142.2	52.1	142.2	89.9	1.57	6,153	1587601	1,778
James	McMullin	59	125,000	24%	95,517	3,455	0.0033	17.5	69.74	152.8	69.7	152.8	83.0	1.45	3,429	1087759	1,218
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0036	19.0	65.31	227.4	65.3	47.4	17.9	0.31	1,432	481325	539
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0029	15.3	22.52	315.0	22.5	135.0	67.5	1.18	6,574	1741388	1,951
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0016	8.3	13.08	288.4	13.1	108.4	84.7	1.48	16,744	2299587	2,576
North Fork Kings	McMullin	63	123,000	31%	85,245	11,841	0.0009	4.5	358.92	334.5	178.9	154.5	24.5	0.43	4,901	356286	399
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0030	15.8	352.40	270.1	172.4	90.1	82.3	1.44	10,477	2716397	3,043
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0013	6.8	333.11	270.8	153.1	90.8	62.3	1.09	4,735	318590	357
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0011	5.9	306.54	180.5	126.5	0.5	54.0	0.94	4,269	248095	278

Attachment 3 - 1999 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Fork Kings	McMullin	67	75,000	32%	51,283	5,354	0.0014	7.6	305.94	270.1	125.9	90.1	35.8	0.63	3,133	232163	260
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0026	13.8	283.65	0.8	103.6	0.8	77.1	1.35	5,125	700861	785
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0034	17.7	301.42	270.2	121.4	90.2	31.2	0.55	5,514	1021328	1,144
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0036	19.1	301.81	270.3	121.8	90.3	31.6	0.55	5,543	1111193	1,245
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0037	19.7	244.01	270.4	64.0	90.4	26.4	0.46	4,744	966933	1,083
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0027	14.1	239.91	0.5	59.9	0.5	59.4	1.04	4,541	666526	747
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0027	14.3	234.65	270.4	54.7	90.4	35.8	0.62	9,252	1370502	1,535
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0020	10.5	230.12	180.4	50.1	0.4	49.7	0.87	4,022	449647	504
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0022	11.6	223.54	270.3	43.5	90.3	46.8	0.82	3,878	499791	560
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0031	16.4	213.47	270.7	33.5	90.7	57.2	1.00	12,259	3063816	3,432
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0041	21.6	226.00	270.8	46.0	90.8	44.8	0.78	939	336355	377
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0024	12.7	227.83	315.4	47.8	135.4	87.6	1.53	14,863	3128890	3,505
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0020	10.7	244.46	270.3	64.5	90.3	25.8	0.45	1,822	436539	489
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0020	10.7	240.68	271.5	60.7	91.5	30.8	0.54	5,000	1194726	1,338
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0021	10.9	285.22	0.7	105.2	0.7	75.5	1.32	10,341	2519883	2,823
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0018	9.2	329.00	68.3	149.0	68.3	80.7	1.41	6,207	1282920	1,437
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0016	8.5	136.80	263.5	136.8	83.5	53.3	0.93	9,326	1287004	1,442
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0017	9.2	130.42	281.3	130.4	101.3	29.2	0.51	3,185	481349	539
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0016	8.7	107.17	263.8	107.2	83.8	23.4	0.41	7,198	1032911	1,157

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2000 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0036	19.2	252.26	180.1	72.3	0.1	72.1	1.26	3,767	1316144	1,474
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0052	27.6	171.44	90.6	171.4	90.6	80.8	1.41	5,183	2599198	2,911
McMullin	North Kings	2	96,000	0%	96,000	5,317	0.0051	26.9	163.75	180.0	163.8	0.0	16.2	0.28	1,488	727123	814
McMullin	North Kings	3	96,000	6%	90,147	10,532	0.0025	13.3	175.91	180.1	175.9	0.1	4.2	0.07	775	176460	198
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0036	19.1	213.03	90.9	33.0	90.9	57.9	1.01	10,057	3204712	3,590
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0041	21.5	208.67	181.4	28.7	1.4	27.3	0.48	3,551	1278284	1,432
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0046	24.1	219.43	136.3	39.4	136.3	83.2	1.45	22,327	8773951	9,828
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0053	28.1	248.07	180.7	68.1	0.7	67.3	1.17	7,406	4736176	5,305
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0034	17.8	221.39	90.3	41.4	90.3	48.9	0.85	8,994	3020576	3,383
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0051	27.1	209.28	90.6	29.3	90.6	61.3	1.07	10,429	5576807	6,247
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0045	23.7	208.73	90.0	28.7	90.0	61.3	1.07	10,472	5132508	5,749
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0046	24.5	202.31	90.2	22.3	90.2	67.9	1.19	11,034	9313783	10,433
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0036	19.0	207.43	180.9	27.4	0.9	26.5	0.46	7,086	2928485	3,280
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0042	22.4	224.17	279.5	44.2	99.5	55.4	0.97	8,841	3017778	3,380
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0033	17.6	224.78	279.5	44.8	99.5	54.7	0.96	4,367	1182023	1,324
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0021	11.1	230.63	0.9	50.6	0.9	49.7	0.87	6,059	995993	1,116
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0029	15.3	254.07	90.3	74.1	90.3	16.2	0.28	4,382	933441	1,046
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0025	13.2	232.08	179.9	52.1	179.9	52.2	0.91	4,188	783069	877
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0022	11.5	244.65	90.2	64.6	90.2	25.5	0.45	6,816	1122827	1,258
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0030	15.9	253.91	0.5	73.9	0.5	73.4	1.28	10,128	2558578	2,866
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0021	10.9	239.17	90.3	59.2	90.3	31.1	0.54	9,660	1829021	2,049
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0015	7.9	221.42	1.1	41.4	1.1	40.3	0.70	3,422	480575	538
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0015	8.1	284.60	0.3	104.6	0.3	75.7	1.32	10,302	1709951	1,915
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0020	10.7	284.66	232.2	104.7	52.2	52.5	0.92	13,320	2902665	3,251
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0049	25.7	237.48	268.3	57.5	88.3	30.8	0.54	5,114	2034316	2,279
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0015	7.8	211.63	268.3	31.6	88.3	56.7	0.99	15,220	2253350	2,524
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0019	10.3	215.38	268.3	35.4	88.3	52.9	0.92	2,736	505829	567
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0024	12.7	220.62	268.3	40.6	88.3	47.7	0.83	1,961	446384	500
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0028	14.9	222.71	235.8	42.7	55.8	13.0	0.23	2,142	575379	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0042	22.3	211.18	235.8	31.2	55.8	24.6	0.43	2,672	665426	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0039	20.8	201.17	235.8	21.2	55.8	34.6	0.60	1,718	202787	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0025	13.0	219.88	255.3	39.9	75.3	35.4	0.62	1,679	392911	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0021	10.9	207.13	220.0	27.1	40.0	12.8	0.22	1,091	212996	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0014	7.4	179.90	189.4	179.9	9.4	9.5	0.16	2,256	259878	0
Central Kings	Kings River East	36	80,000	-3%	82,432	5,888	0.0010	5.4	157.68	349.5	157.7	169.5	11.8	0.21	1,204	101745	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0014	7.2	131.82	360.0	131.8	180.0	48.1	0.84	4,042	459847	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0016	8.5	133.60	360.0	133.6	180.0	46.4	0.81	2,504	400824	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0015	8.1	137.50	96.4	137.5	96.4	41.1	0.72	2,047	311729	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0015	8.1	172.81	96.4	172.8	96.4	76.4	1.33	15,397	2204537	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0013	6.9	223.93	178.6	43.9	178.6	45.3	0.79	12,688	1529077	0
Kings River East	Central Kings	42	90,000	-3%	92,338	17,872	0.0006	3.3	248.36	186.7	68.4	6.7	61.7	1.08	15,736	899564	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0008	4.5	307.94	229.9	127.9	49.9	78.1	1.36	5,531	371596	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0015	7.8	265.25	203.7	85.2	23.7	61.5	1.07	14,759	1712251	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0014	7.2	241.61	173.3	61.6	173.3	68.3	1.19	5,581	915298	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0010	5.3	227.60	254.6	47.6	74.6	27.0	0.47	2,908	347725	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0009	4.5	235.69	211.1	55.7	31.1	24.6	0.43	3,282	335422	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0049	26.0	237.21	180.8	57.2	0.8	56.4	0.98	12,427	4646827	5,205
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0040	21.3	263.26	180.8	83.3	0.8	82.4	1.44	10,450	2314122	2,592
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0029	15.3	256.32	270.3	76.3	90.3	14.0	0.24	1,275	203165	228
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0017	9.0	236.37	180.7	56.4	0.7	55.7	0.97	8,799	833188	933
James	McMullin	52	128,000	11%	114,224	6,877	0.0026	13.8	80.09	132.3	80.1	132.3	52.2	0.91	5,435	1626485	1,822
James	McMullin	53	128,000	11%	114,064	7,174	0.0018	9.6	96.52	130.2	96.5	130.2	33.7	0.59	3,984	824511	924
James	McMullin	54	107,000	13%	92,969	6,829	0.0012	6.2	112.86	132.7	112.9	132.7	19.8	0.35	2,319	254189	285
McMullin	James	55	***112,000***	0%	112,000	9,572	0.0008	4.3	176.94	141.8	176.9	141.8	35.2	0.61	5,514	508220	569
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0016	8.4	133.42	141.6	133.4	141.6	8.2	0.14	1,374	243605	273
James	McMullin	57	128,000	22%	99,217	9,585	0.0040	21.2	92.85	142.0	92.9	142.0	49.1	0.86	7,248	2885741	3,232
James	McMullin	58	128,000	24%	97,258	6,153	0.0022	11.5	71.73	142.2	71.7	142.2	70.4	1.23	5,798	1226015	1,373
James	McMullin	59	125,000	24%	95,517	3,455	0.0015	8.1	19.50	152.8	19.5	152.8	46.7	0.82	2,515	370669	415
North Fork Kings	McMullin	60	125,000	25%	93,183	4,656	0.0025	13.2	355.69	227.4	175.7	47.4	51.7	0.90	3,654	851341	954
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0031	16.5	16.99	315.0	17.0	135.0	62.0	1.08	6,281	1796363	2,012
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0017	9.0	3.82	288.4	3.8	108.4	75.4	1.32	16,276	2432995	2,725
North Fork Kings	McMullin	63	123,000	31%	85,245	11,841	0.0010	5.3	347.48	334.5	167.5	154.5	13.0	0.23	2,665	227557	255
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0006	3.3	12.62	270.1	12.6	90.1	77.5	1.35	10,324	557702	625
McMullin	North Fork Kings	65	75,000	30%	52,395	5,349	0.0018	9.5	267.04	270.8	87.0	90.8	3.8	0.07	352	33169	37
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0016	8.4	261.64	180.5	81.6	0.5	81.1	1.42	5,214	429147	481

Attachment 3 - 2000 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0012	6.3	235.01	270.1	55.0	90.1	35.1	0.61	3,080	187489	210
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0016	8.2	295.14	0.8	115.1	0.8	65.6	1.15	4,789	389679	436
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0025	13.5	286.03	270.2	106.0	90.2	15.8	0.28	2,902	408731	458
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0039	20.8	293.00	270.3	113.0	90.3	22.7	0.40	4,096	892612	1,000
North Fork Kings	Central Kings	71	73,000	25%	54,577	10,677	0.0035	18.4	308.42	270.4	128.4	90.4	38.0	0.66	6,578	1250531	1,401
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0056	29.8	257.84	0.5	77.8	0.5	77.3	1.35	5,148	1598516	1,791
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0031	16.3	221.12	270.4	41.1	90.4	49.3	0.86	12,002	2028512	2,272
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0026	13.7	233.54	180.4	53.5	0.4	53.1	0.93	4,218	613088	687
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0022	11.7	224.08	270.3	44.1	90.3	46.2	0.81	3,843	497512	557
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0028	15.0	216.19	270.7	36.2	90.7	54.5	0.95	11,871	2708078	3,033
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0042	22.0	221.43	270.8	41.4	90.8	49.3	0.86	1,012	368106	412
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0023	12.1	224.87	315.4	44.9	135.4	89.5	1.56	14,876	2993064	3,353
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0023	12.0	236.20	270.3	56.2	90.3	34.1	0.59	2,344	629589	705
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0024	12.5	230.52	271.5	50.5	91.5	40.9	0.71	6,402	1783855	1,998
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0018	9.7	272.53	0.7	92.5	0.7	88.2	1.54	10,677	2315527	2,594
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0019	10.0	324.72	68.3	144.7	68.3	76.4	1.33	6,113	1363135	1,527
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0016	8.5	157.07	263.5	157.1	83.5	73.6	1.28	11,155	1553312	1,740
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0020	10.4	153.88	281.3	153.9	101.3	52.6	0.92	5,195	893984	1,001
North Fork Kings	James	85	87,000	0%	87,000	18,139	0.0025	13.3	74.06	263.8	74.1	83.8	9.7	0.17	3,065	670817	751

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2001 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^{0})	Flow Direction converted to between 0 & 180^{0}	Segement Azimuth converted to between 0 & 180^{0}	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0040	21.0	274.78	180.1	94.8	0.1	85.4	1.49	3,945	1507717	1,689
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0064	33.7	193.66	90.6	13.7	90.6	76.9	1.34	5,114	3130001	3,506
McMullin	North Kings	2	96,000	0%	96,000	5,317	0.0092	48.8	178.19	180.0	178.2	0.0	1.8	0.03	168	148801	167
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0025	13.1	237.06	180.1	57.1	0.1	56.9	0.99	8,827	1967045	2,203
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0028	14.5	210.27	90.9	30.3	90.9	60.7	1.06	10,350	2513801	2,816
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0032	16.8	197.73	181.4	17.7	1.4	16.4	0.29	2,181	612526	686
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0042	22.3	218.29	136.3	38.3	136.3	82.0	1.43	22,269	8127501	9,104
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0036	18.9	213.31	180.7	33.3	0.7	32.6	0.57	4,320	1853475	2,076
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0043	22.8	198.85	90.3	18.8	90.3	71.4	1.25	11,315	4858115	5,442
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0036	19.2	206.02	90.6	26.0	90.6	64.6	1.13	10,737	4062099	4,550
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0057	30.0	210.73	90.0	30.7	90.0	59.3	1.04	10,266	6369804	7,135
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0066	34.8	199.71	90.2	19.7	90.2	70.5	1.23	11,225	13469419	15,088
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0042	22.3	205.86	180.9	25.9	0.9	24.9	0.44	6,694	3256716	3,648
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0042	22.3	224.32	279.5	44.3	99.5	55.2	0.96	8,824	3003451	3,364
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0035	18.3	227.85	279.5	47.9	99.5	51.7	0.90	4,195	1178301	1,320
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0026	13.9	221.35	0.9	41.3	0.9	40.4	0.71	5,151	1062580	1,190
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0028	14.9	237.49	90.3	57.5	90.3	32.8	0.57	8,505	1763053	1,975
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0027	14.4	228.29	179.9	48.3	179.9	48.4	0.84	3,964	809997	907
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0028	14.6	233.29	90.2	53.3	90.2	36.9	0.64	9,495	1985069	2,224
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0020	10.7	219.25	0.5	39.3	0.5	38.7	0.68	6,615	1117836	1,252
Central Kings	North Kings	20	95,000	4%	91,507	18,685	0.0016	8.5	303.34	90.3	123.3	90.3	33.0	0.58	10,187	1505598	1,686
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0017	8.8	243.46	1.1	63.5	1.1	62.3	1.09	4,687	736750	825
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0010	5.5	301.48	0.3	121.5	0.3	58.8	1.03	9,096	1022181	1,145
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0017	8.8	241.71	232.2	61.7	52.2	9.5	0.17	2,783	501543	562
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0018	9.7	231.48	268.3	51.5	88.3	36.8	0.64	5,984	896543	1,004
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0018	9.4	238.86	268.3	58.9	88.3	29.4	0.51	8,950	1594185	1,786
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0018	9.5	220.50	268.3	40.5	88.3	47.8	0.83	2,540	433820	*486*
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0022	11.5	221.91	268.3	41.9	88.3	46.4	0.81	1,920	398623	*447*
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0029	15.2	221.67	235.8	41.7	55.8	14.1	0.25	2,310	633532	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0044	23.0	206.10	235.8	26.1	55.8	29.7	0.52	3,178	815876	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0043	22.5	190.88	235.8	10.9	55.8	44.9	0.78	2,136	272499	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0022	11.7	220.50	255.3	40.5	75.3	34.8	0.61	1,653	348952	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0018	9.7	212.56	220.0	32.6	40.0	7.4	0.13	633	110808	0
Central Kings	Kings River East	35	80,000	-3%	82,389	13,736	0.0014	7.2	189.26	189.4	9.3	9.4	0.1	0.00	21	2415	0
Central Kings	Kings River East	36	80,000	-3%	82,432	5,888	0.0011	6.0	170.29	349.5	170.3	169.5	0.8	0.01	83	7826	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0013	6.9	143.28	360.0	143.3	180.0	36.7	0.64	3,242	353732	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0015	7.9	139.11	360.0	139.1	180.0	40.8	0.71	2,263	336963	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0015	7.7	141.50	96.4	141.5	96.4	45.1	0.79	2,206	320524	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0014	7.5	171.68	96.4	171.7	96.4	75.2	1.31	15,320	2012900	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0010	5.3	209.54	178.6	29.5	178.6	30.9	0.54	9,172	836952	0
Kings River East	Central Kings	42	90,000	-3%	92,338	17,872	0.0007	3.6	244.74	186.7	64.7	6.7	58.1	1.01	15,168	964975	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0006	3.0	284.71	229.9	104.7	49.9	54.9	0.96	4,622	210534	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0012	6.6	260.84	203.7	80.8	23.7	57.1	1.00	14,098	1390613	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0013	7.1	249.87	173.3	69.9	173.3	76.5	1.34	5,843	945934	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0010	5.0	237.56	254.6	57.6	74.6	17.1	0.30	1,878	215395	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0011	5.7	230.67	211.1	50.7	31.1	19.6	0.34	2,643	344705	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0053	28.2	237.56	180.8	57.6	0.8	56.7	0.99	12,477	5065351	5,674
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0031	16.5	260.93	180.8	80.9	0.8	80.1	1.40	10,385	1777442	1,991
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0029	15.4	246.10	270.3	66.1	90.3	24.2	0.42	2,161	345622	387
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0019	10.0	235.84	180.7	55.8	0.7	55.1	0.96	8,743	916072	1,026
James	McMullin	52	128,000	11%	114,224	6,877	0.0032	16.9	81.78	132.3	81.8	132.3	50.5	0.88	5,308	1944244	2,178
James	McMullin	53	128,000	11%	114,064	7,174	0.0023	12.0	66.92	130.2	66.9	130.2	63.3	1.11	6,410	1665630	1,866
James	McMullin	54	107,000	13%	92,969	6,829	0.0025	13.1	52.97	132.7	53.0	132.7	79.7	1.39	6,720	1551689	1,738
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0039	20.8	48.41	141.8	48.4	141.8	86.6	1.51	9,556	4221603	4,729
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0040	21.1	76.63	141.6	76.6	141.6	65.0	1.13	8,716	3900762	4,369
James	McMullin	57	128,000	22%	99,217	9,585	0.0048	25.1	82.28	142.0	82.3	142.0	59.7	1.04	8,276	3905850	4,375
James	McMullin	58	128,000	24%	97,258	6,153	0.0053	28.2	73.49	142.2	73.5	142.2	68.7	1.20	5,733	2974188	3,332
James	McMullin	59	125,000	24%	95,517	3,455	0.0053	28.0	38.68	152.8	38.7	152.8	65.9	1.15	3,153	1594462	1,786
North Fork Kings	McMullin	60	125,000	25%	93,183	4,656	0.0050	26.3	26.27	227.4	26.3	47.4	21.1	0.37	1,678	778352	872
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0041	21.8	9.59	315.0	9.6	135.0	54.6	0.95	5,798	2192756	2,456
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0015	8.1	358.52	288.4	178.5	108.4	70.2	1.22	15,816	2125761	2,381
North Fork Kings	McMullin	63	123,000	31%	85,245	11,841	0.0016	8.7	57.81	334.5	57.8	154.5	83.3	1.45	11,761	1653864	1,853
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0020	10.4	338.56	270.1	158.6	90.1	68.4	1.19	9,833	1686765	1,889
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0014	7.4	296.73	270.8	116.7	90.8	25.9	0.45	2,338	172742	193
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0012	6.3	296.42	180.5	116.4	0.5	64.1	1.12	4,747	294724	330

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GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Fork Kings	McMullin	67	75,000	32%	51,283	5,354	0.0015	7.9	337.33	270.1	157.3	90.1	67.2	1.17	4,936	377023	422
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0029	15.3	296.62	0.8	116.6	0.8	64.1	1.12	4,731	715177	801
McMullin	North Fork Kings	69	75,000	26%	55,265	10,633	0.0021	11.0	267.28	270.2	87.3	90.2	2.9	0.05	539	62104	70
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0035	18.4	293.50	270.3	113.5	90.3	23.3	0.41	4,182	808091	905
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0029	15.5	273.16	270.4	93.2	90.4	2.8	0.05	516	82520	92
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0047	25.0	256.36	0.5	76.4	0.5	75.8	1.32	5,116	1333824	1,494
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0025	13.3	252.81	270.4	72.8	90.4	17.6	0.31	4,785	658763	738
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0025	13.5	233.61	180.4	53.6	0.4	53.2	0.93	4,222	605018	678
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0035	18.4	212.50	270.3	32.5	90.3	57.8	1.01	4,504	921207	1,032
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0031	16.5	213.13	270.7	33.1	90.7	57.5	1.00	12,306	3096235	3,468
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0043	22.8	221.00	270.8	41.0	90.8	49.8	0.87	1,018	384451	431
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0027	14.1	223.04	315.4	43.0	135.4	87.6	1.53	14,864	3488284	3,907
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0027	14.3	240.16	270.3	60.2	90.3	30.1	0.53	2,100	670045	751
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0024	12.4	228.88	271.5	48.9	91.5	42.6	0.74	6,611	1836003	2,057
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0011	6.0	247.82	0.7	67.8	0.7	67.1	1.17	9,842	1318967	1,477
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0004	2.3	351.06	68.3	171.1	68.3	77.3	1.35	6,136	316122	354
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0020	10.5	137.20	263.5	137.2	83.5	53.7	0.94	9,374	1607678	1,801
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0024	12.8	143.96	281.3	144.0	101.3	42.7	0.75	4,433	932689	1,045
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0028	15.0	85.84	263.8	85.8	83.8	2.1	0.04	649	160091	179

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North Kings	McMullin	0	96,000	0%	96,000	3958	0.0017	8.8	279.55	180.1	99.5	0.1	80.6	1.41	3,905	627817	703
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0031	16.3	217.13	90.6	37.1	90.6	53.5	0.93	4,219	1246491	1,396
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0054	28.6	184.15	180.0	4.1	0.0	4.1	0.07	385	199665	224
McMullin	North Kings	3	96,000	6%	90,147	10,532	0.0036	18.8	167.65	180.1	167.7	0.1	12.5	0.22	2,275	730700	818
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0034	17.8	217.81	90.9	37.8	90.9	53.1	0.93	9,496	2820241	3,159
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0038	20.1	215.31	181.4	35.3	1.4	33.9	0.59	4,323	1455219	1,630
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0038	19.9	203.09	136.3	23.1	136.3	66.8	1.17	20,671	6732697	7,542
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0049	26.0	246.68	180.7	66.7	0.7	65.9	1.15	7,329	4329923	4,850
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0042	22.1	214.12	90.3	34.1	90.3	56.2	0.98	9,914	4119830	4,615
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0053	28.0	195.67	90.6	15.7	90.6	74.9	1.31	11,478	6344575	7,107
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0047	25.0	208.45	90.0	28.5	90.0	61.6	1.07	10,499	5420557	6,072
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0055	29.1	209.21	90.2	29.2	90.2	61.0	1.06	10,415	10444847	11,700
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0044	23.3	218.33	180.9	38.3	0.9	37.4	0.65	9,644	4903972	5,493
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0045	23.5	213.37	279.5	33.4	99.5	66.2	1.15	9,828	3525605	3,949
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0043	22.7	227.50	279.5	47.5	99.5	52.0	0.91	4,216	1466261	1,642
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0034	17.9	222.37	0.9	42.4	0.9	41.4	0.72	5,258	1396171	1,564
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0028	14.7	234.00	90.3	54.0	90.3	36.3	0.63	9,293	1907380	2,137
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0030	15.8	235.29	179.9	55.3	179.9	55.4	0.97	4,364	978479	1,096
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0028	15.0	229.30	90.2	49.3	90.2	40.9	0.71	10,354	2215914	2,482
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0019	10.2	252.28	0.5	72.3	0.5	71.8	1.25	10,038	1626913	1,822
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0016	8.7	261.48	90.3	81.5	90.3	8.8	0.15	2,864	431614	483
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0014	7.5	247.53	1.1	67.5	1.1	66.4	1.16	4,849	644555	722
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0020	10.3	280.07	0.3	100.1	0.3	80.2	1.40	10,478	2214039	2,480
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0013	7.1	272.24	232.2	92.2	52.2	40.1	0.70	10,808	1569601	1,758
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0053	28.2	231.13	268.3	51.1	88.3	37.1	0.65	6,032	2638536	2,956
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0011	5.9	257.99	268.3	78.0	88.3	10.3	0.18	3,254	364306	408
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0019	10.1	219.40	268.3	39.4	88.3	48.9	0.85	2,584	471505	*528*
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0025	13.1	217.29	268.3	37.3	88.3	51.0	0.89	2,061	484785	*543*
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0033	17.7	221.03	235.8	41.0	55.8	14.7	0.26	2,413	766386	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0035	18.7	218.44	235.8	38.4	55.8	17.3	0.30	1,912	399292	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0025	13.4	214.44	235.8	34.4	55.8	21.3	0.37	1,100	83904	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0025	13.1	215.54	255.3	35.5	75.3	39.8	0.69	1,853	436316	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0019	10.0	207.14	220.0	27.1	40.0	12.8	0.22	1,090	195509	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0013	7.1	193.31	189.4	13.3	9.4	4.0	0.07	948	104787	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0014	7.4	169.71	349.5	169.7	169.5	0.2	0.00	23	2638	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0014	7.2	148.16	360.0	148.2	180.0	31.8	0.56	2,860	323108	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0014	7.2	134.33	360.0	134.3	180.0	45.6	0.80	2,473	336566	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0015	7.7	133.83	96.4	133.8	96.4	37.4	0.65	1,892	275625	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0017	9.2	166.48	96.4	166.5	96.4	70.0	1.22	14,892	2401247	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0011	5.6	216.18	178.6	36.2	178.6	37.6	0.66	10,881	1048846	0
Kings River East	Central Kings	42	90,000	-3%	92,338	17,872	0.0007	3.9	233.49	186.7	53.5	6.7	46.8	0.82	13,033	882043	0
Central Kings	Kings River East	43	78,000	-2%	79,423	5,653	0.0007	3.9	213.99	229.9	34.0	49.9	15.9	0.28	1,546	90948	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0007	4.0	258.31	203.7	78.3	23.7	54.6	0.95	13,683	808318	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0018	9.5	232.29	173.3	52.3	173.3	59.0	1.03	5,148	1114980	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0020	10.3	223.15	254.6	43.2	74.6	31.5	0.55	3,341	784927	0
Central Kings	Kings River East	47	***120,000***	0%	120,000	7,877	0.0009	5.0	204.67	211.1	24.7	31.1	6.4	0.11	878	98947	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0048	25.3	238.22	180.8	58.2	0.8	57.4	1.00	12,572	4578859	5,129
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0034	17.9	264.94	180.8	84.9	0.8	84.1	1.47	10,486	1950422	2,185
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0032	16.9	254.73	270.3	74.7	90.3	15.6	0.27	1,417	249432	279
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0016	8.5	294.34	180.7	114.3	0.7	66.4	1.16	9,760	871233	976
McMullin	James	52	128,000	11%	114,224	6,877	0.0011	5.9	154.78	132.3	154.8	132.3	22.5	0.39	2,630	332904	373
McMullin	James	53	128,000	11%	114,064	7,174	0.0012	6.2	159.14	130.2	159.1	130.2	28.9	0.50	3,466	467523	524
McMullin	James	54	107,000	13%	92,969	6,829	0.0012	6.2	153.58	132.7	153.6	132.7	20.9	0.36	2,434	264518	296
McMullin	James	55	***112,000***	0%	112,000	9,572	0.0004	2.0	246.13	141.8	66.1	141.8	75.6	1.32	9,273	400438	449
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0006	2.9	43.14	141.6	43.1	141.6	81.5	1.42	9,512	594102	665
James	McMullin	57	128,000	22%	99,217	9,585	0.0031	16.1	102.97	142.0	103.0	142.0	39.0	0.68	6,034	1827053	2,047
James	McMullin	58	128,000	24%	97,258	6,153	0.0046	24.3	62.59	142.2	62.6	142.2	79.6	1.39	6,052	2709688	3,035
James	McMullin	59	125,000	24%	95,517	3,455	0.0049	26.1	24.41	152.8	24.4	152.8	51.6	0.90	2,708	1276772	1,430
North Fork Kings	McMullin	60	125,000	25%	93,183	4,656	0.0043	22.5	8.46	227.4	8.5	47.4	38.9	0.68	2,926	1161453	1,301
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0030	15.7	352.90	315.0	172.9	135.0	37.9	0.66	4,369	1188974	1,332
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0019	9.9	24.15	288.4	24.1	108.4	84.2	1.47	16,730	2761881	3,094
North Fork Kings	McMullin	63	123,000	31%	85,245	11,841	0.0020	10.7	14.34	334.5	14.3	154.5	39.9	0.70	7,590	1312025	1,470
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0022	11.6	313.35	270.1	133.4	90.1	43.2	0.75	7,241	1381907	1,548
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0020	10.5	286.76	270.8	106.8	90.8	15.9	0.28	1,469	152803	171
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0021	11.1	288.27	180.5	108.3	0.5	72.3	1.26	5,026	548194	614

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Fork Kings	McMullin	67	75,000	32%	51,283	5,354	0.0018	9.7	314.52	270.1	134.5	90.1	44.4	0.77	3,746	352964	395
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0024	12.6	295.56	0.8	115.6	0.8	65.2	1.14	4,773	595904	667
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0031	16.5	310.23	270.2	130.2	90.2	40.0	0.70	6,842	1180888	1,323
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0030	16.0	323.19	270.3	143.2	90.3	52.9	0.92	8,454	1423428	1,594
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0028	14.6	253.06	270.4	73.1	90.4	17.3	0.30	3,179	480201	538
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0043	22.6	267.49	0.5	87.5	0.5	86.9	1.52	5,270	1239539	1,388
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0024	12.8	228.65	270.4	48.6	90.4	41.8	0.73	10,545	1394044	1,562
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0028	15.0	229.29	180.4	49.3	0.4	48.9	0.85	3,971	635475	712
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0023	12.4	229.77	270.3	49.8	90.3	40.6	0.71	3,460	475785	533
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0033	17.6	210.22	270.7	30.2	90.7	60.4	1.06	12,687	3396097	3,804
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0047	24.6	222.00	270.8	42.0	90.8	48.8	0.85	1,003	408678	458
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0028	14.7	226.74	315.4	46.7	135.4	88.7	1.55	14,873	3634400	4,071
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0023	12.4	243.81	270.3	63.8	90.3	26.5	0.46	1,865	515872	578
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0020	10.7	251.64	271.5	71.6	91.5	19.8	0.35	3,312	791311	886
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0012	6.3	238.44	0.7	58.4	0.7	57.7	1.01	9,034	1273609	1,427
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0012	6.3	264.50	68.3	84.5	68.3	16.2	0.28	1,751	245398	275
North Fork Kings	James	83	86,000	0%	86,000	11,628	N/A	N/A	85.55	263.5	85.5	83.5	2.1	0.04	421	N/A	N/A
James	North Fork Kings	84	87,000	0%	87,000	6,538	N/A	N/A	98.86	281.3	98.9	101.3	2.4	0.04	273	N/A	N/A
North Fork Kings	James	85	87,000	0%	87,000	18,139	0.0030	15.8	54.88	263.8	54.9	83.8	28.9	0.50	8,768	2282316	2,557

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2003 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0026	13.6	283.34	180.1	103.3	0.1	76.8	1.34	3,854	953,392	1,068
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0026	13.9	159.92	90.6	159.9	90.6	69.3	1.21	4,912	1,239,233	1,388
McMullin	North Kings	2	96,000	0%	96,000	5,317	0.0035	18.6	174.09	180.0	174.1	0.0	5.9	0.10	547	185,436	208
McMullin	North Kings	3	96,000	6%	90,147	10,532	0.0042	22.0	179.47	180.1	179.5	0.1	0.7	0.01	121	45,511	51
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0051	27.2	194.10	90.9	14.1	90.9	76.8	1.34	11,559	5,246,683	5,877
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0037	19.6	213.68	181.4	33.7	1.4	32.3	0.56	4,139	1,358,870	1,522
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0047	24.6	223.00	136.3	43.0	136.3	86.7	1.51	22,450	9,010,790	10,093
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0045	23.8	236.36	180.7	56.4	0.7	55.6	0.97	6,624	3,576,785	4,007
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0048	25.5	203.94	90.3	23.9	90.3	66.3	1.16	10,933	5,238,921	5,868
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0052	27.7	196.60	90.6	16.6	90.6	74.0	1.29	11,427	6,231,355	6,980
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0071	37.7	204.32	90.0	24.3	90.0	65.7	1.15	10,881	8,474,057	9,492
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0048	25.1	198.84	90.2	18.8	90.2	71.4	1.25	11,284	9,774,173	10,948
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0040	20.9	221.53	180.9	41.5	0.9	40.6	0.71	10,332	4,706,940	5,272
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0037	19.8	219.55	279.5	39.6	99.5	60.0	1.05	9,303	2,807,801	3,145
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0038	20.3	226.27	279.5	46.3	99.5	53.3	0.93	4,285	1,335,831	1,496
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0034	17.8	224.75	0.9	44.8	0.9	43.8	0.76	5,501	1,456,561	1,632
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0026	13.7	235.00	90.3	55.0	90.3	35.3	0.62	9,071	1,730,090	1,938
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0030	16.1	237.06	179.9	57.1	179.9	57.2	1.00	4,455	1,016,372	1,138
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0033	17.5	222.56	90.2	42.6	90.2	47.6	0.83	11,688	2,929,573	3,282
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0020	10.6	250.84	0.5	70.8	0.5	70.3	1.23	9,952	1,671,589	1,872
Central Kings	North Kings	20	95,000	4%	91,507	18,685	0.0017	9.1	286.54	90.3	106.5	90.3	16.2	0.28	5,225	826,272	926
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0021	11.0	266.80	1.1	86.8	1.1	85.7	1.50	5,277	1,030,732	1,155
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0019	10.1	280.36	0.3	100.4	0.3	79.9	1.40	10,469	2,163,428	2,423
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0022	11.5	287.39	232.2	107.4	52.2	55.2	0.96	13,793	3,239,849	3,629
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0030	15.7	253.38	268.3	73.4	88.3	14.9	0.26	2,569	626,569	702
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0017	9.1	236.04	268.3	56.0	88.3	32.2	0.56	9,720	1,680,652	1,883
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0022	11.8	222.92	268.3	42.9	88.3	45.4	0.79	2,440	520,076	583
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0027	14.2	216.42	268.3	36.4	88.3	51.9	0.91	2,086	531,878	596
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0035	18.7	219.77	235.8	39.8	55.8	16.0	0.28	2,614	879,557	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0036	18.8	220.13	235.8	40.1	55.8	15.6	0.27	1,731	364,225	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0028	14.6	212.53	235.8	32.5	55.8	23.2	0.41	1,194	98,876	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0026	13.9	215.60	255.3	35.6	75.3	39.7	0.69	1,850	463,889	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0021	11.0	213.58	220.0	33.6	40.0	6.4	0.11	546	107,634	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0013	7.0	198.14	189.4	18.1	9.4	8.8	0.15	2,098	227,639	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0011	5.9	176.17	349.5	176.2	169.5	6.7	0.12	686	63,143	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0012	6.3	159.07	360.0	159.1	180.0	20.9	0.36	1,935	192,564	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0012	6.3	139.09	360.0	139.1	180.0	40.9	0.71	2,264	266,867	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0016	8.7	129.42	96.4	129.4	96.4	33.0	0.58	1,696	276,227	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0022	11.7	163.00	96.4	163.0	96.4	66.6	1.16	14,535	2,997,064	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0010	5.1	223.46	178.6	43.5	178.6	44.9	0.78	12,585	1,120,593	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0004	2.0	186.34	186.7	6.3	6.7	0.3	0.01	99	3,558	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0007	3.9	308.54	229.9	128.5	49.9	78.7	1.37	5,543	321,968	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0022	11.6	278.75	203.7	98.7	23.7	75.0	1.31	16,221	2,809,200	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0016	8.5	237.60	173.3	57.6	173.3	64.3	1.12	5,412	1,048,077	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0009	4.5	220.05	254.6	40.0	74.6	34.6	0.60	3,631	375,155	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0009	4.8	244.79	211.1	64.8	31.1	33.7	0.59	4,374	473,600	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0038	19.8	234.65	180.8	54.6	0.8	53.8	0.94	12,046	3,430,340	3,842
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0029	15.4	259.96	180.8	80.0	0.8	79.1	1.38	10,353	1,655,689	1,855
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0033	17.2	252.86	270.3	72.9	90.3	17.5	0.31	1,581	283,263	317
McMullin	Central Kings	51	75,000	26%	55,425	10,654	0.0013	6.7	165.10	180.7	165.1	0.7	15.6	0.27	2,864	200,566	225
James	McMullin	52	128,000	11%	114,224	6,877	0.0026	13.9	93.00	132.3	93.0	132.3	39.3	0.69	4,356	1,307,075	1,464
James	McMullin	53	128,000	11%	114,064	7,174	0.0021	11.0	93.13	130.2	93.1	130.2	37.1	0.65	4,329	1,029,820	1,154
James	McMullin	54	107,000	13%	92,969	6,829	0.0016	8.3	59.17	132.7	59.2	132.7	73.5	1.28	6,549	954,934	1,070
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0015	8.1	63.43	141.8	63.4	141.8	78.3	1.37	9,375	1,608,301	1,802
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0017	8.8	99.45	141.6	99.4	141.6	42.2	0.74	6,458	1,210,622	1,356
James	McMullin	57	128,000	22%	99,217	9,585	0.0017	9.1	91.65	142.0	91.6	142.0	50.3	0.88	7,378	1,261,235	1,413
James	McMullin	58	128,000	24%	97,258	6,153	0.0017	9.0	83.85	142.2	83.9	142.2	58.3	1.02	5,237	866,867	971
James	McMullin	59	125,000	24%	95,517	3,455	0.0015	7.8	104.00	152.8	104.0	152.8	48.8	0.85	2,599	364,889	409
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0016	8.4	109.30	227.4	109.3	47.4	61.9	1.08	4,107	611,499	685
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0019	9.9	102.99	315.0	103.0	135.0	32.0	0.56	3,773	646,605	724
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0015	8.0	215.99	288.4	36.0	108.4	72.4	1.26	16,026	2,133,322	2,390
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0021	10.9	309.49	334.5	129.5	154.5	25.0	0.44	5,002	878,903	984
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0013	6.8	312.97	270.1	133.0	90.1	42.8	0.75	7,188	806,068	903
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0024	12.8	281.44	270.8	101.4	90.8	10.6	0.19	986	125,381	140
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0023	12.2	283.46	180.5	103.5	0.5	77.1	1.34	5,143	614,109	688

Attachment 3 - 2003 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Fork Kings	McMullin	67	75,000	32%	51,283	5,354	0.0021	10.9	294.46	270.1	114.5	90.1	24.3	0.42	2,207	233,968	262
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0032	17.2	291.77	0.8	111.8	0.8	69.0	1.20	4,908	833,006	933
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0021	11.0	311.05	270.2	131.0	90.2	40.9	0.71	6,957	799,586	896
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0035	18.5	314.66	270.3	134.7	90.3	44.4	0.77	7,412	1,436,961	1,610
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0027	14.4	253.06	270.4	73.1	90.4	17.3	0.30	3,180	472,381	529
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0033	17.7	250.07	0.5	70.1	0.5	69.5	1.21	4,944	909,606	1,019
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0027	14.4	236.34	270.4	56.3	90.4	34.1	0.59	8,868	1,320,339	1,479
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0034	17.8	245.25	180.4	65.3	0.4	64.8	1.13	4,772	903,012	1,012
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0019	10.0	237.71	270.3	57.7	90.3	32.6	0.57	2,868	318,180	356
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0022	11.5	229.93	270.7	49.9	90.7	40.7	0.71	9,517	1,670,883	1,872
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0032	17.1	235.00	270.8	55.0	90.8	35.8	0.62	780	220,343	247
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0021	11.3	233.96	315.4	54.0	135.4	81.4	1.42	14,711	2,768,140	3,101
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0021	11.2	231.94	270.3	51.9	90.3	38.3	0.67	2,596	646,895	725
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0020	10.4	230.48	271.5	50.5	91.5	41.0	0.72	6,408	1,495,549	1,675
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0015	8.1	205.12	0.7	25.1	0.7	24.4	0.43	4,416	801,969	898
North Fork Kings	Central Kings	82	***118,000***	0%	118,000	6,290	0.0010	5.2	115.91	68.3	115.9	68.3	47.6	0.83	4,643	537,238	602
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0024	12.4	141.94	263.5	141.9	83.5	58.5	1.02	9,910	2,006,382	2,247
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0018	9.7	127.04	281.3	127.0	101.3	25.8	0.45	2,843	455,782	511
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0016	8.6	108.86	263.8	108.9	83.8	25.1	0.44	7,688	1089868	1,221

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2004 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0048	25.4	257.50	180.1	77.5	0.1	77.4	1.35	3,862	1780670	1,995
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0047	24.6	250.09	90.6	70.1	90.6	20.5	0.36	1,839	822495	921
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0049	26.0	219.31	180.0	39.3	0.0	39.3	0.69	3,368	1592028	1,783
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0042	22.1	222.47	180.1	42.5	0.1	42.3	0.74	7,094	2672561	2,994
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0055	29.3	202.04	90.9	22.0	90.9	68.9	1.20	11,075	5412047	6,062
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0050	26.4	210.50	181.4	30.5	1.4	29.1	0.51	3,770	1661968	1,862
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0049	25.8	224.86	136.3	44.9	136.3	88.6	1.55	22,480	9470205	10,608
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0048	25.5	230.80	180.7	50.8	0.7	50.1	0.87	6,153	3559759	3,987
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0050	26.2	212.36	90.3	32.4	90.3	57.9	1.01	10,114	4994208	5,594
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0054	28.4	195.17	90.6	15.2	90.6	75.4	1.32	11,505	6437680	7,211
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0050	26.2	209.81	90.0	29.8	90.0	60.2	1.05	10,362	5612555	6,287
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0043	22.7	205.75	90.2	25.7	90.2	64.5	1.13	10,745	8398861	9,408
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0043	22.7	221.94	180.9	41.9	0.9	41.0	0.72	10,419	5156951	5,777
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0039	20.6	223.61	279.5	43.6	99.5	55.9	0.98	8,900	2796331	3,132
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0045	23.9	217.63	279.5	37.6	99.5	61.9	1.08	4,717	1731638	1,940
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0041	21.4	221.63	0.9	41.6	0.9	40.7	0.71	5,181	1650320	1,849
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0026	13.8	228.84	90.3	48.8	90.3	41.4	0.72	10,394	2006270	2,247
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0035	18.7	229.74	179.9	49.7	179.9	49.8	0.87	4,052	1078003	1,208
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0028	14.9	233.36	90.2	53.4	90.2	36.8	0.64	9,481	2013547	2,255
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0031	16.6	234.81	0.5	54.8	0.5	54.3	0.95	8,582	2257212	2,528
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0014	7.3	255.35	90.3	75.4	90.3	14.9	0.26	4,819	611854	685
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0020	10.3	258.75	1.1	78.7	1.1	77.6	1.35	5,169	950240	1,064
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0026	13.5	282.35	0.3	102.4	0.3	77.9	1.36	10,398	2874257	3,220
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0021	11.1	292.99	232.2	113.0	52.2	60.8	1.06	14,661	3327671	3,727
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0068	36.1	232.66	268.3	52.7	88.3	35.6	0.62	5,817	3254927	3,646
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0014	7.6	199.40	268.3	19.4	88.3	68.9	1.20	16,996	2434014	2,726
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0022	11.5	221.00	268.3	41.0	88.3	47.3	0.83	2,520	519836	582
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0025	13.4	218.37	268.3	38.4	88.3	49.9	0.87	2,029	488764	547
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0032	17.0	217.59	235.8	37.6	55.8	18.2	0.32	2,959	903798	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0044	23.2	211.14	235.8	31.1	55.8	24.6	0.43	2,676	694398	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0037	19.3	203.67	235.8	23.7	55.8	32.1	0.56	1,608	176520	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0025	13.1	217.93	255.3	37.9	75.3	37.4	0.65	1,758	413740	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0020	10.6	218.58	220.0	38.6	40.0	1.4	0.02	118	22672	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0014	7.3	214.57	189.4	34.6	9.4	25.2	0.44	5,853	667293	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0012	6.3	196.74	349.5	16.7	169.5	27.3	0.48	2,697	263249	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0010	5.2	171.42	360.0	171.4	180.0	8.5	0.15	806	66461	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0011	5.6	150.25	360.0	150.3	180.0	29.7	0.52	1,714	181682	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0016	8.4	139.33	96.4	139.3	96.4	42.9	0.75	2,121	337293	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0025	13.1	163.78	96.4	163.8	96.4	67.3	1.18	14,620	3383771	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0009	5.0	193.02	178.6	13.0	178.6	14.4	0.25	4,440	382484	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0006	3.2	182.84	186.7	2.8	6.7	3.8	0.07	1,192	67213	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0012	6.5	325.09	229.9	145.1	49.9	84.8	1.48	5,629	553732	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0024	12.4	281.37	203.7	101.4	23.7	77.6	1.35	16,403	3048265	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0018	9.6	242.53	173.3	62.5	173.3	69.2	1.21	5,617	1224350	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0012	6.1	227.84	254.6	47.8	74.6	26.8	0.47	2,884	400770	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0009	4.8	264.69	211.1	84.7	31.1	53.6	0.94	6,342	697526	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0031	16.2	225.88	180.8	45.9	0.8	45.0	0.79	10,562	2452005	2,747
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0024	12.5	258.99	180.8	79.0	0.8	78.2	1.36	10,318	1336586	1,497
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0036	19.2	245.39	270.3	65.4	90.3	24.9	0.44	2,221	445129	499
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0020	10.7	231.01	180.7	51.0	0.7	50.3	0.88	8,199	925135	1,036
James	McMullin	52	128,000	11%	114,224	6,877	0.0020	10.5	61.18	132.3	61.2	132.3	71.1	1.24	6,507	1471307	1,648
James	McMullin	53	128,000	11%	114,064	7,174	0.0026	14.0	16.26	130.2	16.3	130.2	66.0	1.15	6,554	1979448	2,217
James	McMullin	54	107,000	13%	92,969	6,829	0.0014	7.4	358.58	132.7	178.6	132.7	45.9	0.80	4,902	642153	719
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0008	4.4	30.27	141.8	30.3	141.8	68.5	1.20	8,907	834174	934
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0022	11.4	87.05	141.6	87.0	141.6	54.6	0.95	7,838	1899344	2,128
James	McMullin	57	128,000	22%	99,217	9,585	0.0040	21.0	92.15	142.0	92.2	142.0	49.8	0.87	7,324	2890329	3,238
James	McMullin	58	128,000	24%	97,258	6,153	0.0071	37.4	54.51	142.2	54.5	142.2	87.7	1.53	6,148	4238152	4,747
James	McMullin	59	125,000	24%	95,517	3,455	0.0059	31.1	69.16	152.8	69.2	152.8	83.6	1.46	3,433	1928707	2,160
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0049	25.7	52.03	227.4	52.0	47.4	4.6	0.08	376	170573	191
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0026	13.9	17.18	315.0	17.2	135.0	62.2	1.09	6,292	1518030	1,700
McMullin	North Fork Kings	62	123,000	29%	87,645	16,815	0.0023	12.3	274.38	288.4	94.4	108.4	14.0	0.24	4,063	829580	929
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0017	9.0	185.92	334.5	5.9	154.5	31.4	0.55	6,178	895984	1,004
McMullin	North Fork Kings	64	123,000	29%	86,845	10,574	0.0011	6.0	226.75	270.1	46.8	90.1	43.4	0.76	7,262	719693	806
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0019	10.0	292.45	270.8	112.5	90.8	21.6	0.38	1,972	195269	219
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0018	9.4	274.51	180.5	94.5	0.5	86.0	1.50	5,264	486302	545

Attachment 3 - 2004 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0020	10.6	251.20	270.1	71.2	90.1	18.9	0.33	1,736	179284	201
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0017	9.2	261.59	0.8	81.6	0.8	80.8	1.41	5,191	473571	530
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0028	14.7	273.37	270.2	93.4	90.2	3.2	0.06	591	90824	102
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0033	17.5	310.91	270.3	130.9	90.3	40.7	0.71	6,901	1269129	1,422
North Fork Kings	Central Kings	71	73,000	25%	54,577	10,677	0.0025	13.4	281.48	270.4	101.5	90.4	11.1	0.19	2,054	284766	319
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0031	16.1	270.50	0.5	90.5	0.5	90.0	1.57	5,277	885240	992
North Fork Kings	Central Kings	73	73,000	25%	54,623	15,835	0.0027	14.1	304.30	270.4	124.3	90.4	33.9	0.59	8,831	1288805	1,444
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0041	21.5	303.80	180.4	123.8	0.4	56.6	0.99	4,403	1008930	1,130
North Fork Kings	Central Kings	75	73,000	20%	58,546	5,321	0.0039	20.5	272.56	270.3	92.6	90.3	2.2	0.04	208	47182	53
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0030	16.1	241.49	270.7	61.5	90.7	29.2	0.51	7,111	1741413	1,951
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0036	19.1	231.60	270.8	51.6	90.8	39.2	0.68	842	266555	299
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0024	12.9	232.31	315.4	52.3	135.4	83.1	1.45	14,769	3165325	3,546
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0020	10.7	215.79	270.3	35.8	90.3	54.5	0.95	3,406	816808	915
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0025	13.3	231.84	271.5	51.8	91.5	39.6	0.69	6,230	1855240	2,078
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0020	10.7	215.50	0.7	35.5	0.7	34.8	0.61	6,097	1460157	1,636
North Fork Kings	Central Kings	82	***118,000***	0%	118,000	6,290	0.0014	7.5	192.33	68.3	12.3	68.3	56.0	0.98	5,216	877925	983
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0014	7.5	119.29	263.5	119.3	83.5	35.8	0.63	6,804	835905	936
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0018	9.4	113.56	281.3	113.6	101.3	12.3	0.21	1,392	215214	241
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0024	12.7	97.32	263.8	97.3	83.8	13.5	0.24	4,243	889807	997

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2005 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0051	27.1	268.40	180.1	88.4	0.1	88.3	1.54	3,956	1950756	2,185
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0054	28.3	244.29	90.6	64.3	90.6	26.3	0.46	2,327	1198528	1,343
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0048	25.1	208.04	180.0	28.0	0.0	28.0	0.49	2,499	1141715	1,279
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0043	22.9	225.24	180.1	45.2	0.1	45.1	0.79	7,462	2912479	3,262
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0061	32.3	190.15	90.9	10.2	90.9	80.8	1.41	11,718	6316143	7,075
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0047	24.8	213.71	181.4	33.7	1.4	32.3	0.56	4,143	1719024	1,926
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0049	25.9	224.36	136.3	44.4	136.3	88.1	1.54	22,474	9490946	10,631
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0042	22.4	242.82	180.7	62.8	0.7	62.1	1.08	7,092	3615284	4,050
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0030	15.6	217.88	90.3	37.9	90.3	52.4	0.91	9,456	2773740	3,107
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0044	23.3	190.74	90.6	10.7	90.6	79.9	1.39	11,701	5385850	6,033
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0052	27.5	205.94	90.0	25.9	90.0	64.1	1.12	10,739	6107403	6,841
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0053	28.2	209.45	90.2	29.4	90.2	60.8	1.06	10,391	10108790	11,323
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0038	20.2	218.71	180.9	38.7	0.9	37.8	0.66	9,727	4284076	4,799
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0033	17.6	229.49	279.5	49.5	99.5	50.0	0.87	8,235	2204846	2,470
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0042	22.1	226.20	279.5	46.2	99.5	53.3	0.93	4,289	1455913	1,631
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0034	18.2	220.29	0.9	40.3	0.9	39.4	0.69	5,039	1362687	1,526
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0025	13.1	233.26	90.3	53.3	90.3	37.0	0.65	9,457	1732352	1,940
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0031	16.3	235.16	179.9	55.2	179.9	55.3	0.96	4,357	1008204	1,129
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0030	15.6	225.00	90.2	45.0	90.2	45.2	0.79	11,223	2504931	2,806
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0019	10.1	260.91	0.5	80.9	0.5	80.4	1.40	10,421	1668322	1,869
Central Kings	North Kings	20	95,000	4%	91,507	18,685	0.0017	9.1	286.90	90.3	106.9	90.3	16.6	0.29	5,340	845837	947
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0021	11.2	245.96	1.1	66.0	1.1	64.8	1.13	4,790	954998	1,070
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0027	14.1	272.70	0.3	92.7	0.3	87.6	1.53	10,623	3063375	3,431
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0023	12.3	280.09	232.2	100.1	52.2	47.9	0.84	12,464	3127880	3,504
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0036	18.7	247.00	268.3	67.0	88.3	21.3	0.37	3,626	1052948	1,179
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0016	8.2	246.06	268.3	66.1	88.3	22.2	0.39	6,891	1071856	1,201
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0021	11.0	222.44	268.3	42.4	88.3	45.8	0.80	2,460	488767	547
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0026	13.8	222.29	268.3	42.3	88.3	46.0	0.80	1,908	473710	531
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0036	18.9	223.97	235.8	44.0	55.8	11.8	0.21	1,939	660725	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0038	20.2	222.72	235.8	42.7	55.8	13.0	0.23	1,449	327498	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0024	12.8	216.00	235.8	36.0	55.8	19.8	0.34	1,023	74682	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0026	13.8	220.73	255.3	40.7	75.3	34.6	0.60	1,644	408940	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0020	10.7	214.06	220.0	34.1	40.0	5.9	0.10	505	97111	0
Central Kings	Kings River East	35	80,000	-3%	82,389	13,736	0.0015	7.8	185.73	189.4	5.7	9.4	3.6	0.06	867	105781	0
Central Kings	Kings River East	36	80,000	-3%	82,432	5,888	0.0015	8.0	150.74	349.5	150.7	169.5	18.7	0.33	1,893	235789	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0012	6.4	134.71	360.0	134.7	180.0	45.2	0.79	3,854	386410	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0013	6.7	130.00	360.0	130.0	180.0	50.0	0.87	2,649	334295	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0017	8.7	128.25	96.4	128.3	96.4	31.8	0.56	1,643	270150	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0019	10.1	163.87	96.4	163.9	96.4	67.4	1.18	14,629	2600509	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0012	6.1	207.69	178.6	27.7	178.6	29.1	0.51	8,671	918948	0
Kings River East	Central Kings	42	90,000	-3%	92,338	17,872	0.0006	3.3	247.55	186.7	67.5	6.7	60.9	1.06	15,614	897868	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0010	5.1	300.48	229.9	120.5	49.9	70.6	1.23	5,332	412645	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0016	8.6	266.26	203.7	86.3	23.7	62.5	1.09	14,898	1911352	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0014	7.6	247.34	173.3	67.3	173.3	74.0	1.29	5,776	1000491	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0010	5.5	224.71	254.6	44.7	74.6	29.9	0.52	3,191	400266	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0007	3.6	289.94	211.1	109.9	31.1	78.9	1.38	7,729	639298	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0040	21.4	233.34	180.8	53.3	0.8	52.5	0.92	11,842	3639610	4,077
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0036	18.8	256.71	180.8	76.7	0.8	75.9	1.32	10,223	1993669	2,233
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0022	11.5	255.37	270.3	75.4	90.3	15.0	0.26	1,360	163024	183
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0017	9.1	272.75	180.7	92.8	0.7	87.9	1.53	10,647	1020831	1,143
James	McMullin	52	128,000	11%	114,224	6,877	0.0050	26.2	68.33	132.3	68.3	132.3	64.0	1.12	6,180	3497265	3,917
James	McMullin	53	128,000	11%	114,064	7,174	0.0046	24.5	32.94	130.2	32.9	130.2	82.7	1.44	7,115	3769489	4,222
James	McMullin	54	107,000	13%	92,969	6,829	0.0044	23.2	64.10	132.7	64.1	132.7	68.6	1.20	6,358	2592430	2,904
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0038	20.1	91.64	141.8	91.6	141.8	50.1	0.87	7,346	3132488	3,509
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0025	13.1	105.40	141.6	105.4	141.6	36.2	0.63	5,684	1574317	1,763
James	McMullin	57	128,000	22%	99,217	9,585	0.0045	23.6	75.70	142.0	75.7	142.0	66.3	1.16	8,776	3893778	4,362
James	McMullin	58	128,000	24%	97,258	6,153	0.0031	16.3	80.31	142.2	80.3	142.2	61.9	1.08	5,426	1632045	1,828
James	McMullin	59	125,000	24%	95,517	3,455	0.0027	14.4	86.50	152.8	86.5	152.8	66.3	1.16	3,163	824083	923
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0025	13.1	73.08	227.4	73.1	47.4	25.7	0.45	2,018	465929	522
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0022	11.8	21.89	315.0	21.9	135.0	66.9	1.17	6,544	1342653	1,504
McMullin	North Fork Kings	62	123,000	29%	87,645	16,815	0.0021	11.2	161.78	288.4	161.8	108.4	53.4	0.93	13,501	2510977	2,813
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0030	15.7	284.84	334.5	104.8	154.5	49.6	0.87	9,022	2291464	2,567
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0007	3.6	301.38	270.1	121.4	90.1	31.2	0.55	5,485	320801	359
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0018	9.7	282.44	270.8	102.4	90.8	11.6	0.20	1,077	103760	116
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0022	11.4	294.18	180.5	114.2	0.5	66.3	1.16	4,834	543139	608

Attachment 3 - 2005 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Fork Kings	McMullin	67	75,000	32%	51,283	5,354	0.0022	11.5	291.18	270.1	111.2	90.1	21.1	0.37	1,924	214678	240
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0024	12.7	303.63	0.8	123.6	0.8	57.1	1.00	4,416	556764	624
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0035	18.2	329.90	270.2	149.9	90.2	59.7	1.04	9,182	1751873	1,962
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0031	16.4	336.58	270.3	156.6	90.3	66.3	1.16	9,702	1668914	1,869
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0030	16.0	269.66	270.4	89.7	90.4	0.7	0.01	136	22477	25
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0036	18.8	239.38	0.5	59.4	0.5	58.8	1.03	4,516	882431	988
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0025	13.2	247.30	270.4	67.3	90.4	23.1	0.40	6,212	846010	948
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0028	14.6	237.72	180.4	57.7	0.4	57.3	1.00	4,437	688341	771
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0028	14.5	226.78	270.3	46.8	90.3	43.5	0.76	3,666	590241	661
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0028	14.6	223.62	270.7	43.6	90.7	47.1	0.82	10,675	2370631	2,655
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0039	20.4	223.50	270.8	43.5	90.8	47.3	0.82	980	330614	370
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0021	11.3	237.07	315.4	57.1	135.4	78.3	1.37	14,569	2721884	3,049
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0017	8.8	228.86	270.3	48.9	90.3	41.4	0.72	2,768	541331	606
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0024	12.9	233.58	271.5	53.6	91.5	37.9	0.66	5,998	1733357	1,942
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0016	8.7	254.23	0.7	74.2	0.7	73.5	1.28	10,244	1984821	2,223
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0006	3.3	352.23	68.3	172.2	68.3	76.1	1.33	6,107	452090	506
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0023	12.0	159.05	263.5	159.0	83.5	75.6	1.32	11,261	2208722	2,474
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0028	14.8	162.25	281.3	162.3	101.3	61.0	1.06	5,718	1397024	1,565
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0029	15.5	118.37	263.8	118.4	83.8	34.6	0.60	10,297	2626069	2,942

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2006 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0022	11.7	308.5	180.1	128.5	0.1	51.6	0.90	3,104	662017	742
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0032	16.9	161.5	90.6	161.5	90.6	70.9	1.24	4,962	1526606	1,710
McMullin	North Kings	2	96,000	0%	96,000	5,317	0.0053	27.9	159.2	180.0	159.2	0.0	20.8	0.36	1,889	957427	1,072
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0036	19.1	196.1	180.1	16.1	0.1	15.9	0.28	2,892	942343	1,056
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0049	25.7	194.0	90.9	14.0	90.9	77.0	1.34	11,564	4961791	5,558
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0033	17.2	216.9	181.4	36.9	1.4	35.6	0.62	4,504	1296207	1,452
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0040	21.4	217.1	136.3	37.1	136.3	80.9	1.41	22,201	7742806	8,673
McMullin	North Kings	7	***120,000***	0%	120,000	8,027	0.0032	16.8	184.1	180.7	4.1	0.7	3.3	0.06	465	177698	199
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0076	40.0	181.8	90.3	1.8	90.3	88.5	1.54	11,932	8972108	10,050
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0055	29.2	196.7	90.6	16.7	90.6	73.9	1.29	11,423	6574130	7,364
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0062	32.8	198.0	90.0	18.0	90.0	72.1	1.26	11,356	7688576	8,612
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0065	34.1	200.3	90.2	20.3	90.2	69.9	1.22	11,185	13158178	14,739
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0043	22.7	211.1	180.9	31.1	0.9	30.2	0.53	7,986	3951011	4,426
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0039	20.8	207.9	279.5	27.9	99.5	71.6	1.25	10,194	3235419	3,624
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0052	27.3	220.0	279.5	40.0	99.5	59.6	1.04	4,611	1933711	2,166
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0046	24.1	222.4	0.9	42.4	0.9	41.5	0.72	5,259	1880445	2,106
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0029	15.4	222.5	90.3	42.5	90.3	47.8	0.83	11,631	2500811	2,801
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0030	15.8	229.5	179.9	49.5	179.9	49.6	0.87	4,038	908016	1,017
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0031	16.1	224.9	90.2	44.9	90.2	45.2	0.79	11,237	2588933	2,900
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0022	11.8	238.1	0.5	58.1	0.5	57.6	1.01	8,925	1665663	1,866
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0013	7.1	247.2	90.3	67.2	90.3	23.1	0.40	7,332	896029	1,004
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0015	7.7	253.9	1.1	73.9	1.1	72.7	1.27	5,054	689557	772
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0016	8.5	269.5	0.3	89.5	0.3	89.2	1.56	10,631	1837670	2,058
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0022	11.4	269.7	232.2	89.7	52.2	37.5	0.65	10,226	2377633	2,663
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0024	12.8	263.9	268.3	83.9	88.3	4.4	0.08	759	151003	169
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0021	10.9	247.9	268.3	67.9	88.3	20.4	0.36	6,349	1311550	1,469
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0021	10.8	228.0	268.3	48.0	88.3	40.3	0.70	2,217	432206	*484*
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0022	11.4	219.8	268.3	39.8	88.3	48.5	0.85	1,987	408944	*458*
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0030	15.8	220.7	235.8	40.7	55.8	15.1	0.26	2,472	703471	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0035	18.5	217.7	235.8	37.7	55.8	18.1	0.32	1,990	411995	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0033	17.2	219.2	235.8	39.2	55.8	16.6	0.29	863	84151	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0022	11.5	218.6	255.3	38.6	75.3	36.7	0.64	1,730	358760	0
Kings River East	Central Kings	34	***95,000***	0%	95,000	4,909	0.0020	10.8	220.5	220.0	40.5	40.0	0.5	0.01	42	8154	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0018	9.6	212.8	189.4	32.8	9.4	23.4	0.41	5,460	818664	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0015	8.1	183.6	349.5	3.6	169.5	14.1	0.25	1,433	180421	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0015	8.1	154.9	360.0	154.9	180.0	25.0	0.44	2,296	291540	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0015	8.0	136.1	360.0	136.1	180.0	43.8	0.77	2,396	361708	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0018	9.7	128.2	96.4	128.2	96.4	31.8	0.56	1,643	300591	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0016	8.4	155.1	96.4	155.1	96.4	58.6	1.02	13,526	2003289	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0004	2.3	220.6	178.6	40.6	178.6	42.0	0.73	11,943	466886	0
Kings River East	Central Kings	42	90,000	-3%	92,338	17,872	0.0008	4.2	211.0	186.7	31.0	6.7	24.4	0.43	7,378	546355	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0008	4.2	302.8	229.9	122.8	49.9	72.9	1.27	5,404	338857	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0017	8.9	273.7	203.7	93.7	23.7	70.0	1.22	15,777	2098311	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0015	8.1	247.3	173.3	67.3	173.3	74.0	1.29	5,775	1068218	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0012	6.2	221.9	254.6	41.9	74.6	32.7	0.57	3,456	488700	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0008	4.5	266.8	211.1	86.8	31.1	55.8	0.97	6,512	662011	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0031	16.3	230.6	180.8	50.6	0.8	49.7	0.87	11,390	2666926	2,987
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0058	30.4	256.3	180.8	76.3	0.8	75.5	1.32	10,206	3222392	3,610
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0043	22.9	261.1	270.3	81.1	90.3	9.2	0.16	842	201249	225
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0012	6.2	234.1	180.7	54.1	0.7	53.4	0.93	8,553	556066	623
McMullin	James	52	128,000	11%	114,224	6,877	0.0008	4.2	195.4	132.3	15.4	132.3	63.1	1.10	6,134	558248	625
McMullin	James	53	128,000	11%	114,064	7,174	0.0015	7.9	147.8	130.2	147.8	130.2	17.6	0.31	2,167	368008	412
James	McMullin	54	107,000	13%	92,969	6,829	0.0022	11.4	127.7	132.7	127.7	132.7	5.0	0.09	590	118672	133
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0025	13.0	118.2	141.8	118.2	141.8	23.5	0.41	3,821	1056763	1,184
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0018	9.7	108.6	141.6	108.6	141.6	33.0	0.58	5,239	1075817	1,205
James	McMullin	57	128,000	22%	99,217	9,585	0.0010	5.2	61.2	142.0	61.2	142.0	80.8	1.41	9,463	931389	1,043
James	McMullin	58	128,000	24%	97,258	6,153	0.0018	9.5	79.9	142.2	79.9	142.2	62.3	1.09	5,449	956039	1,071
James	McMullin	59	125,000	24%	95,517	3,455	0.0020	10.6	86.4	152.8	86.4	152.8	66.3	1.16	3,165	604197	677
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0021	10.9	76.0	227.4	76.0	47.4	28.6	0.50	2,232	429849	481
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0022	11.5	50.9	315.0	50.9	135.0	84.1	1.47	7,077	1409620	1,579
McMullin	North Fork Kings	62	123,000	29%	87,645	16,815	0.0010	5.1	128.7	288.4	128.7	108.4	20.3	0.35	5,838	489433	548
North Fork Kings	McMullin	63	123,000	31%	85,245	11,841	0.0015	7.9	344.0	334.5	164.0	154.5	9.5	0.17	1,949	247993	278
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0013	6.9	338.3	270.1	158.3	90.1	68.1	1.19	9,813	1120993	1,256
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0013	6.9	297.7	270.8	117.7	90.8	26.9	0.47	2,419	166273	186
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0020	10.6	274.4	180.5	94.4	0.5	86.2	1.50	5,265	545608	611

Attachment 3 - 2006 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0028	14.9	264.0	270.1	84.0	90.1	6.1	0.11	571	82726	93
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0031	16.1	269.2	0.8	89.2	0.8	88.4	1.54	5,256	837592	938
McMullin	North Fork Kings	69	75,000	26%	55,265	10,633	0.0022	11.7	265.6	270.2	85.6	90.2	4.6	0.08	858	105242	118
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0034	17.9	279.6	270.3	99.6	90.3	9.4	0.16	1,726	324619	364
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0032	16.7	253.1	270.4	73.1	90.4	17.3	0.30	3,168	545270	611
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0036	19.3	233.7	0.5	53.7	0.5	53.2	0.93	4,224	847289	949
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0027	14.5	234.5	270.4	54.5	90.4	35.9	0.63	9,290	1392445	1,560
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0024	12.6	248.8	180.4	68.8	0.4	68.4	1.19	4,902	655475	734
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0023	12.2	254.8	270.3	74.8	90.3	15.6	0.27	1,429	194003	217
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0031	16.5	223.9	270.7	43.9	90.7	46.8	0.82	10,626	2665827	2,986
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0037	19.3	223.0	270.8	43.0	90.8	47.8	0.83	988	315568	353
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0026	13.8	225.3	315.4	45.3	135.4	89.9	1.57	14,877	3416514	3,827
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0027	14.1	225.7	270.3	45.7	90.3	44.6	0.78	2,937	924353	1,035
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0032	16.7	239.0	271.5	59.0	91.5	32.5	0.57	5,243	1959153	2,195
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0026	13.8	263.2	0.7	83.2	0.7	82.5	1.44	10,591	3258322	3,650
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0014	7.4	316.5	68.3	136.5	68.3	68.2	1.19	5,839	963523	1,079
James	North Fork Kings	83	86,000	0%	86,000	11,628	N/A	N/A	95.0	263.5	95.0	83.5	11.5	0.20	2,328	N/A	N/A
North Fork Kings	James	84	87,000	0%	87,000	6,538	0.0009	4.6	83.5	281.3	83.5	101.3	17.7	0.31	1,992	152339	171
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0017	8.9	94.5	263.8	94.5	83.8	10.7	0.19	3,376	494444	554

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2007 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0035	18.4	236.1	180.1	56.1	0.1	56.0	0.98	3,281	1097204	1,229
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0074	38.9	180.9	90.6	0.9	90.6	89.7	1.57	5,250	3714363	4,161
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0073	38.6	195.2	180.0	15.2	0.0	15.2	0.27	1,395	980360	1,098
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0024	12.7	215.0	180.1	35.0	0.1	34.9	0.61	6,020	1304143	1,461
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0037	19.8	192.1	90.9	12.1	90.9	78.9	1.38	11,648	3848119	4,310
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0049	26.0	220.7	181.4	40.7	1.4	39.3	0.69	4,907	2135415	2,392
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0049	25.6	219.0	136.3	39.0	136.3	82.7	1.44	22,304	9329274	10,450
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0039	20.4	220.6	180.7	40.6	0.7	39.9	0.70	5,147	2387737	2,675
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0049	25.8	210.1	90.3	30.1	90.3	60.2	1.05	10,356	5035179	5,640
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0057	30.3	193.0	90.6	13.0	90.6	77.6	1.35	11,609	6927972	7,760
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0061	32.4	205.3	90.0	25.3	90.0	64.7	1.13	10,796	7215003	8,082
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0064	33.8	202.5	90.2	22.5	90.2	67.7	1.18	11,019	12828444	14,370
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0045	23.8	211.0	180.9	31.0	0.9	30.1	0.53	7,959	4119045	4,614
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0047	24.8	221.0	279.5	41.0	99.5	58.5	1.02	9,160	3456686	3,872
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0036	19.0	217.8	279.5	37.8	99.5	61.7	1.08	4,711	1376165	1,542
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0031	16.4	216.4	0.9	36.4	0.9	35.4	0.62	4,606	1123435	1,258
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0033	17.5	207.7	90.3	27.7	90.3	62.6	1.09	13,944	3400022	3,809
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0026	13.8	217.4	179.9	37.4	179.9	37.5	0.65	3,226	631379	707
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0037	19.8	226.9	90.2	46.9	90.2	43.2	0.75	10,841	3067813	3,436
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0032	16.9	249.3	0.5	69.3	0.5	68.8	1.20	9,852	2639069	2,956
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0018	9.5	245.8	90.3	65.8	90.3	24.5	0.43	7,753	1281745	1,436
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0020	10.7	271.5	1.1	91.5	1.1	89.6	1.56	5,292	1008477	1,130
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0017	8.9	279.5	0.3	99.5	0.3	80.8	1.41	10,497	1913844	2,144
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0020	10.7	255.1	232.2	75.1	52.2	22.9	0.40	6,534	1429118	1,601
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0020	10.5	256.0	268.3	76.0	88.3	12.2	0.21	2,117	343361	385
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0021	11.2	244.1	268.3	64.1	88.3	24.2	0.42	7,455	1575479	1,765
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0024	12.8	230.8	268.3	50.8	88.3	37.5	0.65	2,087	481132	*539*
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0028	14.8	231.1	268.3	51.1	88.3	37.1	0.65	1,602	425459	*477*
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0031	16.3	230.9	235.8	50.9	55.8	4.9	0.09	812	237751	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0029	15.4	221.3	235.8	41.3	55.8	14.5	0.25	1,606	275621	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0026	13.7	215.0	235.8	35.0	55.8	20.8	0.36	1,073	83634	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0028	14.9	230.3	255.3	50.3	75.3	25.1	0.44	1,226	327696	0
Kings River East	Central Kings	34	***95,000***	0%	95,000	4,909	0.0024	12.8	227.3	220.0	47.3	40.0	7.3	0.13	626	143644	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0018	9.3	215.2	189.4	35.2	9.4	25.8	0.45	5,978	864160	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0013	6.7	198.7	349.5	18.7	169.5	29.2	0.51	2,874	301646	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0011	5.7	167.4	360.0	167.4	180.0	12.5	0.22	1,179	106496	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0012	6.5	144.1	360.0	144.1	180.0	35.9	0.63	2,028	248721	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0015	8.1	136.3	96.4	136.3	96.4	39.9	0.70	1,997	303997	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0020	10.4	171.1	96.4	171.1	96.4	74.6	1.30	15,277	2792823	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0011	5.7	232.0	178.6	52.0	178.6	53.4	0.93	14,320	1409139	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0011	5.8	161.7	186.7	161.7	6.7	25.0	0.44	7,541	770967	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0004	2.2	315.9	229.9	135.9	49.9	86.0	1.50	5,639	185493	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0017	8.9	273.3	203.7	93.3	23.7	69.6	1.21	15,737	2083672	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0017	9.1	239.0	173.3	59.0	173.3	65.6	1.15	5,473	1126161	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0015	7.8	211.6	254.6	31.6	74.6	43.0	0.75	4,367	774041	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0005	2.6	223.3	211.1	43.3	31.1	12.2	0.21	1,665	97600	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0048	25.5	232.8	180.8	52.8	0.8	52.0	0.91	11,752	4301461	4,818
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0038	20.3	255.0	180.8	75.0	0.8	74.2	1.29	10,143	2138402	2,395
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0031	16.5	269.8	270.3	89.8	90.3	0.6	0.01	52	8999	10
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0027	14.4	264.6	180.7	84.6	0.7	83.9	1.46	10,594	1599416	1,792
James	McMullin	52	128,000	11%	114,224	6,877	0.0047	25.0	23.2	132.3	23.2	132.3	70.9	1.24	6,501	3520719	3,944
James	McMullin	53	128,000	11%	114,064	7,174	0.0058	30.8	34.7	130.2	34.7	130.2	84.5	1.47	7,140	4755858	5,327
James	McMullin	54	107,000	13%	92,969	6,829	0.0061	32.4	57.8	132.7	57.8	132.7	74.9	1.31	6,595	3762616	4,215
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0061	32.2	89.8	141.8	89.8	141.8	52.0	0.91	7,544	5146194	5,764
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0057	30.1	79.5	141.6	79.5	141.6	62.2	1.08	8,504	5425755	6,078
James	McMullin	57	128,000	22%	99,217	9,585	0.0041	21.7	32.4	142.0	32.4	142.0	70.4	1.23	9,031	3674569	4,116
James	McMullin	58	128,000	24%	97,258	6,153	0.0029	15.2	67.6	142.2	67.6	142.2	74.6	1.30	5,932	1666071	1,866
James	McMullin	59	125,000	24%	95,517	3,455	0.0033	17.6	93.0	152.8	93.0	152.8	59.8	1.04	2,985	952994	1,067
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0040	21.0	99.0	227.4	99.0	47.4	51.6	0.90	3,649	1354801	1,518
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0039	20.5	110.2	315.0	110.2	135.0	24.8	0.43	2,984	1057718	1,185
McMullin	North Fork Kings	62	123,000	29%	87,645	16,815	0.0010	5.2	235.1	288.4	55.1	108.4	53.2	0.93	13,472	1154718	1,293
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0023	12.2	274.1	334.5	94.1	154.5	60.4	1.05	10,296	2022405	2,265
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0014	7.3	291.8	270.1	111.8	90.1	21.7	0.38	3,906	469426	526
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0028	14.9	278.5	270.8	98.5	90.8	7.7	0.13	715	105851	119
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0033	17.3	259.9	180.5	79.9	0.5	79.3	1.38	5,186	878399	984

Attachment 3 - 2007 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0038	20.2	222.5	270.1	42.5	90.1	47.6	0.83	3,955	775269	868
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0024	12.8	275.7	0.8	95.7	0.8	85.1	1.49	5,239	662023	742
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0029	15.1	295.2	270.2	115.2	90.2	25.0	0.44	4,499	711054	796
Central Kings	North Fork Kings	70	75,000	26%	55,396	10,594	0.0030	15.6	248.9	270.3	68.9	90.3	21.4	0.37	3,865	633123	709
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0029	15.2	259.6	270.4	79.6	90.4	10.8	0.19	1,994	313711	351
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0045	23.8	252.8	0.5	72.8	0.5	72.2	1.26	5,026	1243541	1,393
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0029	15.3	253.3	270.4	73.3	90.4	17.1	0.30	4,644	735989	824
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0015	8.0	247.7	180.4	67.7	0.4	67.3	1.17	4,864	416316	466
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0021	11.3	237.8	270.3	57.8	90.3	32.5	0.57	2,861	358310	401
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0032	17.1	215.7	270.7	35.7	90.7	54.9	0.96	11,936	3111958	3,486
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0044	23.2	226.0	270.8	46.0	90.8	44.8	0.78	939	361407	405
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0028	14.8	232.7	315.4	52.7	135.4	82.7	1.44	14,755	3624493	4,060
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0026	13.6	248.1	270.3	68.1	90.3	22.2	0.39	1,580	481989	540
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0027	14.0	233.2	271.5	53.2	91.5	38.3	0.67	6,052	1899371	2,128
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0030	15.9	264.5	0.7	84.5	0.7	83.8	1.46	10,620	3767264	4,220
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0022	11.7	298.0	68.3	118.0	68.3	49.7	0.87	4,797	1257042	1,408
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0024	12.7	137.6	263.5	137.6	83.5	54.1	0.94	9,419	1945804	2,180
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0029	15.4	143.7	281.3	143.7	101.3	42.5	0.74	4,416	1121189	1,256
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0027	14.0	140.5	263.8	140.5	83.8	56.7	0.99	15,166	3509220	3,931

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2008 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0009	4.7	256.1	180.1	76.1	0.1	76.0	1.33	3,840	327690	367
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0022	11.7	218.5	90.6	38.5	90.6	52.1	0.91	4,143	883805	990
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0035	18.7	218.4	180.0	38.4	0.0	38.4	0.67	3,300	1123826	1,259
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0037	19.5	208.3	180.1	28.3	0.1	28.1	0.49	4,967	1652224	1,851
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0058	30.7	189.6	90.9	9.6	90.9	81.4	1.42	11,737	6020838	6,744
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0049	25.9	215.1	181.4	35.1	1.4	33.7	0.59	4,301	1866162	2,090
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0041	21.7	225.5	136.3	45.5	136.3	89.2	1.56	22,485	7962197	8,919
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0047	24.6	218.9	180.7	38.9	0.7	38.2	0.67	4,964	2777793	3,112
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0054	28.8	203.5	90.3	23.5	90.3	66.8	1.17	10,967	5934136	6,647
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0059	31.1	196.9	90.6	16.9	90.6	73.7	1.29	11,410	7007241	7,849
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0060	31.8	205.3	90.0	25.3	90.0	64.7	1.13	10,796	7096688	7,949
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0065	34.2	205.0	90.2	25.0	90.2	65.2	1.14	10,811	12751897	14,284
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0052	27.5	214.3	180.9	34.3	0.9	33.4	0.58	8,744	5228569	5,857
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0047	24.7	225.2	279.5	45.2	99.5	54.3	0.95	8,726	3283490	3,678
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0038	20.0	219.3	279.5	39.3	99.5	60.2	1.05	4,640	1426781	1,598
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0035	18.4	218.6	0.9	38.6	0.9	37.7	0.66	4,859	1325878	1,485
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0030	15.7	224.2	90.3	44.2	90.3	46.1	0.80	11,310	2471438	2,768
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0031	16.2	230.5	179.9	50.5	179.9	50.6	0.88	4,097	941429	1,055
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0031	16.4	224.5	90.2	44.5	90.2	45.7	0.80	11,320	2655788	2,975
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0021	11.2	238.1	0.5	58.1	0.5	57.6	1.01	8,922	1578751	1,768
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0016	8.2	243.0	90.3	63.0	90.3	27.3	0.48	8,561	1214258	1,360
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0016	8.7	254.0	1.1	74.0	1.1	72.8	1.27	5,056	782508	877
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0015	8.0	278.4	0.3	98.4	0.3	81.8	1.43	10,525	1722555	1,930
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0017	9.2	262.3	232.2	82.3	52.2	30.1	0.52	8,416	1578176	1,768
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0024	12.6	255.8	268.3	75.8	88.3	12.4	0.22	2,153	421678	472
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0021	11.1	237.9	268.3	57.9	88.3	30.4	0.53	9,226	1941500	2,175
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0025	13.2	218.9	268.3	38.9	88.3	49.4	0.86	2,602	619127	694
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0025	13.4	213.3	268.3	33.3	88.3	54.9	0.96	2,172	525155	588
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0030	15.8	215.3	235.8	35.3	55.8	20.5	0.36	3,319	940561	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0035	18.4	214.5	235.8	34.5	55.8	21.3	0.37	2,332	480250	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0033	17.5	212.4	235.8	32.4	55.8	23.4	0.41	1,201	119395	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0025	13.3	213.3	255.3	33.3	75.3	42.0	0.73	1,937	463042	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0023	12.1	216.4	220.0	36.4	40.0	3.6	0.06	306	66534	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0014	7.6	215.2	189.4	35.2	9.4	25.8	0.45	5,985	714189	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0012	6.3	205.7	349.5	25.7	169.5	36.2	0.63	3,478	341150	0
Kings River East	Central Kings	37	80,000	-4%	83,016	5,428	0.0011	5.7	193.9	360.0	13.9	180.0	14.0	0.24	1,310	116657	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0007	3.9	160.0	360.0	160.0	180.0	19.9	0.35	1,178	86355	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0013	6.6	134.1	96.4	134.1	96.4	37.6	0.66	1,903	237295	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0022	11.4	150.1	96.4	150.1	96.4	53.7	0.94	12,761	2561090	0
Central Kings	Kings River East	41	90,000	-2%	91,624	17,844	0.0010	5.1	124.0	178.6	124.0	178.6	54.6	0.95	14,545	1291427	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0011	5.7	181.7	186.7	1.7	6.7	5.0	0.09	1,552	155024	0
Kings River East	Central Kings	43	78,000	-2%	79,423	5,653	0.0008	4.0	327.4	229.9	147.4	49.9	82.4	1.44	5,603	337095	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0017	8.9	277.5	203.7	97.5	23.7	73.8	1.29	16,126	2143337	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0012	6.3	234.4	173.3	54.4	173.3	61.0	1.07	5,256	754212	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0013	6.9	196.7	254.6	16.7	74.6	57.9	1.01	5,420	853304	0
Central Kings	Kings River East	47	***120,000***	0%	120,000	7,877	0.0007	3.9	116.9	211.1	116.9	31.1	85.8	1.50	7,856	702632	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0050	26.5	232.7	180.8	52.7	0.8	51.8	0.90	11,735	4467670	5,004
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0045	24.0	258.2	180.8	78.2	0.8	77.4	1.35	10,288	2564974	2,873
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0040	21.1	264.3	270.3	84.3	90.3	6.1	0.11	557	122561	137
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0017	8.9	305.1	180.7	125.1	0.7	55.6	0.97	8,790	817257	915
James	McMullin	52	128,000	11%	114,224	6,877	0.0018	9.5	90.2	132.3	90.2	132.3	42.1	0.74	4,615	947854	1,062
James	McMullin	53	128,000	11%	114,064	7,174	0.0039	20.8	114.7	130.2	114.7	130.2	15.6	0.27	1,927	864637	969
James	McMullin	54	107,000	13%	92,969	6,829	0.0043	22.9	110.2	132.7	110.2	132.7	22.5	0.39	2,616	1053674	1,180
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0032	17.2	78.7	141.8	78.7	141.8	63.1	1.10	8,535	3105441	3,479
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0034	17.7	64.5	141.6	64.5	141.6	77.1	1.35	9,374	3527494	3,951
James	McMullin	57	128,000	22%	99,217	9,585	0.0044	23.0	60.6	142.0	60.6	142.0	81.4	1.42	9,478	4104130	4,597
James	McMullin	58	128,000	24%	97,258	6,153	0.0056	29.5	92.7	142.2	92.7	142.2	49.4	0.86	4,675	2537288	2,842
James	McMullin	59	125,000	24%	95,517	3,455	0.0042	22.3	61.5	152.8	61.5	152.8	88.7	1.55	3,454	1390465	1,558
North Fork Kings	McMullin	60	125,000	25%	93,183	4,656	0.0028	14.8	41.2	227.4	41.2	47.4	6.2	0.11	503	131219	147
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0018	9.3	346.9	315.0	166.9	135.0	31.9	0.56	3,760	604278	677
McMullin	North Fork Kings	62	123,000	29%	87,645	16,815	0.0026	13.5	238.7	288.4	58.7	108.4	49.6	0.87	12,813	2877046	3,223
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0035	18.5	261.7	334.5	81.7	154.5	72.7	1.27	11,308	3386306	3,793
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0012	6.1	300.5	270.1	120.5	90.1	30.4	0.53	5,349	536151	601
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0018	9.3	309.9	270.8	129.9	90.8	39.1	0.68	3,371	311957	349
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0017	9.2	289.3	180.5	109.3	0.5	71.2	1.24	4,997	452703	507

Attachment 3 - 2008 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0020	10.7	267.0	270.1	87.0	90.1	3.1	0.05	292	30340	34
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0034	18.0	290.4	0.8	110.4	0.8	70.3	1.23	4,952	881564	987
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0024	12.5	301.9	270.2	121.9	90.2	31.7	0.55	5,590	731886	820
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0032	16.9	322.3	270.3	142.3	90.3	52.0	0.91	8,351	1478378	1,656
North Fork Kings	Central Kings	71	73,000	25%	54,577	10,677	0.0031	16.2	274.6	270.4	94.6	90.4	4.2	0.07	780	131066	147
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0029	15.6	247.7	0.5	67.7	0.5	67.1	1.17	4,863	787860	883
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0023	12.2	242.0	270.4	62.0	90.4	28.4	0.50	7,542	952829	1,067
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0027	14.5	219.8	180.4	39.8	0.4	39.4	0.69	3,345	514559	576
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0031	16.4	226.7	270.3	46.7	90.3	43.6	0.76	3,670	667935	748
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0029	15.1	220.7	270.7	40.7	90.7	49.9	0.87	11,160	2567222	2,876
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0039	20.6	227.9	270.8	47.9	90.8	42.9	0.75	908	309881	347
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0030	15.8	232.0	315.4	52.0	135.4	83.4	1.46	14,778	3867619	4,332
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0028	14.6	249.2	270.3	69.2	90.3	21.1	0.37	1,506	490549	549
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0027	14.2	235.7	271.5	55.7	91.5	35.7	0.62	5,704	1807110	2,024
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0029	15.3	258.9	0.7	78.9	0.7	78.2	1.37	10,458	3570246	3,999
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0015	7.9	282.0	68.3	102.0	68.3	33.6	0.59	3,482	616585	691
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0021	11.3	149.3	263.5	149.3	83.5	65.8	1.15	10,608	1955804	2,191
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0027	14.4	148.5	281.3	148.5	101.3	47.2	0.82	4,800	1135369	1,272
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0039	20.5	92.8	263.8	92.8	83.8	9.0	0.16	2,829	954679	1,069

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2009 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0027	14.3	288.05	180.1	108.1	0.1	72.1	1.26	3,766	980457	1,098
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0015	7.7	252.28	90.6	72.3	90.6	18.3	0.32	1,650	230849	259
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0017	8.9	201.19	180.0	21.2	0.0	21.2	0.37	1,922	309925	347
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0046	24.1	188.00	180.1	8.0	0.1	7.9	0.14	1,443	592844	664
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0042	22.1	198.87	90.9	18.9	90.9	72.1	1.26	11,294	4158519	4,658
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0047	24.9	207.50	181.4	27.5	1.4	26.1	0.46	3,410	1419278	1,590
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0035	18.4	223.35	136.3	43.3	136.3	87.1	1.52	22,458	6765309	7,578
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0044	23.1	203.43	180.7	23.4	0.7	22.7	0.40	3,095	1625084	1,820
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0069	36.4	182.06	90.3	2.1	90.3	88.2	1.54	11,930	8161694	9,142
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0065	34.1	200.50	90.6	20.5	90.6	70.1	1.22	11,178	7518826	8,422
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0058	30.6	207.79	90.0	27.8	90.0	62.3	1.09	10,565	6681284	7,484
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0070	37.1	199.44	90.2	19.4	90.2	70.8	1.24	11,244	14390462	16,119
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0048	25.4	212.81	180.9	32.8	0.9	31.9	0.56	8,388	4631888	5,188
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0045	23.8	218.48	279.5	38.5	99.5	61.1	1.07	9,402	3411992	3,822
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0037	19.5	218.69	279.5	38.7	99.5	60.8	1.06	4,670	1399871	1,568
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0037	19.6	226.00	0.9	46.0	0.9	45.1	0.79	5,625	1636708	1,833
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0030	15.6	226.70	90.3	46.7	90.3	43.6	0.76	10,828	2357615	2,641
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0030	15.6	229.00	179.9	49.0	179.9	49.1	0.86	4,008	887957	995
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0032	16.8	222.00	90.2	42.0	90.2	48.2	0.84	11,792	2825520	3,165
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0017	9.1	229.90	0.5	49.9	0.5	49.4	0.86	8,024	1161015	1,301
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0017	9.1	241.62	90.3	61.6	90.3	28.7	0.50	8,968	1417805	1,588
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0023	12.2	266.43	1.1	86.4	1.1	85.3	1.49	5,274	1142785	1,280
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0019	9.8	271.39	0.3	91.4	0.3	88.9	1.55	10,630	2124320	2,380
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0019	10.3	250.85	232.2	70.9	52.2	18.7	0.33	5,378	1127901	1,263
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0021	11.0	246.13	268.3	66.1	88.3	22.2	0.39	3,767	643917	721
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0020	10.7	244.52	268.3	64.5	88.3	23.8	0.41	7,340	1480927	1,659
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0025	13.3	230.60	268.3	50.6	88.3	37.7	0.66	2,096	502865	563
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0025	13.4	224.00	268.3	44.0	88.3	44.3	0.77	1,852	446464	500
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0031	16.2	214.65	235.8	34.6	55.8	21.1	0.37	3,418	996308	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0046	24.3	211.07	235.8	31.1	55.8	24.7	0.43	2,683	729792	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0035	18.3	201.55	235.8	21.6	55.8	34.2	0.60	1,701	177380	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	N/A	235.8	N/A	55.8	N/A	N/A	N/A	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0025	13.2	224.06	255.3	44.1	75.3	31.3	0.55	1,502	357919	0
Kings River East	Central Kings	34	***95,000***	0%	95,000	4,909	0.0024	12.6	226.59	220.0	46.6	40.0	6.6	0.12	566	127887	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0017	9.1	203.22	189.4	23.2	9.4	13.9	0.24	3,293	466784	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0013	7.1	173.75	349.5	173.7	169.5	4.3	0.07	438	48253	0
Kings River East	Central Kings	37	80,000	-4%	83,016	5,428	0.0004	2.3	197.69	360.0	17.7	180.0	17.7	0.31	1,653	60102	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0005	2.4	177.27	360.0	177.3	180.0	2.7	0.05	162	7335	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0014	7.2	137.87	96.4	137.9	96.4	41.4	0.72	2,062	278070	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0028	15.0	170.03	96.4	170.0	96.4	73.6	1.28	15,198	4011202	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0015	7.7	213.02	178.6	33.0	178.6	34.4	0.60	10,082	1348400	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0011	5.7	164.77	186.7	164.8	6.7	21.9	0.38	6,662	663970	0
Central Kings	Kings River East	43	78,000	-2%	79,423	5,653	0.0009	4.5	150.25	229.9	150.3	49.9	79.6	1.39	5,560	377349	0
Kings River East	Central Kings	44	78,000	-1%	78,916	16,793	0.0009	4.6	262.70	203.7	82.7	23.7	59.0	1.03	14,388	995646	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0027	14.1	237.75	173.3	57.7	173.3	64.4	1.12	5,419	1734256	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0034	17.7	187.75	254.6	7.8	74.6	66.9	1.17	5,885	2368454	0
Central Kings	Kings River East	47	***120,000***	0%	120,000	7,877	0.0024	12.5	102.59	211.1	102.6	31.1	71.5	1.25	7,471	2129305	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0034	17.7	222.91	180.8	42.9	0.8	42.1	0.73	10,002	2544216	2,850
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0041	21.6	243.09	180.8	63.1	0.8	62.3	1.09	9,331	2095074	2,347
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0037	19.6	249.20	270.3	69.2	90.3	21.1	0.37	1,898	387808	434
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0014	7.4	259.49	180.7	79.5	0.7	78.8	1.38	10,451	809312	907
James	McMullin	52	128,000	11%	114,224	6,877	0.0022	11.4	92.71	132.3	92.7	132.3	39.6	0.69	4,382	1085151	1,216
James	McMullin	53	128,000	11%	114,064	7,174	0.0007	3.8	105.47	130.2	105.5	130.2	24.8	0.43	3,006	245840	275
James	McMullin	54	107,000	13%	92,969	6,829	0.0019	10.0	130.08	132.7	130.1	132.7	2.6	0.05	312	54683	61
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0029	15.2	102.70	141.8	102.7	141.8	39.1	0.68	6,032	1941995	2,175
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0033	17.6	65.41	141.6	65.4	141.6	76.2	1.33	9,340	3479882	3,898
James	McMullin	57	128,000	22%	99,217	9,585	0.0043	22.6	70.83	142.0	70.8	142.0	71.1	1.24	9,071	3844325	4,306
James	McMullin	58	128,000	24%	97,258	6,153	0.0034	18.1	89.41	142.2	89.4	142.2	52.8	0.92	4,899	1636339	1,833
James	McMullin	59	125,000	24%	95,517	3,455	0.0041	21.9	88.50	152.8	88.5	152.8	64.3	1.12	3,113	1231954	1,380
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0049	25.7	84.17	227.4	84.2	47.4	36.8	0.64	2,787	1262012	1,414
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0037	19.7	54.25	315.0	54.3	135.0	80.8	1.41	7,023	2400062	2,688
McMullin	North Fork Kings	62	123,000	29%	87,645	16,815	0.0009	4.7	227.57	288.4	47.6	108.4	60.8	1.06	14,679	1137660	1,274
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0018	9.3	305.54	334.5	125.5	154.5	28.9	0.51	5,729	863195	967
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0012	6.6	2.16	270.1	2.2	90.1	88.0	1.54	10,567	1147059	1,285
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0011	5.8	309.36	270.8	129.4	90.8	38.5	0.67	3,333	191684	215
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0028	15.0	244.10	180.5	64.1	0.5	63.6	1.11	4,726	696571	780

Attachment 3 - 2009 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0053	28.1	236.86	270.1	56.9	90.1	33.3	0.58	2,937	802683	899
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0079	41.9	259.90	0.8	79.9	0.8	79.1	1.38	5,164	2141649	2,399
North Fork Kings	McMullin	69	75,000	26%	55,265	10,633	0.0042	22.4	313.74	270.2	133.7	90.2	43.6	0.76	7,327	1720312	1,927
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0024	12.8	307.20	270.3	127.2	90.3	36.9	0.64	6,367	855879	959
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0036	19.2	261.54	270.4	81.5	90.4	8.8	0.15	1,642	325210	364
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0041	21.6	254.32	0.5	74.3	0.5	73.8	1.29	5,067	1137730	1,274
North Fork Kings	Central Kings	73	73,000	25%	54,623	15,835	0.0025	13.1	289.42	270.4	109.4	90.4	19.0	0.33	5,161	699993	784
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0039	20.7	279.81	180.4	99.8	0.4	80.6	1.41	5,202	1145789	1,283
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0046	24.3	258.75	270.3	78.8	90.3	11.6	0.20	1,068	287368	322
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0037	19.6	222.34	270.7	42.3	90.7	48.3	0.84	10,894	3254388	3,645
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0057	30.0	223.43	270.8	43.4	90.8	47.3	0.83	981	487580	546
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0033	17.5	233.59	315.4	53.6	135.4	81.8	1.43	14,725	4268098	4,781
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0021	11.3	242.62	270.3	62.6	90.3	27.6	0.48	1,942	491052	550
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0025	13.4	225.42	271.5	45.4	91.5	46.0	0.80	7,032	2109636	2,363
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0029	15.3	256.08	0.7	76.1	0.7	75.4	1.32	10,337	3537631	3,963
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0017	9.1	280.74	68.3	100.7	68.3	32.4	0.57	3,370	681785	764
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0019	10.1	149.38	263.5	149.4	83.5	65.9	1.15	10,615	1745721	1,955
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0025	13.3	146.00	281.3	146.0	101.3	44.7	0.78	4,602	1005685	1,127
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0029	15.2	112.17	263.8	112.2	83.8	28.4	0.50	8,624	2156351	2,415

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2011 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3,958	0.0023	12.0	242.81	180.1	62.8	0.1	62.7	1.09	3,516	766410	858
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0021	11.1	216.67	90.6	36.7	90.6	53.9	0.94	4,244	857175	960
McMullin	North Kings	2	96,000	0%	96,000	5,317	0.0035	18.7	178.91	180.0	178.9	0.0	1.1	0.02	101	34347	38
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0040	21.0	195.38	180.1	15.4	0.1	15.3	0.27	2,771	992070	1,111
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0059	31.1	191.09	90.9	11.1	90.9	79.8	1.39	11,685	6058303	6,786
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0050	26.2	222.00	181.4	42.0	1.4	40.6	0.71	5,043	2213063	2,479
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0041	21.8	222.77	136.3	42.8	136.3	86.5	1.51	22,445	7977339	8,936
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0046	24.3	212.50	180.7	32.5	0.7	31.8	0.55	4,224	2330181	2,610
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0050	26.3	203.07	90.3	23.1	90.3	67.2	1.17	11,004	5440859	6,095
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0053	27.8	196.15	90.6	16.1	90.6	74.5	1.30	11,452	6268334	7,021
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0063	33.2	202.46	90.0	22.5	90.0	67.6	1.18	11,035	7563387	8,472
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0069	36.3	200.45	90.2	20.5	90.2	69.8	1.22	11,173	13972773	15,652
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0052	27.6	218.85	180.9	38.8	0.9	37.9	0.66	9,758	5859028	6,563
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0052	27.6	217.42	279.5	37.4	99.5	62.1	1.08	9,497	3995068	4,475
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0037	19.8	208.23	279.5	28.2	99.5	71.3	1.24	5,065	1538060	1,723
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0035	18.3	214.31	0.9	34.3	0.9	33.4	0.58	4,371	1191489	1,335
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0030	15.9	224.55	90.3	44.6	90.3	45.7	0.80	11,245	2488887	2,788
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0023	12.1	241.16	179.9	61.2	179.9	61.3	1.07	4,649	801943	898
North Kings	Central Kings	18	83,000	9%	75,507	15,829	0.0024	12.9	229.94	90.2	49.9	90.2	40.2	0.70	10,220	1878082	2,104
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0020	10.3	229.86	0.5	49.9	0.5	49.4	0.86	8,019	1313588	1,471
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0024	12.5	232.19	90.3	52.2	90.3	38.1	0.67	11,532	2504796	2,806
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0018	9.8	252.49	1.1	72.5	1.1	71.4	1.25	5,014	869140	974
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0011	5.7	307.08	0.3	127.1	0.3	53.2	0.93	8,515	995393	1,115
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0020	10.7	268.28	232.2	88.3	52.2	36.1	0.63	9,896	2154475	2,413
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0024	12.5	257.96	268.3	78.0	88.3	10.3	0.18	1,789	345213	387
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0020	10.6	246.12	268.3	66.1	88.3	22.2	0.39	6,871	1377924	1,543
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0017	9.0	222.00	268.3	42.0	88.3	46.3	0.81	2,479	400966	449
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0025	13.1	225.00	268.3	45.0	88.3	43.3	0.76	1,819	428597	480
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0032	16.7	224.71	235.8	44.7	55.8	11.0	0.19	1,818	547656	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0042	22.2	208.79	235.8	28.8	55.8	27.0	0.47	2,913	721373	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0034	17.9	199.39	235.8	19.4	55.8	36.4	0.63	1,795	182813	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	0.0027	14.2	194.96	235.8	15.0	55.8	40.8	0.71	3,314	267980	0
North Kings	Kings River East	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0025	13.0	223.53	255.3	43.5	75.3	31.8	0.56	1,526	356207	0
Central Kings	Kings River East	34	***95,000***	0%	95,000	4,909	0.0016	8.4	215.35	220.0	35.4	40.0	4.6	0.08	395	59789	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0015	8.0	206.50	189.4	26.5	9.4	17.2	0.30	4,051	502587	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0015	7.9	196.57	349.5	16.6	169.5	27.1	0.47	2,681	329243	0
Kings River East	Central Kings	37	80,000	-4%	83,016	5,428	0.0011	5.8	192.27	360.0	12.3	180.0	12.3	0.21	1,158	105717	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0007	3.7	170.36	360.0	170.4	180.0	9.6	0.17	577	39648	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0013	6.6	138.07	96.4	138.1	96.4	41.6	0.73	2,070	259088	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0024	12.7	161.36	96.4	161.4	96.4	64.9	1.13	14,349	3218060	0
Central Kings	Kings River East	41	90,000	-2%	91,624	17,844	0.0008	4.4	175.89	178.6	175.9	178.6	2.7	0.05	848	65157	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0009	5.0	167.42	186.7	167.4	6.7	19.2	0.34	5,890	515600	0
Central Kings	Kings River East	43	78,000	-2%	79,423	5,653	0.0011	5.7	190.02	229.9	10.0	49.9	39.8	0.70	3,621	307851	0
Central Kings	Kings River East	44	78,000	-1%	78,916	16,793	0.0007	3.6	178.33	203.7	178.3	23.7	25.4	0.44	7,208	384177	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0017	9.1	230.07	173.3	50.1	173.3	56.7	0.99	5,024	1042682	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0028	14.9	195.18	254.6	15.2	74.6	59.4	1.04	5,511	1869365	0
Kings River East	Central Kings	47	***120,000***	0%	120,000	7,877	0.0012	6.4	211.12	211.1	31.1	31.1	0.1	0.00	8	1105	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0044	23.2	222.83	180.8	42.8	0.8	42.0	0.73	9,986	3326656	3,726
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0043	22.9	252.35	180.8	72.3	0.8	71.5	1.25	9,998	2382977	2,669
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0038	19.9	266.29	270.3	86.3	90.3	4.1	0.07	372	77071	86
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0028	14.7	253.02	180.7	73.0	0.7	72.3	1.26	10,151	1571611	1,760
McMullin	James	52	128,000	11%	114,224	6,877	0.0031	16.4	141.08	132.3	141.1	132.3	8.8	0.15	1,050	373651	419
James	McMullin	53	128,000	11%	114,064	7,174	0.0015	7.7	68.85	130.2	68.8	130.2	61.4	1.07	6,298	1045686	1,171
James	McMullin	54	107,000	13%	92,969	6,829	0.0030	15.6	70.31	132.7	70.3	132.7	62.4	1.09	6,052	1667073	1,867
James	McMullin	55	***112,000***	0%	112,000	9,572	0.0049	25.9	97.41	141.8	97.4	141.8	44.4	0.77	6,692	3675959	4,118
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0034	17.7	96.88	141.6	96.9	141.6	44.7	0.78	6,770	2544296	2,850
James	McMullin	57	128,000	22%	99,217	9,585	0.0022	11.6	85.76	142.0	85.8	142.0	56.2	0.98	7,967	1734242	1,943
James	McMullin	58	128,000	24%	97,258	6,153	0.0025	13.0	87.17	142.2	87.2	142.2	55.0	0.96	5,041	1211716	1,357
James	McMullin	59	125,000	24%	95,517	3,455	0.0021	11.0	59.03	152.8	59.0	152.8	86.2	1.51	3,447	683393	765
North Fork Kings	McMullin	60	125,000	25%	93,183	4,656	0.0021	10.8	45.59	227.4	45.6	47.4	1.8	0.03	146	27990	31
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0020	10.7	34.21	315.0	34.2	135.0	79.2	1.38	6,989	1301855	1,458
McMullin	North Fork Kings	62	123,000	29%	87,645	16,815	0.0009	4.6	133.22	288.4	133.2	108.4	24.9	0.43	7,068	543160	608
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0015	7.9	264.27	334.5	84.3	154.5	70.2	1.23	11,141	1414985	1,585
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0015	7.8	302.78	270.1	122.8	90.1	32.6	0.57	5,704	728869	816
McMullin	North Fork Kings	65	75,000	30%	52,395	5,349	0.0015	8.0	263.29	270.8	83.3	90.8	7.5	0.13	701	55800	63
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0017	9.2	256.92	180.5	76.9	0.5	76.4	1.33	5,129	462546	518

Attachment 3 - 2011 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0017	8.7	266.18	270.1	86.2	90.1	3.9	0.07	368	31161	35
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0043	22.8	292.90	0.8	112.9	0.8	67.9	1.18	4,870	1098342	1,230
McMullin	North Fork Kings	69	75,000	26%	55,265	10,633	0.0023	12.4	265.33	270.2	85.3	90.2	4.9	0.08	900	116578	131
Central Kings	North Fork Kings	70	75,000	26%	55,396	10,594	0.0026	13.8	247.25	270.3	67.3	90.3	23.0	0.40	4,140	600397	673
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0036	19.0	249.57	270.4	69.6	90.4	20.8	0.36	3,794	744370	834
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0033	17.4	229.70	0.5	49.7	0.5	49.2	0.86	3,992	723650	811
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0028	14.7	233.49	270.4	53.5	90.4	36.9	0.64	9,510	1450542	1,625
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0025	13.0	221.00	180.4	41.0	0.4	40.6	0.71	3,430	476331	534
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0027	14.3	216.50	270.3	36.5	90.3	53.8	0.94	4,295	682875	765
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0038	19.9	216.76	270.7	36.8	90.7	53.9	0.94	11,785	3566100	3,995
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0049	25.8	221.60	270.8	41.6	90.8	49.2	0.86	1,009	431594	483
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0030	15.7	231.74	315.4	51.7	135.4	83.7	1.46	14,786	3845923	4,308
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0022	11.4	234.46	270.3	54.5	90.3	35.8	0.62	2,449	624036	699
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0027	14.1	233.45	271.5	53.5	91.5	38.0	0.66	6,016	1892852	2,120
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0029	15.4	244.92	0.7	64.9	0.7	64.2	1.12	9,620	3306101	3,703
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0026	13.7	243.84	68.3	63.8	68.3	4.5	0.08	494	151491	170
James	North Fork Kings	83	86,000	0%	86,000	11,628	0.0017	8.9	114.52	263.5	114.5	83.5	31.0	0.54	5,997	868951	973
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0018	9.5	107.00	281.3	107.0	101.3	5.7	0.10	654	102668	115
North Fork Kings	James	85	87,000	0%	87,000	18,139	0.0023	12.0	67.73	263.8	67.7	83.8	16.1	0.28	5,017	992152	1,111

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2012 Flow Estimate, Internal

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	McMullin	0	96,000	0%	96,000	3958	0.0031	16.6	274.1	180.1	94.1	0.1	86.0	1.50	3,949	1193467	1,337
North Kings	McMullin	1	96,000	0%	96,000	5,250	0.0028	14.5	248.8	90.6	68.8	90.6	21.8	0.38	1,950	515242	577
North Kings	McMullin	2	96,000	0%	96,000	5,317	0.0027	14.5	225.4	180.0	45.4	0.0	45.4	0.79	3,789	996199	1,116
North Kings	McMullin	3	96,000	6%	90,147	10,532	0.0042	22.3	206.6	180.1	26.6	0.1	26.4	0.46	4,688	1784954	1,999
North Kings	McMullin	4	97,000	9%	88,161	11,871	0.0049	26.0	197.9	90.9	17.9	90.9	73.0	1.27	11,352	4933038	5,526
North Kings	McMullin	5	98,000	10%	88,337	7,744	0.0047	24.7	218.9	181.4	38.9	1.4	37.5	0.66	4,717	1950078	2,184
North Kings	McMullin	6	98,000	12%	86,236	22,487	0.0028	15.0	201.5	136.3	21.5	136.3	65.2	1.14	20,415	5006299	5,608
North Kings	McMullin	7	***120,000***	0%	120,000	8,027	0.0030	15.7	234.6	180.7	54.6	0.7	53.9	0.94	6,484	2314907	2,593
North Kings	McMullin	8	120,000	17%	99,359	11,936	0.0050	26.2	206.8	90.3	26.8	90.3	63.4	1.11	10,676	5270239	5,903
North Kings	McMullin	9	120,000	13%	104,129	11,887	0.0061	32.3	194.6	90.6	14.6	90.6	76.1	1.33	11,536	7345925	8,228
North Kings	McMullin	10	120,000	9%	109,054	11,937	0.0065	34.2	207.3	90.0	27.3	90.0	62.7	1.09	10,608	7498411	8,399
North Kings	McMullin	11	***182,000***	0%	182,000	11,909	0.0063	33.5	203.0	90.2	23.0	90.2	67.2	1.17	10,981	12678443	14,202
North Kings	McMullin	12	***115,000***	0%	115,000	15,873	0.0046	24.3	217.9	180.9	37.9	0.9	37.0	0.65	9,550	5062267	5,670
North Kings	McMullin	13	98,000	18%	80,494	10,744	0.0042	22.0	207.4	279.5	27.4	99.5	72.2	1.26	10,228	3428717	3,841
North Kings	Central Kings	14	98,000	17%	81,042	5,348	0.0043	22.7	249.0	279.5	69.0	99.5	30.6	0.53	2,719	947074	1,061
Central Kings	North Kings	15	91,000	14%	78,480	7,944	0.0037	19.4	232.7	0.9	52.7	0.9	51.8	0.90	6,242	1801017	2,017
North Kings	Central Kings	16	83,000	11%	73,698	15,707	0.0030	15.6	227.5	90.3	47.5	90.3	42.7	0.75	10,661	2320329	2,599
North Kings	Central Kings	17	83,000	10%	74,984	5,303	0.0027	14.0	243.8	179.9	63.8	179.9	63.9	1.12	4,762	948372	1,062
Central Kings	North Kings	18	83,000	9%	75,507	15,829	0.0021	11.3	288.0	90.2	108.0	90.2	17.8	0.31	4,843	780506	874
Central Kings	North Kings	19	89,000	6%	83,730	10,569	0.0016	8.5	232.6	0.5	52.6	0.5	52.1	0.91	8,335	1124774	1,260
North Kings	Central Kings	20	95,000	4%	91,507	18,685	0.0017	8.8	247.4	90.3	67.4	90.3	22.9	0.40	7,267	1114023	1,248
Central Kings	North Kings	21	95,000	1%	93,861	5,292	0.0020	10.4	270.5	1.1	90.5	1.1	89.4	1.56	5,292	974952	1,092
Central Kings	North Kings	22	111,000	3%	108,001	10,632	0.0018	9.6	264.6	0.3	84.6	0.3	84.3	1.47	10,580	2075411	2,325
Central Kings	North Kings	23	111,000	3%	107,937	16,792	0.0020	10.7	261.8	232.2	81.8	52.2	29.6	0.52	8,294	1812334	2,030
North Kings	Central Kings	24	80,000	-2%	81,808	9,989	0.0023	12.2	253.7	268.3	73.7	88.3	14.5	0.25	2,509	473406	530
North Kings	Central Kings	25	***100,000***	0%	100,000	18,219	0.0023	12.2	248.6	268.3	68.6	88.3	19.7	0.34	6,146	1423352	1,594
North Kings	Central Kings	26	***95,000***	0%	95,000	3,430	0.0028	14.7	233.3	268.3	53.3	88.3	35.0	0.61	1,966	521413	584
North Kings	Central Kings	27	***95,000***	0%	95,000	2,653	0.0030	16.0	227.5	268.3	47.5	88.3	40.8	0.71	1,734	498452	558
North Kings	Kings River East	28	***95,000***	0%	95,000	9,490	0.0030	15.7	224.2	235.8	44.2	55.8	11.6	0.20	1,901	535818	0
North Kings	Kings River East	29	59,000	0%	59,000	6,424	0.0024	12.9	211.3	235.8	31.3	55.8	24.4	0.43	2,655	382194	0
North Kings	Kings River East	30	30,000	0%	30,000	3,027	0.0028	14.6	205.7	235.8	25.7	55.8	30.0	0.52	1,514	125960	0
North Kings	Kings River East	31	30,000	0%	30,000	5,071	N/A	N/A	207.0	235.8	27.0	55.8	28.8	0.50	2,440	N/A	0
Kings River East	North Kings	32	30,000	0%	30,000	16,502	N/A	N/A	N/A	34.6	N/A	34.6	N/A	N/A	N/A	N/A	0
Central Kings	Kings River East	33	***95,000***	0%	95,000	2,895	0.0030	15.9	226.9	255.3	46.9	75.3	28.4	0.50	1,377	393741	0
Kings River East	Central Kings	34	***95,000***	0%	95,000	4,909	0.0027	14.1	226.9	220.0	46.9	40.0	6.9	0.12	591	149721	0
Kings River East	Central Kings	35	80,000	-3%	82,389	13,736	0.0017	9.1	215.9	189.4	35.9	9.4	26.5	0.46	6,137	867529	0
Kings River East	Central Kings	36	80,000	-3%	82,432	5,888	0.0010	5.1	193.8	349.5	13.8	169.5	24.3	0.42	2,420	194293	0
Central Kings	Kings River East	37	80,000	-4%	83,016	5,428	0.0011	5.6	141.4	360.0	141.4	180.0	38.6	0.67	3,384	299740	0
Central Kings	Kings River East	38	95,000	-4%	99,209	3,460	0.0015	7.9	122.5	360.0	122.5	180.0	57.5	1.00	2,917	435641	0
Kings River East	Central Kings	39	95,000	-5%	99,384	3,116	0.0020	10.3	119.5	96.4	119.5	96.4	23.1	0.40	1,221	237321	0
Kings River East	Central Kings	40	90,000	-3%	93,041	15,843	0.0018	9.5	156.0	96.4	156.0	96.4	59.5	1.04	13,656	2288643	0
Kings River East	Central Kings	41	90,000	-2%	91,624	17,844	0.0012	6.3	223.5	178.6	43.5	178.6	44.8	0.78	12,584	1385654	0
Central Kings	Kings River East	42	90,000	-3%	92,338	17,872	0.0016	8.4	119.9	186.7	119.9	6.7	66.8	1.17	16,425	2399630	0
Central Kings	Kings River East	43	78,000	-2%	79,423	5,653	0.0012	6.2	164.0	229.9	164.0	49.9	65.9	1.15	5,159	478456	0
Central Kings	Kings River East	44	78,000	-1%	78,916	16,793	0.0007	3.6	159.3	203.7	159.3	23.7	44.5	0.78	11,767	634452	0
Kings River East	Central Kings	45	***120,000***	0%	120,000	6,008	0.0019	10.1	221.2	173.3	41.2	173.3	47.9	0.84	4,459	1022453	0
Central Kings	Kings River East	46	***120,000***	0%	120,000	6,400	0.0026	13.6	190.8	254.6	10.8	74.6	63.8	1.11	5,743	1768512	0
Central Kings	Kings River East	47	***120,000***	0%	120,000	7,877	0.0011	6.0	119.3	211.1	119.3	31.1	88.2	1.54	7,873	1065103	0
Central Kings	McMullin	48	98,000	23%	75,891	14,924	0.0055	28.9	247.9	180.8	67.9	0.8	67.1	1.17	13,743	5712665	6,399
Central Kings	McMullin	49	75,000	27%	54,886	10,541	0.0051	26.8	246.6	180.8	66.6	0.8	65.7	1.15	9,611	2676678	2,998
McMullin	Central Kings	50	75,000	27%	54,997	5,264	0.0041	21.5	251.9	270.3	71.9	90.3	18.5	0.32	1,669	373748	419
Central Kings	McMullin	51	75,000	26%	55,425	10,654	0.0019	10.3	271.2	180.7	91.2	0.7	89.5	1.56	10,654	1150708	1,289
McMullin	James	52	128,000	11%	114,224	6,877	0.0028	15.0	132.7	132.3	132.7	132.3	0.4	0.01	47	15228	17
James	McMullin	53	128,000	11%	114,064	7,174	0.0025	13.4	129.6	130.2	129.6	130.2	0.6	0.01	80	23164	26
McMullin	James	54	107,000	13%	92,969	6,829	0.0022	11.8	143.0	132.7	143.0	132.7	10.3	0.18	1,221	253479	284
McMullin	James	55	***112,000***	0%	112,000	9,572	0.0021	10.9	158.9	141.8	158.9	141.8	17.2	0.30	2,827	653082	732
James	McMullin	56	***112,000***	0%	112,000	9,617	0.0025	13.4	130.3	141.6	130.3	141.6	11.3	0.20	1,891	539341	604
James	McMullin	57	128,000	22%	99,217	9,585	0.0016	8.3	59.0	142.0	59.0	142.0	83.0	1.45	9,514	1482595	1,661
James	McMullin	58	128,000	24%	97,258	6,153	0.0026	13.9	81.5	142.2	81.5	142.2	60.7	1.06	5,365	1374076	1,539
James	McMullin	59	125,000	24%	95,517	3,455	0.0022	11.5	71.5	152.8	71.5	152.8	81.3	1.42	3,415	709470	795
McMullin	North Fork Kings	60	125,000	25%	93,183	4,656	0.0015	7.9	58.2	227.4	58.2	47.4	10.8	0.19	874	121624	136
North Fork Kings	McMullin	61	125,000	27%	91,501	7,115	0.0012	6.1	23.5	315.0	23.5	135.0	68.5	1.20	6,619	704141	789
North Fork Kings	McMullin	62	123,000	29%	87,645	16,815	0.0021	11.0	72.1	288.4	72.1	108.4	36.3	0.63	9,954	1817907	2,036
McMullin	North Fork Kings	63	123,000	31%	85,245	11,841	0.0045	23.5	292.1	334.5	112.1	154.5	42.4	0.74	7,983	3029638	3,394
North Fork Kings	McMullin	64	123,000	29%	86,845	10,574	0.0025	13.4	29.4	270.1	29.4	90.1	60.7	1.06	9,223	2032014	2,276
North Fork Kings	McMullin	65	75,000	30%	52,395	5,349	0.0019	9.8	0.1	270.8	0.1	90.8	89.3	1.56	5,348	519109	581
North Fork Kings	McMullin	66	75,000	31%	51,830	5,277	0.0027	14.4	258.4	180.5	78.4	0.5	77.9	1.36	5,159	730844	819

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McMullin	North Fork Kings	67	75,000	32%	51,283	5,354	0.0061	32.3	240.4	270.1	60.4	90.1	29.7	0.52	2,652	833030	933
McMullin	North Fork Kings	68	75,000	30%	52,225	5,258	0.0073	38.7	260.3	0.8	80.3	0.8	79.5	1.39	5,170	1979651	2,217
McMullin	North Fork Kings	69	75,000	26%	55,265	10,633	0.0032	17.0	264.2	270.2	84.2	90.2	6.0	0.10	1,104	196017	220
North Fork Kings	Central Kings	70	75,000	26%	55,396	10,594	0.0026	13.9	289.8	270.3	109.8	90.3	19.5	0.34	3,537	517175	579
Central Kings	North Fork Kings	71	73,000	25%	54,577	10,677	0.0044	23.4	243.9	270.4	63.9	90.4	26.5	0.46	4,761	1149793	1,288
Central Kings	North Fork Kings	72	73,000	25%	54,969	5,277	0.0046	24.2	229.7	0.5	49.7	0.5	49.2	0.86	3,994	1005754	1,127
Central Kings	North Fork Kings	73	73,000	25%	54,623	15,835	0.0030	16.0	233.6	270.4	53.6	90.4	36.8	0.64	9,476	1573159	1,762
North Fork Kings	Central Kings	74	73,000	23%	56,203	5,273	0.0025	13.0	223.7	180.4	43.7	0.4	43.3	0.76	3,618	499887	560
Central Kings	North Fork Kings	75	73,000	20%	58,546	5,321	0.0023	12.4	213.3	270.3	33.3	90.3	57.0	1.00	4,463	612981	687
Central Kings	North Fork Kings	76	93,000	14%	80,296	14,584	0.0044	23.0	216.5	270.7	36.5	90.7	54.2	0.95	11,823	4141967	4,640
Central Kings	North Fork Kings	77	93,000	6%	87,498	1,334	0.0042	22.0	218.5	270.8	38.5	90.8	52.3	0.91	1,055	385167	431
Central Kings	North Fork Kings	78	93,000	6%	87,676	14,877	0.0031	16.5	223.2	315.4	43.2	135.4	87.8	1.53	14,866	4075609	4,565
Central Kings	North Fork Kings	79	***118,000***	0%	118,000	4,185	0.0028	14.9	228.8	270.3	48.8	90.3	41.5	0.72	2,771	923999	1,035
Central Kings	North Fork Kings	80	***118,000***	0%	118,000	9,772	0.0036	19.1	239.6	271.5	59.6	91.5	31.8	0.56	5,152	2203915	2,469
Central Kings	North Fork Kings	81	***118,000***	0%	118,000	10,682	0.0034	18.1	279.1	0.7	99.1	0.7	81.6	1.42	10,568	4279275	4,793
Central Kings	North Fork Kings	82	***118,000***	0%	118,000	6,290	0.0030	16.1	326.7	68.3	146.7	68.3	78.3	1.37	6,160	2212730	2,479
James	North Fork Kings	83	86,000	0%	86,000	11,628	N/A	N/A	120.5	263.5	120.5	83.5	37.0	0.65	7,000	N/A	N/A
James	North Fork Kings	84	87,000	0%	87,000	6,538	0.0017	9.2	113.9	281.3	113.9	101.3	12.6	0.22	1,429	216379	242
James	North Fork Kings	85	87,000	0%	87,000	18,139	0.0029	15.2	88.8	263.8	88.8	83.8	5.0	0.09	1,585	395971	444

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therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

External

Attachment 3 - 1925 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Percent Thickness Change (1925-1962)	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segment Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	N/A	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	N/A	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	102	30,000	N/A	N/A	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	N/A	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	N/A	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	105	***93,000***	N/A	N/A	12121.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	106	***211,000***	N/A	N/A	5396.1	N/A	N/A	N/A	278.3	N/A	98.3	N/A	N/A	N/A	N/A	0
North Kings	Root Creek WD	107	***211,000***	N/A	N/A	14767.3	N/A	N/A	N/A	278.3	N/A	98.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	108	***237,000***	N/A	N/A	18127.3	N/A	N/A	N/A	247.8	N/A	67.8	N/A	N/A	N/A	N/A	0
North Kings	Madera ID	109	***237,000***	N/A	N/A	8977.7	N/A	N/A	N/A	270.9	N/A	90.9	N/A	N/A	N/A	N/A	0
North Kings	Madera ID	110	***237,000***	N/A	N/A	19839.8	N/A	N/A	N/A	248.0	N/A	68.0	N/A	N/A	N/A	N/A	0
North Kings	Madera ID	111	***184,000***	N/A	N/A	6346.9	N/A	N/A	N/A	282.4	N/A	102.4	N/A	N/A	N/A	N/A	0
North Kings	Madera ID	112	***184,000***	N/A	N/A	7833.8	N/A	N/A	N/A	282.4	N/A	102.4	N/A	N/A	N/A	N/A	0
North Kings	Madera ID	113	***184,000***	N/A	N/A	25138.2	N/A	N/A	N/A	253.7	N/A	73.7	N/A	N/A	N/A	N/A	0
McMullin	Aliso WD	114	***180,000***	N/A	N/A	11667.2	N/A	N/A	N/A	213.3	N/A	33.3	N/A	N/A	N/A	N/A	0
McMullin	Aliso WD	115	***180,000***	N/A	N/A	6284.1	N/A	N/A	N/A	323.7	N/A	143.7	N/A	N/A	N/A	N/A	0
McMullin	Aliso WD	116	***180,000***	N/A	N/A	9065.2	N/A	N/A	N/A	250.8	N/A	70.8	N/A	N/A	N/A	N/A	0
McMullin	Aliso WD	117	***180,000***	N/A	N/A	4645.4	N/A	N/A	N/A	173.6	N/A	173.6	N/A	N/A	N/A	N/A	0
McMullin	Aliso WD	118	***180,000***	N/A	N/A	13996.9	N/A	N/A	N/A	273.4	N/A	93.4	N/A	N/A	N/A	N/A	0
McMullin	Aliso WD	119	***180,000***	N/A	N/A	3456.2	N/A	N/A	N/A	273.4	N/A	93.4	N/A	N/A	N/A	N/A	0
McMullin	Farmer WD	120	***180,000***	N/A	N/A	3470.6	0.0008	4.1	249.7	215.4	69.7	35.4	34.3	0.60	1957	N/A	0
McMullin	Farmer WD	121	***175,000***	N/A	N/A	5165.0	0.0013	6.8	221.9	181.0	41.9	1.0	41.0	0.72	3387	N/A	N/A
McMullin	Fresno County	122	***175,000***	N/A	N/A	8089.5	N/A	N/A	N/A	181.0	N/A	1.0	N/A	N/A	N/A	N/A	N/A
McMullin	Fresno County	123	***175,000***	N/A	N/A	5472.0	N/A	N/A	N/A	101.0	N/A	101.0	N/A	N/A	N/A	N/A	N/A
Fresno County	McMullin	124	***175,000***	N/A	N/A	8939.7	N/A	N/A	N/A	101.0	N/A	101.0	N/A	N/A	N/A	N/A	N/A
McMullin	Fresno County	125	***175,000***	3%	179,375	7147.8	0.0006	3.0	247.8	90.6	67.8	90.6	22.8	0.40	2773	285979	320
McMullin	Fresno County	126	***175,000***	N/A	N/A	12139.4	0.0005	2.9	237.6	181.4	57.6	1.4	56.2	0.98	10085	N/A	N/A
James ID	Fresno County	127	***175,000***	N/A	N/A	10727.6	N/A	N/A	N/A	268.0	N/A	88.0	N/A	N/A	N/A	N/A	N/A
James ID	Fresno County	128	***171,000***	N/A	N/A	3722.6	N/A	N/A	N/A	180.0	N/A	180.0	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	129	***171,000***	N/A	N/A	7865.6	N/A	N/A	N/A	130.8	N/A	130.8	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	130	***171,000***	N/A	N/A	16667.1	N/A	N/A	N/A	165.8	N/A	165.8	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	131	***171,000***	N/A	N/A	5212.2	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	132	***171,000***	N/A	N/A	8711.3	N/A	N/A	N/A	270.5	N/A	90.5	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	133	***171,000***	N/A	N/A	5559.6	N/A	N/A	N/A	200.4	N/A	20.4	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	134	***171,000***	N/A	N/A	5435.6	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
James ID	Westlands WD	135	***87,000***	N/A	N/A	6701.1	N/A	N/A	N/A	90.6	N/A	90.6	N/A	N/A	N/A	N/A	N/A
James ID	Westlands WD	136	***87,000***	N/A	N/A	10529.2	N/A	N/A	N/A	118.7	N/A	118.7	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	137	***87,000***	N/A	N/A	23573.7	N/A	N/A	N/A	153.4	N/A	153.4	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	138	***90,000***	N/A	N/A	5362.7	N/A	N/A	N/A	91.6	N/A	91.6	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	139	***90,000***	N/A	N/A	9680.0	N/A	N/A	N/A	0.9	N/A	0.9	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	140	***90,000***	N/A	N/A	8413.5	N/A	N/A	N/A	90.5	N/A	90.5	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	141	***90,000***	N/A	N/A	14877.4	N/A	N/A	N/A	178.8	N/A	178.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	142	***90,000***	N/A	N/A	7984.0	N/A	N/A	N/A	178.9	N/A	178.9	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	143	***90,000***	N/A	N/A	10906.7	N/A	N/A	N/A	104.2	N/A	104.2	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	144	***90,000***	N/A	N/A	5362.7	N/A	N/A	N/A	181.6	N/A	1.6	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	145	***90,000***	N/A	N/A	5361.1	N/A	N/A	N/A	269.2	N/A	89.2	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	146	***90,000***	N/A	N/A	5063.3	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	147	***60,000***	N/A	N/A	10639.8	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	148	***60,000***	N/A	N/A	10581.3	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	149	***60,000***	N/A	N/A	14856.4	0.0005	2.5	24.3	135.4	24.3	135.4	68.9	1.20	13864	N/A	N/A
Westlands WD	North Fork Kings	150	***60,000***	N/A	N/A	15047.2	N/A	N/A	N/A	135.4	N/A	135.4	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	151	***60,000***	N/A	N/A	8452.6	N/A	N/A	N/A	72.0	N/A	72.0	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	152	***60,000***	N/A	N/A	11535.4	N/A	N/A	N/A	136.8	N/A	136.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	153	***60,000***	N/A	N/A	15489.2	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	154	***60,000***	N/A	N/A	5285.2	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	155	***90,000***	N/A	N/A	5361.1	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	N/A	5346.1	N/A	N/A	N/A	77.1	N/A	77.1	N/A	N/A	N/A	N/A	N/A
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	N/A	4074.8	N/A	N/A	N/A	0.7	N/A	0.7	N/A	N/A	N/A	N/A	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	N/A	2477.5	N/A	N/A	N/A	0.7	N/A	0.7	N/A	N/A	N/A	N/A	0
North Fork Kings	South Fork Kings GSA	159	***90,000***	2%	91,573	6526.5	0.0007	3.7	257.7	54.4	77.7	54.4	23.3	0.41	2580	165647	0
North Fork Kings	South Fork Kings GSA	160	***90,000***	1%	91,051	37726.0	0.0008	4.0	241.3	48.0	61.3	48.0	13.3	0.23	8709	599723	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	6%	95,273	4940.9	0.0006	3.2	301.3	47.3	121.3	47.3	74.0	1.29	4749	275894	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	2%	92,201	5730.5	0.0009	4.9	295.7	47.3	115.7	47.3	68.4	1.19	5328	456389	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	3%	92,484	19953.9	0.0007	3.8	269.4	90.4	89.4	90.4	1.0	0.02	358	24048	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	10%	98,822	10560.8	0.0005	2.8	251.9	46.9	71.9	46.9	25.0	0.44	4467	234941	263
Mid Kings River GSA	North Fork Kings	165	***90,000***	3%	92,624	6769.4	0.0006	3.4	253.8	46.9	73.8	46.9	26.9	0.47	3058	179843	201
Central Kings	Mid Kings River GSA	166	***90,000***	11%	100,026	8937.1	0.0007	3.5	249.6	178.6	69.6	178.6	71.0	1.24	8450	556573	623
Central Kings	Mid Kings River GSA	167	***84,000***	11%	93,137	18901.3	0.0006	3.1	238.1	69.0	58.1	69.0	10.9	0.19	3575	194489	0
Mid Kings River GSA	Central Kings	168	***84,000***	N/A	N/A	16749.2	0.0007	3.8	247.6	27.2	67.6	27.2	40.4	0.70	10853	N/A	0
Kings River East	Mid Kings River GSA	169	***84,000***	N/A	N/A	1489.1	0.0006	3.3	251.8	90.0	71.8	90.0	18.2	0.32	465	N/A	N/A
Kings River East	Mid Kings River GSA	170	***84,000***	N/A	N/A	31942.3	0.0007	3.7	184.1	180.7	4.1	0.7	3.4	0.06	1895	N/A	N/A
Kings River East	Mid Kings River GSA	171	***99,000***	N/A	N/A	10649.1	0.0005	2.8	198.9	91.2	18.9	91.2	72.3	1.26	10143	N/A	N/A
Kings River East	Greater Kaweah GSA	172	***99,000***	N/A	N/A	23363.7	0.0007	3.8	238.0	64.0	58.0	64.0	6.0	0.10	2441	N/A	N/A
Greater Kaweah GSA	Kings River East	173	***99,000***	N/A	N/A	5805.0	0.0014	7.3	269.8	64.0	89.8	64.0	25.8	0.45	2530	N/A	N/A
Greater Kaweah GSA	Kings River East	174	***50,000***	N/A	N/A	15892.6	0.0006	3.1	284.7	93.8	104.7	93.8	11.0	0.19	3026	N/A	N/A
Kings River East	Greater Kaweah GSA	175	***40,000***	N/A	N/A	1714.0	0.0010	5.3	282.0	182.5	102.0	2.5	80.5	1.40	1690	N/A	N/A
Greater Kaweah GSA	Kings River East	176	***40,000***	N/A	N/A	10626.4	0.0012	6.1	276.7	90.5	96.7	90.5	6.2	0.11	1140	N/A	N/A
Greater Kaweah GSA	Kings River East	177	***40,000***	N/A	N/A	13273.9	0.0011	5.7	274.0	90.5	94.0	90.5	3.4	0.06	795	N/A	N/A
East Kaweah GSA	Kings River East	178	***20,000***	N/A	N/A	15785.5	0.0017	9.1	267.6	0.8	87.6	0.8	86.8	1.51	15761	N/A	N/A

Attachment 3 - 1925 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Percent Thickness Change (1925-1962)	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
East Kaweah GSA	Kings River East	179	***20,000***	N/A	N/A	16008.0	0.0014	7.6	297.5	90.5	117.5	90.5	26.9	0.47	7253	N/A	N/A
Kings River East	East Kaweah GSA	180	***20,000***	N/A	N/A	4996.5	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
Kings River East	East Kaweah GSA	181	***20,000***	N/A	N/A	3194.6	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
Kings River East	East Kaweah GSA	182	***20,000***	N/A	N/A	5861.0	N/A	N/A	N/A	295.6	N/A	115.6	N/A	N/A	N/A	N/A	N/A

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 1997 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	310.4	214.3	130.4	34.3	84.0	1.47	20560	N/A	0
North Kings	Madera County	105	***93,000***	25%	93,000	12121.9	0.0012	6.6	13.2	214.3	13.2	34.3	21.1	0.37	4371	506253	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0032	16.7	181.6	278.3	1.6	98.3	83.3	1.45	5359	3586165	0
North Kings	Root Creek WD	107	***211,000***	13%	211,000	14767.3	0.0029	15.5	282.1	278.3	102.1	98.3	3.8	0.07	987	610166	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0027	14.3	351.3	247.8	171.3	67.8	76.5	1.34	17627	11278873	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0023	12.0	11.3	270.9	11.3	90.9	79.7	1.39	8833	4741214	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0016	8.5	313.8	248.0	133.8	68.0	65.9	1.15	18104	6917640	0
Madera ID	North Kings	111	***184,000***	-1%	184,000	6346.9	0.0015	7.8	273.7	282.4	93.7	102.4	8.7	0.15	964	260997	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0015	7.9	313.1	282.4	133.1	102.4	30.6	0.53	3992	1093038	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0020	10.3	339.2	253.7	159.2	73.7	85.5	1.49	25061	8992186	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0048	25.6	231.7	213.3	51.7	33.3	18.5	0.32	3693	3219982	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0026	13.9	217.5	323.7	37.5	143.7	73.8	1.29	6034	2850998	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0041	21.8	295.4	250.8	115.4	70.8	44.6	0.78	6360	4724116	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0037	19.6	224.5	173.6	44.5	173.6	50.9	0.89	3607	2409653	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0026	13.7	96.7	273.4	96.7	93.4	3.2	0.06	790	370343	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0028	14.6	44.2	273.4	44.2	93.4	49.2	0.86	2616	1301242	0
Farmer WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0014	7.6	58.9	215.4	58.9	35.4	23.5	0.41	1384	356201	0
Farmer WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0014	7.2	91.3	181.0	91.3	1.0	89.7	1.57	5165	1239606	1389
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0015	8.1	106.2	181.0	106.2	1.0	74.7	1.30	7804	2106301	2359
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0011	5.7	114.7	101.0	114.7	101.0	13.7	0.24	1294	242342	271
Fresno County	McMullin	124	***175,000***	5%	175,000	8939.7	0.0011	5.6	98.7	101.0	98.7	101.0	2.3	0.04	363	67328	75
Fresno County	McMullin	125	***175,000***	8%	175,000	7147.8	0.0008	4.4	88.4	90.6	88.4	90.6	2.2	0.04	275	40091	45
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0007	3.9	104.6	181.4	104.6	1.4	76.8	1.34	11821	1532826	1717
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0008	4.5	121.2	268.0	121.2	88.0	33.2	0.58	5875	866894	971
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0008	4.1	127.0	180.0	127.0	180.0	53.0	0.93	2973	391824	439
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0009	4.8	123.9	130.8	123.9	130.8	6.9	0.12	939	146399	164
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0007	3.6	117.9	165.8	117.9	165.8	47.9	0.84	12365	1429380	1601
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0010	5.1	133.8	180.8	133.8	0.8	47.0	0.82	3812	633773	710
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0009	4.5	151.3	270.5	151.3	90.5	60.8	1.06	7602	1107958	1241
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0008	4.3	168.3	200.4	168.3	20.4	32.0	0.56	2950	409724	459
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0011	5.7	164.3	180.8	164.3	0.8	16.5	0.29	1539	284739	319
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0013	6.7	156.7	90.6	156.7	90.6	66.1	1.15	6125	677540	759
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0015	8.1	144.2	118.7	144.2	118.7	25.5	0.44	4529	603469	676
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0018	9.7	128.7	153.4	128.7	153.4	24.7	0.43	9844	1578657	1768
Westlands WD	North Fork Kings	138	***90,000***	N/A	90,000	5362.7	0.0019	10.2	83.4	91.6	83.4	91.6	8.2	0.14	765	132586	149
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0029	15.2	103.7	0.9	103.7	0.9	77.2	1.35	9438	2445419	2739
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0035	18.6	109.7	90.5	109.7	90.5	19.2	0.34	2771	879349	985
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0017	8.8	35.4	178.8	35.4	178.8	36.5	0.64	8856	1331629	1492
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0019	9.8	1.7	178.9	1.7	178.9	2.8	0.05	389	64955	73
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0013	6.8	349.6	104.2	169.6	104.2	65.4	1.14	9913	1143910	1281
North Fork Kings	Westlands WD	144	***90,000***	N/A	90,000	5362.7	0.0011	5.9	332.2	181.6	152.2	1.6	29.4	0.51	2636	264893	297
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0008	4.3	333.5	269.2	153.5	89.2	64.3	1.12	4831	351642	394
North Fork Kings	Westlands WD	146	***90,000***	N/A	90,000	5063.3	0.0006	3.3	335.0	180.8	155.0	0.8	25.8	0.45	2207	124570	140
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0007	3.4	321.8	90.8	141.8	90.8	51.0	0.89	8270	322693	361
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0008	4.0	312.4	90.8	132.4	90.8	41.6	0.73	7030	316684	355
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0011	6.0	263.6	135.4	83.6	135.4	51.8	0.90	11676	794472	890
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0014	7.5	239.6	135.4	59.6	135.4	75.8	1.32	14589	1242446	1392
Westlands WD	North Fork Kings	151	***60,000***	N/A	60,000	8452.6	0.0026	13.7	308.4	72.0	128.4	72.0	56.4	0.98	7039	1098617	1231
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0014	7.3	267.6	136.8	87.6	136.8	49.2	0.86	8730	724298	811
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0006	3.0	246.3	180.8	66.3	0.8	65.5	1.14	14098	481122	539
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0008	4.3	288.6	180.8	108.6	0.8	72.2	1.26	5033	243711	273
Westlands WD	North Fork Kings	155	***90,000***	N/A	90,000	5361.1	0.0009	4.7	295.3	90.8	115.3	90.8	24.5	0.43	2224	177037	198
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	0.0010	5.4	296.5	77.1	116.5	77.1	39.4	0.69	3394	310749	348
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0013	6.6	298.7	0.7	118.7	0.7	61.9	1.08	3596	405489	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0011	5.8	297.1	0.7	117.1	0.7	63.6	1.11	2219	218715	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0011	5.7	270.5	54.4	90.5	54.4	36.1	0.63	3842	374626	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0017	9.2	246.3	48.0	66.3	48.0	18.3	0.32	11831	1847333	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0026	13.6	252.8	47.3	72.8	47.3	25.5	0.44	2125	493182	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0027	14.3	258.3	47.3	78.3	47.3	31.0	0.54	2950	719129	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0033	17.2	229.3	90.4	49.3	90.4	41.1	0.72	13116	3838445	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	7%	90,000	10560.8	0.0015	8.0	253.3	46.9	73.3	46.9	26.4	0.46	4689	637005	714
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0027	14.2	328.0	46.9	148.0	46.9	78.9	1.38	6642	1613348	1807
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0018	9.7	17.1	178.6	17.1	178.6	18.5	0.32	2839	467913	524
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0032	16.8	160.5	69.0	160.5	69.0	88.5	1.54	18895	5063329	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0035	18.3	133.3	27.2	133.3	27.2	73.9	1.29	16094	4691890	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0031	16.5	135.0	90.0	135.0	90.0	45.0	0.79	1053	275797	309

Attachment 3 - 1997 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0036	19.0	119.0	180.7	119.0	0.7	61.6	1.08	28103	8501510	9523
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0012	6.4	182.3	91.2	2.3	91.2	88.9	1.55	10647	1275040	1428
Greater Kaweah GSA	Kings River East	172	***99,000***	19%	99,000	23363.7	0.0020	10.5	263.8	64.0	83.8	64.0	19.8	0.35	7926	1563550	1751
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0044	23.1	261.4	64.0	81.4	64.0	17.4	0.30	1735	751251	842
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0014	7.5	231.6	93.8	51.6	93.8	42.1	0.74	10664	761061	852
Greater Kaweah GSA	Kings River East	175	***40,000***	-2%	40,000	1714.0	0.0014	7.2	174.4	182.5	174.4	2.5	8.1	0.14	242	13161	15
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0030	15.9	143.2	90.5	143.2	90.5	52.6	0.92	8447	1019431	1142
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0025	13.0	202.9	90.5	22.9	90.5	67.7	1.18	12279	1211867	1357
Kings River East	East Kaweah GSA	178	***20,000***	N/A	20,000	15785.5	0.0047	24.7	128.7	0.8	128.7	0.8	52.1	0.91	12463	1167681	1308
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0070	36.8	206.2	90.5	26.2	90.5	64.3	1.12	14423	2011322	2253
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0063	33.2	243.2	359.0	63.2	179.0	64.2	1.12	4499	565398	633
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0073	38.5	235.2	359.0	55.2	179.0	56.2	0.98	2655	387408	434
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0067	35.1	230.8	295.6	50.8	115.6	64.8	1.13	5303	705982	791

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 1998 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	N/A	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	N/A	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	102	30,000	N/A	N/A	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	N/A	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	0.0045	23.5	312.5	214.3	132.5	34.3	81.8	1.43	20465	2735091	0
North Kings	Madera County	105	***93,000***	25%	93,000	12121.9	0.0012	6.5	260.2	214.3	80.2	34.3	45.9	0.80	8698	989743	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0012	6.2	201.0	278.3	21.0	98.3	77.3	1.35	5264	1300888	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0020	10.8	204.4	278.3	24.4	98.3	73.8	1.29	14183	6106035	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0017	8.8	321.1	247.8	141.1	67.8	73.3	1.28	17361	6827086	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0032	16.8	12.2	270.9	12.2	90.9	78.7	1.37	8803	6636601	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0016	8.7	328.9	248.0	148.9	68.0	81.0	1.41	19593	7618705	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0012	6.4	317.7	282.4	137.7	102.4	35.3	0.62	3663	818833	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0023	12.2	329.0	282.4	149.0	102.4	46.6	0.81	5691	2414145	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0028	14.9	332.4	253.7	152.4	73.7	78.8	1.37	24655	12776844	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0038	19.8	255.7	213.3	75.7	33.3	42.5	0.74	7875	5326202	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0025	13.4	263.9	323.7	83.9	143.7	59.8	1.04	5432	2478562	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0025	13.1	301.1	250.8	121.1	70.8	50.2	0.88	6968	3108696	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0024	12.8	194.8	173.6	14.8	173.6	21.2	0.37	1680	732006	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0012	6.5	139.7	273.4	139.7	93.4	46.3	0.81	10121	2255695	0
Aliso WD	McMullin	119	***180,000***	N/A	180,000	3456.2	0.0010	5.0	186.0	273.4	6.0	93.4	87.4	1.52	3453	591720	0
Farmer WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0010	5.0	125.8	215.4	125.8	35.4	89.6	1.56	3471	595056	0
Farmer WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0013	6.9	57.4	181.0	57.4	1.0	56.5	0.99	4306	981898	1100
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0009	4.6	88.6	181.0	88.6	1.0	87.6	1.53	8082	1220640	1367
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0010	5.3	122.5	101.0	122.5	101.0	21.5	0.38	2006	354675	397
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0014	7.2	100.7	101.0	100.7	101.0	0.4	0.01	57	13615	15
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0019	10.2	92.8	90.6	92.8	90.6	2.2	0.04	279	93910	105
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0019	10.1	77.9	181.4	77.9	1.4	76.5	1.34	11805	3950395	4425
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0010	5.3	112.4	268.0	112.4	88.0	24.4	0.43	4429	775443	869
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0010	5.1	136.6	180.0	136.6	180.0	43.4	0.76	2560	426255	477
James ID	Central Delta Mendota Regional Mulit Agency GSA	129	***171,000***	4%	171,000	7865.6	0.0012	6.2	141.5	130.8	141.5	130.8	10.7	0.19	1463	294365	330
James ID	Central Delta Mendota Regional Mulit Agency GSA	130	***171,000***	5%	171,000	16667.1	0.0010	5.3	165.3	165.8	165.3	165.8	0.4	0.01	129	22098	25
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0004	2.4	171.9	180.8	171.9	0.8	8.9	0.16	809	62156	70
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0005	2.5	179.0	270.5	179.0	90.5	88.5	1.55	8708	712034	798
James ID	Central Delta Mendota Regional Mulit Agency GSA	133	***171,000***	N/A	171,000	5559.6	0.0006	3.4	192.9	200.4	12.9	20.4	7.5	0.13	726	79176	89
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0008	4.4	173.6	180.8	173.6	0.8	7.2	0.13	680	95976	108
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0011	6.0	165.8	90.6	165.8	90.6	75.2	1.31	6478	645749	723
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0012	6.4	161.7	118.7	161.7	118.7	42.9	0.75	7170	750827	841
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0016	8.7	126.5	153.4	126.5	153.4	26.9	0.47	10658	1526795	1710
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0015	7.9	107.9	91.6	107.9	91.6	16.3	0.28	1506	201834	226
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0012	6.6	120.7	0.9	120.7	0.9	60.1	1.05	8396	941523	1055
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0012	6.5	162.0	90.5	162.0	90.5	71.5	1.25	7980	883135	989
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0003	1.8	167.1	178.8	167.1	178.8	11.7	0.20	3026	90700	102
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0003	1.6	27.3	178.9	27.3	178.9	28.3	0.49	3789	102345	115
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0006	3.1	21.1	104.2	21.1	104.2	83.1	1.45	10828	575533	645
North Fork Kings	Westlands WD	144	***90,000***	N/A	90,000	5362.7	0.0011	5.9	337.2	181.6	157.2	1.6	24.4	0.43	2217	222903	250
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0009	4.5	341.4	269.2	161.4	89.2	72.2	1.26	5105	393204	440
North Fork Kings	Westlands WD	146	***90,000***	N/A	90,000	5063.3	0.0007	3.7	346.4	180.8	166.4	0.8	14.4	0.25	1263	79093	89
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0009	4.8	326.1	90.8	146.1	90.8	55.3	0.96	8744	477137	534
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0011	5.7	312.0	90.8	132.0	90.8	41.2	0.72	6969	449424	503
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0008	4.1	328.1	135.4	148.1	135.4	12.7	0.22	3258	153607	172
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0010	5.4	248.4	135.4	68.4	135.4	67.0	1.17	13855	845650	947
Westlands WD	North Fork Kings	151	***60,000***	N/A	60,000	8452.6	0.0016	8.6	256.3	72.0	76.3	72.0	4.2	0.07	625	60909	68
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0017	8.9	271.9	136.8	91.9	136.8	44.9	0.78	8144	821332	920
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0012	6.2	292.3	180.8	112.3	0.8	68.6	1.20	14418	1022962	1146
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0003	1.6	276.3	180.8	96.3	0.8	84.5	1.47	5261	93662	105
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	0.0003	1.6	254.0	90.8	74.0	90.8	16.8	0.29	1549	42683	48
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	0.0004	2.3	259.5	77.1	79.5	77.1	2.4	0.04	222	8678	10
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0005	2.6	275.7	0.7	95.7	0.7	84.9	1.48	4059	180405	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0004	2.3	289.2	0.7	109.2	0.7	71.5	1.25	2349	91672	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0005	2.9	296.1	54.4	116.1	54.4	61.7	1.08	5746	282991	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0019	10.0	240.3	48.0	60.3	48.0	12.3	0.21	8035	1369411	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0028	14.7	239.7	47.3	59.7	47.3	12.3	0.22	1056	265391	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0027	14.5	233.0	47.3	53.0	47.3	5.7	0.10	564	139439	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0021	10.9	221.7	90.4	41.7	90.4	48.8	0.85	15006	2780080	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0009	4.7	198.6	46.9	18.6	46.9	28.3	0.49	5003	401692	450
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0016	8.3	305.8	46.9	125.8	46.9	78.9	1.38	6643	936354	1049
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0013	7.0	246.1	178.6	66.1	178.6	67.5	1.18	8258	986134	1105
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0031	16.2	170.0	69.0	170.0	69.0	79.0	1.38	18551	4775509	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0012	6.4	163.2	27.2	163.2	27.2	44.1	0.77	11654	1178915	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0010	5.5	209.2	90.0	29.2	90.0	60.8	1.06	1300	113499	127
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0030	16.0	169.2	180.7	169.2	0.7	11.4	0.20	6333	1611592	1805
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0011	6.0	248.0	91.2	68.0	91.2	23.2	0.40	4190	469063	525
Greater Kaweah GSA	Kings River East	172	***99,000***	19%	99,000	23363.7	0.0019	10.1	269.8	64.0	89.8	64.0	25.8	0.45	10182	1919158	2150
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0035	18.7	255.1	64.0	75.1	64.0	11.2	0.19	1124	394846	442
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0017	9.2	232.5	93.8	52.5	93.8	41.2	0.72	10477	912071	1022
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0019	9.9	163.5	182.5	163.5	2.5	18.9	0.33	556	41741	47

Attachment 3 - 1998 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0034	17.9	144.9	90.5	144.9	90.5	54.3	0.95	8634	1172845	1314
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0031	16.4	168.2	90.5	168.2	90.5	77.7	1.36	12970	1608319	1802
Kings River East	East Kaweah GSA	178	***20,000***	N/A	20,000	15785.5	0.0035	18.6	166.5	0.8	166.5	0.8	14.3	0.25	3895	274820	308
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0053	27.7	193.6	90.5	13.6	90.5	77.0	1.34	15595	1639195	1836
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0032	17.0	225.8	359.0	45.8	179.0	46.9	0.82	3646	234704	263
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0033	17.2	213.4	359.0	33.4	179.0	34.5	0.60	1809	117574	132
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0040	21.3	204.6	295.6	24.6	115.6	89.0	1.55	5860	472964	530

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 1999 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	N/A	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	N/A	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	102	30,000	N/A	N/A	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	N/A	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	0.0010	5.3	274.9	214.3	94.9	34.3	60.6	1.06	18014	540403	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0012	6.3	154.0	214.3	154.0	34.3	60.3	1.05	10530	1159675	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0034	17.8	195.6	278.3	15.6	98.3	82.7	1.44	5353	3808632	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0018	9.4	200.6	278.3	20.6	98.3	77.7	1.36	14426	5396415	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0017	8.8	320.5	247.8	140.5	67.8	72.6	1.27	17302	6826725	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0024	12.5	356.9	270.9	176.9	90.9	85.9	1.50	8955	5010116	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0019	9.8	320.4	248.0	140.4	68.0	72.5	1.26	18916	8352762	0
Madera ID	North Kings	111	***184,000***	-1%	184,000	6346.9	0.0012	6.5	276.2	282.4	96.2	102.4	6.3	0.11	694	157461	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0010	5.5	323.6	282.4	143.6	102.4	41.2	0.72	5159	991593	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0023	12.0	338.5	253.7	158.5	73.7	84.8	1.48	25035	10471910	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0035	18.3	235.8	213.3	55.8	33.3	22.5	0.39	4462	2784620	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0021	11.0	213.9	323.7	33.9	143.7	70.2	1.23	5914	2213227	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0019	10.2	300.2	250.8	120.2	70.8	49.4	0.86	6883	2385477	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0031	16.5	213.7	173.6	33.7	173.6	40.2	0.70	2996	1683704	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0016	8.4	221.5	273.4	41.5	93.4	51.9	0.91	11014	3148211	0
Aliso WD	McMullin	119	***180,000***	N/A	180,000	3456.2	0.0005	2.8	249.7	273.4	69.7	93.4	23.7	0.41	1390	132429	0
McMullin	Farmers WD	120	***180,000***	N/A	180,000	3470.6	0.0005	2.7	241.3	215.4	61.3	35.4	25.9	0.45	1515	139271	0
McMullin	Farmers WD	121	***175,000***	N/A	175,000	5165.0	N/A	N/A	N/A	181.0	N/A	1.0	N/A	N/A	N/A	N/A	N/A
McMullin	Fresno County	122	***175,000***	N/A	175,000	8089.5	N/A	N/A	N/A	181.0	N/A	1.0	N/A	N/A	N/A	N/A	N/A
Fresno County	McMullin	123	***175,000***	N/A	175,000	5472.0	0.0011	5.7	331.8	101.0	151.8	101.0	50.8	0.89	4239	798536	894
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0017	9.1	47.3	101.0	47.3	101.0	53.7	0.94	7204	2167683	2428
Fresno County	McMullin	125	***175,000***	8%	175,000	7147.8	0.0030	15.9	80.7	90.6	80.7	90.6	9.8	0.17	1222	645639	723
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0030	16.0	97.0	181.4	97.0	1.4	84.4	1.47	12081	6399861	7169
James ID	Fresno County	127	***175,000***	6%	175,000	10727.6	0.0031	16.5	76.8	268.0	76.8	88.0	11.2	0.20	2092	1142080	1279
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0022	11.4	66.3	180.0	66.3	180.0	66.3	1.16	3409	1254157	1405
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0018	9.7	56.7	130.8	56.7	130.8	74.1	1.29	7565	2383518	2670
James ID	Central Delta Mendota Regional Mulit Agency GSA	130	***171,000***	5%	171,000	16667.1	0.0015	8.1	236.8	165.8	56.8	165.8	71.0	1.24	15761	4146164	4644
James ID	Central Delta Mendota Regional Mulit Agency GSA	131	***171,000***	8%	171,000	5212.2	0.0019	10.1	189.2	180.8	9.2	0.8	8.4	0.15	760	247433	277
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0014	7.6	185.0	270.5	5.0	90.5	85.5	1.49	8684	2144316	2402
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0010	5.4	181.9	200.4	1.9	20.4	18.4	0.32	1757	308729	346
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0007	3.8	179.8	180.8	179.8	0.8	1.0	0.02	97	11828	13
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0006	3.1	175.4	90.6	175.4	90.6	84.8	1.48	6673	345117	387
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0011	5.7	158.7	118.7	158.7	118.7	40.0	0.70	6764	630746	707
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0019	9.9	126.0	153.4	126.0	153.4	27.3	0.48	10827	1769851	1982
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0015	8.1	108.1	91.6	108.1	91.6	16.5	0.29	1520	209939	235
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0013	6.7	114.2	0.9	114.2	0.9	66.6	1.16	8887	1014617	1137
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0014	7.3	121.4	90.5	121.4	90.5	30.9	0.54	4321	538218	603
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0019	9.8	94.8	178.8	94.8	178.8	84.0	1.47	14796	2475094	2772
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0014	7.4	37.1	178.9	37.1	178.9	38.1	0.67	4930	619744	694
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0009	4.8	44.4	104.2	44.4	104.2	59.9	1.04	9433	776002	869
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0005	2.7	50.9	181.6	50.9	1.6	49.3	0.86	4063	189011	212
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0004	2.3	77.3	269.2	77.3	89.2	11.9	0.21	1103	43814	49
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0007	3.9	69.7	180.8	69.7	0.8	68.9	1.20	4724	310313	348
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0011	5.7	347.1	90.8	167.1	90.8	76.3	1.33	10338	672340	753
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0025	12.9	288.8	90.8	108.8	90.8	18.0	0.31	3268	480396	538
Westlands WD	North Fork Kings	149	***60,000***	N/A	60,000	14856.4	0.0010	5.5	325.7	135.4	145.7	135.4	10.3	0.18	2666	167148	187
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0008	4.4	276.4	135.4	96.4	135.4	39.0	0.68	9475	471456	528
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0013	7.1	205.2	72.0	25.2	72.0	46.8	0.82	6164	494998	554
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0019	9.8	235.2	136.8	55.2	136.8	81.7	1.43	11413	1276398	1430
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0019	10.1	263.9	180.8	83.9	0.8	83.1	1.45	15378	1757065	1968
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	South Fork Kings GSA	156	***90,000***	N/A	90,000	5346.1	N/A	N/A	N/A	77.1	N/A	77.1	N/A	N/A	N/A	N/A	N/A
North Fork Kings	South Fork Kings GSA	157	***90,000***	N/A	90,000	4074.8	N/A	N/A	N/A	0.7	N/A	0.7	N/A	N/A	N/A	N/A	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0012	6.5	265.5	0.7	85.5	0.7	84.8	1.48	2467	271306	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0011	5.9	260.0	54.4	80.0	54.4	25.6	0.45	2819	284744	0
North Fork Kings	South Fork Kings GSA	160	***90,000***	19%	90,000	37726.0	0.0015	8.1	221.3	48.0	41.3	48.0	6.7	0.12	4394	608775	0
North Fork Kings	Mid Kings River GSA	161	***90,000***	18%	90,000	4940.9	0.0014	7.5	169.8	47.3	169.8	47.3	57.6	1.00	4170	536527	0
North Fork Kings	Mid Kings River GSA	162	***90,000***	17%	90,000	5730.5	0.0036	19.0	211.5	47.3	31.5	47.3	15.9	0.28	1568	507653	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0030	15.6	215.9	90.4	35.9	90.4	54.5	0.95	16253	4331216	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	7%	90,000	10560.8	0.0012	6.4	229.3	46.9	49.3	46.9	2.4	0.04	436	47361	53
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0014	7.5	318.6	46.9	138.6	46.9	88.3	1.54	6766	859762	963
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0013	6.6	261.3	178.6	81.3	178.6	82.8	1.44	8866	1001551	1122
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0023	12.2	178.3	69.0	178.3	69.0	70.7	1.23	17837	3470824	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0023	12.1	122.8	27.2	122.8	27.2	84.5	1.47	16671	3208172	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0022	11.8	160.7	90.0	160.7	90.0	70.7	1.23	1405	263258	295
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0030	15.6	131.7	180.7	131.7	0.7	49.0	0.86	24113	5994120	6714
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0015	8.0	149.3	91.2	149.3	91.2	58.1	1.01	9041	1360944	1524
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0021	11.3	223.9	64.0	43.9	64.0	20.1	0.35	8024	1704609	1909
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0030	15.8	268.1	64.0	88.1	64.0	24.2	0.42	2375	703125	788
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0015	7.8	249.3	93.8	69.3	93.8	24.4	0.43	6573	487405	546
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0010	5.4	157.8	182.5	157.8	2.5	24.7	0.43	717	29272	33
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0027	14.3	126.9	90.5	126.9	90.5	36.3	0.63	6297	680046	762
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0039	20.5	160.9	90.5	160.9	90.5	70.3	1.23	12500	1942796	2176
Kings River East	East Kaweah GSA	178	***20,000***	N/A	20,000	15785.5	0.0042	22.3	147.1	0.8	147.1	0.8	33.7	0.59	8766	741445	831
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0061	32.2	197.8	90.5	17.8	90.5	72.7	1.27	15284	1861338	2085
Kings River East	East Kaweah GSA	180	***20,000***	N/A	20,000	4996.5	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A

Attachment 3 - 1999 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	East Kaweah GSA	181	***20,000***	N/A	20,000	3194.6	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0046	24.5	205.2	295.6	25.2	115.6	89.6	1.56	5861	544075	609

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2000 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0012	6.4	152.1	214.3	152.1	34.3	62.2	1.09	10725	1212833	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0029	15.5	198.6	278.3	18.6	98.3	79.7	1.39	5308	3287759	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0017	9.0	206.6	278.3	26.6	98.3	71.7	1.25	14022	5059090	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0018	9.6	331.5	247.8	151.5	67.8	83.7	1.46	18018	7752917	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0025	13.1	349.4	270.9	169.4	90.9	78.4	1.37	8795	5153213	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0018	9.7	340.0	248.0	160.0	68.0	88.0	1.54	19827	8613435	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0016	8.4	304.6	282.4	124.6	102.4	22.2	0.39	2397	704123	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0025	13.1	340.7	282.4	160.7	102.4	58.2	1.02	6660	3050162	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0025	13.3	348.4	253.7	168.4	73.7	85.2	1.49	25051	11602538	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0035	18.3	242.0	213.3	62.0	33.3	28.7	0.50	5597	3493754	0
McMullin	Aliso WD	115	***180,000***	N/A	180,000	6284.1	0.0021	11.1	116.3	323.7	116.3	143.7	27.4	0.48	2893	1092409	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0030	16.0	299.4	250.8	119.4	70.8	48.6	0.85	6796	3704968	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0022	11.7	215.6	173.6	35.6	173.6	42.1	0.73	3112	1241328	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0015	7.8	23.5	273.4	23.5	93.4	69.9	1.22	13146	3493083	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0021	11.1	332.3	273.4	152.3	93.4	58.9	1.03	2959	1117051	0
McMullin	Farmers WD	120	***180,000***	N/A	180,000	3470.6	0.0021	11.1	316.0	215.4	136.0	35.4	79.4	1.39	3411	1290962	0
McMullin	Farmers WD	121	***175,000***	N/A	175,000	5165.0	0.0011	5.7	332.4	181.0	152.4	1.0	28.6	0.50	2473	465214	521
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0002	0.9	97.2	181.0	97.2	1.0	83.8	1.46	8042	241728	271
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0003	1.6	106.0	101.0	106.0	101.0	5.0	0.09	475	25242	28
Fresno County	McMullin	124	***175,000***	5%	175,000	8939.7	0.0010	5.1	76.7	101.0	76.7	101.0	24.4	0.43	3689	624837	700
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0034	17.8	101.3	90.6	101.3	90.6	10.7	0.19	1322	780809	875
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0038	20.3	97.6	181.4	97.6	1.4	83.8	1.46	12068	8126988	9103
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0024	12.8	99.0	268.0	99.0	88.0	11.0	0.19	2045	869458	974
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0017	9.1	112.8	180.0	112.8	180.0	67.2	1.17	3431	1010503	1132
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0019	10.1	114.5	130.8	114.5	130.8	16.2	0.28	2199	722328	809
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0017	9.1	102.0	165.8	102.0	165.8	63.8	1.11	14954	4397001	4925
James ID	Central Delta Mendota Regional Mulit Agency GSA	131	***171,000***	8%	171,000	5212.2	0.0007	3.9	182.9	180.8	2.9	0.8	2.1	0.04	193	24120	27
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0016	8.6	187.0	270.5	7.0	90.5	83.5	1.46	8655	2404397	2693
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0017	8.9	138.1	200.4	138.1	20.4	62.3	1.09	4921	1412450	1582
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0014	7.4	142.8	180.8	142.8	0.8	38.0	0.66	3348	807170	904
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0014	7.5	147.0	90.6	147.0	90.6	56.4	0.98	5579	693990	777
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0016	8.4	155.2	118.7	155.2	118.7	36.5	0.64	6262	861930	965
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0015	7.7	140.7	153.4	140.7	153.4	12.6	0.22	5154	654443	733
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0009	4.6	122.9	91.6	122.9	91.6	31.3	0.55	2783	216711	243
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0011	5.6	137.0	0.9	137.0	0.9	43.9	0.77	6710	645145	723
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0014	7.2	167.6	90.5	167.6	90.5	77.1	1.35	8201	1000935	1121
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0006	3.3	149.9	178.8	149.9	178.8	28.9	0.50	7189	401473	450
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0001	0.7	67.6	178.9	67.6	178.9	68.6	1.20	7436	93188	104
North Fork Kings	Westlands WD	143	***90,000***	N/A	90,000	10906.7	0.0004	1.9	111.1	104.2	111.1	104.2	6.9	0.12	1308	41343	46
North Fork Kings	Westlands WD	144	***90,000***	N/A	90,000	5362.7	0.0006	3.0	314.4	181.6	134.4	1.6	47.2	0.82	3933	203117	228
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0004	2.4	341.1	269.2	161.1	89.2	71.9	1.25	5095	205952	231
North Fork Kings	Westlands WD	146	***90,000***	N/A	90,000	5063.3	0.0004	1.9	359.6	180.8	179.6	0.8	1.3	0.02	113	3684	4
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0006	3.1	320.6	90.8	140.6	90.8	49.8	0.87	8127	290468	325
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0011	5.8	297.3	90.8	117.3	90.8	26.5	0.46	4726	312893	350
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0010	5.5	264.4	135.4	84.4	135.4	51.0	0.89	11541	719819	806
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0033	17.5	201.5	135.4	21.5	135.4	66.1	1.15	13754	2738736	3068
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0027	14.2	220.1	72.0	40.1	72.0	31.9	0.56	4466	722069	809
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0028	14.8	256.1	136.8	76.1	136.8	60.7	1.06	10058	1689100	1892
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0029	15.4	263.3	180.8	83.3	0.8	82.5	1.44	15357	2691713	3015
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0023	12.2	249.3	180.8	69.3	0.8	68.5	1.20	4918	680058	762
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	0.0023	11.9	242.0	90.8	62.0	90.8	28.8	0.50	2582	524071	587
North Fork Kings	South Fork Kings GSA	156	***90,000***	N/A	90,000	5346.1	0.0021	11.4	237.3	77.1	57.3	77.1	19.8	0.35	1813	350781	393
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0020	10.5	233.5	0.7	53.5	0.7	52.8	0.92	3248	583890	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0020	10.6	233.7	0.7	53.7	0.7	53.1	0.93	1980	358745	0
North Fork Kings	South Fork Kings GSA	159	***90,000***	20%	90,000	6526.5	0.0019	10.1	229.1	54.4	49.1	54.4	5.3	0.09	607	104283	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0018	9.6	228.2	48.0	48.2	48.0	0.3	0.00	166	27218	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0026	13.8	238.1	47.3	58.1	47.3	10.8	0.19	924	217163	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0035	18.2	234.2	47.3	54.2	47.3	6.9	0.12	687	213552	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0024	12.7	214.5	90.4	34.5	90.4	56.0	0.98	16535	3567631	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	7%	90,000	10560.8	0.0017	8.8	259.2	46.9	79.2	46.9	32.2	0.56	5634	843367	945
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0024	12.5	323.4	46.9	143.4	46.9	83.5	1.46	6726	1433709	1606
Mid Kings River GSA	Central Kings	166	***90,000***	9%	90,000	8937.1	0.0015	7.8	37.4	178.6	37.4	178.6	38.8	0.68	5602	741024	830
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0025	13.3	165.6	69.0	165.6	69.0	83.4	1.46	18775	3969608	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0012	6.1	159.0	27.2	159.0	27.2	48.2	0.84	12495	1218367	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0013	6.8	182.5	90.0	2.5	90.0	87.5	1.53	1488	160567	180
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0023	12.2	144.3	180.7	144.3	0.7	36.3	0.63	18925	3668051	4109
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0013	7.0	138.9	91.2	138.9	91.2	47.7	0.83	7882	1038007	1163
Greater Kaweah GSA	Kings River East	172	***99,000***	19%	99,000	23363.7	0.0021	11.3	241.2	64.0	61.2	64.0	2.8	0.05	1139	242368	271
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0028	14.8	245.7	64.0	65.7	64.0	1.7	0.03	175	48424	54
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0010	5.1	232.0	93.8	52.0	93.8	41.8	0.73	10590	516309	578
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0009	4.7	162.8	182.5	162.8	2.5	19.7	0.34	578	20591	23
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0030	16.0	139.8	90.5	139.8	90.5	49.3	0.86	8052	978975	1097
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0059	31.1	174.7	90.5	174.7	90.5	84.1	1.47	13204	3108401	3482
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0044	23.1	183.4	0.8	3.4	0.8	2.6	0.05	715	62539	70
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0042	22.0	202.3	90.5	22.3	90.5	68.2	1.19	14865	1239994	1389
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0035	18.6	239.4	359.0	59.4	179.0	60.5	1.06	4348	306779	344

Attachment 3 - 2000 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0035	18.5	232.0	359.0	52.0	179.0	53.0	0.93	2553	178423	200
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0044	23.1	208.6	295.6	28.6	115.6	87.0	1.52	5853	512706	574

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2001 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	105	***93,000***	25%	93,000	12121.9	0.0023	12.3	306.7	214.3	126.7	34.3	87.6	1.53	12112	2631057	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0018	9.4	213.8	278.3	33.8	98.3	64.5	1.13	4871	1834977	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0017	8.8	190.1	278.3	10.1	98.3	88.2	1.54	14760	5213527	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0022	11.7	321.7	247.8	141.7	67.8	73.9	1.29	17415	9147321	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0040	20.9	5.7	270.9	5.7	90.9	85.2	1.49	8947	8378134	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0026	13.5	324.3	248.0	144.3	68.0	76.3	1.33	19279	11688237	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0014	7.6	323.6	282.4	143.6	102.4	41.2	0.72	4179	1112523	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0025	13.2	344.7	282.4	164.7	102.4	62.3	1.09	6934	3193668	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0034	18.2	335.9	253.7	155.9	73.7	82.3	1.44	24910	15779559	0
Aliso WD	McMullin	114	***180,000***	N/A	180,000	11667.2	0.0034	17.8	217.1	213.3	37.1	33.3	3.9	0.07	784	475782	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0025	13.1	327.8	323.7	147.8	143.7	4.1	0.07	450	201122	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0035	18.5	304.4	250.8	124.4	70.8	53.5	0.93	7291	4606339	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0018	9.6	226.0	173.6	46.0	173.6	52.5	0.92	3683	1205080	0
McMullin	Aliso WD	118	***180,000***	N/A	180,000	13996.9	0.0019	10.2	310.9	273.4	130.9	93.4	37.5	0.65	8524	2972238	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0018	9.3	352.1	273.4	172.1	93.4	78.7	1.37	3389	1076428	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0028	14.6	76.7	215.4	76.7	35.4	41.4	0.72	2293	1144698	0
Farmers WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0014	7.3	92.0	181.0	92.0	1.0	88.9	1.55	5164	1246475	1396
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0005	2.4	152.8	181.0	152.8	1.0	28.2	0.49	3825	304624	341
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0003	1.8	145.8	101.0	145.8	101.0	44.7	0.78	3852	232978	261
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0003	1.3	40.7	101.0	40.7	101.0	60.3	1.05	7766	344236	386
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0029	15.5	109.4	90.6	109.4	90.6	18.8	0.33	2302	1183446	1326
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0041	21.6	103.4	181.4	103.4	1.4	78.0	1.36	11873	8503790	9525
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0026	14.0	99.0	268.0	99.0	88.0	11.0	0.19	2045	947202	1061
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0016	8.4	90.8	180.0	90.8	180.0	89.2	1.56	3722	1015023	1137
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0022	11.4	87.7	130.8	87.7	130.8	43.1	0.75	5371	1991515	2231
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0023	11.9	80.9	165.8	80.9	165.8	84.8	1.48	16599	6412637	7183
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0019	9.8	112.0	180.8	112.0	0.8	68.9	1.20	4861	1550203	1736
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0023	11.9	127.5	270.5	127.5	90.5	37.0	0.65	5244	2020569	2263
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0021	11.1	139.6	200.4	139.6	20.4	60.8	1.06	4854	1743511	1953
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0021	11.3	146.6	180.8	146.6	0.8	34.2	0.60	3055	1115019	1249
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0025	13.4	148.2	90.6	148.2	90.6	57.5	1.00	5653	1248429	1398
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0020	10.4	148.8	118.7	148.8	118.7	30.0	0.52	5270	906251	1015
North Fork Kings	Westlands WD	137	***87,000***	N/A	87,000	23573.7	0.0021	11.2	169.9	153.4	169.9	153.4	16.6	0.29	6723	1241550	1391
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0020	10.8	178.3	91.6	178.3	91.6	86.8	1.51	5354	982357	1100
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0025	13.0	149.5	0.9	149.5	0.9	31.4	0.55	5039	1119470	1254
Westlands WD	North Fork Kings	140	***90,000***	N/A	90,000	8413.5	0.0039	20.4	74.1	90.5	74.1	90.5	16.4	0.29	2378	827114	926
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0013	6.8	84.7	178.8	84.7	178.8	85.8	1.50	14838	1711179	1917
North Fork Kings	Westlands WD	142	***90,000***	N/A	90,000	7984.0	0.0005	2.5	327.8	178.9	147.8	178.9	31.1	0.54	4128	173374	194
North Fork Kings	Westlands WD	143	***90,000***	N/A	90,000	10906.7	0.0005	2.7	176.0	104.2	176.0	104.2	71.8	1.25	10362	485309	544
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	N/A	N/A	N/A	181.6	N/A	1.6	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	145	***90,000***	N/A	90,000	5361.1	N/A	N/A	N/A	269.2	N/A	89.2	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	147	***60,000***	N/A	60,000	10639.8	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	148	***60,000***	N/A	60,000	10581.3	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0041	21.9	254.9	135.4	74.9	135.4	60.5	1.06	12930	3214711	3601
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0016	8.7	199.6	135.4	19.6	135.4	64.2	1.12	13547	1334826	1495
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0013	6.6	291.0	72.0	111.0	72.0	39.0	0.68	5317	401609	450
Westlands WD	North Fork Kings	152	***60,000***	N/A	60,000	11535.4	0.0017	9.0	330.7	136.8	150.7	136.8	13.9	0.24	2767	281607	315
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0026	13.9	258.0	180.8	78.0	0.8	77.2	1.35	15105	2390244	2677
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0019	10.1	272.0	180.8	92.0	0.8	88.8	1.55	5284	603641	676
Westlands WD	North Fork Kings	155	***90,000***	N/A	90,000	5361.1	0.0021	11.0	274.9	90.8	94.9	90.8	4.1	0.07	386	72412	81
North Fork Kings	South Fork Kings GSA	156	***90,000***	N/A	90,000	5346.1	0.0026	13.7	256.7	77.1	76.7	77.1	0.4	0.01	37	8683	10
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0030	15.9	249.5	0.7	69.5	0.7	68.8	1.20	3800	1029151	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0032	16.6	250.4	0.7	70.4	0.7	69.7	1.22	2324	659111	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0030	15.7	246.6	54.4	66.6	54.4	12.2	0.21	1379	368389	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0020	10.7	239.9	48.0	59.9	48.0	11.9	0.21	7761	1421290	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0029	15.2	230.2	47.3	50.2	47.3	2.9	0.05	249	64556	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0033	17.5	234.7	47.3	54.7	47.3	7.4	0.13	737	219655	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0019	10.1	219.0	90.4	39.0	90.4	51.4	0.90	15599	2683785	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0011	5.8	221.9	46.9	41.9	46.9	5.0	0.09	920	91213	102
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0005	2.8	19.8	46.9	19.8	46.9	27.1	0.47	3083	146452	164
Mid Kings River GSA	Central Kings	166	***90,000***	9%	90,000	8937.1	0.0015	8.2	120.3	178.6	120.3	178.6	58.2	1.02	7598	1056706	1184
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0024	12.9	184.2	69.0	4.2	69.0	64.8	1.13	17103	3518760	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0013	6.8	160.5	27.2	160.5	27.2	46.7	0.82	12191	1324864	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0014	7.3	185.7	90.0	5.7	90.0	84.3	1.47	1482	171651	192
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0024	12.5	149.4	180.7	149.4	0.7	31.3	0.55	16594	3313077	3711

Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0021	10.9	161.9	91.2	161.9	91.2	70.7	1.23	10050	2049286	2295
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0026	13.7	214.9	64.0	34.9	64.0	29.0	0.51	11331	2909039	3259
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0031	16.2	242.9	64.0	62.9	64.0	1.0	0.02	106	32135	36
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0015	8.1	233.7	93.8	53.7	93.8	40.1	0.70	10228	788607	883
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0017	8.9	187.0	182.5	7.0	2.5	4.5	0.08	135	9117	10
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0021	11.3	150.3	90.5	150.3	90.5	59.8	1.04	9185	785867	880
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0017	8.9	110.3	90.5	110.3	90.5	19.8	0.35	4490	303791	340
Kings River East	East Kaweah GSA	178	***20,000***	N/A	20,000	15785.5	0.0033	17.4	149.6	0.8	149.6	0.8	31.2	0.55	8189	539983	605
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0061	32.0	207.6	90.5	27.6	90.5	63.0	1.10	14257	1725488	1933
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0046	24.2	246.3	359.0	66.3	179.0	67.3	1.18	4610	423036	474
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0044	23.5	239.0	359.0	59.0	179.0	60.1	1.05	2769	246235	276
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0049	25.8	210.3	295.6	30.3	115.6	85.2	1.49	5841	571184	640

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2002 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0014	7.4	188.0	214.3	8.0	34.3	26.3	0.46	5371	695668	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0024	12.4	174.6	278.3	174.6	98.3	76.3	1.33	5244	2605573	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0009	4.8	193.6	278.3	13.6	98.3	84.7	1.48	14704	2827410	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0016	8.5	316.5	247.8	136.5	67.8	68.7	1.20	16885	6466923	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0016	8.5	16.2	270.9	16.2	90.9	74.7	1.30	8661	3322159	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0015	7.9	298.4	248.0	118.4	68.0	50.4	0.88	15288	5452861	0
Madera ID	North Kings	111	***184,000***	-1%	184,000	6346.9	0.0012	6.1	248.8	282.4	68.8	102.4	33.6	0.59	3511	747029	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0010	5.5	326.7	282.4	146.7	102.4	44.3	0.77	5469	1053455	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0026	13.5	326.2	253.7	146.2	73.7	72.5	1.27	23976	11308734	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0017	9.1	229.5	213.3	49.5	33.3	16.2	0.28	3250	1011473	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0018	9.8	218.7	323.7	38.7	143.7	75.1	1.31	6072	2021064	0
Aliso WD	McMullin	116	***180,000***	N/A	180,000	9065.2	0.0018	9.4	200.6	250.8	20.6	70.8	50.2	0.88	6969	2227185	0
Aliso WD	McMullin	117	***180,000***	N/A	180,000	4645.4	0.0030	16.1	162.7	173.6	162.7	173.6	10.9	0.19	878	481100	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0036	19.2	146.9	273.4	146.9	93.4	53.5	0.93	11247	7356144	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	N/A	N/A	N/A	273.4	N/A	93.4	N/A	N/A	N/A	N/A	0
McMullin	Farmers WD	120	***180,000***	N/A	180,000	3470.6	N/A	N/A	N/A	215.4	N/A	35.4	N/A	N/A	N/A	N/A	0
McMullin	Farmers WD	121	***175,000***	N/A	175,000	5165.0	N/A	N/A	N/A	181.0	N/A	1.0	N/A	N/A	N/A	N/A	N/A
McMullin	Fresno County	122	***175,000***	N/A	175,000	8089.5	N/A	N/A	N/A	181.0	N/A	1.0	N/A	N/A	N/A	N/A	N/A
Fresno County	McMullin	123	***175,000***	N/A	175,000	5472.0	N/A	N/A	N/A	101.0	N/A	101.0	N/A	N/A	N/A	N/A	N/A
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	N/A	N/A	N/A	101.0	N/A	101.0	N/A	N/A	N/A	N/A	N/A
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0020	10.5	204.9	90.6	24.9	90.6	65.7	1.15	6515	2263087	2535
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0017	9.1	180.8	181.4	0.8	1.4	0.6	0.01	135	40798	46
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	N/A	N/A	N/A	268.0	N/A	88.0	N/A	N/A	N/A	N/A	N/A
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	N/A	N/A	N/A	180.0	N/A	180.0	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	129	***171,000***	4%	171,000	7865.6	N/A	N/A	N/A	130.8	N/A	130.8	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	N/A	N/A	N/A	165.8	N/A	165.8	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	132	***171,000***	N/A	171,000	8711.3	N/A	N/A	N/A	270.5	N/A	90.5	N/A	N/A	N/A	N/A	N/A
James ID	Central Delta Mendota Regional Mulit Agency GSA	133	***171,000***	N/A	171,000	5559.6	N/A	N/A	N/A	200.4	N/A	20.4	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
Westlands WD	James ID	135	***87,000***	N/A	87,000	6701.1	N/A	N/A	N/A	90.6	N/A	90.6	N/A	N/A	N/A	N/A	N/A
Westlands WD	James ID	136	***87,000***	N/A	87,000	10529.2	N/A	N/A	N/A	118.7	N/A	118.7	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0011	5.8	118.6	153.4	118.6	153.4	34.7	0.61	13436	1288936	1444
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0013	6.7	142.3	91.6	142.3	91.6	50.7	0.88	4147	470387	527
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0013	6.8	139.2	0.9	139.2	0.9	41.7	0.73	6441	750880	841
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0015	8.1	132.4	90.5	132.4	90.5	41.9	0.73	5613	770829	863
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0009	4.7	121.1	178.8	121.1	178.8	57.8	1.01	12587	999425	1119
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0013	6.8	141.4	178.9	141.4	178.9	37.6	0.66	4868	560688	628
North Fork Kings	Westlands WD	143	***90,000***	N/A	90,000	10906.7	0.0024	12.7	130.8	104.2	130.8	104.2	26.6	0.46	4883	1053390	1180
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0013	6.8	121.5	181.6	121.5	1.6	60.1	1.05	4650	536634	601
Westlands WD	North Fork Kings	145	***90,000***	N/A	90,000	5361.1	0.0015	8.1	115.8	269.2	115.8	89.2	26.6	0.46	2400	330249	370
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0014	7.3	103.2	180.8	103.2	0.8	77.7	1.36	4947	612043	686
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0011	5.7	15.4	90.8	15.4	90.8	75.4	1.32	10298	672194	753
North Fork Kings	Westlands WD	148	***60,000***	N/A	60,000	10581.3	0.0029	15.1	259.7	90.8	79.7	90.8	11.1	0.19	2041	349985	392
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0022	11.6	181.2	135.4	1.2	135.4	45.8	0.80	10650	1409572	1579
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0023	12.0	241.7	135.4	61.7	135.4	73.7	1.29	14445	1966461	2203
Westlands WD	North Fork Kings	151	***60,000***	N/A	60,000	8452.6	0.0024	12.9	253.7	72.0	73.7	72.0	1.6	0.03	241	35184	39
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0032	17.0	270.4	136.8	90.4	136.8	46.5	0.81	8362	1619916	1815
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0031	16.4	250.5	180.8	70.5	0.8	69.7	1.22	14523	2708812	3034
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0037	19.3	228.4	180.8	48.4	0.8	47.5	0.83	3899	855368	958
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	0.0036	19.3	231.3	90.8	51.3	90.8	39.5	0.69	3407	1118389	1253
North Fork Kings	South Fork Kings GSA	156	***90,000***	N/A	90,000	5346.1	0.0037	19.4	235.1	77.1	55.1	77.1	22.1	0.38	2008	664453	744
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0033	17.6	233.0	0.7	53.0	0.7	52.3	0.91	3226	968634	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0032	17.0	227.2	0.7	47.2	0.7	46.5	0.81	1799	522492	0
North Fork Kings	South Fork Kings GSA	159	***90,000***	20%	90,000	6526.5	0.0028	14.9	220.7	54.4	40.7	54.4	13.7	0.24	1544	393242	0
North Fork Kings	South Fork Kings GSA	160	***90,000***	19%	90,000	37726.0	0.0020	10.5	222.4	48.0	42.4	48.0	5.6	0.10	3676	657863	0
North Fork Kings	Mid Kings River GSA	161	***90,000***	18%	90,000	4940.9	0.0023	11.9	221.2	47.3	41.2	47.3	6.1	0.11	525	106441	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0033	17.3	233.5	47.3	53.5	47.3	6.1	0.11	614	180562	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0025	13.1	227.7	90.4	47.7	90.4	42.7	0.75	13534	3028150	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	7%	90,000	10560.8	0.0029	15.2	306.4	46.9	126.4	46.9	79.5	1.39	10384	2697926	3022
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0035	18.5	316.6	46.9	136.6	46.9	89.7	1.57	6769	2137762	2395
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0028	14.6	352.0	178.6	172.0	178.6	6.5	0.11	1018	254124	285
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0029	15.5	142.6	69.0	142.6	69.0	73.6	1.28	18131	4465388	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0014	7.4	173.9	27.2	173.9	27.2	33.3	0.58	9205	1088710	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0005	2.7	191.1	90.0	11.1	90.0	78.9	1.38	1461	63783	71
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0024	12.6	156.3	180.7	156.3	0.7	24.4	0.43	13178	2644215	2962
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0018	9.6	181.0	91.2	1.0	91.2	89.8	1.57	10649	1925260	2157
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0016	8.3	236.7	64.0	56.7	64.0	7.3	0.13	2967	461269	517
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0027	14.4	261.4	64.0	81.4	64.0	17.5	0.30	1741	471350	528
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0015	7.7	246.7	93.8	66.7	93.8	27.1	0.47	7237	530536	594
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0010	5.3	203.0	182.5	23.0	2.5	20.5	0.36	601	24223	27
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0018	9.3	201.9	90.5	21.9	90.5	68.6	1.20	9894	697061	781
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0019	9.9	158.1	90.5	158.1	90.5	67.6	1.18	12269	916780	1027
Kings River East	East Kaweah GSA	178	***20,000***	N/A	20,000	15785.5	0.0029	15.6	164.4	0.8	164.4	0.8	16.4	0.29	4451	262613	294
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0033	17.2	198.6	90.5	18.6	90.5	72.0	1.26	15221	990721	1110
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0031	16.2	213.0	359.0	33.0	179.0	34.0	0.59	2797	171716	192

Attachment 3 - 2002 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0030	15.8	208.0	359.0	28.0	179.0	29.0	0.51	1551	93038	104
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0028	14.9	210.1	295.6	30.1	115.6	85.5	1.49	5843	330452	370

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2003 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^{0})	Flow Direction converted to between 0 & 180^{0}	Segement Azimuth converted to between 0 & 180^{0}	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	105	***93,000***	25%	93,000	12121.9	0.0013	6.7	2.7	214.3	2.7	34.3	31.7	0.55	6363	746616	0
North Kings	Madera County	106	***211,000***	28%	211,000	5396.1	0.0010	5.2	82.4	278.3	82.4	98.3	15.9	0.28	1476	307167	0
North Kings	Root Creek WD	107	***211,000***	13%	211,000	14767.3	0.0010	5.4	28.6	278.3	28.6	98.3	69.7	1.22	13852	2995412	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0010	5.2	345.7	247.8	165.7	67.8	82.1	1.43	17957	4210285	0
Madera ID	North Kings	109	***237,000***	3%	237,000	8977.7	0.0019	9.9	341.3	270.9	161.3	90.9	70.4	1.23	8456	3762754	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0023	12.0	331.4	248.0	151.4	68.0	83.5	1.46	19711	10611030	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0021	11.3	294.0	282.4	114.0	102.4	11.6	0.20	1273	501087	0
Madera ID	North Kings	112	***184,000***	N/A	184,000	7833.8	0.0016	8.5	339.3	282.4	159.3	102.4	56.8	0.99	6557	1932971	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0027	14.4	334.5	253.7	154.5	73.7	80.8	1.41	24816	12416648	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0047	24.7	245.5	213.3	65.5	33.3	32.2	0.56	6224	5234054	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0044	23.3	231.8	323.7	51.8	143.7	88.2	1.54	6281	4986868	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0026	13.9	261.7	250.8	81.7	70.8	10.9	0.19	1715	811104	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0015	8.1	294.6	173.6	114.6	173.6	59.0	1.03	3981	1102357	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0019	10.3	346.7	273.4	166.7	93.4	73.3	1.28	13405	4685823	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0031	16.2	64.5	273.4	64.5	93.4	28.9	0.50	1670	924110	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0009	4.8	52.0	215.4	52.0	35.4	16.6	0.29	991	160886	0
Farmers WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0008	4.0	2.6	181.0	2.6	1.0	1.6	0.03	149	19898	22
McMullin	Fresno County	122	***175,000***	N/A	175,000	8089.5	0.0010	5.3	329.7	181.0	149.7	1.0	31.3	0.55	4200	735231	824
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0003	1.8	250.3	101.0	70.3	101.0	30.7	0.54	2797	163891	184
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0017	9.0	137.3	101.0	137.3	101.0	36.3	0.63	5293	1581821	1772
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0067	35.4	126.8	90.6	126.8	90.6	36.2	0.63	4221	4957959	5554
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0043	22.5	96.0	181.4	96.0	1.4	85.4	1.49	12101	9033848	10119
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0026	13.8	102.8	268.0	102.8	88.0	14.8	0.26	2734	1253485	1404
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0026	13.9	113.1	180.0	113.1	180.0	66.9	1.17	3423	1544468	1730
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0022	11.7	102.3	130.8	102.3	130.8	28.4	0.50	3745	1419164	1590
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0022	11.5	70.6	165.8	70.6	165.8	84.8	1.48	16598	6203103	6948
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0015	7.9	74.8	180.8	74.8	0.8	74.0	1.29	5011	1289102	1444
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0008	4.1	140.4	270.5	140.4	90.5	49.9	0.87	6662	887949	995
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0013	6.6	187.9	200.4	7.9	20.4	12.5	0.22	1206	258228	289
James ID	Central Delta Mendota Regional Mulit Agency GSA	134	***171,000***	N/A	171,000	5435.6	0.0013	7.1	189.5	180.8	9.5	0.8	8.7	0.15	824	189568	212
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0017	9.2	176.6	90.6	176.6	90.6	85.9	1.50	6684	1012083	1134
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0023	12.4	162.3	118.7	162.3	118.7	43.5	0.76	7253	1479265	1657
North Fork Kings	Westlands WD	137	***87,000***	N/A	87,000	23573.7	0.0017	9.2	162.0	153.4	162.0	153.4	8.7	0.15	3561	542097	607
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0009	4.9	139.2	91.6	139.2	91.6	47.6	0.83	3963	330693	370
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0010	5.3	136.2	0.9	136.2	0.9	44.7	0.78	6811	618645	693
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0013	7.0	139.4	90.5	139.4	90.5	48.9	0.85	6338	751699	842
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0011	5.8	100.9	178.8	100.9	178.8	78.0	1.36	14551	1435748	1608
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0007	3.8	81.6	178.9	81.6	178.9	82.6	1.44	7918	516206	578
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0019	10.0	80.8	104.2	80.8	104.2	23.5	0.41	4345	742300	831
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0017	9.0	15.6	181.6	15.6	1.6	14.0	0.24	1298	198812	223
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0013	7.0	33.1	269.2	33.1	89.2	56.1	0.98	4450	529774	593
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0011	5.9	49.1	180.8	49.1	0.8	48.2	0.84	3776	380887	427
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0009	4.7	8.4	90.8	8.4	90.8	82.4	1.44	10546	568634	637
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0013	6.7	355.5	90.8	175.5	90.8	84.7	1.48	10536	807715	905
Westlands WD	North Fork Kings	149	***60,000***	N/A	60,000	14856.4	0.0019	10.1	34.7	135.4	34.7	135.4	79.3	1.38	14597	1673056	1874
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0017	8.8	230.4	135.4	50.4	135.4	85.0	1.48	14990	1506344	1687
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0022	11.7	221.5	72.0	41.5	72.0	30.5	0.53	4293	569944	638
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0026	13.5	245.9	136.8	65.9	136.8	70.9	1.24	10901	1669321	1870
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0032	16.7	236.8	180.8	56.8	0.8	55.9	0.98	12831	2433774	2726
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0020	10.6	241.2	180.8	61.2	0.8	60.4	1.05	4594	553348	620
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	0.0021	10.8	243.5	90.8	63.5	90.8	27.3	0.48	2459	454487	509
North Fork Kings	South Fork Kings GSA	156	***90,000***	N/A	90,000	5346.1	0.0025	13.0	234.1	77.1	54.1	77.1	23.1	0.40	2094	462625	518
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0028	14.9	228.0	0.7	48.0	0.7	47.3	0.83	2997	763616	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0032	16.9	226.8	0.7	46.8	0.7	46.1	0.80	1785	512951	0
North Fork Kings	South Fork Kings GSA	159	***90,000***	20%	90,000	6526.5	0.0034	18.1	224.4	54.4	44.4	54.4	10.0	0.17	1132	349464	0
North Fork Kings	South Fork Kings GSA	160	***90,000***	19%	90,000	37726.0	0.0023	12.3	217.3	48.0	37.3	48.0	10.7	0.19	7016	1467991	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0035	18.2	238.2	47.3	58.2	47.3	10.8	0.19	926	287719	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0032	16.7	247.6	47.3	67.6	47.3	20.2	0.35	1980	563425	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0030	15.9	216.8	90.4	36.8	90.4	53.6	0.94	16066	4359774	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0013	6.8	189.3	46.9	9.3	46.9	37.6	0.66	6441	745994	836
North Fork Kings	Mid Kings River GSA	165	***90,000***	11%	90,000	6769.4	0.0012	6.5	86.1	46.9	86.1	46.9	39.2	0.68	4282	475264	532
Mid Kings River GSA	Central Kings	166	***90,000***	9%	90,000	8937.1	0.0032	16.9	106.3	178.6	106.3	178.6	72.3	1.26	8514	2452334	2747
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0035	18.5	173.1	69.0	173.1	69.0	75.9	1.32	18328	5385062	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0029	15.1	163.6	27.2	163.6	27.2	43.7	0.76	11567	2773629	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0025	13.1	164.6	90.0	164.6	90.0	74.6	1.30	1435	298664	335
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0029	15.3	149.1	180.7	149.1	0.7	31.6	0.55	16726	4072123	4561
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0021	11.3	164.2	91.2	164.2	91.2	73.0	1.27	10184	2158388	2418
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0023	12.1	207.8	64.0	27.8	64.0	36.2	0.63	13798	3140639	3518
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0032	16.9	244.7	64.0	64.7	64.0	0.8	0.01	79	25082	28
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0012	6.2	271.1	93.8	91.1	93.8	2.6	0.05	735	43300	49
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0013	6.6	224.2	182.5	44.2	2.5	41.7	0.73	1140	57398	64
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0019	10.2	162.7	90.5	162.7	90.5	72.2	1.26	10116	778267	872
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0017	9.1	103.4	90.5	103.4	90.5	12.9	0.22	2954	203823	228
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0031	16.5	226.8	0.8	46.8	0.8	46.0	0.80	11349	708576	794
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0059	31.1	200.0	90.5	20.0	90.5	70.5	1.23	15093	1775388	1989
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0054	28.4	222.5	359.0	42.5	179.0	43.5	0.76	3442	370789	415

Attachment 3 - 2003 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0042	22.4	225.2	359.0	45.2	179.0	46.2	0.81	2306	195613	219
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0043	22.5	226.8	295.6	46.8	115.6	68.8	1.20	5464	465707	522

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2004 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360°)	Flow Direction converted to between 0 & 180°	Segement Azimuth converted to between 0 & 180°	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0009	4.6	175.9	214.3	175.9	34.3	38.4	0.67	7533	604938	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0015	7.8	193.7	278.3	13.7	98.3	84.5	1.48	5372	1681651	0
North Kings	Root Creek WD	107	***211,000***	13%	211,000	14767.3	0.0009	4.5	84.0	278.3	84.0	98.3	14.2	0.25	3631	659310	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0013	6.9	341.6	247.8	161.6	67.8	86.2	1.50	18087	5603698	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0021	11.2	335.1	270.9	155.1	90.9	64.2	1.12	8082	4051789	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0030	16.1	336.5	248.0	156.5	68.0	88.5	1.55	19833	14312791	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0019	10.2	328.7	282.4	148.7	102.4	46.2	0.81	4583	1624665	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0028	14.9	317.7	282.4	137.7	102.4	35.3	0.62	4529	2356688	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0023	11.9	318.1	253.7	138.1	73.7	64.5	1.12	22681	9443897	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0034	18.1	269.5	213.3	89.5	33.3	56.2	0.98	9698	5994887	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0017	8.7	276.2	323.7	96.2	143.7	47.4	0.83	4628	1379752	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0020	10.7	242.6	250.8	62.6	70.8	8.3	0.14	1301	475755	0
Aliso WD	McMullin	117	***180,000***	N/A	180,000	4645.4	0.0026	14.0	166.2	173.6	166.2	173.6	7.4	0.13	596	284085	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0014	7.6	123.2	273.4	123.2	93.4	29.8	0.52	6955	1797120	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0028	14.9	63.8	273.4	63.8	93.4	29.6	0.52	1708	867060	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0025	12.9	70.8	215.4	70.8	35.4	35.4	0.62	2012	887629	0
Farmers WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0018	9.6	114.9	181.0	114.9	1.0	66.0	1.15	4720	1499872	1680
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0024	12.9	151.6	181.0	151.6	1.0	29.4	0.51	3973	1697007	1901
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0027	14.0	139.8	101.0	139.8	101.0	38.8	0.68	3429	1595768	1787
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0021	11.1	146.7	101.0	146.7	101.0	45.6	0.80	6392	2347039	2629
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0028	15.0	161.3	90.6	161.3	90.6	70.7	1.23	6744	3342227	3744
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0029	15.2	137.0	181.4	137.0	1.4	44.4	0.77	8494	4289764	4805
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0028	14.9	95.4	268.0	95.4	88.0	7.4	0.13	1383	681384	763
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0018	9.6	80.3	180.0	80.3	180.0	80.3	1.40	3669	1141422	1279
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0027	14.4	50.6	130.8	50.6	130.8	80.2	1.40	7750	3626284	4062
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0026	13.8	33.1	165.8	33.1	165.8	47.3	0.83	12257	5497153	6158
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0013	7.0	74.2	180.8	74.2	0.8	73.4	1.28	4996	1128300	1264
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0006	3.2	112.0	270.5	112.0	90.5	21.5	0.38	3194	333482	374
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0005	2.9	158.0	200.4	158.0	20.4	42.4	0.74	3747	350335	392
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0012	6.5	165.5	180.8	165.5	0.8	15.3	0.27	1433	299678	336
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0016	8.2	153.1	90.6	153.1	90.6	62.4	1.09	5939	802866	899
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0019	9.9	135.3	118.7	135.3	118.7	16.6	0.29	3008	488934	548
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0014	7.3	119.7	153.4	119.7	153.4	33.6	0.59	13051	1579793	1770
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0014	7.3	97.7	91.6	97.7	91.6	6.1	0.11	569	70578	79
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0018	9.3	102.4	0.9	102.4	0.9	78.5	1.37	9484	1502031	1682
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0021	11.0	106.2	90.5	106.2	90.5	15.7	0.27	2272	427242	479
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0016	8.4	83.8	178.8	83.8	178.8	84.9	1.48	14819	2134031	2390
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0015	8.1	51.9	178.9	51.9	178.9	52.9	0.92	6371	874461	980
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0021	11.1	31.1	104.2	31.1	104.2	73.2	1.28	10439	1972631	2210
North Fork Kings	Westlands WD	144	***90,000***	N/A	90,000	5362.7	0.0031	16.3	356.4	181.6	176.4	1.6	5.2	0.09	483	134164	150
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0022	11.8	355.6	269.2	175.6	89.2	86.4	1.51	5350	1079292	1209
North Fork Kings	Westlands WD	146	***90,000***	N/A	90,000	5063.3	0.0013	6.9	346.9	180.8	166.9	0.8	13.9	0.24	1218	144145	161
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0009	4.6	314.7	90.8	134.7	90.8	43.9	0.77	7372	385266	432
North Fork Kings	Westlands WD	148	***60,000***	N/A	60,000	10581.3	0.0012	6.3	141.7	90.8	141.7	90.8	50.9	0.89	8214	589272	660
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0014	7.6	172.0	135.4	172.0	135.4	36.6	0.64	8860	765241	857
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0006	3.1	230.3	135.4	50.3	135.4	85.1	1.49	14992	530675	594
Westlands WD	North Fork Kings	151	***60,000***	N/A	60,000	8452.6	0.0006	3.2	258.1	72.0	78.1	72.0	6.0	0.11	889	31965	36
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0019	9.9	280.1	136.8	100.1	136.8	36.7	0.64	6891	773162	866
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0024	12.5	287.9	180.8	107.9	0.8	72.9	1.27	14805	2111337	2365
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	155	***90,000***	N/A	90,000	5361.1	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	N/A	N/A	N/A	77.1	N/A	77.1	N/A	N/A	N/A	N/A	N/A
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	N/A	N/A	N/A	0.7	N/A	0.7	N/A	N/A	N/A	N/A	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0023	12.0	271.2	0.7	91.2	0.7	89.5	1.56	2477	504846	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0024	12.7	274.5	54.4	94.5	54.4	40.1	0.70	4203	907692	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0024	12.8	254.4	48.0	74.4	48.0	26.4	0.46	16771	3670499	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0029	15.2	226.4	47.3	46.4	47.3	0.9	0.02	81	21095	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0033	17.5	247.5	47.3	67.5	47.3	20.1	0.35	1971	589335	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0022	11.4	214.2	90.4	34.2	90.4	56.2	0.98	16579	3217269	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0011	5.6	184.1	46.9	4.1	46.9	42.8	0.75	7176	682525	765
North Fork Kings	Mid Kings River GSA	165	***90,000***	11%	90,000	6769.4	0.0011	5.6	145.6	46.9	145.6	46.9	81.3	1.42	6692	637644	714
Mid Kings River GSA	Central Kings	166	***90,000***	9%	90,000	8937.1	0.0019	10.2	153.0	178.6	153.0	178.6	25.5	0.45	3852	667381	748
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0025	13.4	173.7	69.0	173.7	69.0	75.3	1.31	18284	3894471	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0031	16.3	179.0	27.2	179.0	27.2	28.2	0.49	7922	2053564	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0020	10.7	169.1	90.0	169.1	90.0	79.1	1.38	1462	249180	279
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0025	13.1	146.4	180.7	146.4	0.7	34.3	0.60	18003	3737734	4187

Attachment 3 - 2004 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0015	7.9	167.3	91.2	167.3	91.2	76.1	1.33	10336	1537885	1723
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0022	11.6	223.9	64.0	43.9	64.0	20.0	0.35	8004	1735978	1945
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0025	13.2	263.7	64.0	83.7	64.0	19.7	0.34	1956	485197	543
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0013	7.0	272.9	93.8	92.9	93.8	0.9	0.02	242	16078	18
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0006	3.4	280.8	182.5	100.8	2.5	81.7	1.43	1696	43523	49
Greater Kaweah GSA	Kings River East	176	***40,000***	N/A	40,000	10626.4	0.0008	4.3	301.7	90.5	121.7	90.5	31.2	0.54	5502	178823	200
Greater Kaweah GSA	Kings River East	177	***40,000***	N/A	40,000	13273.9	0.0014	7.2	287.1	90.5	107.1	90.5	16.5	0.29	3775	205036	230
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0021	10.9	239.9	0.8	59.9	0.8	59.1	1.03	13549	558984	626
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0020	10.4	233.6	90.5	53.6	90.5	36.9	0.64	9617	380648	426
Kings River East	East Kaweah GSA	180	***20,000***	N/A	20,000	4996.5	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
Kings River East	East Kaweah GSA	181	***20,000***	N/A	20,000	3194.6	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0028	14.8	218.5	295.6	38.5	115.6	77.1	1.35	5713	320801	359

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2005 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0013	6.7	180.3	214.3	0.3	34.3	34.0	0.59	6783	801564	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0014	7.3	190.2	278.3	10.2	98.3	88.0	1.54	5393	1567942	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0009	5.0	106.3	278.3	106.3	98.3	8.0	0.14	2062	411142	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0020	10.5	334.7	247.8	154.7	67.8	86.9	1.52	18101	8555274	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0033	17.6	10.6	270.9	10.6	90.9	80.3	1.40	8849	6999329	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0029	15.2	333.1	248.0	153.1	68.0	85.2	1.49	19769	13469603	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0016	8.2	347.4	282.4	167.4	102.4	64.9	1.13	5749	1652821	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0031	16.1	321.6	282.4	141.6	102.4	39.2	0.68	4952	2782741	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0035	18.2	323.9	253.7	143.9	73.7	70.2	1.23	23656	15023509	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0044	23.3	253.7	213.3	73.7	33.3	40.4	0.71	7563	6017372	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0015	8.0	268.3	323.7	88.3	143.7	55.4	0.97	5171	1408671	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0028	15.0	319.4	250.8	139.4	70.8	68.6	1.20	8439	4308675	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0023	12.3	296.9	173.6	116.9	173.6	56.7	0.99	3881	1629949	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0019	10.2	343.2	273.4	163.2	93.4	69.7	1.22	13131	4551217	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0036	18.8	79.6	273.4	79.6	93.4	13.9	0.24	828	531927	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0044	23.0	99.7	215.4	99.7	35.4	64.3	1.12	3127	2449670	0
Farmers WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0029	15.2	136.7	181.0	136.7	1.0	44.2	0.77	3603	1815731	2034
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0018	9.6	66.9	181.0	66.9	1.0	65.9	1.15	7386	2340252	2621
Fresno County	McMullin	123	***175,000***	N/A	175,000	5472.0	0.0033	17.6	23.5	101.0	23.5	101.0	77.5	1.35	5343	3108274	3482
Fresno County	McMullin	124	***175,000***	5%	175,000	8939.7	0.0050	26.5	15.2	101.0	15.2	101.0	85.9	1.50	8916	7830777	8772
Fresno County	McMullin	125	***175,000***	8%	175,000	7147.8	0.0054	28.7	22.4	90.6	22.4	90.6	68.2	1.19	6636	6302363	7060
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0047	24.6	62.9	181.4	62.9	1.4	61.5	1.07	10669	8709605	9756
James ID	Fresno County	127	***175,000***	6%	175,000	10727.6	0.0038	20.3	76.9	268.0	76.9	88.0	11.1	0.19	2069	1392766	1560
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0027	14.3	79.2	180.0	79.2	180.0	79.2	1.38	3656	1694101	1898
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0028	15.0	99.1	130.8	99.1	130.8	31.7	0.55	4133	2011847	2254
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0019	10.2	135.0	165.8	135.0	165.8	30.8	0.54	8535	2817531	3156
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0015	8.1	165.9	180.8	165.9	0.8	15.0	0.26	1346	352754	395
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	N/A	N/A	N/A	270.5	N/A	90.5	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	N/A	N/A	N/A	200.4	N/A	20.4	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	N/A	N/A	N/A	90.6	N/A	90.6	N/A	N/A	N/A	N/A	N/A
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	N/A	N/A	N/A	118.7	N/A	118.7	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0014	7.6	126.7	153.4	126.7	153.4	26.6	0.46	10561	1329778	1490
Westlands WD	North Fork Kings	138	***90,000***	N/A	90,000	5362.7	0.0012	6.3	86.4	91.6	86.4	91.6	5.2	0.09	487	52562	59
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0014	7.3	105.9	0.9	105.9	0.9	75.0	1.31	9349	1156590	1296
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0020	10.5	118.3	90.5	118.3	90.5	27.8	0.49	3925	704805	789
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0016	8.5	84.7	178.8	84.7	178.8	85.9	1.50	14839	2143475	2401
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0016	8.7	47.2	178.9	47.2	178.9	48.3	0.84	5958	884003	990
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0020	10.5	37.6	104.2	37.6	104.2	66.6	1.16	10010	1789535	2005
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0018	9.4	50.9	181.6	50.9	1.6	49.3	0.86	4063	652220	731
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	N/A	N/A	N/A	269.2	N/A	89.2	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	147	***60,000***	N/A	60,000	10639.8	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	148	***60,000***	N/A	60,000	10581.3	0.0013	6.6	117.8	90.8	117.8	90.8	27.0	0.47	4808	363280	407
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0009	4.6	218.9	135.4	38.9	135.4	83.5	1.46	14761	774268	867
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0030	15.8	289.1	135.4	109.1	135.4	26.3	0.46	6670	1194985	1339
Westlands WD	North Fork Kings	151	***60,000***	N/A	60,000	8452.6	0.0027	14.1	263.8	72.0	83.8	72.0	11.8	0.21	1722	276617	310
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0013	7.1	238.8	136.8	58.8	136.8	78.0	1.36	11284	908101	1017
Westlands WD	North Fork Kings	153	***60,000***	N/A	60,000	15489.2	0.0017	9.2	169.4	180.8	169.4	0.8	11.4	0.20	3058	319830	358
Westlands WD	North Fork Kings	154	***60,000***	N/A	60,000	5285.2	0.0009	4.7	167.7	180.8	167.7	0.8	13.2	0.23	1203	63943	72
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	0.0008	4.4	208.1	90.8	28.1	90.8	62.7	1.09	4765	356433	399
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	0.0020	10.7	261.5	77.1	81.5	77.1	4.4	0.08	409	74866	84
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0037	19.4	276.9	0.7	96.9	0.7	83.8	1.46	4051	1337850	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0036	19.2	274.9	0.7	94.9	0.7	85.7	1.50	2471	808984	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0057	29.9	254.1	54.4	74.1	54.4	19.6	0.34	2194	1117810	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0022	11.5	254.2	48.0	74.2	48.0	26.2	0.46	16638	3263069	0
North Fork Kings	Mid Kings River GSA	161	***90,000***	18%	90,000	4940.9	0.0017	9.0	217.0	47.3	37.0	47.3	10.3	0.18	884	135120	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0023	12.3	239.7	47.3	59.7	47.3	12.4	0.22	1226	256306	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0027	14.3	218.0	90.4	38.0	90.4	52.5	0.92	15820	3862888	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0026	13.6	201.1	46.9	21.1	46.9	25.8	0.45	4599	1062464	1190
North Fork Kings	Mid Kings River GSA	165	***90,000***	11%	90,000	6769.4	0.0012	6.3	73.5	46.9	73.5	46.9	26.6	0.46	3027	326600	366
Mid Kings River GSA	Central Kings	166	***90,000***	9%	90,000	8937.1	0.0030	15.7	123.1	178.6	123.1	178.6	55.5	0.97	7362	1966505	2203
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0028	14.9	187.1	69.0	7.1	69.0	61.9	1.08	16680	3956304	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0024	12.8	198.6	27.2	18.6	27.2	8.6	0.15	2512	512907	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0018	9.7	156.0	90.0	156.0	90.0	66.0	1.15	1360	210968	236
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0024	12.6	159.4	180.7	159.4	0.7	21.3	0.37	11588	2316414	2595

Attachment 3 - 2005 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0021	11.3	156.8	91.2	156.8	91.2	65.6	1.15	9699	2052565	2299
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0020	10.6	213.3	64.0	33.3	64.0	30.7	0.54	11920	2358404	2642
Kings River East	Greater Kaweah GSA	173	***99,000***	7%	99,000	5805.0	0.0027	14.4	231.3	64.0	51.3	64.0	12.6	0.22	1269	343094	384
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0016	8.5	212.3	93.8	32.3	93.8	61.5	1.07	13966	1127007	1262
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0023	12.2	188.5	182.5	8.5	2.5	6.0	0.10	178	16471	18
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0031	16.6	178.7	90.5	178.7	90.5	88.2	1.54	10621	1334184	1494
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0018	9.7	167.5	90.5	167.5	90.5	77.0	1.34	12934	948689	1063
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0030	15.7	187.8	0.8	7.8	0.8	7.0	0.12	1928	114686	128
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0045	23.8	210.0	90.5	30.0	90.5	60.5	1.06	13937	1255131	1406
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0029	15.4	212.0	359.0	32.0	179.0	33.0	0.58	2724	158609	178
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0023	12.4	209.8	359.0	29.8	179.0	30.9	0.54	1639	76972	86
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0023	12.1	216.6	295.6	36.6	115.6	79.0	1.38	5754	263473	295

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2006 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0015	7.7	200.4	214.3	20.4	34.3	14.0	0.24	2923	395281	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0016	8.3	205.6	278.3	25.6	98.3	72.6	1.27	5151	1707706	0
North Kings	Root Creek WD	107	***211,000***	13%	211,000	14767.3	0.0013	7.1	68.7	278.3	68.7	98.3	29.6	0.52	7286	2061703	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0010	5.1	1.3	247.8	1.3	67.8	66.5	1.16	16620	3786640	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0013	6.8	327.9	270.9	147.9	90.9	57.0	0.99	7528	2280943	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0020	10.8	323.8	248.0	143.8	68.0	75.8	1.32	19238	9299350	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0027	14.2	16.7	282.4	16.7	102.4	85.8	1.50	6330	3135845	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0041	21.7	327.2	282.4	147.2	102.4	44.8	0.78	5517	4170821	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0048	25.2	345.1	253.7	165.1	73.7	88.6	1.55	25131	22076372	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0048	25.4	252.2	213.3	72.2	33.3	38.9	0.68	7322	6335135	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0047	24.9	210.3	323.7	30.3	143.7	66.6	1.16	5768	4893227	0
Aliso WD	McMullin	116	***180,000***	N/A	180,000	9065.2	0.0039	20.6	194.0	250.8	14.0	70.8	56.8	0.99	7588	5335414	0
Aliso WD	McMullin	117	***180,000***	N/A	180,000	4645.4	0.0019	10.1	146.3	173.6	146.3	173.6	27.3	0.48	2129	735370	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0008	4.1	113.4	273.4	113.4	93.4	20.0	0.35	4777	671860	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0024	12.9	90.7	273.4	90.7	93.4	2.7	0.05	162	71340	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0015	7.9	161.8	215.4	161.8	35.4	53.6	0.94	2795	751156	0
McMullin	Farmers WD	121	***175,000***	N/A	175,000	5165.0	0.0013	7.0	223.6	181.0	43.6	1.0	42.6	0.74	3496	806789	904
McMullin	Fresno County	122	***175,000***	N/A	175,000	8089.5	0.0008	4.1	242.1	181.0	62.1	1.0	61.1	1.07	7083	960908	1076
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0011	5.8	196.6	101.0	16.6	101.0	84.4	1.47	5446	1050729	1177
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0019	9.8	166.0	101.0	166.0	101.0	65.0	1.13	8102	2635550	2952
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0022	11.8	137.6	90.6	137.6	90.6	47.0	0.82	5226	2052343	2299
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0008	4.1	154.5	181.4	154.5	1.4	26.9	0.47	5495	739116	828
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0008	4.1	206.4	268.0	26.4	88.0	61.6	1.08	9440	1287813	1443
James ID	Fresno County	128	***171,000***	4%	171,000	3722.6	0.0007	3.5	200.2	180.0	20.2	180.0	20.2	0.35	1286	145151	163
James ID	Central Delta Mendota Regional Mulit Agency GSA	129	***171,000***	4%	171,000	7865.6	N/A	N/A	N/A	130.8	N/A	130.8	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	N/A	N/A	N/A	165.8	N/A	165.8	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	N/A	N/A	N/A	270.5	N/A	90.5	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	N/A	N/A	N/A	200.4	N/A	20.4	N/A	N/A	N/A	N/A	N/A
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	N/A	N/A	N/A	180.8	N/A	0.8	N/A	N/A	N/A	N/A	N/A
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	N/A	N/A	N/A	90.6	N/A	90.6	N/A	N/A	N/A	N/A	N/A
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	N/A	N/A	N/A	118.7	N/A	118.7	N/A	N/A	N/A	N/A	N/A
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	N/A	N/A	N/A	153.4	N/A	153.4	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	N/A	N/A	N/A	91.6	N/A	91.6	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	N/A	N/A	N/A	0.9	N/A	0.9	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0013	6.8	128.8	90.5	128.8	90.5	38.3	0.67	5211	606393	679
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0008	4.0	106.6	178.8	106.6	178.8	72.2	1.26	14168	967582	1084
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0005	2.6	57.3	178.9	57.3	178.9	58.4	1.02	6800	303952	340
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0006	3.0	343.6	104.2	163.6	104.2	59.4	1.04	9390	485924	544
North Fork Kings	Westlands WD	144	***90,000***	N/A	90,000	5362.7	0.0004	2.2	323.5	181.6	143.5	1.6	38.1	0.67	3310	124165	139
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0006	3.0	4.7	269.2	4.7	89.2	84.5	1.47	5336	275779	309
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0009	4.9	12.1	180.8	12.1	0.8	11.2	0.20	984	81923	92
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0009	4.7	55.9	90.8	55.9	90.8	34.9	0.61	6086	324083	363
North Fork Kings	Westlands WD	148	***60,000***	N/A	60,000	10581.3	0.0011	6.0	55.8	90.8	55.8	90.8	35.0	0.61	6071	414243	464
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0028	15.0	310.3	135.4	130.3	135.4	5.1	0.09	1322	226060	253
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0018	9.5	153.3	135.4	153.3	135.4	17.9	0.31	4623	501109	561
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0014	7.4	167.3	72.0	167.3	72.0	84.8	1.48	8418	707475	792
Westlands WD	North Fork Kings	152	***60,000***	N/A	60,000	11535.4	0.0012	6.3	0.9	136.8	0.9	136.8	44.0	0.77	8019	576643	646
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0018	9.4	272.5	180.8	92.5	0.8	88.3	1.54	15482	1662283	1862
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0014	7.5	234.6	180.8	54.6	0.8	53.8	0.94	4264	361302	405
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	0.0020	10.5	238.0	90.8	58.0	90.8	32.8	0.57	2900	518785	581
North Fork Kings	South Fork Kings GSA	156	***90,000***	N/A	90,000	5346.1	0.0023	12.2	254.2	77.1	74.2	77.1	2.9	0.05	273	56854	64
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0021	11.0	255.1	0.7	75.1	0.7	74.4	1.30	3925	737636	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0021	10.9	246.8	0.7	66.8	0.7	66.2	1.15	2266	422407	0
North Fork Kings	South Fork Kings GSA	159	***90,000***	20%	90,000	6526.5	0.0021	11.2	233.5	54.4	53.5	54.4	1.0	0.02	108	20729	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0018	9.4	238.9	48.0	58.9	48.0	10.9	0.19	7121	1141143	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0022	11.6	230.0	47.3	50.0	47.3	2.7	0.05	231	45538	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0025	13.0	229.5	47.3	49.5	47.3	2.1	0.04	210	46785	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0032	16.7	214.5	90.4	34.5	90.4	56.0	0.98	16534	4705907	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	7%	90,000	10560.8	0.0022	11.4	235.3	46.9	55.3	46.9	8.3	0.15	1534	299298	335
North Fork Kings	Mid Kings River GSA	165	***90,000***	11%	90,000	6769.4	0.0013	6.8	21.4	46.9	21.4	46.9	25.5	0.45	2917	339163	380
Mid Kings River GSA	Central Kings	166	***90,000***	9%	90,000	8937.1	0.0029	15.4	105.8	178.6	105.8	178.6	72.7	1.27	8534	2236200	2505
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0039	20.7	177.8	69.0	177.8	69.0	71.1	1.24	17887	5880571	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0019	10.0	173.0	27.2	173.0	27.2	34.3	0.60	9428	1503795	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0010	5.0	182.3	90.0	2.3	90.0	87.7	1.53	1488	119338	134
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0036	19.2	144.3	180.7	144.3	0.7	36.4	0.64	18953	5802890	6500
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0023	12.2	177.5	91.2	177.5	91.2	86.3	1.51	10627	2420978	2712
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0020	10.4	222.7	64.0	42.7	64.0	21.3	0.37	8486	1651759	1850
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0018	9.4	243.6	64.0	63.6	64.0	0.3	0.01	34	5954	7
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0024	12.7	243.7	93.8	63.7	93.8	30.0	0.52	7950	958633	1074
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0018	9.4	152.0	182.5	152.0	2.5	30.5	0.53	870	61704	69

Attachment 3 - 2006 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0030	15.7	137.3	90.5	137.3	90.5	46.8	0.82	7747	919875	1030
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0042	22.2	173.9	90.5	173.9	90.5	83.4	1.46	13186	2214074	2480
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0040	21.3	195.9	0.8	15.9	0.8	15.1	0.26	4107	330798	371
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0040	21.1	207.0	90.5	27.0	90.5	63.5	1.11	14331	1146229	1284
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0040	21.3	217.0	359.0	37.0	179.0	38.0	0.66	3079	248825	279
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0030	15.8	216.6	359.0	36.6	179.0	37.6	0.66	1950	116964	131
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0025	13.4	213.9	295.6	33.9	115.6	81.6	1.42	5799	293954	329

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2007 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	105	***93,000***	25%	93,000	12121.9	0.0009	4.7	235.7	214.3	55.7	34.3	21.3	0.37	4413	365805	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0020	10.4	203.6	278.3	23.6	98.3	74.7	1.30	5205	2161355	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0017	9.2	136.5	278.3	136.5	98.3	38.2	0.67	9133	3339699	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0020	10.8	303.8	247.8	123.8	67.8	56.0	0.98	15031	7275908	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0018	9.4	351.5	270.9	171.5	90.9	80.6	1.41	8856	3756030	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0023	12.0	335.5	248.0	155.5	68.0	87.5	1.53	19821	10653759	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0016	8.6	356.3	282.4	176.3	102.4	73.8	1.29	6096	1825522	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0040	21.1	333.2	282.4	153.2	102.4	50.8	0.89	6072	4461911	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0040	21.0	347.2	253.7	167.2	73.7	86.4	1.51	25090	18391077	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0054	28.3	208.5	213.3	28.5	33.3	4.8	0.08	982	946417	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0031	16.2	184.4	323.7	4.4	143.7	40.7	0.71	4098	2264862	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0038	19.9	276.2	250.8	96.2	70.8	25.4	0.44	3883	2639294	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0016	8.6	306.0	173.6	126.0	173.6	47.5	0.83	3427	1000909	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0022	11.7	327.6	273.4	147.6	93.4	54.2	0.95	11352	4531118	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0046	24.0	59.2	273.4	59.2	93.4	34.2	0.60	1945	1594272	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0014	7.6	123.5	215.4	123.5	35.4	88.1	1.54	3469	899044	0
Farmers WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0014	7.6	180.1	181.0	0.1	1.0	0.8	0.01	74	18537	21
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0014	7.4	140.4	181.0	140.4	1.0	40.6	0.71	5261	1291216	1446
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0022	11.7	121.9	101.0	121.9	101.0	20.9	0.37	1953	758616	850
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0028	14.8	118.8	101.0	118.8	101.0	17.8	0.31	2735	1344514	1506
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0020	10.3	115.3	90.6	115.3	90.6	24.7	0.43	2985	1023187	1146
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0022	11.5	62.0	181.4	62.0	1.4	60.6	1.06	10571	4018896	4502
James ID	Fresno County	127	***175,000***	6%	175,000	10727.6	0.0026	13.5	16.0	268.0	16.0	88.0	72.0	1.26	10203	4560177	5108
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0022	11.5	16.3	180.0	16.3	180.0	16.3	0.28	1044	387841	434
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0023	11.9	355.9	130.8	175.9	130.8	45.1	0.79	5573	2153081	2412
James ID	Central Delta Mendota Regional Mulit Agency GSA	130	***171,000***	5%	171,000	16667.1	0.0013	6.7	229.4	165.8	49.4	165.8	63.6	1.11	14930	3220585	3608
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0020	10.4	150.6	180.8	150.6	0.8	30.2	0.53	2620	884439	991
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0030	15.6	105.3	270.5	105.3	90.5	14.8	0.26	2226	1123657	1259
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0037	19.5	78.1	200.4	78.1	20.4	57.7	1.01	4699	2964250	3320
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0044	23.2	72.5	180.8	72.5	0.8	71.7	1.25	5161	3878103	4344
Westlands WD	James ID	135	***87,000***	N/A	87,000	6701.1	0.0050	26.3	79.4	90.6	79.4	90.6	11.2	0.20	1301	564686	633
Westlands WD	James ID	136	***87,000***	N/A	87,000	10529.2	0.0035	18.5	106.2	118.7	106.2	118.7	12.5	0.22	2280	695336	779
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0020	10.4	107.9	153.4	107.9	153.4	45.5	0.79	16804	2884961	3232
Westlands WD	North Fork Kings	138	***90,000***	N/A	90,000	5362.7	0.0018	9.3	70.2	91.6	70.2	91.6	21.4	0.37	1954	310245	348
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0020	10.5	88.9	0.9	88.9	0.9	88.0	1.54	9674	1735513	1944
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0022	11.5	118.8	90.5	118.8	90.5	28.3	0.49	3986	783330	877
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0020	10.5	90.0	178.8	90.0	178.8	88.8	1.55	14874	2652156	2971
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0023	12.0	58.4	178.9	58.4	178.9	59.4	1.04	6875	1408361	1578
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0020	10.6	82.2	104.2	82.2	104.2	22.0	0.38	4094	736331	825
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0025	13.2	81.3	181.6	81.3	1.6	79.7	1.39	5276	1188487	1331
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0024	12.5	58.1	269.2	58.1	89.2	31.1	0.54	2770	590351	661
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0018	9.6	38.9	180.8	38.9	0.8	38.0	0.66	3120	511300	573
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0034	18.1	9.9	90.8	9.9	90.8	80.9	1.41	10506	2165942	2426
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0054	28.5	355.0	90.8	175.0	90.8	84.2	1.47	10527	3414879	3825
Westlands WD	North Fork Kings	149	***60,000***	N/A	60,000	14856.4	0.0022	11.4	29.5	135.4	29.5	135.4	74.1	1.29	14286	1842956	2064
Westlands WD	North Fork Kings	150	***60,000***	N/A	60,000	15047.2	0.0022	11.9	30.3	135.4	30.3	135.4	74.9	1.31	14526	1960435	2196
Westlands WD	North Fork Kings	151	***60,000***	N/A	60,000	8452.6	0.0024	12.6	351.7	72.0	171.7	72.0	80.4	1.40	8334	1192320	1336
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0012	6.3	302.2	136.8	122.2	136.8	14.7	0.26	2919	209357	235
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0025	13.2	215.8	180.8	35.8	0.8	35.0	0.61	8884	1328624	1488
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0019	10.3	275.1	180.8	95.1	0.8	85.8	1.50	5271	615623	690
Westlands WD	North Fork Kings	155	***90,000***	N/A	90,000	5361.1	0.0031	16.5	280.6	90.8	100.6	90.8	9.8	0.17	910	255435	286
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	0.0048	25.5	263.2	77.1	83.2	77.1	6.1	0.11	567	246679	276
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0054	28.3	262.5	0.7	82.5	0.7	81.8	1.43	4034	1943559	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0051	26.9	268.7	0.7	88.7	0.7	88.1	1.54	2476	1136452	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0041	21.9	277.3	54.4	97.3	54.4	42.9	0.75	4441	1657354	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0018	9.7	261.1	48.0	81.1	48.0	33.1	0.58	20585	3392308	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0023	12.3	233.5	47.3	53.5	47.3	6.2	0.11	533	111469	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0038	20.1	240.3	47.3	60.3	47.3	13.0	0.23	1286	439811	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0030	16.0	212.8	90.4	32.8	90.4	57.7	1.01	16859	4605117	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	7%	90,000	10560.8	0.0010	5.5	251.3	46.9	71.3	46.9	24.4	0.43	4365	409459	459
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0015	8.2	311.5	46.9	131.5	46.9	84.5	1.48	6739	936537	1049
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0014	7.3	241.1	178.6	61.1	178.6	62.5	1.09	7930	986904	1105
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0033	17.7	181.1	69.0	1.1	69.0	67.9	1.19	17513	4926850	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0027	14.5	137.6	27.2	137.6	27.2	69.7	1.22	15706	3620272	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0012	6.2	163.4	90.0	163.4	90.0	73.4	1.28	1427	139731	157
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0036	19.2	145.2	180.7	145.2	0.7	35.5	0.62	18539	5663549	6344
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0022	11.8	152.4	91.2	152.4	91.2	61.2	1.07	9329	2065223	2313
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0028	14.8	209.1	64.0	29.1	64.0	34.9	0.61	13356	3699005	4143
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0030	15.8	248.1	64.0	68.1	64.0	4.2	0.07	422	124911	140
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0020	10.5	262.0	93.8	82.0	93.8	11.8	0.21	3239	320851	359
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0007	3.7	186.9	182.5	6.9	2.5	4.4	0.08	132	3724	4

Attachment 3 - 2007 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0010	5.2	118.6	90.5	118.6	90.5	28.1	0.49	5004	197861	222
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0024	12.8	145.7	90.5	145.7	90.5	55.1	0.96	10891	1060007	1187
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0036	19.2	192.1	0.8	12.1	0.8	11.3	0.20	3093	224958	252
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0022	11.6	214.1	90.5	34.1	90.5	56.4	0.98	13333	586363	657
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0018	9.6	237.2	359.0	57.2	179.0	58.2	1.02	4248	154018	173
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0018	9.5	230.2	359.0	50.2	179.0	51.3	0.89	2492	89640	100
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0024	12.8	197.9	295.6	17.9	115.6	82.3	1.44	5808	281797	316

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2008 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0022	11.7	157.1	214.3	157.1	34.3	57.3	1.00	10195	2101554	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0037	19.4	173.6	278.3	173.6	98.3	75.4	1.32	5221	4053246	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0026	14.0	234.2	278.3	54.2	98.3	44.0	0.77	10266	5726215	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0023	12.3	332.2	247.8	152.2	67.8	84.4	1.47	18041	9970604	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0018	9.7	344.4	270.9	164.4	90.9	73.5	1.28	8607	3749813	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0030	15.6	341.1	248.0	161.1	68.0	86.9	1.52	19811	13852477	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0016	8.5	1.6	282.4	1.6	102.4	79.2	1.38	6234	1852441	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0032	17.0	324.9	282.4	144.9	102.4	42.5	0.74	5291	3134727	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0040	21.2	329.7	253.7	149.7	73.7	76.0	1.33	24394	18044365	0
Aliso WD	McMullin	114	***180,000***	N/A	180,000	11667.2	0.0026	13.6	195.6	213.3	15.6	33.3	17.7	0.31	3541	1639706	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0041	21.7	204.4	323.7	24.4	143.7	60.7	1.06	5480	4058053	0
Aliso WD	McMullin	116	***180,000***	N/A	180,000	9065.2	0.0042	22.4	247.8	250.8	67.8	70.8	3.0	0.05	479	366124	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0022	11.4	261.2	173.6	81.2	173.6	87.7	1.53	4642	1811737	0
Aliso WD	McMullin	118	***180,000***	N/A	180,000	13996.9	0.0017	9.0	158.8	273.4	158.8	93.4	65.4	1.14	12722	3894761	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0025	13.5	27.6	273.4	27.6	93.4	65.8	1.15	3153	1446621	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0026	13.9	19.5	215.4	19.5	35.4	15.9	0.28	948	450783	0
McMullin	Farmers WD	121	***175,000***	N/A	175,000	5165.0	0.0018	9.7	200.0	181.0	20.0	1.0	19.1	0.33	1689	543873	609
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0010	5.4	131.3	181.0	131.3	1.0	49.7	0.87	6167	1111077	1245
Fresno County	McMullin	123	***175,000***	N/A	175,000	5472.0	0.0016	8.5	96.2	101.0	96.2	101.0	4.8	0.08	456	128372	144
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0018	9.7	128.8	101.0	128.8	101.0	27.8	0.49	4169	1339835	1501
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0016	8.4	119.1	90.6	119.1	90.6	28.5	0.50	3407	949458	1064
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0013	6.6	82.9	181.4	82.9	1.4	81.5	1.42	12007	2630299	2946
James ID	Fresno County	127	***175,000***	6%	175,000	10727.6	0.0013	6.8	55.6	268.0	55.6	88.0	32.4	0.57	5744	1290577	1446
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0021	11.3	51.8	180.0	51.8	180.0	51.8	0.90	2924	1072024	1201
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0019	9.9	74.3	130.8	74.3	130.8	56.5	0.99	6560	2110340	2364
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0029	15.2	85.1	165.8	85.1	165.8	80.6	1.41	16446	8102042	9075
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0025	13.1	90.7	180.8	90.7	0.8	89.8	1.57	5212	2219292	2486
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0036	19.2	97.7	270.5	97.7	90.5	7.2	0.13	1097	682926	765
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0039	20.5	99.9	200.4	99.9	20.4	79.5	1.39	5466	3627455	4063
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0039	20.8	103.4	180.8	103.4	0.8	77.3	1.35	5303	3567886	3997
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0045	23.7	104.2	90.6	104.2	90.6	13.6	0.24	1572	613190	687
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0029	15.1	126.2	118.7	126.2	118.7	7.5	0.13	1366	339987	381
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	N/A	N/A	N/A	153.4	N/A	153.4	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	N/A	N/A	N/A	91.6	N/A	91.6	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	N/A	N/A	N/A	0.9	N/A	0.9	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0035	18.3	147.6	90.5	147.6	90.5	57.1	1.00	7064	2208920	2474
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0028	14.6	107.7	178.8	107.7	178.8	71.1	1.24	14076	3506007	3927
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0035	18.6	34.4	178.9	34.4	178.9	35.5	0.62	4633	1468487	1645
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0033	17.4	36.2	104.2	36.2	104.2	68.0	1.19	10114	3002537	3363
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0043	22.5	79.6	181.6	79.6	1.6	78.0	1.36	5245	2010658	2252
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0027	14.2	87.1	269.2	87.1	89.2	2.1	0.04	199	48158	54
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0024	12.4	108.3	180.8	108.3	0.8	72.5	1.27	4830	1022948	1146
North Fork Kings	Westlands WD	147	***60,000***	N/A	60,000	10639.8	0.0022	11.6	93.1	90.8	93.1	90.8	2.3	0.04	432	56791	64
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0017	8.8	346.1	90.8	166.1	90.8	75.3	1.31	10234	1024073	1147
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0012	6.3	284.3	135.4	104.3	135.4	31.1	0.54	7670	551201	617
Westlands WD	North Fork Kings	150	***60,000***	N/A	60,000	15047.2	0.0012	6.1	84.1	135.4	84.1	135.4	51.3	0.90	11749	815231	913
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0010	5.4	190.1	72.0	10.1	72.0	61.9	1.08	7459	455230	510
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0019	10.0	294.7	136.8	114.7	136.8	22.1	0.39	4339	491089	550
Westlands WD	North Fork Kings	153	***60,000***	N/A	60,000	15489.2	0.0029	15.2	96.2	180.8	96.2	0.8	84.6	1.48	15422	2666892	2987
Westlands WD	North Fork Kings	154	***60,000***	N/A	60,000	5285.2	0.0051	27.2	65.8	180.8	65.8	0.8	65.0	1.13	4789	1478091	1656
Westlands WD	North Fork Kings	155	***90,000***	N/A	90,000	5361.1	0.0040	21.0	32.8	90.8	32.8	90.8	58.0	1.01	4545	1630691	1827
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	0.0025	13.4	330.1	77.1	150.1	77.1	73.0	1.27	5113	1167231	1307
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0031	16.1	291.8	0.7	111.8	0.7	68.9	1.20	3801	1045870	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0029	15.1	259.6	0.7	79.6	0.7	78.9	1.38	2431	624166	0
North Fork Kings	South Fork Kings GSA	159	***90,000***	20%	90,000	6526.5	0.0050	26.2	221.6	54.4	41.6	54.4	12.8	0.22	1444	643761	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0032	17.1	250.0	48.0	70.0	48.0	22.0	0.38	14146	4111490	0
North Fork Kings	Mid Kings River GSA	161	***90,000***	18%	90,000	4940.9	0.0028	15.0	226.4	47.3	46.4	47.3	0.9	0.02	79	20324	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0025	13.4	238.3	47.3	58.3	47.3	11.0	0.19	1091	250097	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0021	11.2	218.5	90.4	38.5	90.4	51.9	0.91	15710	2992702	0
Mid Kings River GSA	North Fork Kings	164	***90,000***	7%	90,000	10560.8	0.0018	9.2	283.0	46.9	103.0	46.9	56.1	0.98	8763	1380937	1547
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0006	3.1	7.7	46.9	7.7	46.9	39.2	0.68	4279	223523	250
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0010	5.2	205.9	178.6	25.9	178.6	27.3	0.48	4100	366070	410
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0027	14.5	169.9	69.0	169.9	69.0	79.1	1.38	18562	4274255	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0033	17.5	158.5	27.2	158.5	27.2	48.8	0.85	12601	3501363	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0022	11.6	132.0	90.0	132.0	90.0	42.0	0.73	996	183383	205
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0029	15.1	170.3	180.7	170.3	0.7	10.4	0.18	5773	1384521	1551

Attachment 3 - 2008 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0016	8.6	184.8	91.2	4.8	91.2	86.4	1.51	10628	1704168	1909
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0014	7.3	209.3	64.0	29.3	64.0	34.7	0.60	13287	1809908	2027
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0031	16.2	250.1	64.0	70.1	64.0	6.2	0.11	623	189758	213
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0030	15.6	217.7	93.8	37.7	93.8	56.0	0.98	13183	1946723	2181
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0013	6.7	177.0	182.5	177.0	2.5	5.5	0.10	164	8354	9
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0008	4.4	171.2	90.5	171.2	90.5	80.7	1.41	10486	352110	394
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0016	8.7	196.2	90.5	16.2	90.5	74.4	1.30	12783	843579	945
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0017	9.0	181.6	0.8	1.6	0.8	0.8	0.01	210	7157	8
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0039	20.4	211.5	90.5	31.5	90.5	59.1	1.03	13732	1060624	1188
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0045	23.8	234.0	359.0	54.0	179.0	55.0	0.96	4095	368650	413
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0046	24.1	222.1	359.0	42.1	179.0	43.2	0.75	2185	199178	223
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0045	23.9	216.9	295.6	36.9	115.6	78.7	1.37	5748	519486	582

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2009 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (L) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	105	***93,000***	25%	93,000	12121.9	0.0014	7.6	329.8	214.3	149.8	34.3	64.5	1.13	10943	1468065	0
North Kings	Madera County	106	***211,000***	28%	211,000	5396.1	0.0009	4.6	13.6	278.3	13.6	98.3	84.7	1.48	5373	987874	0
North Kings	Root Creek WD	107	***211,000***	13%	211,000	14767.3	0.0015	8.1	52.8	278.3	52.8	98.3	45.5	0.79	10534	3417436	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0021	11.3	319.0	247.8	139.0	67.8	71.2	1.24	17161	8689783	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0021	10.9	352.3	270.9	172.3	90.9	81.4	1.42	8877	4353804	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0027	14.1	326.3	248.0	146.3	68.0	78.4	1.37	19433	12317967	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0022	11.6	16.1	282.4	16.1	102.4	86.3	1.51	6334	2557256	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0035	18.3	336.8	282.4	156.8	102.4	54.3	0.95	6365	4063914	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0040	21.0	328.8	253.7	148.8	73.7	75.2	1.31	24299	17812858	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0032	17.0	246.2	213.3	66.2	33.3	32.9	0.57	6342	3682219	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0026	13.6	224.8	323.7	44.8	143.7	81.2	1.42	6209	2877465	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0029	15.1	292.9	250.8	112.9	70.8	42.0	0.73	6071	3122180	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0007	3.6	283.5	173.6	103.5	173.6	70.1	1.22	4367	532994	0
McMullin	Aliso WD	118	***180,000***	N/A	180,000	13996.9	0.0007	3.6	87.6	273.4	87.6	93.4	5.8	0.10	1415	175585	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0008	4.0	76.3	273.4	76.3	93.4	17.1	0.30	1016	138386	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0004	2.2	50.9	215.4	50.9	35.4	15.6	0.27	931	71241	0
Farmers WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0003	1.7	25.4	181.0	25.4	1.0	24.5	0.43	2139	119950	134
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0002	0.9	89.6	181.0	89.6	1.0	88.6	1.55	8087	238939	268
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0005	2.8	141.5	101.0	141.5	101.0	40.5	0.71	3552	325924	365
McMullin	Fresno County	124	***175,000***	5%	175,000	8939.7	0.0008	4.3	113.7	101.0	113.7	101.0	12.7	0.22	1968	278170	312
McMullin	Fresno County	125	***175,000***	8%	175,000	7147.8	0.0017	9.1	104.4	90.6	104.4	90.6	13.8	0.24	1704	512010	574
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0031	16.1	114.4	181.4	114.4	1.4	67.0	1.17	11174	5975513	6693
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0026	13.5	123.5	268.0	123.5	88.0	35.5	0.62	6234	2785354	3120
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0018	9.3	131.2	180.0	131.2	180.0	48.8	0.85	2802	843972	945
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0017	9.2	108.8	130.8	108.8	130.8	22.0	0.38	2948	879177	985
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0018	9.6	79.3	165.8	79.3	165.8	86.5	1.51	16636	5187731	5811
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0014	7.4	90.1	180.8	90.1	0.8	89.3	1.56	5212	1251087	1401
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0010	5.2	166.9	270.5	166.9	90.5	76.5	1.33	8469	1436479	1609
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0010	5.4	198.0	200.4	18.0	20.4	2.4	0.04	230	40335	45
Central Delta Mendota Regional Mulit Agency GSA	James ID	134	***171,000***	N/A	171,000	5435.6	0.0011	6.0	178.2	180.8	178.2	0.8	2.6	0.05	249	48289	54
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0016	8.6	159.9	90.6	159.9	90.6	69.2	1.21	6266	890082	997
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0022	11.4	146.1	118.7	146.1	118.7	27.3	0.48	4834	909106	1018
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0011	5.6	77.0	153.4	77.0	153.4	76.3	1.33	22905	2131177	2387
Westlands WD	North Fork Kings	138	***90,000***	N/A	90,000	5362.7	N/A	N/A	N/A	91.6	N/A	91.6	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0019	10.1	66.1	0.9	66.1	0.9	65.2	1.14	8788	1511077	1693
Westlands WD	North Fork Kings	140	***90,000***	N/A	90,000	8413.5	0.0025	13.3	54.9	90.5	54.9	90.5	35.6	0.62	4895	1108886	1242
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0037	19.4	83.4	178.8	83.4	178.8	84.6	1.48	14811	4907318	5497
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0033	17.5	69.9	178.9	69.9	178.9	71.0	1.24	7548	2254817	2526
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0030	16.0	55.6	104.2	55.6	104.2	48.6	0.85	8185	2238777	2508
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0038	20.1	82.4	181.6	82.4	1.6	80.8	1.41	5293	1814112	2032
Westlands WD	North Fork Kings	145	***90,000***	N/A	90,000	5361.1	0.0032	16.6	90.9	269.2	90.9	89.2	1.7	0.03	159	45248	51
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0024	12.6	86.7	180.8	86.7	0.8	85.9	1.50	5050	1086998	1218
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0030	15.6	65.8	90.8	65.8	90.8	25.0	0.44	4490	796946	893
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0025	13.4	359.3	90.8	179.3	90.8	88.5	1.55	10578	1608889	1802
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0012	6.4	225.3	135.4	45.3	135.4	89.9	1.57	14856	1079074	1209
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0018	9.7	201.9	135.4	21.9	135.4	66.5	1.16	13795	1514471	1696
Westlands WD	North Fork Kings	151	***60,000***	N/A	60,000	8452.6	0.0028	14.9	288.6	72.0	108.6	72.0	36.6	0.64	5040	851537	954
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0028	14.9	310.5	136.8	130.5	136.8	6.3	0.11	1267	214173	240
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0028	14.6	295.7	180.8	115.7	0.8	65.2	1.14	14056	2333636	2614
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0025	13.2	294.5	180.8	114.5	0.8	66.3	1.16	4840	728028	815
Westlands WD	North Fork Kings	155	***90,000***	N/A	90,000	5361.1	N/A	N/A	N/A	90.8	N/A	90.8	N/A	N/A	N/A	N/A	N/A
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	N/A	N/A	N/A	77.1	N/A	77.1	N/A	N/A	N/A	N/A	N/A
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0026	13.8	287.8	0.7	107.8	0.7	72.9	1.27	3894	913866	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0027	14.3	290.0	0.7	110.0	0.7	70.7	1.23	2338	571056	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0026	13.8	291.8	54.4	111.8	54.4	57.4	1.00	5497	1288599	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0019	9.9	271.6	48.0	91.6	48.0	43.7	0.76	26042	4392678	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0032	16.7	245.8	47.3	65.8	47.3	18.4	0.32	1563	445651	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0038	19.8	249.1	47.3	69.1	47.3	21.7	0.38	2122	717899	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0023	12.2	219.0	90.4	39.0	90.4	51.4	0.90	15595	3256108	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0007	3.6	211.5	46.9	31.5	46.9	15.4	0.27	2812	173693	195
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0011	5.6	295.2	46.9	115.2	46.9	68.3	1.19	6288	602915	675
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0014	7.2	230.3	178.6	50.3	178.6	51.7	0.90	7017	865887	970
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0032	16.8	179.7	69.0	179.7	69.0	69.3	1.21	17677	4723788	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0031	16.5	157.3	27.2	157.3	27.2	50.0	0.87	12824	3363803	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0035	18.4	99.5	90.0	99.5	90.0	9.5	0.17	246	72028	81
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0040	21.1	132.2	180.7	132.2	0.7	48.5	0.85	23923	8043150	9009

Attachment 3 - 2009 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0019	9.8	189.1	91.2	9.1	91.2	82.1	1.43	10547	1944569	2178
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0011	5.6	204.2	64.0	24.2	64.0	39.7	0.69	14938	1570418	1759
Kings River East	Greater Kaweah GSA	173	***99,000***	7%	99,000	5805.0	0.0025	13.4	222.3	64.0	42.3	64.0	21.7	0.38	2142	536222	601
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0028	14.9	206.7	93.8	26.7	93.8	67.0	1.17	14633	2064385	2312
Kings River East	Greater Kaweah GSA	175	***40,000***	-2%	40,000	1714.0	0.0033	17.3	196.5	182.5	16.5	2.5	14.0	0.24	415	54315	61
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0043	22.4	177.7	90.5	177.7	90.5	87.2	1.52	10614	1805123	2022
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0043	22.7	190.1	90.5	10.1	90.5	80.4	1.40	13088	2255114	2526
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0044	23.2	205.3	0.8	25.3	0.8	24.5	0.43	6536	573120	642
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0036	18.9	205.3	90.5	25.3	90.5	65.2	1.14	14537	1042131	1167
Kings River East	East Kaweah GSA	180	***20,000***	N/A	20,000	4996.5	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
Kings River East	East Kaweah GSA	181	***20,000***	N/A	20,000	3194.6	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0034	17.8	213.9	295.6	33.9	115.6	81.7	1.43	5800	390285	437

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2011 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	105	***93,000***	25%	93,000	12121.9	0.0011	5.7	204.9	214.3	24.9	34.3	9.4	0.16	1977	199711	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0019	9.9	201.4	278.3	21.4	98.3	76.8	1.34	5254	2086119	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0010	5.4	108.9	278.3	108.9	98.3	10.6	0.19	2728	588466	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0009	4.8	321.8	247.8	141.8	67.8	74.0	1.29	17428	3728710	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0023	12.2	339.8	270.9	159.8	90.9	68.8	1.20	8372	4600718	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0028	14.5	346.3	248.0	166.3	68.0	81.6	1.42	19629	12802672	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0022	11.5	340.8	282.4	160.8	102.4	58.3	1.02	5402	2169617	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0037	19.7	320.9	282.4	140.9	102.4	38.5	0.67	4872	3339167	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0028	15.0	323.5	253.7	143.5	73.7	69.8	1.22	23593	12301263	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0036	19.1	218.4	213.3	38.4	33.3	5.1	0.09	1043	678565	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0032	17.1	203.0	323.7	23.0	143.7	59.3	1.03	5403	3157330	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0050	26.2	270.7	250.8	90.7	70.8	19.9	0.35	3089	2762421	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0050	26.4	257.9	173.6	77.9	173.6	84.3	1.47	4623	4162513	0
McMullin	Aliso WD	118	***180,000***	N/A	180,000	13996.9	0.0030	15.6	7.6	273.4	7.6	93.4	85.9	1.50	13960	7445029	0
McMullin	Aliso WD	119	***180,000***	N/A	180,000	3456.2	0.0077	40.5	327.5	273.4	147.5	93.4	54.1	0.94	2799	3864773	0
McMullin	Farmers WD	120	***180,000***	N/A	180,000	3470.6	0.0057	29.9	346.2	215.4	166.2	35.4	49.2	0.86	2628	2678888	0
McMullin	Farmers WD	121	***175,000***	N/A	175,000	5165.0	0.0028	15.0	349.4	181.0	169.4	1.0	11.5	0.20	1033	514894	577
McMullin	Fresno County	122	***175,000***	N/A	175,000	8089.5	0.0005	2.8	276.9	181.0	96.9	1.0	84.0	1.47	8046	755180	846
McMullin	Fresno County	123	***175,000***	N/A	175,000	5472.0	0.0005	2.5	179.0	101.0	179.0	101.0	78.0	1.36	5352	434861	487
Fresno County	McMullin	124	***175,000***	5%	175,000	8939.7	0.0004	2.3	82.9	101.0	82.9	101.0	18.1	0.32	2773	211989	237
Fresno County	McMullin	125	***175,000***	8%	175,000	7147.8	0.0016	8.2	49.2	90.6	49.2	90.6	41.4	0.72	4725	1289186	1444
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0012	6.5	116.2	181.4	116.2	1.4	65.2	1.14	11022	2379940	2666
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0015	7.9	155.0	268.0	155.0	88.0	66.9	1.17	9870	2587945	2899
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0009	4.8	140.1	180.0	140.1	180.0	39.9	0.70	2390	372891	418
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0012	6.2	124.4	130.8	124.4	130.8	6.4	0.11	878	176494	198
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0010	5.2	138.7	165.8	138.7	165.8	27.1	0.47	7586	1279916	1434
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0014	7.5	149.1	180.8	149.1	0.8	31.7	0.55	2742	663532	743
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0013	6.8	149.5	270.5	149.5	90.5	59.0	1.03	7465	1637793	1835
Central Delta Mendota Regional Mulit Agency GSA	James ID	133	***171,000***	N/A	171,000	5559.6	0.0010	5.4	153.9	200.4	153.9	20.4	46.4	0.81	4029	702511	787
Westlands WD	James ID	134	***171,000***	N/A	171,000	5435.6	0.0010	5.1	150.0	180.8	150.0	0.8	30.8	0.54	2782	458886	514
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0011	6.0	140.6	90.6	140.6	90.6	49.9	0.87	5127	506466	567
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0013	6.8	126.9	118.7	126.9	118.7	8.2	0.14	1497	167329	187
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0016	8.7	111.7	153.4	111.7	153.4	41.7	0.73	15673	2244926	2515
North Fork Kings	Westlands WD	138	***90,000***	N/A	90,000	5362.7	0.0012	6.1	102.2	91.6	102.2	91.6	10.6	0.18	985	102952	115
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0011	5.6	111.7	0.9	111.7	0.9	69.2	1.21	9048	856896	960
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0014	7.2	106.2	90.5	106.2	90.5	15.7	0.27	2272	279203	313
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0012	6.1	93.9	178.8	93.9	178.8	84.9	1.48	14819	1550633	1737
Westlands WD	North Fork Kings	142	***90,000***	N/A	90,000	7984.0	0.0009	4.7	74.4	178.9	74.4	178.9	75.4	1.32	7727	616590	691
Westlands WD	North Fork Kings	143	***90,000***	N/A	90,000	10906.7	0.0008	4.0	31.6	104.2	31.6	104.2	72.6	1.27	10407	705969	791
Westlands WD	North Fork Kings	144	***90,000***	N/A	90,000	5362.7	0.0008	4.3	0.9	181.6	0.9	1.6	0.7	0.01	62	4498	5
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0005	2.4	356.6	269.2	176.6	89.2	87.4	1.53	5356	219313	246
North Fork Kings	Westlands WD	146	***90,000***	N/A	90,000	5063.3	0.0002	0.8	332.5	180.8	152.5	0.8	28.4	0.50	2405	32851	37
North Fork Kings	Westlands WD	147	***60,000***	N/A	60,000	10639.8	0.0001	0.6	275.3	90.8	95.3	90.8	4.5	0.08	839	5908	7
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0005	2.5	305.3	90.8	125.3	90.8	34.5	0.60	5986	167828	188
North Fork Kings	Westlands WD	149	***60,000***	N/A	60,000	14856.4	0.0014	7.4	286.4	135.4	106.4	135.4	29.0	0.51	7198	607675	681
North Fork Kings	Westlands WD	150	***60,000***	N/A	60,000	15047.2	0.0010	5.1	269.4	135.4	89.4	135.4	46.0	0.80	10824	629791	705
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0007	3.8	119.7	72.0	119.7	72.0	47.6	0.83	6244	271739	304
North Fork Kings	Westlands WD	152	***60,000***	N/A	60,000	11535.4	0.0007	3.6	166.2	136.8	166.2	136.8	29.4	0.51	5662	231157	259
North Fork Kings	Westlands WD	153	***60,000***	N/A	60,000	15489.2	0.0007	3.8	196.5	180.8	16.5	0.8	15.6	0.27	4175	181132	203
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0008	4.1	222.1	180.8	42.1	0.8	41.3	0.72	3489	163204	183
North Fork Kings	Westlands WD	155	***90,000***	N/A	90,000	5361.1	0.0009	4.7	227.2	90.8	47.2	90.8	43.6	0.76	3695	295405	331
North Fork Kings	South Fork Kings GSA	156	***90,000***	N/A	90,000	5346.1	0.0014	7.3	228.5	77.1	48.5	77.1	28.6	0.50	2561	320507	359
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0018	9.7	225.0	0.7	45.0	0.7	44.3	0.77	2848	470419	0
North Fork Kings	South Fork Kings GSA	158	***90,000***	N/A	90,000	2477.5	0.0021	11.3	228.1	0.7	48.1	0.7	47.4	0.83	1825	353006	0
North Fork Kings	South Fork Kings GSA	159	***90,000***	20%	90,000	6526.5	0.0026	13.5	228.2	54.4	48.2	54.4	6.2	0.11	704	161893	0
North Fork Kings	South Fork Kings GSA	160	***90,000***	19%	90,000	37726.0	0.0019	10.0	215.4	48.0	35.4	48.0	12.6	0.22	8241	1401359	0
Mid Kings River GSA	North Fork Kings	161	***90,000***	18%	90,000	4940.9	0.0023	12.2	239.1	47.3	59.1	47.3	11.8	0.21	1008	209908	0
Mid Kings River GSA	North Fork Kings	162	***90,000***	17%	90,000	5730.5	0.0020	10.7	248.4	47.3	68.4	47.3	21.1	0.37	2062	376759	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0028	14.6	236.8	90.4	56.8	90.4	33.7	0.59	11063	2753704	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0022	11.4	86.2	46.9	86.2	46.9	39.3	0.69	6684	1301038	1457
North Fork Kings	Mid Kings River GSA	165	***90,000***	11%	90,000	6769.4	0.0010	5.2	172.7	46.9	172.7	46.9	54.2	0.95	5494	483639	542
Central Kings	Mid Kings River GSA	166	***90,000***	9%	90,000	8937.1	0.0015	7.9	194.2	178.6	14.2	178.6	15.6	0.27	2407	325762	365
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0033	17.2	191.7	69.0	11.7	69.0	57.3	1.00	15910	4351792	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0020	10.6	176.3	27.2	176.3	27.2	31.0	0.54	8615	1457085	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0008	4.0	172.3	90.0	172.3	90.0	82.3	1.44	1476	94369	106
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0027	14.2	155.6	180.7	155.6	0.7	25.0	0.44	13513	3054499	3421

Attachment 3 - 2011 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0014	7.5	166.1	91.2	166.1	91.2	74.9	1.31	10280	1438760	1612
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0029	15.1	237.5	64.0	57.5	64.0	6.4	0.11	2623	740959	830
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0024	12.4	258.9	64.0	78.9	64.0	15.0	0.26	1500	349711	392
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0014	7.6	188.9	93.8	8.9	93.8	84.8	1.48	15828	1139706	1277
Greater Kaweah GSA	Kings River East	175	***40,000***	-2%	40,000	1714.0	0.0023	12.2	130.9	182.5	130.9	2.5	51.6	0.90	1343	124132	139
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0020	10.6	151.4	90.5	151.4	90.5	60.8	1.06	9280	745605	835
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0017	8.8	194.3	90.5	14.3	90.5	76.3	1.33	12895	857724	961
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0044	23.3	200.3	0.8	20.3	0.8	19.4	0.34	5256	463820	520
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0046	24.3	185.1	90.5	5.1	90.5	85.5	1.49	15958	1470723	1647
Kings River East	East Kaweah GSA	180	***20,000***	N/A	20,000	4996.5	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
Kings River East	East Kaweah GSA	181	***20,000***	N/A	20,000	3194.6	N/A	N/A	N/A	359.0	N/A	179.0	N/A	N/A	N/A	N/A	N/A
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0104	55.0	227.1	295.6	47.1	115.6	68.5	1.19	5452	1135892	1272

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 3 - 2012 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
North Kings	Madera County	100	30,000	N/A	30,000	8310.4	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	101	30,000	N/A	30,000	4325.1	N/A	N/A	N/A	225.5	N/A	45.5	N/A	N/A	N/A	N/A	0
Madera County	North Kings	102	30,000	N/A	30,000	7349.7	N/A	N/A	N/A	166.5	N/A	166.5	N/A	N/A	N/A	N/A	0
North Kings	Madera County	103	30,000	N/A	30,000	12097.8	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
Madera County	North Kings	104	***30,000***	N/A	30,000	20674.9	N/A	N/A	N/A	214.3	N/A	34.3	N/A	N/A	N/A	N/A	0
North Kings	Madera County	105	***93,000***	25%	93,000	12121.9	0.0011	5.8	231.0	214.3	51.0	34.3	16.7	0.29	3486	353948	0
Madera County	North Kings	106	***211,000***	28%	211,000	5396.1	0.0013	7.1	210.4	278.3	30.4	98.3	67.8	1.18	4997	1416284	0
Root Creek WD	North Kings	107	***211,000***	13%	211,000	14767.3	0.0014	7.6	101.0	278.3	101.0	98.3	2.7	0.05	701	212276	0
North Kings	Madera County	108	***237,000***	5%	237,000	18127.3	0.0017	8.8	334.3	247.8	154.3	67.8	86.5	1.51	18093	7153562	0
North Kings	Madera ID	109	***237,000***	3%	237,000	8977.7	0.0021	11.3	334.5	270.9	154.5	90.9	63.6	1.11	8040	4067413	0
North Kings	Madera ID	110	***237,000***	0%	237,000	19839.8	0.0029	15.2	333.8	248.0	153.8	68.0	85.9	1.50	19788	13500915	0
North Kings	Madera ID	111	***184,000***	-1%	184,000	6346.9	0.0018	9.6	343.6	282.4	163.6	102.4	61.1	1.07	5558	1863218	0
North Kings	Madera ID	112	***184,000***	N/A	184,000	7833.8	0.0026	13.9	320.2	282.4	140.2	102.4	37.7	0.66	4794	2320700	0
North Kings	Madera ID	113	***184,000***	N/A	184,000	25138.2	0.0027	14.1	322.8	253.7	142.8	73.7	69.1	1.21	23485	11578277	0
McMullin	Aliso WD	114	***180,000***	N/A	180,000	11667.2	0.0031	16.3	263.2	213.3	83.2	33.3	49.9	0.87	8922	4950807	0
Aliso WD	McMullin	115	***180,000***	N/A	180,000	6284.1	0.0036	18.8	260.0	323.7	80.0	143.7	63.7	1.11	5633	3616535	0
McMullin	Aliso WD	116	***180,000***	N/A	180,000	9065.2	0.0034	18.1	283.9	250.8	103.9	70.8	33.1	0.58	4948	3058726	0
McMullin	Aliso WD	117	***180,000***	N/A	180,000	4645.4	0.0023	12.3	296.7	173.6	116.7	173.6	56.8	0.99	3888	1629666	0
McMullin	Aliso WD	118	***180,000***	N/A	180,000	13996.9	0.0015	7.7	320.6	273.4	140.6	93.4	47.2	0.82	10269	2697616	0
Aliso WD	McMullin	119	***180,000***	N/A	180,000	3456.2	0.0024	12.5	110.9	273.4	110.9	93.4	17.5	0.31	1039	441661	0
Farmers WD	McMullin	120	***180,000***	N/A	180,000	3470.6	0.0030	15.9	128.8	215.4	128.8	35.4	86.6	1.51	3465	1879712	0
Farmers WD	McMullin	121	***175,000***	N/A	175,000	5165.0	0.0025	13.2	117.4	181.0	117.4	1.0	63.6	1.11	4625	2026474	2270
Fresno County	McMullin	122	***175,000***	N/A	175,000	8089.5	0.0019	9.9	75.0	181.0	75.0	1.0	74.0	1.29	7776	2547003	2853
Fresno County	McMullin	123	***175,000***	N/A	175,000	5472.0	0.0020	10.5	17.3	101.0	17.3	101.0	83.7	1.46	5439	1894174	2122
Fresno County	McMullin	124	***175,000***	5%	175,000	8939.7	0.0035	18.6	338.3	101.0	158.3	101.0	57.2	1.00	7517	4637172	5194
Fresno County	McMullin	125	***175,000***	8%	175,000	7147.8	0.0026	13.9	340.8	90.6	160.8	90.6	70.2	1.23	6727	3095665	3468
Fresno County	McMullin	126	***175,000***	9%	175,000	12139.4	0.0018	9.7	96.3	181.4	96.3	1.4	85.1	1.48	12094	3879619	4346
Fresno County	James ID	127	***175,000***	6%	175,000	10727.6	0.0016	8.5	154.4	268.0	154.4	88.0	66.4	1.16	9832	2782155	3116
Fresno County	James ID	128	***171,000***	4%	171,000	3722.6	0.0008	4.1	147.8	180.0	147.8	180.0	32.2	0.56	1983	265902	298
Central Delta Mendota Regional Mulit Agency GSA	James ID	129	***171,000***	4%	171,000	7865.6	0.0018	9.6	126.5	130.8	126.5	130.8	4.3	0.07	587	183091	205
Central Delta Mendota Regional Mulit Agency GSA	James ID	130	***171,000***	5%	171,000	16667.1	0.0017	8.8	103.7	165.8	103.7	165.8	62.1	1.08	14731	4181103	4683
Central Delta Mendota Regional Mulit Agency GSA	James ID	131	***171,000***	8%	171,000	5212.2	0.0014	7.2	89.4	180.8	89.4	0.8	88.6	1.55	5211	1222625	1370
Central Delta Mendota Regional Mulit Agency GSA	James ID	132	***171,000***	N/A	171,000	8711.3	0.0006	3.2	133.7	270.5	133.7	90.5	43.2	0.75	5959	614601	688
James ID	Central Delta Mendota Regional Mulit Agency GSA	133	***171,000***	N/A	171,000	5559.6	0.0008	4.0	212.7	200.4	32.7	20.4	12.4	0.22	1189	155553	174
James ID	Westlands WD	134	***171,000***	N/A	171,000	5435.6	0.0006	3.2	248.5	180.8	68.5	0.8	67.8	1.18	5031	518444	581
James ID	Westlands WD	135	***87,000***	N/A	87,000	6701.1	0.0007	3.5	214.8	90.6	34.8	90.6	55.8	0.97	5546	317975	356
James ID	Westlands WD	136	***87,000***	N/A	87,000	10529.2	0.0014	7.1	147.3	118.7	147.3	118.7	28.6	0.50	5041	593466	665
Westlands WD	North Fork Kings	137	***87,000***	N/A	87,000	23573.7	0.0018	9.5	140.2	153.4	140.2	153.4	13.1	0.23	5345	834330	935
Westlands WD	North Fork Kings	138	***90,000***	N/A	90,000	5362.7	N/A	N/A	N/A	91.6	N/A	91.6	N/A	N/A	N/A	N/A	N/A
North Fork Kings	Westlands WD	139	***90,000***	N/A	90,000	9680.0	0.0017	9.0	140.7	0.9	140.7	0.9	40.2	0.70	6250	956768	1072
North Fork Kings	Westlands WD	140	***90,000***	N/A	90,000	8413.5	0.0019	9.8	116.9	90.5	116.9	90.5	26.4	0.46	3738	623450	698
Westlands WD	North Fork Kings	141	***90,000***	N/A	90,000	14877.4	0.0010	5.2	33.4	178.8	33.4	178.8	34.6	0.60	8438	753278	844
North Fork Kings	Westlands WD	142	***90,000***	N/A	90,000	7984.0	0.0011	6.0	298.8	178.9	118.8	178.9	60.1	1.05	6923	709456	795
North Fork Kings	Westlands WD	143	***90,000***	N/A	90,000	10906.7	0.0016	8.4	103.6	104.2	103.6	104.2	0.7	0.01	127	18236	20
North Fork Kings	Westlands WD	144	***90,000***	N/A	90,000	5362.7	0.0012	6.2	347.1	181.6	167.1	1.6	14.5	0.25	1345	143121	160
North Fork Kings	Westlands WD	145	***90,000***	N/A	90,000	5361.1	0.0007	3.7	329.8	269.2	149.8	89.2	60.6	1.06	4670	291181	326
Westlands WD	North Fork Kings	146	***90,000***	N/A	90,000	5063.3	0.0007	3.8	12.2	180.8	12.2	0.8	11.3	0.20	993	63781	71
Westlands WD	North Fork Kings	147	***60,000***	N/A	60,000	10639.8	0.0007	3.5	287.0	90.8	107.0	90.8	16.2	0.28	2965	118838	133
Westlands WD	North Fork Kings	148	***60,000***	N/A	60,000	10581.3	0.0007	3.5	79.4	90.8	79.4	90.8	11.4	0.20	2098	83538	94
Westlands WD	North Fork Kings	149	***60,000***	N/A	60,000	14856.4	0.0017	8.9	344.8	135.4	164.8	135.4	29.4	0.51	7288	741073	830
Westlands WD	North Fork Kings	150	***60,000***	N/A	60,000	15047.2	0.0013	7.0	103.0	135.4	103.0	135.4	32.4	0.57	8068	645488	723
North Fork Kings	Westlands WD	151	***60,000***	N/A	60,000	8452.6	0.0013	6.9	222.9	72.0	42.9	72.0	29.1	0.51	4115	321895	361
Westlands WD	North Fork Kings	152	***60,000***	N/A	60,000	11535.4	0.0012	6.3	120.5	136.8	120.5	136.8	16.3	0.28	3243	231888	260
Westlands WD	North Fork Kings	153	***60,000***	N/A	60,000	15489.2	0.0005	2.6	13.7	180.8	13.7	0.8	12.9	0.22	3447	100007	112
North Fork Kings	Westlands WD	154	***60,000***	N/A	60,000	5285.2	0.0007	3.7	297.2	180.8	117.2	0.8	63.6	1.11	4736	200319	224
Westlands WD	North Fork Kings	155	***90,000***	N/A	90,000	5361.1	0.0013	6.7	299.6	90.8	119.6	90.8	28.8	0.50	2581	296054	332
South Fork Kings GSA	North Fork Kings	156	***90,000***	N/A	90,000	5346.1	0.0016	8.5	305.5	77.1	125.5	77.1	48.4	0.84	3998	579014	649
South Fork Kings GSA	North Fork Kings	157	***90,000***	N/A	90,000	4074.8	0.0017	9.0	284.6	0.7	104.6	0.7	76.1	1.33	3955	604801	0
South Fork Kings GSA	North Fork Kings	158	***90,000***	N/A	90,000	2477.5	0.0026	13.5	260.6	0.7	80.6	0.7	79.9	1.40	2439	563021	0
South Fork Kings GSA	North Fork Kings	159	***90,000***	20%	90,000	6526.5	0.0045	23.7	243.0	54.4	63.0	54.4	8.6	0.15	974	394265	0
South Fork Kings GSA	North Fork Kings	160	***90,000***	19%	90,000	37726.0	0.0022	11.7	262.8	48.0	82.8	48.0	34.8	0.61	21533	4298109	0
North Fork Kings	Mid Kings River GSA	161	***90,000***	18%	90,000	4940.9	0.0027	14.1	210.2	47.3	30.2	47.3	17.2	0.30	1461	350285	0
North Fork Kings	Mid Kings River GSA	162	***90,000***	17%	90,000	5730.5	0.0040	21.4	216.7	47.3	36.7	47.3	10.7	0.19	1063	387332	0
North Fork Kings	Mid Kings River GSA	163	***90,000***	8%	90,000	19953.9	0.0040	21.0	216.8	90.4	36.8	90.4	53.7	0.94	16075	5746847	0
North Fork Kings	Mid Kings River GSA	164	***90,000***	7%	90,000	10560.8	0.0021	11.2	195.0	46.9	15.0	46.9	32.0	0.56	5589	1070269	1199
Mid Kings River GSA	North Fork Kings	165	***90,000***	11%	90,000	6769.4	0.0020	10.4	36.5	46.9	36.5	46.9	10.4	0.18	1223	217105	243
Mid Kings River GSA	Central Kings	166	***90,000***	9%	90,000	8937.1	0.0026	13.6	84.8	178.6	84.8	178.6	86.2	1.50	8918	2072910	2322
Central Kings	Mid Kings River GSA	167	***84,000***	4%	84,000	18901.3	0.0051	26.7	170.1	69.0	170.1	69.0	78.9	1.38	18550	7884064	0
Central Kings	Mid Kings River GSA	168	***84,000***	4%	84,000	16749.2	0.0026	13.5	137.6	27.2	137.6	27.2	69.7	1.22	15707	3377352	0
Kings River East	Mid Kings River GSA	169	***84,000***	8%	84,000	1489.1	0.0020	10.6	106.0	90.0	106.0	90.0	16.0	0.28	410	69522	78
Mid Kings River GSA	Kings River East	170	***84,000***	15%	84,000	31942.3	0.0035	18.7	163.5	180.7	163.5	0.7	17.1	0.30	9409	2795219	3131
Kings River East	Mid Kings River GSA	171	***99,000***	22%	99,000	10649.1	0.0017	9.1	203.9	91.2	23.9	91.2	67.3	1.18	9828	1683644	1886
Kings River East	Greater Kaweah GSA	172	***99,000***	19%	99,000	23363.7	0.0024	12.5	243.9	64.0	63.9	64.0	0.0	0.00	17	4068	5
Greater Kaweah GSA	Kings River East	173	***99,000***	7%	99,000	5805.0	0.0038	20.2	287.9	64.0	107.9	64.0	43.9	0.77	4027	1527193	1711
Kings River East	Greater Kaweah GSA	174	***50,000***	-2%	50,000	15892.6	0.0021	10.9	265.8	93.8	85.8	93.8	8.0	0.14	2199	227543	255
Greater Kaweah GSA	Kings River East	175	***40,000***	-2%	40,000	1714.0	0.0023	12.1	116.3	182.5	116.3	2.5	66.2	1.15	1568	144060	161
Kings River East	Greater Kaweah GSA	176	***40,000***	N/A	40,000	10626.4	0.0025	13.3	107.0	90.5	107.0	90.5	16.5	0.29	3012	303958	340
Kings River East	Greater Kaweah GSA	177	***40,000***	N/A	40,000	13273.9	0.0049	26.1	167.3	90.5	167.3	90.5	76.8	1.34	12922	2557875	2865
East Kaweah GSA	Kings River East	178	***20,000***	N/A	20,000	15785.5	0.0051	26.9	191.8	0.8	11.8	0.8	11.0	0.19	3008	306908	344
Kings River East	East Kaweah GSA	179	***20,000***	N/A	20,000	16008.0	0.0033	17.5	197.1	90.5	17.1	90.5	73.5	1.28	15346	1019747	1142
East Kaweah GSA	Kings River East	180	***20,000***	N/A	20,000	4996.5	0.0047	24.8	239.9	359.0	59.9	179.0	60.9	1.06	4368	409634	459

Attachment 3 - 2012 Flow Estimate, External

GSA where flow originates	GSA receiving flow	Flow Segment Number	Estimated Transmissivity Value (GPD/FT)	Average Percent change 1962 to 1999 and 1962 to 2011	Adjusted for thickness	Flow Segment Total Length (FT)	Avg slope in flow direction (unitless)	Average Slope (FT/Mile)	Direction of Flow	Boundary Flow Segment Azimuth (based on 360^0)	Flow Direction converted to between 0 & 180^0	Segement Azimuth converted to between 0 & 180^0	Acute Angle between Flow Segment and Flow Direction	Convert Angle to radians	Flow Segment Length (**L**) perpendicular to Flow Direction	Flow Across Flow Segment (GPD)	Flow Across Flow Segment (AF/Year)
East Kaweah GSA	Kings River East	181	***20,000***	N/A	20,000	3194.6	0.0057	30.2	225.0	359.0	45.0	179.0	46.0	0.80	2300	262788	294
East Kaweah GSA	Kings River East	182	***20,000***	N/A	20,000	5861.0	0.0051	27.0	212.5	295.6	32.5	115.6	83.1	1.45	5819	595778	667

Italicized T Values = Transmissivities based on recent pump test data
therefore they are not adjusted for hydrologic base period years

The other T values are USGS 1618 (specific capacity * 1500) T values based on publication date of 1964
therefore, they are adjusted based on avg % change in aquifer thickness from time period 1962 to 1998-2016

N/A represents flow segments that lack data coverage.

Attachment 4

Estimated Flows
Grouped by Shared Boundaries

Internal

Kings Subbasin Groundwater Flow (Unconfined) Estimation

10-24-18 Boundary Flow Estimations.
Values will change if contours are revised.

		1925		1997		1998		1999		2000		2001	
GSA	Neighboring GSA	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External
Central/South Kings		-10,500	-600	-26,900	-500	-20,100	-1,100	-24,200	-1,100	-21,000	800	-19,000	1,200
	McMullin	-4,400		-8,000		-7,400		-8,500		-8,500		-8,300	
	North Fork	-9,500		-15,800		-15,400		-15,600		-15,200		-14,200	
	Kings River East	0		0		0		0		0		0	
	North Kings	3,400		-3,100		2,700		-100		2,700		3,500	
	Mid Kings River GSA		-600		-500		-1,100		-1,100		800		1,200
James		2,500	0	-16,400	4,500	-14,800	200	-45,300	-500	-9,800	11,300	-27,400	16,400
	McMullin	2,400		-10,100		-13,000		-42,200		-7,800		-24,400	
	North Fork	100		-6,300		-1,800		-3,100		-2,000		-3,000	
	Fresno County		0		1,400		1,300		100		2,100		2,200
	CDMRMA		0		4,200		500		500		10,900		16,600
	Westlands WD		0		-1,100		-1,600		-1,100		-1,700		-2,400
Kings River East		0	0	0	5,400	0	-1,600	0	-2,000	0	-2,300	0	-5,200
	Central/South Kings	0		0		0		0		0		0	
	North Kings	0		0		0		0		0		0	
	Mid Kings River GSA		0		7,800		1,200		4,900		2,800		1,200
	Greater Kaweah GSA		0		-700		-1,600		-4,600		-4,900		-5,300
	East Kaweah GSA		0		-1,700		-1,200		-2,300		-200		-1,100
McMullin		16,600	-300	92,000	5,300	89,600	6,400	113,000	6,400	79,100	8,700	103,300	10,100
	North Kings	18,800		69,000		54,300		53,600		56,000		61,100	
	Central/South Kings	4,400		8,000		7,400		8,500		8,500		8,300	
	North Fork	-4,200		4,900		14,900		8,700		6,800		9,500	
	James	-2,400		10,100		13,000		42,200		7,800		24,400	
	Aliso WD		0		0		0		0		0		0
	Farmers WD		0		1,400		1,100		0		-500		1,400
	Frenso County		-300		3,900		5,300		6,400		9,200		8,700
North Fork Kings		13,600	500	17,200	1,200	2,300	-2,100	10,000	2,900	10,400	-9,400	7,700	-11,000
	Central/South Kings	9,500		15,800		15,400		15,600		15,200		14,200	
	McMullin	4,200		-4,900		-14,900		-8,700		-6,800		-9,500	
	James	-100		6,300		1,800		3,100		2,000		3,000	
	Westlands WD		0		-1,600		-2,700		1,900		-11,600		-11,100
	South Fork Kings GSA		0		300		0		0		-400		0
	Mid Kings River GSA		500		2,500		600		1,000		2,600		100
North Kings		-22,200	0	-65,900	0	-57,000	0	-53,500	0	-58,700	0	-64,600	0
	Kings River East	0		0		0		0		0		0	
	McMullin	-18,800		-69,000		-54,300		-53,600		-56,000		-61,100	
	Central/South Kings	-3,400		3,100		-2,700		100		-2,700		-3,500	
	Madera County		0		0		0		0		0		0
	Root Creek WD		0		0		0		0		0		0
	Madera ID		0		0		0		0		0		0

		2002		2003		2004		2005		2006		2007	
GSA	Neighboring GSA	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External
Central/South Kings		-17,300	-300	-13,900	2,700	-7,500	700	-20,000	2,200	-21,400	2,500	-23,500	-1,100
	McMullin	-8,000		-5,200		-4,800		-7,300		-7,000		-9,000	
	North Fork	-13,200		-8,700		-6,100		-11,300		-17,400		-19,500	
	Kings River East	0		0		0		0		0		0	
	North Kings	3,900		0		3,400		-1,400		3,000		5,000	
	Mid Kings River GSA		-300		2,700		700		2,200		2,500		-1,100
James		-2,900	0	-13,600	11,400	-20,000	13,200	-30,400	6,100	-4,700	1,300	-39,800	600
	McMullin	-5,500		-9,600		-17,800		-23,400		-4,300		-32,400	
	North Fork	2,600		-4,000		-2,200		-7,000		-400		-7,400	
	Fresno County		0		3,100		2,000		300		1,300		-4,700
	CDMRMA		0		11,100		12,600		5,800		0		3,900
	Westlands WD		0		-2,800		-1,400		0		0		1,400
Kings River East		0	-2,400	0	-2,900	0	1,800	0	-7,500	0	-3,000	0	-1,700
	Central/South Kings	0		0		0		0		0		0	
	North Kings	0		0		0		0		0		0	
	Mid Kings River GSA		700		1,800		2,200		100		3,700		3,900
	Greater Kaweah GSA		-2,400		-4,700		-1,000		-6,900		-6,500		-5,800
	East Kaweah GSA		-700		0		600		-700		-200		200
McMullin		81,700	-2,500	83,600	1,800	89,100	200	95,300	33,700	79,700	-7,600	110,400	2,400
	North Kings	57,600		65,400		67,600		66,300		66,700		72,100	
	Central/South Kings	8,000		5,200		4,800		7,300		7,000		9,000	
	North Fork	10,600		3,400		-1,100		-1,700		1,700		-3,100	
	James	5,500		9,600		17,800		23,400		4,300		32,400	
	Aliso WD		0		0		0		0		0		0
	Farmers WD		0		0		1,700		2,000		-900		0
	Frenso County		-2,500		1,800		-1,500		31,700		-6,700		2,400
North Fork Kings		0	-4,300	9,300	-6,000	9,400	-2,800	20,000	800	16,100	-3,100	30,000	18,900
	Central/South Kings	13,200		8,700		6,100		11,300		17,400		19,500	
	McMullin	-10,600		-3,400		1,100		1,700		-1,700		3,100	
	James	-2,600		4,000		2,200		7,000		400		7,400	
	Westlands WD		-9,000		-4,100		-1,300		2,300		-3,000		17,100
	South Fork Kings GSA		-700		-500		0		100		-100		300
	Mid Kings River GSA		5,400		-1,400		-1,500		-1,600		0		1,500
North Kings		-61,500	0	-65,400	0	-71,000	0	-64,900	0	-69,700	0	-77,100	0
	Kings River East	0		0		0		0		0		0	
	McMullin	-57,600		-65,400		-67,600		-66,300		-66,700		-72,100	
	Central/South Kings	-3,900		0		-3,400		1,400		-3,000		-5,000	
	Madera County		0		0		0		0		0		0
	Root Creek WD		0		0		0		0		0		0
	Madera ID		0		0		0		0		0		0

		2008		2009		2011		2012		Average 97-12	
GSA	Neighboring GSA	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External
Central/South Kings		-17,900	-400	-15,900	-1,000	-21,900	-400	-34,800	2,300	-20,400	400
	McMullin	-8,700		-5,700		-8,100		-10,300		-7,700	
	North Fork	-15,100		-15,500		-19,700		-24,100		-15,100	
	Kings River East	0		0		0		0		0	
	North Kings	5,900		5,300		5,900		-400		2,400	
	Mid Kings River GSA		-400		-1,000		-400		2,300		400
James		-24,100	21,500	-20,600	12,000	-13,700	8,100	-4,300	8,600	-19,200	7,700
	McMullin	-19,600		-15,100		-13,700		-3,600		-16,200	
	North Fork	-4,500		-5,500		0		-700		-3,000	
	Fresno County		-200		4,100		3,300		3,400		1,300
	CDMRMA		22,800		9,900		5,000		6,800		7,400
	Westlands WD		-1,100		-2,000		-200		-1,600		-1,000
Kings River East		0	-5,900	0	-2,600	0	-1,600	0	200	0	-2,100
	Central/South Kings	0		0		0		0		0	
	North Kings	0		0		0		0		0	
	Mid Kings River GSA		-600		6,800		1,700		1,200		2,600
	Greater Kaweah GSA		-5,300		-9,300		-3,400		-1,600		-4,300
	East Kaweah GSA		0		-100		100		600		-400
McMullin		95,000	1,200	88,900	5,800	93,000	2,400	80,700	20,300	91,700	6,300
	North Kings	71,600		68,200		72,000		67,200		64,600	
	Central/South Kings	8,700		5,700		8,100		10,300		7,700	
	North Fork	-4,900		-100		-800		-400		3,200	
	James	19,600		15,100		13,700		3,600		16,200	
	Aliso WD		0		0		0		0		0
	Farmers WD		-600		100		-600		2,300		500
	Frenso County		1,800		5,700		3,000		18,000		5,800
North Fork Kings		24,500	19,700	21,100	13,300	20,500	-800	25,200	3,700	14,900	1,400
	Central/South Kings	15,100		15,500		19,700		24,100		15,100	
	McMullin	4,900		100		800		400		-3,200	
	James	4,500		5,500		0		700		3,000	
	Westlands WD		16,600		12,800		1,600		4,300		800
	South Fork Kings GSA		1,300		0		-400		600		0
	Mid Kings River GSA		1,800		500		-2,000		-1,200		600
North Kings		-77,500	0	-73,500	0	-77,900	0	-66,800	0	-67,000	0
	Kings River East	0		0		0		0		0	
	McMullin	-71,600		-68,200		-72,000		-67,200		-64,600	
	Central/South Kings	-5,900		-5,300		-5,900		400		-2,400	
	Madera County		0		0		0		0		0
	Root Creek WD		0		0		0		0		0
	Madera ID		0		0		0		0		0

Notes: 1) Values are acre-feet. Positive means inflow from neighboring GSA. Negative value means outflow to neighboring GSA.
2) CDMRMA = Central Delta Mendota Regional Multi Agency GSA
3) External flows are draft as of 10/24/2018

1925 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	0
			2	415
			3	1,390
			4	1,317
			5	1,067
			6	4,194
			7	2,318
			8	1,374
			9	1,465
			10	1,346
			11	1,557
			12	1,871
			13	1,089
		Total		**19,404**
McMullin	→	North Kings	1	638
		Total		**638**
North Kings	→	Central Kings	14	568
			16	1,399
			17	599
			18	697
			20	808
			24	1,265
			25	3,165
			26	593
			27	373
		Total		**9,468**
Central Kings	→	North Kings	15	918
			19	1,142
			21	483
			22	1,515
			23	1,970
		Total		**6,029**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
			32	0
		Total		**0**

1925 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Central Kings	→	Kings River East	33	0
			37	0
			38	0
			40	0
			44	0
			45	0
			46	0
		Total		**0**
Kings River East	→	Central Kings	34	0
			35	0
			36	0
			39	0
			41	0
			42	0
			43	0
			47	0
		Total		**0**
Central Kings	→	McMullin	48	2,007
			49	861
			50	189
			51	1,326
		Total		**4,383**
McMullin	→	James	52	407
			53	431
			54	271
			55	390
			56	308
			57	237
			58	153
			59	170
		Total		**2,367**
North Fork Kings	→	McMullin	60	269
			64	5
			66	300
		Total		**574**
McMullin	→	North Fork Kings	61	759
			62	1,404
			63	1,538
			65	47
			67	99
			68	504
			69	381
		Total		**4,733**

1925 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Central Kings	→	North Fork Kings	70	429
			71	627
			72	360
			73	951
			75	805
			76	2,300
			77	137
			78	1,827
			79	525
			80	701
			81	1,011
			82	85
		Total		**9,758**
North Fork Kings	→	Central Kings	74	223
		Total		**223**
North Fork Kings	→	James	83	N/A
			84	14
			85	48
		Total		**61**

1997 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,408
			1	2,413
			3	2,244
			4	5,279
			5	1,261
			6	10,923
			7	5,065
			8	5,469
			9	7,075
			10	5,921
			11	11,302
			12	7,255
			13	3,973
		Total		**69,587**
McMullin	→	North Kings	2	622
		Total		**622**
North Kings	→	Central Kings	14	1,604
			16	1,542
			17	369
			18	614
			24	1,282
			25	2,635
			26	670
			27	576
		Total		**9,292**
Central Kings	→	North Kings	15	4,215
			19	2,642
			20	287
			21	805
			22	2,099
			23	2,312
		Total		**12,360**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

1997 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Central Kings	→	Kings River East	33	0
			36	0
			37	0
			38	0
			41	0
			46	0
			47	0
		Total		**0**
Kings River East	→	Central Kings	34	0
			35	0
			39	0
			40	0
			41	0
			42	0
			43	0
			44	0
			45	0
		Total		**0**
Central Kings	→	McMullin	48	4,000
			49	2,212
			51	1,915
		Total		**8,126**
McMullin	→	Central Kings	50	92
		Total		**92**
McMullin	→	James	52	218
			53	709
			54	214
		Total		**1,141**
James	→	McMullin	55	1,396
			56	3,195
			57	3,175
			58	2,048
			59	1,388
		Total		**11,202**
North Fork Kings	→	McMullin	61	2,154
			62	3,295
			63	490
			64	969
			65	112
			66	457
		Total		**7,478**

1997 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
McMullin	→	North Fork Kings	60	1,093
			67	46
			68	631
			69	831
		Total		**2,602**
North Fork Kings	→	Central Kings	74	474
			79	18
		Total		**493**
Central Kings	→	North Fork Kings	70	976
			71	702
			72	894
			73	1,354
			75	708
			76	3,502
			77	400
			78	3,054
			80	217
			81	2,847
			82	1,667
		Total		**16,321**
James	→	North Fork Kings	83	1,417
			84	731
			85	4,119
		Total		**6,267**

1998 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	970
			1	659
			3	880
			4	6,896
			5	2,777
			6	7,871
			7	1,822
			8	3,046
			9	4,270
			10	7,767
			11	9,270
			12	6,215
			13	2,569
		Total		**55,012**
McMullin	→	North Kings	2	694
		Total		**694**
North Kings	→	Central Kings	14	1,642
			16	1,629
			17	953
			18	2,158
			24	1,611
			25	2,429
			26	766
			27	682
		Total		**11,869**
Central Kings	→	North Kings	15	1,564
			19	2,010
			20	2
			21	790
			22	2,002
			23	2,821
		Total		**9,189**
North Kings	→	Kings River East	28	0
			29	0
			30	0
		Total		**0**
Kings River East	→	North Kings	31	0
			32	0
		Total		**0**

1998 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Central Kings	→	Kings River East	33	0
			35	0
			36	0
			37	0
			38	0
			40	0
			41	0
			46	0
		Total		**0**
Kings River East	→	Central Kings	34	0
			39	0
			42	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central Kings	→	McMullin	48	4,147
			49	2,440
			51	1,241
		Total		**7,828**
McMullin	→	Central Kings	50	414
		Total		**414**
James	→	McMullin	52	131
			53	107
			54	719
			55	2,105
			56	2,257
			57	2,893
			58	3,222
			59	1,538
		Total		**12,973**
North Fork Kings	→	McMullin	60	195
			61	2,497
			62	6,822
			63	5,141
			64	1,240
			65	182
			66	197
			67	106
		Total		**16,379**
McMullin	→	North Fork Kings	68	675
			69	808
		Total		**1,483**

1998 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Fork Kings	→	Central Kings	70	733
			74	158
		Total		**891**
Central Kings	→	North Fork Kings	71	663
			72	1,309
			73	1,277
			75	817
			76	3,864
			77	429
			78	4,100
			79	101
			80	575
			81	2,226
			82	971
		Total		**16,333**
James	→	North Fork Kings	83	1,411
			84	509
		Total		**1,920**
North Fork Kings	→	James	85	121
		Total		**121**

1999 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,221
			1	1,837
			3	52
			4	5,931
			5	2,038
			6	9,217
			7	2,310
			8	4,015
			9	4,064
			10	6,381
			11	12,782
			12	1,012
			13	3,077
		Total		**53,935**
McMullin	→	North Kings	2	313
		Total		**313**
North Kings	→	Central	14	1,600
			16	2,734
			17	648
			18	1,785
			20	1,032
			24	283
			25	1,949
			26	516
			27	510
		Total		**11,058**
Central	→	North Kings	15	1,766
			19	2,429
			21	868
			22	2,104
			23	3,950
		Total		**11,118**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

1999 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East		Central	35	0
			39	0
			40	0
			41	0
			44	0
			45	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			37	0
			36	0
			38	0
			42	0
			43	0
			46	0
			47	0
		Total		**0**
North Fork Kings	→	Central	70	1,245
			74	504
		Total		**1,748**
Central	→	North Fork Kings	71	1,083
			72	747
			73	1,535
			75	560
			76	3,432
			77	377
			78	3,505
			79	489
			80	1,338
			81	2,823
			82	1,437
		Total		**17,325**
North Fork Kings	→	McMullin	61	1,951
			62	2,576
			63	399
			64	3,043
			65	357
			66	278
			67	260
			69	1,144
		Total		**10,007**
McMullin	→	North Fork Kings	60	539
			68	785
		Total		**1,324**

1999 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	1,442
			84	539
			85	1,157
		Total		**3,138**
James	→	McMullin	52	4,327
			53	7,139
			54	5,195
			55	9,454
			56	8,310
			57	4,731
			58	1,778
			59	1,218
		Total		**42,152**
McMullin	→	Central	50	261
		Total		**261**
Central	→	McMullin	48	4,814
			49	2,452
			51	1,445
		Total		**8,711**

2000 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,474
			1	2,911
			4	3,590
			5	1,432
			6	9,828
			7	5,305
			8	3,383
			9	6,247
			10	5,749
			11	10,433
			12	3,280
			13	3,380
		Total		**57,014**
McMullin	→	North Kings	3	814
			3	198
		Total		**1,012**
North Kings	→	Central	14	1,324
			16	1,046
			17	877
			18	1,258
			20	2,049
			24	2,279
			25	2,524
			26	567
			27	500
		Total		**12,423**
Central	→	North Kings	15	1,116
			19	2,866
			21	538
			22	1,915
			23	3,251
		Total		**9,687**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2000 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East		Central	35	0
			39	0
			40	0
			41	0
			42	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			36	0
			37	0
			38	0
			46	0
		Total		**0**
North Fork Kings	→	Central	70	1,000
			71	1,401
			74	687
		Total		**3,087**
Central	→	North Fork Kings	72	1,791
			73	2,272
			75	557
			76	3,033
			77	412
			78	3,353
			79	705
			80	1,998
			81	2,594
			82	1,527
		Total		**18,243**
North Fork Kings	→	McMullin	60	954
			61	2,012
			62	2,725
			63	255
			64	625
			66	481
			69	458
		Total		**7,509**
McMullin		North Fork Kings	65	37
			67	210
			68	436
		Total		**684**

2000 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	1,740
			84	1,001
		Total		**2,741**
North Fork Kings	→	James	85	751
				751
James	→	McMullin	52	1,822
			53	924
			54	285
			56	273
			57	3,232
			58	1,373
			59	415
		Total		**8,324**
McMullin	→	James	55	569
		Total		**569**
McMullin	→	Central	50	228
		Total		**228**
Central	→	McMullin	48	5,205
			49	2,592
			51	933
		Total		**8,731**

2001 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,689
			1	3,506
			3	2,203
			4	2,816
			5	686
			6	9,104
			7	2,076
			8	5,442
			9	4,550
			10	7,135
			11	15,088
			12	3,648
			13	3,364
		Total		**61,307**
McMullin	→	North Kings	2	167
		Total		**167**
North Kings	→	Central	14	1,320
			16	1,975
			17	907
			18	2,224
			24	1,004
			25	1,786
			26	486
			27	447
		Total		**10,148**
Central	→	North Kings	15	1,190
			19	1,252
			20	1,686
			21	825
			22	1,145
			23	562
		Total		**6,661**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2001 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
			39	0
			40	0
			41	0
			42	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			35	0
			36	0
			37	0
			38	0
			46	0
		Total		**0**
North Fork Kings	→	Central	70	905
			74	678
		Total		**1,583**
Central	→	North Fork Kings	71	92
			72	1,494
			73	738
			75	1,032
			76	3,468
			77	431
			78	3,907
			79	751
			80	2,057
			81	1,477
			82	354
		Total		**15,801**
North Fork Kings	→	McMullin	60	872
			61	2,456
			62	2,381
			63	1,853
			64	1,889
			65	193
			66	330
			67	422
		Total		**10,397**
McMullin	→	North Fork Kings	68	801
			69	70
		Total		**871**

2001 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	1,801
			84	1,045
			85	179
		Total		**3,025**
James	→	McMullin	52	2,178
			53	1,866
			54	1,738
			55	4,729
			56	4,369
			57	4,375
			58	3,332
			59	1,786
		Total		**24,373**
McMullin	→	Central	50	387
		Total		**387**
Central	→	McMullin	48	5,674
			49	1,991
			51	1,026
		Total		**8,691**

2002 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	703
			1	1,396
			2	224
			4	3,159
			5	1,630
			6	7,542
			7	4,850
			8	4,615
			9	7,107
			10	6,072
			11	11,700
			12	5,493
			13	3,949
		Total		**58,440**
McMullin	→	North Kings	3	818
		Total		**818**
North Kings	→	Central	14	1,642
			16	2,137
			17	1,096
			18	2,482
			20	483
			24	2,956
			25	408
			26	528
			27	543
		Total		**12,275**
Central	→	North Kings	15	1,564
			19	1,822
			21	722
			22	2,480
			23	1,758
		Total		**8,347**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2002 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	35	0
			36	0
			39	0
			40	0
			41	0
			42	0
			44	0
			45	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			37	0
			38	0
			43	0
			46	0
			47	0
		Total		**0**
North Fork Kings	→	Central	70	1,594
			74	712
		Total		**2,306**
Central	→	North Fork Kings	71	538
			72	1,388
			73	1,562
			75	533
			76	3,804
			77	458
			78	4,071
			79	578
			80	886
			81	1,427
			82	275
		Total		**15,520**
North Fork Kings	→	McMullin	60	1,301
			61	1,332
			62	3,094
			63	1,470
			64	1,548
			65	171
			66	614
			67	395
			69	1,323
		Total		**11,247**
McMullin	→	North Fork Kings	68	667
		Total		**667**

2002 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Fork Kings	→	James	83	N/A
			85	2,557
		Total		**2,557**
James	→	North Fork Kings	84	N/A
		Total		**0**
McMullin	→	James	52	373
			53	524
			54	296
			55	449
		Total		**1,641**
James	→	McMullin	56	665
			57	2,047
			58	3,035
			59	1,430
		Total		**7,177**
McMullin	→	Central	50	279
		Total		**279**
Central	→	McMullin	48	5,129
			49	2,185
			51	976
		Total		**8,290**

2003 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,068
			1	1,388
			4	5,877
			5	1,522
			6	10,093
			7	4,007
			8	5,868
			9	6,980
			10	9,492
			11	10,948
			12	5,272
			13	3,145
		Total		**65,662**
McMullin	→	North Kings	2	208
			3	51
		Total		**259**
North Kings	→	Central	14	1,496
			16	1,938
			17	1,138
			18	3,282
			24	702
			25	1,883
			26	583
			27	596
		Total		**11,617**
Central	→	North Kings	15	1,632
			19	1,872
			20	926
			21	1,155
			22	2,423
			23	3,629
		Total		**11,637**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2003 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	35	0
			36	0
			39	0
			40	0
			41	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			37	0
			38	0
			42	0
			46	0
		Total		**0**
North Fork Kings	→	Central	70	1,610
			74	1,012
			82	602
		Total		**3,223**
Central	→	North Fork Kings	71	529
			72	1,019
			73	1,479
			75	356
			76	1,872
			77	247
			78	3,101
			79	725
			80	1,675
			81	898
		Total		**11,901**
North Fork Kings	→	McMullin	61	724
			62	2,390
			64	903
			65	140
			66	688
			67	262
			69	896
		Total		**6,003**
McMullin	→	North Fork Kings	60	685
			63	984
			68	933
		Total		**2,603**

2003 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	2,247
			84	511
			85	1,221
		Total		**3,979**
James	→	McMullin	52	1,464
			53	1,154
			54	1,070
			55	1,802
			56	1,356
			57	1,413
			58	971
			59	409
		Total		**9,637**
McMullin	→	Central	50	317
			51	225
		Total		**542**
Central	→	McMullin	48	3,842
			49	1,855
		Total		**5,697**

2004 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,995
			1	921
			2	1,783
			3	2,994
			4	6,062
			5	1,862
			6	10,608
			7	3,987
			8	5,594
			9	7,211
			10	6,287
			11	9,408
			12	5,777
			13	3,132
		Total		**67,621**
North Kings	→	Central	14	1,940
			16	2,247
			17	1,208
			18	2,255
			20	685
			24	3,646
			25	2,726
			26	582
			27	547
		Total		**15,838**
Central	→	North Kings	15	1,849
			19	2,528
			21	1,064
			22	3,220
			23	3,727
		Total		**12,388**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2004 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	35	0
			36	0
			39	0
			40	0
			41	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			37	0
			38	0
			42	0
			46	0
		Total		**0**
North Fork Kings	→	Central	70	1,422
			71	319
			73	1,444
			74	1,130
			75	53
			82	983
		Total		**5,351**
Central	→	North Fork Kings	72	992
			76	1,951
			77	299
			78	3,546
			79	915
			80	2,078
			81	1,636
		Total		**11,415**
North Fork Kings	→	McMullin	61	1,700
			65	219
			66	545
			69	102
		Total		**2,566**
McMullin	→	North Fork Kings	60	191
			62	929
			63	1,004
			64	806
			67	201
			68	530
		Total		**3,661**

2004 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	936
			84	241
			85	997
		Total		**2,174**
James	→	McMullin	52	1,648
			53	2,217
			54	719
			55	934
			56	2,128
			57	3,238
			58	4,747
			59	2,160
		Total		**17,792**
McMullin	→	Central	50	499
		Total		**499**
Central	→	McMullin	48	2,747
			49	1,497
			51	1,036
		Total		**5,280**

2005 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	2,185
			1	1,343
			2	1,279
			3	3,262
			4	7,075
			5	1,926
			6	10,631
			7	4,050
			8	3,107
			9	6,033
			10	6,841
			11	11,323
			12	4,799
			13	2,470
		Total		**66,323**
North Kings	→	Central	14	1,631
			16	1,940
			17	1,129
			18	2,806
			24	1,179
			25	1,201
			26	547
			27	531
		Total		**10,965**
Central	→	North Kings	15	1,526
			19	1,869
			20	947
			21	1,070
			22	3,431
			23	3,504
		Total		**12,347**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2005 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	39	0
			40	0
			41	0
			42	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			35	0
			36	0
			37	0
			38	0
			46	0
		Total		**0**
North Fork Kings	→	Central	70	1,869
			74	771
		Total		**2,640**
Central	→	North Fork Kings	71	25
			72	988
			73	948
			75	661
			76	2,655
			77	370
			78	3,049
			79	606
			80	1,942
			81	2,223
			82	506
		Total		**13,975**
North Fork Kings	→	McMullin	61	1,504
			64	359
			65	116
			66	608
			67	240
			69	1,962
		Total		**4,791**
McMullin	→	North Fork Kings	60	522
			62	2,813
			63	2,567
			68	624
		Total		**6,525**

2005 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	2,474
			84	1,565
			85	2,942
		Total		**6,981**
James	→	McMullin	52	3,917
			53	4,222
			54	2,904
			55	3,509
			56	1,763
			57	4,362
			58	1,828
			59	923
		Total		**23,429**
McMullin	→	Central	50	183
		Total		**183**
Central	→	McMullin	48	4,077
			49	2,233
			51	1,143
		Total		**7,454**

2006 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	742
			1	1,710
			3	1,056
			4	5,558
			5	1,452
			6	8,673
			8	10,050
			9	7,364
			10	8,612
			11	14,739
			12	4,426
			13	3,624
		Total		**68,005**
McMullin	→	North Kings	2	1,072
			7	199
		Total		**1,272**
North Kings	→	Central	14	2,166
			16	2,801
			17	1,017
			18	2,900
			20	1,004
			24	169
			25	1,469
			26	484
			27	458
		Total		**12,469**
Central	→	North Kings	15	2,106
			19	1,866
			21	772
			22	2,058
			23	2,663
		Total		**9,466**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2006 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East		Central	34	0
			35	0
			36	0
			39	0
			40	0
			41	0
			42	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			37	0
			38	0
			46	0
		Total		**0**
North Fork Kings	→	Central	70	364
			74	734
		Total		**1,098**
Central	→	North Fork Kings	71	611
			72	949
			73	1,560
			75	217
			76	2,986
			77	353
			78	3,827
			79	1,035
			80	2,195
			81	3,650
			82	1,079
		Total		**18,463**
North Fork Kings	→	McMullin	61	1,579
			63	278
			64	1,256
			65	186
			66	611
		Total		**3,910**
McMullin	→	North Fork Kings	60	481
			62	548
			67	93
			68	938
			69	118
		Total		**2,179**

2006 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	N/A
			85	554
		Total		**554**
North Fork Kings	→	James	84	171
		Total		**171**
McMullin	→	James	52	625
			53	412
		Total		**1,038**
James	→	McMullin	54	133
			55	1,184
			56	1,205
			57	1,043
			58	1,071
			59	677
		Total		**5,313**
McMullin	→	Central	50	225
		Total		**225**
Central	→	McMullin	48	2,987
			49	3,610
			51	623
		Total		**7,220**

2007 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,229
			1	4,161
			2	1,098
			3	1,461
			4	4,310
			5	2,392
			6	10,450
			7	2,675
			8	5,640
			9	7,760
			10	8,082
			11	14,370
			12	4,614
			13	3,872
		Total		**72,114**
North Kings	→	Central	14	1,542
			16	3,809
			17	707
			18	3,436
			20	1,436
			24	385
			25	1,765
			26	539
			27	477
		Total		**14,094**
Central	→	North Kings	15	1,258
			19	2,956
			21	1,130
			22	2,144
			23	1,601
		Total		**9,089**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2007 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	34	0
			35	0
			36	0
			39	0
			40	0
			41	0
			43	0
			44	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			37	0
			38	0
			42	0
			46	0
		Total		**0**
North Fork Kings	→	Central	74	466
		Total		**466**
Central	→	North Fork Kings	70	709
			71	351
			72	1,393
			73	824
			75	401
			76	3,486
			77	405
			78	4,060
			79	540
			80	2,128
			81	4,220
			82	1,408
		Total		**19,925**
North Fork Kings	→	McMullin	61	1,185
			64	526
			65	119
			66	984
			69	796
		Total		**3,610**
McMullin	→	North Fork Kings	60	1,518
			62	1,293
			63	2,265
			67	868
			68	742
		Total		**6,686**

2007 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	2,180
			84	1,256
			85	3,931
		Total		**7,366**
James	→	McMullin	52	3,944
			53	5,327
			54	4,215
			55	5,764
			56	6,078
			57	4,116
			58	1,866
			59	1,067
		Total		**32,378**
McMullin	→	Central	50	10
		Total		**10**
Central	→	McMullin	48	4,818
			49	2,395
			51	1,792
		Total		**9,005**

2008 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	367
			1	990
			2	1,259
			3	1,851
			4	6,744
			5	2,090
			6	8,919
			7	3,112
			8	6,647
			9	7,849
			10	7,949
			11	14,284
			12	5,857
			13	3,678
		Total		**71,596**
North Kings	→	Central	14	1,598
			16	2,768
			17	1,055
			18	2,975
			20	1,360
			24	472
			25	2,175
			26	694
			27	588
		Total		**13,685**
Central	→	North Kings	15	1,485
			19	1,768
			21	877
			22	1,930
			23	1,768
		Total		**7,827**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2008 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	35	0
			36	0
			37	0
			39	0
			40	0
			43	0
			44	0
			45	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			38	0
			41	0
			42	0
			46	0
			47	0
		Total		**0**
North Fork Kings	→	Central	70	1,656
			71	147
			74	576
		Total		**2,379**
Central	→	North Fork Kings	72	883
			73	1,067
			75	748
			76	2,876
			77	347
			78	4,332
			79	549
			80	2,024
			81	3,999
			82	691
		Total		**17,517**
North Fork Kings	→	McMullin	60	147
			61	677
			64	601
			65	349
			66	507
			69	820
		Total		**3,101**
McMullin	→	North Fork Kings	62	3,223
			63	3,793
			67	34
			68	987
		Total		**8,037**

2008 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	2,191
			84	1,272
			85	1,069
		Total		**4,532**
James	→	McMullin	52	1,062
			53	969
			54	1,180
			55	3,479
			56	3,951
			57	4,597
			58	2,842
			59	1,558
		Total		**19,637**
McMullin	→	Central	50	137
		Total		**137**
Central	→	McMullin	48	5,004
			49	2,873
			51	915
		Total		**8,793**

2009 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,098
			1	259
			2	347
			3	664
			4	4,658
			5	1,590
			6	7,578
			7	1,820
			8	9,142
			9	8,422
			10	7,484
			11	16,119
			12	5,188
			13	3,822
		Total		**68,193**
North Kings	→	Central	14	1,568
			16	2,641
			17	995
			18	3,165
			20	1,588
			24	721
			25	1,659
			26	563
			27	500
		Total		**13,400**
Central	→	North Kings	15	1,833
			19	1,301
			21	1,280
			22	2,380
			23	1,263
		Total		**8,057**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2009 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	34	0
			35	0
			36	0
			37	0
			39	0
			40	0
			41	0
			44	0
			45	0
		Total		**0**
Central	→	Kings River East	33	0
			38	0
			42	0
			43	0
			46	0
			47	0
		Total		**0**
North Fork Kings	→	Central	70	959
			73	784
			74	1,283
		Total		**3,026**
Central	→	North Fork Kings	71	364
			72	1,274
			75	322
			76	3,645
			77	546
			78	4,781
			79	550
			80	2,363
			81	3,963
			82	764
		Total		**18,573**
North Fork Kings	→	McMullin	61	2,688
			64	1,285
			65	215
			66	780
			69	1,927
		Total		**6,895**
McMullin	→	North Fork Kings	60	1,414
			62	1,274
			63	967
			67	899
			68	2,399
		Total		**6,953**

2009 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	1,955
			84	1,127
			85	2,415
		Total		**5,497**
James	→	McMullin	52	1,216
			53	275
			54	61
			55	2,175
			56	3,898
			57	4,306
			58	1,833
			59	1,380
		Total		**15,145**
McMullin	→	Central	50	434
		Total		**434**
Central	→	McMullin	48	2,850
			49	2,347
			51	907
		Total		**6,103**

2011 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	858
			1	960
			3	1,111
			4	6,786
			5	2,479
			6	8,936
			7	2,610
			8	6,095
			9	7,021
			10	8,472
			11	15,652
			12	6,563
			13	4,475
		Total		**72,019**
McMullin	→	North Kings	2	38
		Total		**38**
North Kings	→	Central	14	1,723
			16	2,788
			17	898
			18	2,104
			20	2,806
			24	387
			25	1,543
			26	449
			27	480
		Total		**13,178**
Central	→	North Kings	15	1,335
			19	1,471
			21	974
			22	1,115
			23	2,413
		Total		**7,308**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
			32	0
		Total		**0**

2011 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	35	0
			36	0
			37	0
			39	0
			40	0
			45	0
			47	0
		Total		**0**
Central	→	Kings River East	33	0
			34	0
			38	0
			41	0
			42	0
			43	0
			44	0
			46	0
		Total		**0**
North Fork Kings	→	Central	74	534
		Total		**534**
Central	→	North Fork Kings	70	673
			71	834
			72	811
			73	1,625
			75	765
			76	3,995
			77	483
			78	4,308
			79	699
			80	2,120
			81	3,703
			82	170
		Total		**20,185**
North Fork Kings	→	McMullin	60	31
			61	1,458
			64	816
			66	518
		Total		**2,824**
McMullin	→	North Fork Kings	62	608
			63	1,585
			65	63
			67	35
			68	1,230
			69	131
		Total		**3,652**

2011 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Fork Kings	→	James	85	1,111
		Total		**1,111**
James	→	North Fork Kings	83	973
			84	115
		Total		**1,088**
McMullin	→	James	52	419
		Total		**419**
James	→	McMullin	53	1,171
			54	1,867
			55	4,118
			56	2,850
			57	1,943
			58	1,357
			59	765
		Total		**14,072**
McMullin	→	Central	50	86
		Total		**86**
Central	→	McMullin	48	3,726
			49	2,669
			51	1,760
		Total		**8,156**

2012 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
North Kings	→	McMullin	0	1,337
			1	577
			2	1,116
			3	1,999
			4	5,526
			5	2,184
			6	5,608
			7	2,593
			8	5,903
			9	8,228
			10	8,399
			11	14,202
			12	5,670
			13	3,841
		Total		**67,184**
North Kings	→	Central	14	1,061
			16	2,599
			17	1,062
			20	1,248
			24	530
			25	1,594
			26	584
			27	558
		Total		**9,237**
Central	→	North Kings	15	2,017
			18	874
			19	1,260
			21	1,092
			22	2,325
			23	2,030
		Total		**9,599**
North Kings	→	Kings River East	28	0
			29	0
			30	0
			31	0
		Total		**0**
Kings River East	→	North Kings	32	0
		Total		**0**

2012 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
Kings River East	→	Central	34	0
			35	0
			36	0
			39	0
			40	0
			41	0
			45	0
		Total		**0**
Central	→	Kings River East	33	0
			37	0
			38	0
			42	0
			43	0
			44	0
			46	0
			47	0
		Total		**0**
North Fork Kings	→	Central	70	579
			74	560
		Total		**1,139**
Central	→	North Fork Kings	71	1,288
			72	1,127
			73	1,762
			75	687
			76	4,640
			77	431
			78	4,565
			79	1,035
			80	2,469
			81	4,793
			82	2,479
		Total		**25,275**
North Fork Kings	→	McMullin	61	789
			62	2,036
			64	2,276
			65	581
			66	819
		Total		**6,501**
McMullin	→	North Fork Kings	60	136
			63	3,394
			67	933
			68	2,217
			69	220
		Total		**6,900**

2012 Kings Subbasin Flow Estimate grouped by GSAs to GSAs

GSA	→	GSA	Segment	Est. Flow
James	→	North Fork Kings	83	N/A
			84	242
			85	444
		Total		**686**
McMullin	→	James	52	17
			54	284
			55	732
		Total		**1,033**
James	→	McMullin	53	26
			56	604
			57	1,661
			58	1,539
			59	795
		Total		**4,625**
McMullin	→	Central	50	419
		Total		**419**
Central	→	McMullin	48	6,399
			49	2,998
			51	1,289
		Total		**10,686**

External

1925 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			102	0
			103	0
			104	0
			105	0
			106	0
			108	0
		Total		**0**
North Kings	→	Root Creek WD	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			115	0
			116	0
			117	0
			118	0
			119	0
		Total		**0**
McMullin	→	Farmer WD	120	0
			121	N/A
		Total		**0**
McMullin	→	Fresno County	122	N/A
			123	N/A
			125	320
			126	N/A
		Total		**320**
Fresno County	→	McMullin	124	N/A
		Total		**0**
James ID	→	Fresno County	127	N/A
			128	N/A
		Total		**0**
James ID	→	Central Delta Mendota Regional Mulit Agency GSA	129	N/A
			130	N/A
			131	N/A
			132	N/A
			133	N/A
			134	N/A
		Total		**0**

1925 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
James ID	→	Westlands WD	135	N/A
			135	N/A
			136	N/A
		Total		**0**
North Fork Kings	→	Westlands WD	137	N/A
			138	N/A
			139	N/A
			141	N/A
			142	N/A
			143	N/A
			144	N/A
			145	N/A
			146	N/A
			147	N/A
			148	N/A
			153	N/A
			154	N/A
			155	N/A
		Total		**0**
Westlands WD	→	North Fork Kings	140	N/A
			149	N/A
			150	N/A
			151	N/A
			152	N/A
		Total		**0**
South Fork Kings GSA	→	North Fork Kings	156	N/A
			157	0
			158	0
		Total		**0**
North Fork Kings	→	South Fork Kings GSA	159	0
			160	0
			161	0
		Total		**0**
North Fork Kings	→	Mid Kings River GSA	163	0
		Total		**0**
Mid Kings River GSA	→	North Fork Kings	162	0
			164	263
			165	201
		Total		**465**
Central Kings	→	Mid Kings River GSA	166	623
			167	0
		Total		**623**

1925 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Mid Kings River GSA	→	Central Kings	168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	N/A
			170	N/A
			171	N/A
		Total		**0**
Kings River East	→	Greater Kaweah GSA	172	N/A
			175	N/A
		Total		**0**
Greater Kaweah GSA	→	Kings River East	173	N/A
			174	N/A
			176	N/A
			177	N/A
		Total		**0**
East Kaweah GSA	→	Kings River East	178	N/A
			179	N/A
		Total		**0**
Kings River East	→	East Kaweah GSA	180	N/A
			181	N/A
			182	N/A
		Total		**0**

1997 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			104	0
			105	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			106	0
		Total		**0**
North Kings	→	Root Creek WD	107	0
		Total		**0**
Madera ID	→	North Kings	111	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			118	0
		Total		**0**
Farmer WD	→	McMullin	120	0
			121	1,389
		Total		**1,389**
Fresno County	→	McMullin	122	2,359
			124	75
			125	45
			126	1,717
		Total		**4,197**
McMullin	→	Fresno County	123	271
		Total		**271**
Fresno County	→	James ID	127	971
			128	439
		Total		**1,410**

1997 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	164
			130	1,601
			131	710
			132	1,241
			133	459
		Total		**4,175**
James ID		Westlands WD	135	759
			136	676
		Total		**1,435**
Westlands WD		James ID	134	319
		Total		**319**
Westlands WD	→	North Fork Kings	137	1,768
			138	149
			141	1,492
			142	73
			143	1,281
			147	361
			148	355
			151	1,231
			155	198
		Total		**6,908**
North Fork Kings	→	Westlands WD	139	2,739
			140	985
			144	297
			145	394
			146	140
			149	890
			150	1,392
			152	811
			153	539
			154	273
		Total		**8,459**
South Fork Kings GSA	→	North Fork Kings	156	348
			157	0
			158	0
			159	0
			160	0
		Total		**348**
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			164	714
			165	1,807
		Total		**2,521**

1997 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	163	0
		Total		**0**
Central Kings	→	Mid Kings River GSA	166	524
			167	0
			168	0
		Total		**524**
Kings River East	→	Mid Kings River GSA	169	309
			171	1,428
		Total		**1,737**
Mid Kings River GSA	→	Kings River East	170	9,523
		Total		**9,523**
Greater Kaweah GSA	→	Kings River East	172	1,751
			173	842
			175	15
		Total		**2,608**
Kings River East	→	Greater Kaweah GSA	174	852
			176	1,142
			177	1,357
		Total		**3,352**
Kings River East	→	East Kaweah GSA	178	1,308
			179	2,253
		Total		**3,561**
East Kaweah GSA	→	Kings River East	180	633
			181	434
			182	791
		Total		**1,858**

1998 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			102	0
			103	0
			104	0
			105	0
			108	0
		Total		**0**
Madera County	→	North Kings	106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			118	0
			119	0
		Total		**0**
Farmer WD	→	McMullin	120	0
			121	1,100
		Total		**1,100**
Fresno County	→	McMullin	122	1,367
			126	4,425
		Total		**5,792**
McMullin	→	Fresno County	123	397
			124	15
			125	105
		Total		**518**
Fresno County	→	James ID	127	869
			128	477
		Total		**1,346**
James ID	→	Central Delta Mendota Regional Mulit Agency GSA	129	330
			130	25
			133	89
		Total		**443**

1998 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	131	70
			132	798
			134	108
		Total		**975**
James ID	→	Westlands WD	135	723
			136	841
		Total		**1,564**
Westlands WD	→	North Fork Kings	137	1,710
			141	102
			142	115
			143	645
			147	534
			148	503
			151	68
		Total		**3,677**
North Fork Kings	→	Westlands WD	138	226
			139	1,055
			140	989
			144	250
			145	440
			146	89
			149	172
			150	947
			152	920
			153	1,146
			154	105
			155	48
		Total		**6,387**
South Fork Kings GSA	→	North Fork Kings	156	10
			157	0
			158	0
			159	0
			160	0
		Total		**10**
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			165	1,049
		Total		**1,049**
North Fork Kings	→	Mid Kings River GSA	163	0
			164	450
		Total		**450**

1998 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Kings	→	Mid Kings River GSA	166	1,105
			167	0
			168	0
		Total		**1,105**
Kings River East	→	Mid Kings River GSA	169	127
			171	525
		Total		**653**
Mid Kings River GSA	→	Kings River East	170	1,805
		Total		**1,805**
Greater Kaweah GSA	→	Kings River East	172	2,150
			173	442
		Total		**2,592**
Kings River East	→	Greater Kaweah GSA	174	1,022
			175	47
			176	1,314
			177	1,802
		Total		**4,184**
Kings River East	→	East Kaweah GSA	178	308
			179	1,836
		Total		**2,144**
East Kaweah GSA	→	Kings River East	180	263
			181	132
			182	530
		Total		**924**

1999 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			102	0
			103	0
			104	0
			108	0
		Total		**0**
Madera County	→	North Kings	105	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
Madera ID	→	North Kings	111	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			118	0
			119	0
		Total		**0**
McMullin	→	Farmers WD	120	0
			121	N/A
		Total		**0**
McMullin	→	Fresno County	122	N/A
			124	2,428
		Total		**2,428**
Fresno County	→	McMullin	123	894
			125	723
			126	7,169
		Total		**8,786**
James ID	→	Fresno County	127	1,279
		Total		**1,279**
Fresno County	→	James ID	128	1,405
		Total		**1,405**

1999 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	2,670
			132	2,402
			133	346
			134	13
		Total		**5,431**
James ID	→	Central Delta Mendota Regional	130	4,644
			131	277
		Total		**4,921**
James ID	→	Westlands WD	135	387
			136	707
		Total		**1,093**
Westlands WD	→	North Fork Kings	137	1,982
			141	2,772
			142	694
			143	869
			144	212
			146	348
			147	753
			148	538
			149	187
		Total		**8,356**
North Fork Kings	→	Westlands WD	138	235
			139	1,137
			140	603
			145	49
			150	528
			151	554
			152	1,430
			153	1,968
			154	N/A
			155	N/A
		Total		**6,504**
North Fork Kings	→	South Fork Kings GSA	156	N/A
			157	0
			160	0
		Total		**0**
South Fork Kings GSA	→	North Fork Kings	158	0
			159	0
		Total		**0**
North Fork Kings	→	Mid Kings River GSA	161	0
			162	0
			163	0
		Total		**0**

1999 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Mid Kings River GSA	→	North Fork Kings	164	53
			165	963
		Total		**1,016**
Central Kings	→	Mid Kings River GSA	166	1,122
			167	0
			168	0
		Total		**1,122**
Kings River East	→	Mid Kings River GSA	169	295
			171	1,524
		Total		**1,819**
Mid Kings River GSA	→	Kings River East	170	6,714
		Total		**6,714**
Kings River East	→	Greater Kaweah GSA	172	1,909
			174	546
			175	33
			176	762
			177	2,176
		Total		**5,426**
Greater Kaweah GSA	→	Kings River East	173	788
		Total		**788**
Kings River East	→	East Kaweah GSA	178	831
			179	2,085
			180	N/A
			181	N/A
		Total		**2,915**
East Kaweah GSA	→	Kings River East	182	609
		Total		**609**

2000 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			103	0
			104	0
			105	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			115	0
			116	0
			117	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	118	0
		Total		**0**
McMullin	→	Farmers WD	120	0
			121	521
		Total		**521**
McMullin	→	Fresno County	123	28
			125	875
		Total		**903**
Fresno County	→	McMullin	122	271
			124	700
			126	9,103
		Total		**10,074**
Fresno County	→	James ID	127	974
			128	1,132
		Total		**2,106**

2000 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	809
			130	4,925
			132	2,693
			133	1,582
			134	904
		Total		**10,914**
James ID	→	Central Delta Mendota Regional Mulit Agency GSA	131	27
		Total		**27**
James ID	→	Westlands WD	135	777
			136	965
		Total		**1,743**
Westlands WD	→	North Fork Kings	137	733
			141	450
			142	104
			147	325
			148	350
		Total		**1,963**
North Fork Kings	→	Westlands WD	138	243
			139	723
			140	1,121
			143	46
			144	228
			145	231
			146	4
			149	806
			150	3,068
			151	809
			152	1,892
			153	3,015
			154	762
			155	587
		Total		**13,534**
North Fork Kings	→	South Fork Kings GSA	156	393
			159	0
		Total		**393**
South Fork Kings GSA	→	North Fork Kings	157	0
			158	0
			160	0
		Total		**0**

2000 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	163	0
		Total		**0**
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			164	945
			165	1,606
		Total		**2,551**
Mid Kings River GSA	→	Central Kings	166	830
		Total		**830**
Central Kings	→	Mid Kings River GSA	167	0
			168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	180
			171	1,163
		Total		**1,343**
Mid Kings River GSA	→	Kings River East	170	4,109
		Total		**4,109**
Kings River East	→	Greater Kaweah GSA	174	578
			175	23
			176	1,097
			177	3,482
		Total		**5,180**
Greater Kaweah GSA	→	Kings River East	172	271
			173	54
		Total		**326**
Kings River East	→	East Kaweah GSA	179	1,389
		Total		**1,389**
East Kaweah GSA	→	Kings River East	178	70
			180	344
			181	200
			182	574
		Total		**1,188**

2001 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			104	0
			105	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	116	0
			117	0
			118	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	114	0
			115	0
		Total		**0**
Farmers WD	→	McMullin	120	0
			121	1,396
		Total		**1,396**
Fresno County	→	McMullin	122	341
			124	386
			126	9,525
		Total		**10,252**
McMullin	→	Fresno County	123	261
			125	1,326
		Total		**1,587**
Fresno County	→	James ID	127	1,061
			128	1,137
		Total		**2,198**

2001 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	2,231
			130	7,183
			131	1,736
			132	2,263
			133	1,953
			134	1,249
		Total		**16,616**
James ID	→	Westlands WD	135	1,398
			136	1,015
		Total		**2,414**
Westlands WD	→	North Fork Kings	140	926
			141	1,917
			144	N/A
			145	N/A
			146	N/A
			152	315
			155	81
		Total		**3,240**
North Fork Kings	→	Westlands WD	137	1,391
			138	1,100
			139	1,254
			140	926
			142	194
			143	544
			147	N/A
			148	N/A
			149	3,601
			150	1,495
			151	450
			153	2,677
			154	676
		Total		**14,309**
North Fork Kings	→	South Fork Kings GSA	156	10
		Total		**10**
South Fork Kings GSA	→	North Fork Kings	157	0
			158	0
			159	0
			160	0
		Total		**0**

2001 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			165	164
		Total		**164**
North Fork Kings	→	Mid Kings River GSA	163	0
			164	102
		Total		**102**
Mid Kings River GSA	→	Central Kings	166	1,184
		Total		**1,184**
Central Kings	→	Mid Kings River GSA	167	0
			168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	192
			171	2,295
		Total		**2,488**
Mid Kings River GSA	→	Kings River East	170	3,711
		Total		**3,711**
Kings River East	→	Greater Kaweah GSA	172	3,259
			174	883
			175	10
			176	880
			177	340
		Total		**5,373**
Greater Kaweah GSA	→	Kings River East	173	36
		Total		**36**
Kings River East	→	East Kaweah GSA	178	605
			179	1,933
		Total		**2,538**
East Kaweah GSA	→	Kings River East	180	474
			181	276
			182	640
		Total		**1,389**

2002 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			104	0
			105	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
Madera ID	→	North Kings	111	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			116	0
			117	0
			118	0
		Total		**0**
McMullin	→	Farmers WD	120	0
			121	N/A
		Total		**0**
Fresno County	→	McMullin	123	N/A
			126	46
		Total		**46**
McMullin	→	Fresno County	122	N/A
			124	N/A
			125	2,535
		Total		**2,535**
Fresno County	→	James ID	127	N/A
			128	N/A
		Total		**0**

2002 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	130	N/A
			131	N/A
			134	N/A
		Total		**0**
James ID	→	Central Delta Mendota Regional Mulit Agency GSA	129	N/A
			132	N/A
			133	N/A
		Total		**0**
Westlands WD	→	James ID	135	N/A
			136	N/A
		Total		**0**
Westlands WD	→	North Fork Kings	137	1,444
			141	1,119
			142	628
			144	601
			145	370
			146	686
			147	753
			151	39
		Total		**5,640**
North Fork Kings	→	Westlands WD	138	527
			139	841
			140	863
			143	1,180
			148	392
			149	1,579
			150	2,203
			152	1,815
			153	3,034
			154	958
			155	1,253
		Total		**14,645**
North Fork Kings	→	South Fork Kings GSA	156	744
			159	0
			160	0
		Total		**744**
South Fork Kings GSA	→	North Fork Kings	157	0
			158	0
		Total		**0**
Mid Kings River GSA	→	North Fork Kings	162	0
			164	3,022
			165	2,395
		Total		**5,417**

2002 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	161	0
			163	0
		Total		**0**
Central Kings	→	Mid Kings River GSA	166	285
			167	0
			168	0
		Total		**285**
Kings River East	→	Mid Kings River GSA	169	71
			171	2,157
		Total		**2,228**
Mid Kings River GSA	→	Kings River East	170	2,962
		Total		**2,962**
Kings River East	→	Greater Kaweah GSA	172	517
			174	594
			175	27
			176	781
			177	1,027
		Total		**2,946**
Greater Kaweah GSA	→	Kings River East	173	528
		Total		**528**
Kings River East	→	East Kaweah GSA	178	294
			179	1,110
		Total		**1,404**
East Kaweah GSA	→	Kings River East	180	192
			181	104
			182	370
		Total		**667**

2003 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			104	0
			105	0
			106	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
		Total		**0**
North Kings	→	Root Creek WD	107	0
		Total		**0**
Madera ID	→	North Kings	109	0
			112	0
		Total		**0**
North Kings	→	Madera ID	110	0
			111	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			118	0
		Total		**0**
Farmers WD	→	McMullin	120	0
			121	22
		Total		**22**
McMullin	→	Fresno County	122	824
			124	1,772
			123	184
			125	5,554
		Total		**8,333**
Fresno County	→	McMullin	126	10,119
		Total		**10,119**
Fresno County	→	James ID	127	1,404
			128	1,730
		Total		**3,134**

2003 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	1,590
			130	6,948
			131	1,444
			132	995
			133	289
		Total		**11,266**
James ID	→	Central Delta Mendota Regional Mulit Agency GSA	134	212
		Total		**212**
James ID	→	Westlands WD	135	1,134
			136	1,657
		Total		**2,791**
Westlands WD	→	North Fork Kings	141	1,608
			142	578
			143	831
			144	223
			146	427
			147	637
			148	905
			149	1,874
		Total		**7,083**
North Fork Kings	→	Westlands WD	137	607
			138	370
			139	693
			140	842
			145	593
			150	1,687
			151	638
			152	1,870
			153	2,726
			154	620
			155	509
		Total		**11,157**
North Fork Kings	→	South Fork Kings GSA	156	518
			159	0
			160	0
		Total		**518**
South Fork Kings GSA	→	North Fork Kings	157	0
			158	0
		Total		**0**

2003 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
		Total		**0**
North Fork Kings	→	Mid Kings River GSA	163	0
			164	836
			165	532
		Total		**1,368**
Mid Kings River GSA	→	Central Kings	166	2,747
		Total		**2,747**
Central Kings	→	Mid Kings River GSA	167	0
			168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	335
			171	2,418
		Total		**2,752**
Mid Kings River GSA	→	Kings River East	170	4,561
		Total		**4,561**
Kings River East	→	Greater Kaweah GSA	172	3,518
			174	49
			175	64
			176	872
			177	228
		Total		**4,731**
Greater Kaweah GSA	→	Kings River East	173	28
		Total		**28**
Kings River East	→	East Kaweah GSA	179	1,989
		Total		**1,989**
East Kaweah GSA	→	Kings River East	178	794
			180	415
			181	219
			182	522
		Total		**1,950**

2004 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			104	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			105	0
			106	0
		Total		**0**
North Kings	→	Root Creek WD	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			117	0
			118	0
		Total		**0**
Farmers WD	→	McMullin	120	0
			121	1,680
		Total		**1,680**
Fresno County	→	McMullin	122	1,901
			126	4,805
		Total		**6,706**
McMullin	→	Fresno County	123	1,787
			124	2,629
			125	3,744
		Total		**8,160**
Fresno County	→	James ID	127	763
			128	1,279
		Total		**2,042**

2004 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	4,062
			130	6,158
			131	1,264
			132	374
			133	392
			134	336
		Total		**12,585**
James ID	→	Westlands WD	135	899
			136	548
		Total		**1,447**
Westlands WD	→	North Fork Kings	137	1,770
			141	2,390
			142	980
			143	2,210
			147	432
			151	36
			155	N/A
		Total		**7,817**
North Fork Kings	→	Westlands WD	138	79
			139	1,682
			140	479
			144	150
			145	1,209
			146	161
			148	660
			149	857
			150	594
			152	866
			153	2,365
			154	N/A
		Total		**9,104**
North Fork Kings	→	South Fork Kings GSA	156	N/A
			157	0
			158	0
			159	0
			160	0
		Total		**0**
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
		Total		**0**

2004 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	163	0
			164	765
			165	714
		Total		**1,479**
Mid Kings River GSA	→	Central Kings	166	748
		Total		**748**
Central Kings	→	Mid Kings River GSA	167	0
			168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	279
			171	1,723
		Total		**2,002**
Mid Kings River GSA	→	Kings River East	170	4,187
		Total		**4,187**
Kings River East	→	Greater Kaweah GSA	172	1,945
			174	18
			175	49
		Total		**2,011**
Greater Kaweah GSA	→	Kings River East	173	543
			176	200
			177	230
		Total		**973**
Kings River East	→	East Kaweah GSA	179	426
			180	N/A
			181	N/A
		Total		**426**
East Kaweah GSA	→	Kings River East	178	626
			182	359
		Total		**985**

2005 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			104	0
			105	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			118	0
		Total		**0**
Farmers WD	→	McMullin	120	0
			121	2,034
		Total		**2,034**
Fresno County	→	McMullin	122	2,621
			123	3,482
			124	8,772
			125	7,060
			126	9,756
		Total		**31,690**
James ID	→	Fresno County	127	1,560
		Total		**1,560**
Fresno County	→	James ID	128	1,898
		Total		**1,898**

2005 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	2,254
			130	3,156
			131	395
			132	N/A
			133	N/A
			134	N/A
		Total		**5,805**
James ID	→	Westlands WD	135	N/A
			136	N/A
		Total		**0**
Westlands WD	→	North Fork Kings	137	1,490
			138	59
			141	2,401
			142	990
			143	2,005
			144	731
			146	N/A
			151	310
			153	358
			154	72
		Total		**8,414**
North Fork Kings	→	Westlands WD	139	1,296
			140	789
			145	N/A
			147	N/A
			148	407
			149	867
			150	1,339
			152	1,017
			155	399
		Total		**6,114**
South Fork Kings GSA	→	North Fork Kings	156	84
			157	0
			158	0
			159	0
			160	0
		Total		**84**
Mid Kings River GSA	→	North Fork Kings	162	0
		Total		**0**

2005 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	161	0
			163	0
			164	1,190
			165	366
		Total		**1,556**
Mid Kings River GSA	→	Central Kings	166	2,203
		Total		**2,203**
Central Kings	→	Mid Kings River GSA	167	0
			168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	236
			171	2,299
		Total		**2,535**
Mid Kings River GSA	→	Kings River East	170	2,595
		Total		**2,595**
Kings River East	→	Greater Kaweah GSA	172	2,642
			173	384
			174	1,262
			175	18
			176	1,494
			177	1,063
		Total		**6,864**
Kings River East	→	East Kaweah GSA	179	1,406
		Total		**1,406**
East Kaweah GSA	→	Kings River East	178	128
			180	178
			181	86
			182	295
		Total		**687**

2006 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			104	0
			105	0
			106	0
		Total		**0**
North Kings	→	Root Creek WD	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			116	0
			117	0
			118	0
		Total		**0**
Farmers WD	→	McMullin	120	0
		Total		**0**
McMullin	→	Farmers WD	121	904
		Total		**904**
Fresno County	→	McMullin	126	828
		Total		**828**
McMullin	→	Fresno County	122	1,076
			123	1,177
			124	2,952
			125	2,299
		Total		**7,504**
Fresno County	→	James ID	127	1,443
		Total		**1,443**
James ID	→	Fresno County	128	163
		Total		**163**

2006 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
James ID	→	Central Delta Mendota Regional Mulit Agency GSA	129	N/A
		Total		**0**
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	130	N/A
			131	N/A
			132	N/A
			133	N/A
			134	N/A
		Total		**0**
James ID	→	Westlands WD	135	N/A
			136	N/A
		Total		**0**
Westlands WD	→	North Fork Kings	137	N/A
			141	1,084
			142	340
			143	544
			146	92
			147	363
			152	646
		Total		**3,069**
North Fork Kings	→	Westlands WD	138	N/A
			139	N/A
			140	679
			144	139
			145	309
			148	464
			149	253
			150	561
			151	792
			153	1,862
			154	405
			155	581
		Total		**6,046**
North Fork Kings	→	South Fork Kings GSA	156	64
			159	0
		Total		**64**
South Fork Kings GSA	→	North Fork Kings	157	0
			158	0
			160	0
		Total		**0**

2006 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			164	335
		Total		**335**
North Fork Kings	→	Mid Kings River GSA	163	0
			165	380
		Total		**380**
Mid Kings River GSA	→	Central Kings	166	2,505
		Total		**2,505**
Central Kings	→	Mid Kings River GSA	167	0
			168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	134
			171	2,712
		Total		**2,846**
Mid Kings River GSA	→	Kings River East	170	6,500
		Total		**6,500**
Kings River East	→	Greater Kaweah GSA	172	1,850
			174	1,074
			175	69
			176	1,030
			177	2,480
		Total		**6,504**
Greater Kaweah GSA	→	Kings River East	173	7
		Total		**7**
Kings River East	→	East Kaweah GSA	179	1,284
		Total		**1,284**
East Kaweah GSA	→	Kings River East	178	371
			180	279
			181	131
			182	329
		Total		**1,110**

2007 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			104	0
			105	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			118	0
		Total		**0**
Farmers WD	→	McMullin	120	0
			121	21
		Total		**21**
Fresno County	→	McMullin	122	1,446
			126	4,502
		Total		**5,948**
McMullin	→	Fresno County	123	850
			124	1,506
			125	1,146
		Total		**3,502**
James ID	→	Fresno County	127	5,108
		Total		**5,108**
Fresno County	→	James ID	128	434
		Total		**434**
James ID	→	Central Delta Mendota Regional	129	2,412
			130	3,608
		Total		**6,019**

2007 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	131	991
			132	1,259
			133	3,320
			134	4,344
		Total		**9,914**
Westlands WD	→	James ID	135	633
			136	779
		Total		**1,411**
Westlands WD	→	North Fork Kings	137	3,232
			138	348
			141	2,971
			142	1,578
			143	825
			144	1,331
			146	573
			147	2,426
			148	3,825
			149	2,064
			150	2,196
			151	1,336
			155	286
		Total		**22,990**
North Fork Kings	→	Westlands WD	139	1,944
			140	877
			145	661
			152	235
			153	1,488
			154	690
		Total		**5,895**
South Fork Kings GSA	→	North Fork Kings	156	276
			157	0
			158	0
			159	0
			160	0
		Total		**276**
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			164	459
			165	1,049
		Total		**1,508**
North Fork Kings	→	Mid Kings River GSA	163	0
		Total		**0**

2007 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Kings	→	Mid Kings River GSA	166	1,105
			167	0
			168	0
		Total		**1,105**
Kings River East	→	Mid Kings River GSA	169	157
			171	2,313
		Total		**2,470**
Mid Kings River GSA	→	Kings River East	170	6,344
		Total		**6,344**
Kings River East	→	Greater Kaweah GSA	172	4,143
			174	359
			175	4
			176	222
			177	1,187
		Total		**5,916**
Greater Kaweah GSA	→	Kings River East	173	140
		Total		**140**
Kings River East	→	East Kaweah GSA	179	657
		Total		**657**
East Kaweah GSA	→	Kings River East	178	252
			180	173
			181	100
			182	316
		Total		**841**

2008 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			104	0
			105	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	117	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	114	0
			115	0
			116	0
			118	0
		Total		**0**
Farmers WD	→	McMullin	120	0
		Total		**0**
McMullin	→	Farmers WD	121	609
		Total		**609**
Fresno County	→	McMullin	122	1,245
			123	144
			126	2,946
		Total		**4,335**
McMullin	→	Fresno County	124	1,501
			125	1,064
		Total		**2,564**
James ID	→	Fresno County	127	1,446
		Total		**1,446**
Fresno County	→	James ID	128	1,201
		Total		**1,201**

2008 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	2,364
			130	9,075
			131	2,486
			132	765
			133	4,063
			134	3,997
		Total		**22,750**
James ID	→	Westlands WD	135	687
			136	381
		Total		**1,068**
Westlands WD	→	North Fork Kings	137	N/A
			141	3,927
			142	1,645
			143	3,363
			144	2,252
			146	1,146
			148	1,147
			150	913
			153	2,987
			154	1,656
			155	1,827
		Total		**20,863**
North Fork Kings	→	Westlands WD	138	N/A
			139	N/A
			140	2,474
			145	54
			147	64
			149	617
			151	510
			152	550
		Total		**4,269**
North Fork Kings	→	South Fork Kings GSA	159	0
		Total		**0**
South Fork Kings GSA	→	North Fork Kings	156	1,307
			157	0
			158	0
			160	0
		Total		**1,307**
Mid Kings River GSA	→	North Fork Kings	162	0
			164	1,547
			165	250
		Total		**1,797**

2008 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	161	0
			163	0
		Total		**0**
Central Kings	→	Mid Kings River GSA	166	410
			167	0
			168	0
		Total		**410**
Kings River East	→	Mid Kings River GSA	169	205
			171	1,909
		Total		**2,114**
Mid Kings River GSA	→	Kings River East	170	1,551
		Total		**1,551**
Kings River East	→	Greater Kaweah GSA	172	2,027
			174	2,181
			175	9
			176	394
			177	945
		Total		**5,557**
Greater Kaweah GSA	→	Kings River East	173	213
		Total		**213**
Kings River East	→	East Kaweah GSA	179	1,188
		Total		**1,188**
East Kaweah GSA	→	Kings River East	178	8
			180	413
			181	223
			182	582
		Total		**1,226**

2009 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			104	0
			105	0
			106	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
		Total		**0**
North Kings	→	Root Creek WD	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
			118	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
		Total		**0**
Farmers WD	→	McMullin	120	0
			121	134
		Total		**134**
Fresno County	→	McMullin	122	268
			126	6,693
		Total		**6,961**
McMullin	→	Fresno County	123	365
			124	312
			125	574
		Total		**1,250**
Fresno County	→	James ID	127	3,120
			128	945
		Total		**4,065**

2009 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	985
			130	5,811
			131	1,401
			132	1,609
			133	45
			134	54
		Total		**9,906**
James ID	→	Westlands WD	135	997
			136	1,018
		Total		**2,015**
Westlands WD	→	North Fork Kings	137	2,387
			138	N/A
			140	1,242
			141	5,497
			142	2,526
			143	2,508
			144	2,032
			145	51
			146	1,218
			147	893
			148	1,802
			151	954
			155	N/A
		Total		**21,109**
North Fork Kings	→	Westlands WD	139	1,693
			149	1,209
			150	1,696
			152	240
			153	2,614
			154	815
		Total		**8,267**
South Fork Kings GSA	→	North Fork Kings	156	N/A
			157	0
			158	0
			159	0
			160	0
		Total		**0**
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
			165	675
		Total		**675**

2009 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	163	0
			164	195
		Total		**195**
Central Kings	→	Mid Kings River GSA	166	970
			167	0
			168	0
		Total		**970**
Kings River East	→	Mid Kings River GSA	169	81
			171	2,178
		Total		**2,259**
Mid Kings River GSA	→	Kings River East	170	9,009
		Total		**9,009**
Kings River East	→	Greater Kaweah GSA	172	1,759
			173	601
			174	2,312
			175	61
			176	2,022
			177	2,526
		Total		**9,281**
Kings River East	→	East Kaweah GSA	179	1,167
			180	N/A
			181	N/A
		Total		**1,167**
East Kaweah GSA	→	Kings River East	178	642
			182	437
		Total		**1,079**

2011 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			102	0
			103	0
			108	0
		Total		**0**
Madera County	→	North Kings	104	0
			105	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
			118	0
			119	0
		Total		**0**
Aliso WD	→	McMullin	115	0
		Total		**0**
McMullin	→	Farmers WD	120	0
			121	577
		Total		**577**
McMullin	→	Fresno County	122	846
			123	487
		Total		**1,333**
Fresno County	→	McMullin	124	237
			125	1,444
			126	2,666
		Total		**4,347**
Fresno County	→	James ID	127	2,899
			128	418
		Total		**3,317**

2011 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	198
			130	1,434
			131	743
			132	1,835
			133	787
		Total		**4,996**
Westlands WD	→	James ID	134	514
		Total		**514**
James ID	→	Westlands WD	135	567
			136	187
		Total		**755**
Westlands WD	→	North Fork Kings	137	2,515
			141	1,737
			142	691
			143	791
			144	5
			148	188
		Total		**5,926**
North Fork Kings	→	Westlands WD	138	115
			139	960
			140	313
			145	246
			146	37
			147	7
			149	681
			150	705
			151	304
			152	259
			153	203
			154	183
			155	331
		Total		**4,343**
North Fork Kings	→	South Fork Kings GSA	156	359
			158	0
			159	0
			160	0
		Total		**359**
South Fork Kings GSA	→	North Fork Kings	157	0
		Total		**0**
Mid Kings River GSA	→	North Fork Kings	161	0
			162	0
		Total		**0**

2011 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Fork Kings	→	Mid Kings River GSA	163	0
			164	1,457
			165	542
		Total		**1,999**
Central Kings	→	Mid Kings River GSA	166	365
			167	0
			168	0
		Total		**365**
Kings River East	→	Mid Kings River GSA	169	106
			171	1,612
		Total		**1,717**
Mid Kings River GSA	→	Kings River East	170	3,421
		Total		**3,421**
Kings River East	→	Greater Kaweah GSA	172	830
			174	1,277
			176	835
			177	961
		Total		**3,903**
Greater Kaweah GSA	→	Kings River East	173	392
			175	139
		Total		**531**
East Kaweah GSA	→	Kings River East	178	520
			182	1,272
		Total		**1,792**
Kings River East	→	East Kaweah GSA	179	1,647
			180	N/A
			181	N/A
		Total		**1,647**

2012 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
North Kings	→	Madera County	100	0
			101	0
			103	0
			105	0
			108	0
		Total		**0**
Madera County	→	North Kings	102	0
			104	0
			106	0
		Total		**0**
Root Creek WD	→	North Kings	107	0
		Total		**0**
North Kings	→	Madera ID	109	0
			110	0
			111	0
			112	0
			113	0
		Total		**0**
McMullin	→	Aliso WD	114	0
			116	0
			117	0
			118	0
		Total		**0**
Aliso WD	→	McMullin	115	0
			119	0
		Total		**0**
Farmers WD	→	McMullin	120	0
			121	2,270
		Total		**2,270**
Fresno County	→	McMullin	122	2,853
			123	2,122
			124	5,194
			125	3,468
			126	4,346
		Total		**17,982**
Fresno County	→	James ID	127	3,116
			128	298
		Total		**3,414**
Central Delta Mendota Regional Mulit Agency GSA	→	James ID	129	205
			130	4,683
			131	1,370
			132	688
		Total		**6,946**

2012 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
James ID	→	Central Delta Mendota Regional Mulit Agency GSA	133	174
		Total		**174**
James ID	→	Westlands WD	134	581
			135	356
			136	665
		Total		**1,602**
Westlands WD	→	North Fork Kings	137	935
			138	N/A
			141	844
			146	71
			147	133
			148	94
			149	830
			150	723
			152	260
			153	112
			155	332
		Total		**4,333**
North Fork Kings	→	Westlands WD	139	1,072
			140	698
			142	795
			143	20
			144	160
			145	326
			151	361
			154	224
		Total		**3,657**

2012 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
South Fork Kings GSA	→	North Fork Kings	156	649
			157	0
			158	0
			159	0
			160	0
		Total		**649**
North Fork Kings	→	Mid Kings River GSA	161	0
			162	0
			163	0
			164	1,199
		Total		**1,199**
Mid Kings River GSA	→	North Fork Kings	165	243
		Total		**243**
Mid Kings River GSA	→	Central Kings	166	2,322
		Total		**2,322**
Central Kings	→	Mid Kings River GSA	167	0
			168	0
		Total		**0**
Kings River East	→	Mid Kings River GSA	169	78
			171	1,886
		Total		**1,964**
Mid Kings River GSA	→	Kings River East	170	3,131
		Total		**3,131**
Kings River East	→	Greater Kaweah GSA	172	5
			174	255
			176	340
			177	2,865
		Total		**3,465**
Greater Kaweah GSA	→	Kings River East	173	1,711
			175	161
		Total		**1,872**

2012 Kings Subbasin Flow Estimate grouped by GSAs to external (neighboring) GSAs

GSA where flow originates	→	GSA receiving flow	Segment	Est. Flow
East Kaweah GSA	→	Kings River East	178	344
			180	459
			181	294
			182	667
		Total		**1,764**
Kings River East	→	East Kaweah GSA	179	1,142
		Total		**1,142**

Technical Memorandum 6
Summary of Alternatives for Initial Estimation

This Technical Memorandum (TM) summarizes the alternatives considered for determining the estimated overdraft volume that each GSA in the Kings Subbasin should initially include in their respective GSPs related to the unconfined aquifer. This TM utilizes the information presented in TMs 1, 2, 3, 4 and 5 from the Kings Basin Coordination Effort.

<u>Alternatives</u>

The following is a description of the alternatives developed for initial consideration. Attachment 1 to this memo includes a table showing the values for each Alternative.

<u>Alternative 1 – Equal Distribution</u>

Alternative 1 includes equal distribution of the total estimated overdraft in the basin. The estimated total storage change from TM4 (122,000AF for the Spring 1997 to Spring 2012 base period) was divided by the total acreage within the Kings Subbasin (981,541 acres) to determine a per acre responsibility. That per acre responsibility was multiplied by the total acreage within each GSA to determine that GSA's responsibility. This alternative was primarily prepared for reference as it does not factor in location or water supply and was not agreeable to GSAs that have an adequate surface water supply.

<u>Alternative 2 – Storage Change Only</u>

Alternative 2 uses the storage change values per GSA that were estimated in TM4. This alternative does not consider boundary flows, which historically occurred but over time have changed significantly within the basin as a depression has formed in the McMullin GSA, as well as the impact from neighboring basins.

<u>Alternative 3 – Storage Change less Recent Boundary Flows</u>

Alternative 3 uses the Storage Change values per GSA estimated in TM4 and also factors in the recent internal boundary flows during the base period estimated in TM5. The average annual boundary flow across internal Kings basin GSA boundaries for the base period of years were determined in TM5 and included in this alternative. The entire boundary flow across a GSA boundary as estimated in TM5 was credited back to the upgradient GSA. Crediting back the entire amount of boundary flow to the upgradient GSA was considered excessive as this assumption ignored the historic boundary flow in the region. It is important to note that the totals shown in this alternative are not adjusted for external boundary flows. External boundary flows in the unconfined aquifer were estimated in TM5, and groundwater flow across the external Kings Basin boundary is predominantly away from the Kings Basin. An adjustment for external basin boundary flows was not included in this alternative as discussions with neighboring basin GSAs is necessary for consideration.

<u>Alternative 4 – Storage Change less the difference between Recent and Historic Boundary Flows</u>

Alternative 4 was developed as a variation of Alternative 3 with the additional consideration of historic boundary flows within the subbasin. The boundary flows from 1925 were determined in TM5 using the same method that was used to estimate recent boundary flows during the base period. This alternative utilized the Storage Change values per GSA from TM4 as a starting point, but then adjusted these values based on the difference between recent (average of all base period years) boundary flows and the historic (1925) boundary flows. This alternative includes as much recent data as possible in estimating current boundary flow conditions and recognizes that some groundwater historically flowed from higher elevations to lower elevations and that the downgradient GSAs should only be responsible for the increased groundwater flow caused by pumping. Similar to Alternative 3, external basin boundary flows are not factored into the totals included in this alternative.

Recommendation

From discussion with GSA representatives in the Kings Basin coordination effort, Alternative 4 is the preferred alternative for GSAs to use in setting an initial target overdraft volume for each GSA to include in their respective GSPs. A table showing the total for each GSA is included below.

GSA	Proposed Initial Responsibility (AF)
Central/South	-7,100
James	16,700
Kings River East	-11,000
McMullin	-91,100
North Fork	-50,300
North Kings	20,800
Total	-122,000

Although specific values are identified, it is critical to understand there is significant margin of error in calculating both storage change and boundary flows. It is recommended for GSAs to consider at least a 20% contingency range when considering projects and programs for implementation to correct the overdraft in the basin. These values do not consider James pumping in McMullin GSA. These initial values will also be compared to estimates developed from the basin water budget development. It is important to remember that these overdraft estimates are only for the unconfined aquifer and do not include any external boundary flow estimates, from either the unconfined or confined aquifer, as the GSAs will need to discuss how these external boundary flows are going to be addressed with the neighboring basin GSAs. The GSAs will need to evaluate and adjust these values regularly in future years as additional information is collected and estimates of storage change are updated.

Attachment 1
Alternatives Table

Kings Basin Methodology Alternatives for Proportionment of Storage Change
10/24/2018

Column #	1	2	3	4	5	6	7
	Alt 1		Alt 2	Alt 3		Alt 4	
Methodology	Equal Distribution		Storage Change Only	Storage Change +/- Recent Boundary Flows		Storage Change +/- Difference between Historic and Recent Boundary Flows	
Column Calculation					3 - 4		3 - (4 - 6)
GSA	Acreage	Total Basin Storage Change 97-12 divided by Total Basin Acreage multiplied by GSA Acreage (AF)	Storage Change Estimation (Spring 97-12) from TM4 (AF)	Average of Base Period (97-12) Internal Boundary Flows [1] (AF)	Total w/Recent (Base Period) Average Internal Boundary Flows (AF)	1925 Internal Boundary Flows from TM4 [1] (AF)	Storage Change less difference between Int Flows only (AF)
Central/South	160,870	-19,995	-17,000	-20,400	3,400	-10,500	-7,100
James	29,051	-3,611	-5,000	-19,200	14,200	2,500	16,700
Kings River East	191,126	-23,756	-11,000	0	-11,000	0	-11,000
McMullin	120,580	-14,987	-16,000	91,700	-107,700	16,600	-91,100
North Fork	168,187	-20,905	-49,000	14,900	-63,900	13,600	-50,300
North Kings	311,728	-38,746	-24,000	-67,000	43,000	-22,200	20,800
Total	981,542	-122,000	-122,000		-122,000		-122,000

Notes: 1) A negative boundary flow value means the total sum of flow is out of or away from the GSA. A positive value means flow into the GSA.

Appendix 3 B Water Quality Characterization Wells

WATER QUALITY CHARACTERIZATION WELLS

Site ID	Well Type	Elevation (feet)	Total Depth (feet bgs)	Perforations (feet bgs)	Aquifer	Monitoring Purpose	Alias	Notes
1010034-004	Municipal	174	500	200-500	Between A and E-Clay	Water Quality	M1	GAMA Website
1010034-003	Municipal	174	510	210-510	Between A and E-Clay	Water Quality	M2	GAMA Website
1010034-005	Municipal	174	UNK	UNK	Between A and E-Clay	Water Quality	M3	GAMA Website
1010034-002	Municipal	174	560	284-560	Between C and E-Clay	Water Quality	M4	GAMA Website
1010030-006	Municipal	174	UNK	UNK	Above E-Clay	Water Quality	N1	GAMA Website
S3-MACK-K07	Domestic	165	300	240-300	Between A and C-Clay	Water Quality	N2	USGS DS 1019, Table 1
KING-26	Non-Domestic	174	480	240-480	Between C and E-Clay	Water Quality	N3	USGS DS 351, Table 1
S3-MACK-K05	Domestic	178	260	200-260	Between A and C-Clay	Water Quality	S1	USGS DS 1019, Table 1
KING-31	Monitoring	173	520	280-520	Between C and E-Clay	Water Quality	S2	USGS DS 351, Table 1

Appendix 3 C Water Budgets (James GSA Format)

		WATER BUDGET TYPE:			HISTORICAL		NOTES	
		Water Year Type:	NORMAL	DRY	WET	LTA		
Surface Water	Inflow	Mendota Pool	33,146	32,122	31,091	32,393	Metered quantity	1
		Kings River	5,083	-	168,907	47,753	Metered quantity	2
		Siphon	23,537	28,154	6,873	20,016	Metered quantity	3
		Tranquillity ID	96	-	-	51	Metered quantity	4
		Fresno Slough (Mud Dam)	-	-	-	-	Metered quantity	5
		Total	**61,861**	**60,276**	**206,871**	**100,213**		6
	Outflow	Tranquillity ID	-	-	-	-	Metered quantity	7
		Kings River (James Bypass)	3,983	-	140,612	39,620	Metered quantity	8
		Fresno Slough	220	144	151	186	Metered quantity	9
		Other	-	-	-	-	Estimated (assumed negligible)	10
		Total	**4,202**	**144**	**140,762**	**39,806**		11
Precipitation		On Agricultural Land Type	13,231	10,067	22,283	15,001	Calculated based on land type	12
		On Municipal Land Type	554	422	933	628	Calculated based on land type	13
		On Other Land Type	693	527	1,167	785	Calculated based on land type	14
		Total	**14,478**	**11,016**	**24,383**	**16,414**		15
		Inches	6.65	5.06	11.20	7.54	Actual precipitation from James ID records	16
Use		Evapotranspiration (Applied Irrigation)	54,114	58,144	48,663	53,466	Estimated based on 95% irrigation efficiency	17
		Evapotranspiration (Precipitation)	13,028	9,921	21,940	14,783	Estimated, 90% of precip over GSA acreage	18
		M&I Consumptive Use	313	365	261	313	Estimated using extractions and wastewater	19
		Other Consumptive Use	-	-	-	-	Estimated value (assumed negligible)	20
		Total	**67,455**	**68,430**	**70,864**	**68,562**		21
Groundwater <--> Surface Water	Recharge	Deep Percolation - Precipitation	1,323	1,007	2,228	1,501	Estimated, 10% of precip over GSA acreage	22
		Deep Percolation - Irrigation	2,848	3,060	2,561	2,814	Estimated based on 95% irrigation efficiency	23
		Deep Percolation - Urban/Stormwater	56	42	94	63	Estimated value	24
		Deep Percolation - Other	69	53	117	79	Estimated value	25
		Distribution System Seepage	16,602	15,292	17,544	16,591	Measured based on diversions and deliveries	26
		Wastewater Disposal	209	209	209	209	Measured and estimated quantities	27
		Managed Recharge	-	-	-	-		28
		Losses - Mendota Pool	2,600	2,600	2,600	2,600	Estimated value	29
		Losses - Wetlands and Sloughs	-	-	-	-	Estimated value (assumed negligible)	30
		Total	**23,707**	**22,264**	**25,352**	**23,857**		31
	Extraction	James Irrigation District (agricultural)	18,286	18,820	5,109	14,879	Metered quantity	32
		City of San Joaquin (municipal)	522	574	470	522	Measured and estimated quantities	33
		Rural Areas (domestic)	100	100	100	100	Estimated value	34
		Landowners (agricultural)	-	-	-	-	Estimated value (assumed negligible)	35
		Total	**18,908**	**19,494**	**5,679**	**15,501**		36
Groundwater	Inflow	North Fork GSA	325	-	-	173	Groundwater inflows calculated based on groundwater contours and assumed transmissivity values. Values have not been calibrated against basin water budget. Values may change after additional analysis.	37
		McMullin Group GSA	-	-	-	-		38
		Westlands WD GSA	-	-	-	-		39
		Central Delta Mendota GSA	8,550	11,033	2,425	7,413		40
		Fresno County GSA	1,375	1,400	1,825	1,500		41
		Total	**10,250**	**12,433**	**4,250**	**9,087**		42
	Outflow	North Fork GSA	4,157	4,200	2,125	3,586	Groundwater outflows calculated based on groundwater contours and assumed transmissivity values. Values have not been calibrated against basin water budget. Values may change after additional analysis.	43
		McMullin Group GSA	17,425	24,867	10,275	17,007		44
		Westlands WD GSA	1,213	1,900	725	1,171		45
		Central Delta Mendota GSA	-	-	-	-		46
		Fresno County GSA	29	1,567	-	377		47
		Total	**22,823**	**32,533**	**13,125**	**22,141**		48
Storage Change	Surface Water	Mendota Pool	-	-	-	-	Storage change assumed negligible for water budget analysis.	49
		James ID K-Basin	-	-	-	-		50
		James ID Basin 1	-	-	-	-		51
		James ID Basin 2	-	-	-	-		52
		James ID Basin 3	-	-	-	-		53
		James ID C-Basin	-	-	-	-		54
		James ID E-Basin	-	-	-	-		55
		City of San Joaquin Stormwater Basins	-	-	-	-		56
		Total	-	-	-	-		57
	Groundwater	Recharge less Extraction	4,799	2,769	19,673	8,356	Calculated values	58
		Inflow less Outflow	(12,573)	(20,100)	(8,875)	(13,054)		59
		Total	**(7,774)**	**(17,331)**	**10,798**	**(4,698)**		60

		WATER BUDGET TYPE:			CURRENT		NOTES	
		Water Year Type:	NORMAL	DRY	WET	LTA		
Surface Water	Inflow	Mendota Pool	26,853	14,689	37,512	26,351		1
		Kings River	14,683	2,038	153,824	56,848		2
		Siphon	18,410	31,186	-	16,532	Estimated based on current supply projections for	3
		Tranquillity ID	-	-	-	-	each source. See text for details on projections.	4
		Fresno Slough (Mud Dam)	-	-	-	-		5
		Total	**59,946**	**47,913**	**191,336**	**99,731**		6
	Outflow	Tranquillity ID	-	-	-	-	Estimated (assumed negligible)	7
		Kings River (James Bypass)	-	-	119,520	39,840	Estimate based on records and current uses	8
		Fresno Slough	-	-	-	-	Estimated (assumed negligible)	9
		Other	-	-	-	-	Estimated (assumed negligible)	10
		Total	**-**	**-**	**119,520**	**39,840**		11
Precipitation		On Agricultural Land Type	13,231	10,067	22,283	15,001		12
		On Municipal Land Type	554	422	933	628		13
		On Other Land Type	693	527	1,167	785	Unchanged from historic conditions	14
		Total	**14,478**	**11,016**	**24,383**	**16,414**		15
		Inches	6.65	5.06	11.20	7.54		16
Use		Evapotranspiration (Applied Irrigation)	54,112	58,140	48,659	53,637	Estimated based on 95% irrigation efficiency	17
		Evapotranspiration (Precipitation)	11,908	9,060	20,055	13,501	Estimated, 90% of precip over GSA acreage	18
		M&I Consumptive Use	352	422	282	352	Estimated using records and population	19
		Other Consumptive Use	-	-	-	-	Estimated (assumed negligible)	20
		Total	**66,372**	**67,622**	**68,996**	**67,490**		21
Groundwater <--> Surface Water	Recharge	Deep Percolation - Precipitation	1,323	1,007	2,228	1,500	Estimated, 10% of precip over GSA acreage	22
		Deep Percolation - Irrigation	2,848	3,060	2,561	2,823	Estimated based on 95% irrigation efficiency	23
		Deep Percolation - Urban/Stormwater	56	42	94	63	Estimated value	24
		Deep Percolation - Other	69	53	117	79	Estimated value	25
		Distribution System Seepage	17,014	15,300	17,996	16,865	Calculated using estimated values	26
		Wastewater Disposal	235	235	235	235	Estimated using records and population	27
		Managed Recharge	-	-	-	-		28
		Losses - Mendota Pool	2,600	2,600	2,600	2,600	No change from estimated historic value	29
		Losses - Wetlands and Sloughs	-	-	-	-	Estimated (assumed negligible)	30
		Total	**24,145**	**22,297**	**25,830**	**24,164**		31
	Extraction	James Irrigation District (agricultural)	16,628	31,187	0	16,034	Calculated based on assumed demands	32
		City of San Joaquin (municipal)	587	657	517	587	Calculated based on assumed demands	33
		Rural Areas (domestic)	100	100	100	100	Estimated	34
		Landowners (agricultural)	-	-	-	-	Estimated (assumed negligible)	35
		Total	**17,315**	**31,944**	**617**	**16,721**		36
Groundwater	Inflow	North Fork GSA	325	-	-	173		37
		McMullin Group GSA	-	-	-	-	Groundwater inflows estimated at historic levels	38
		Westlands WD GSA	-	-	-	-	for each year type. There is insufficient data to	39
		Central Delta Mendota GSA	8,550	11,033	2,425	7,413	calculate groundwater flows for the current year.	40
		Fresno County GSA	1,375	1,400	1,825	1,500		41
		Total	**10,250**	**12,433**	**4,250**	**9,087**		42
	Outflow	North Fork GSA	4,157	4,200	2,125	3,586		43
		McMullin Group GSA	17,425	24,867	10,275	17,007	Groundwater outflows estimated at historic levels	44
		Westlands WD GSA	1,213	1,900	725	1,171	for each year type. There is insufficient data to	45
		Central Delta Mendota GSA	-	-	-	-	calculate groundwater flows for the current year.	46
		Fresno County GSA	29	1,567	-	377		47
		Total	**22,823**	**32,533**	**13,125**	**22,141**		48
Storage Change	Surface Water	Mendota Pool	-	-	-	-		49
		James ID K-Basin	-	-	-	-		50
		James ID Basin 1	-	-	-	-		51
		James ID Basin 2	-	-	-	-		52
		James ID Basin 3	-	-	-	-	Storage change assumed negligible	53
		James ID C-Basin	-	-	-	-	for water budget analysis.	54
		James ID E-Basin	-	-	-	-		55
		City of San Joaquin Stormwater Basins	-	-	-	-		56
		Total (MEASURED)	-	-	-	-		57
	Groundwater	Recharge less Extraction	6,830	(9,647)	25,213	7,444		58
		Inflow less Outflow	(12,573)	(20,100)	(8,875)	(13,054)	Calculated values	59
		Total (CALCULATED)	**(5,743)**	**(29,747)**	**16,338**	**(5,611)**		60

		WATER BUDGET TYPE:	FUTURE				NOTES	
		Water Year Type:	**NORMAL**	**DRY**	**WET**	**LTA**	(Future conditions for WY 2039-40)	
Surface Water	Inflow	Mendota Pool	26,853	14,689	37,512	26,351		1
		Kings River	17,483	2,038	171,358	63,626		2
		Siphon	18,410	31,186	-	16,532	Estimated based on current supply projections for	3
		Tranquillity ID	-	-	-	-	each source. See text for details on projections.	4
		Fresno Slough (Mud Dam)	-	-	-	-		5
		Total	**62,746**	**47,913**	**208,870**	**106,509**		6
	Outflow	Tranquillity ID	-	-	-	-	Estimated (assumed negligible)	7
		Kings River (James Bypass)	-	-	119,520	39,840	Estimate based on records and current uses	8
		Fresno Slough	-	-	-	-	Estimated (assumed negligible)	9
		Other	-	-	-	-	Estimated (assumed negligible)	10
		Total	**-**	**-**	**119,520**	**39,840**		11
Precipitation		On Agricultural Land Type	13,231	10,067	22,283	15,001		12
		On Municipal Land Type	554	422	933	628		13
		On Other Land Type	693	527	1,167	785	Unchanged from historic conditions	14
		Total	**14,478**	**11,016**	**24,383**	**16,414**		15
		Inches	6.65	5.06	11.20	7.54		16
Use		Evapotranspiration (Applied Irrigation)	54,112	58,140	48,659	53,637	Estimated based on 95% irrigation efficiency	17
		Evapotranspiration (Precipitation)	11,908	9,060	20,055	13,501	Estimated, 90% of precip over GSA acreage	18
		M&I Consumptive Use	503	671	335	503	Estimated using records and population	19
		Other Consumptive Use	-	-	-	-	Estimated (assumed negligible)	20
		Total	**66,523**	**67,871**	**69,049**	**67,641**		21
Groundwater <--> Surface Water	Recharge	Deep Percolation - Precipitation	1,323	1,007	2,228	1,500	Estimated, 10% of precip over GSA acreage	22
		Deep Percolation - Irrigation	2,848	3,060	2,561	2,823	Estimated based on 95% irrigation efficiency	23
		Deep Percolation - Urban/Stormwater	56	42	94	63	Estimated value	24
		Deep Percolation - Other	69	53	117	79	Estimated value	25
		Distribution System Seepage	17,014	15,300	17,996	16,865	Calculated using estimated values	26
		Wastewater Disposal	336	336	336	336	Estimated using records and population	27
		Managed Recharge	2,800	-	17,534	6,778		28
		Losses - Mendota Pool	2,600	2,600	2,600	2,600	No change from estimated historic value	29
		Losses - Wetlands and Sloughs	-	-	-	-	Estimated (assumed negligible)	30
		Total	**27,046**	**22,398**	**43,465**	**31,043**		31
	Extraction	James Irrigation District (agricultural)	19,428	31,187	0	16,967	Calculated based on assumed demands	32
		City of San Joaquin (municipal)	839	1,007	671	839	Calculated based on assumed demands	33
		Rural Areas (domestic)	100	100	100	100	Estimated	34
		Landowners (agricultural)	-	-	-	-	Estimated (assumed negligible)	35
		Total	**20,367**	**32,294**	**771**	**17,906**		36
Groundwater	Inflow	North Fork GSA	325	-	-	173		37
		McMullin Group GSA	-	-	-	-	Groundwater inflows estimated at historic levels	38
		Westlands WD GSA	-	-	-	-	for each year type. There is insufficient data	39
		Central Delta Mendota GSA	8,550	11,033	2,425	7,413	and/or modeling to calculate groundwater flows	40
		Fresno County GSA	1,375	1,400	1,825	1,500	for future years.	41
		Total	**10,250**	**12,433**	**4,250**	**9,087**		42
	Outflow	North Fork GSA	4,157	4,200	2,125	3,586		43
		McMullin Group GSA	17,425	24,867	10,275	17,007	Groundwater outflows estimated at historic levels	44
		Westlands WD GSA	1,213	1,900	725	1,171	for each year type. There is insufficient data	45
		Central Delta Mendota GSA	-	-	-	-	and/or modeling to calculate groundwater flows	46
		Fresno County GSA	29	1,567	-	377	for the future years.	47
		Total	**22,823**	**32,533**	**13,125**	**22,141**		48
Storage Change	Surface Water	Mendota Pool	-	-	-	-		49
		James ID K-Basin	-	-	-	-		50
		James ID Basin 1	-	-	-	-		51
		James ID Basin 2	-	-	-	-		52
		James ID Basin 3	-	-	-	-	Storage change assumed negligible	53
		James ID C-Basin	-	-	-	-	for water budget analysis.	54
		James ID E-Basin	-	-	-	-		55
		City of San Joaquin Stormwater Basins	-	-	-	-		56
		Total (MEASURED)	-	-	-	-		57
	Groundwater	Recharge less Extraction	6,679	(9,896)	42,694	13,138		58
		Inflow less Outflow	(12,573)	(20,100)	(8,875)	(13,054)		59
							Calculated values	
		Total (CALCULATED)	**(5,894)**	**(29,996)**	**33,819**	**83**		60

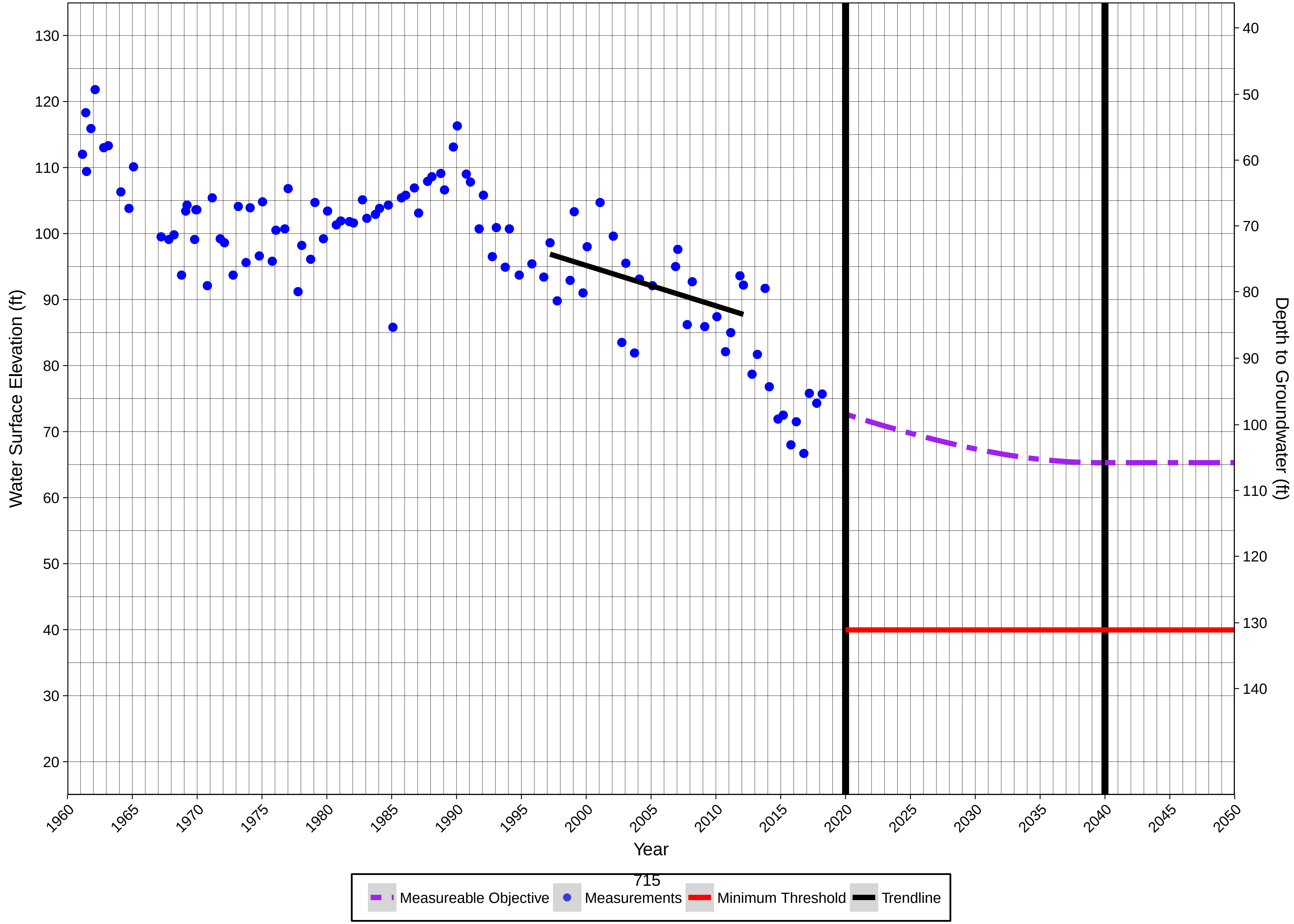
		WATER BUDGET TYPE:	FUTURE WITH CLIMATE CHANGE				NOTES	
		Water Year Type:	**NORMAL**	**DRY**	**WET**	**LTA**	(Future conditions for WY 2069-70)	
Surface Water	Inflow	Mendota Pool	26,143	13,978	36,801	25,641	2% decrease in CVP supply contract	1
		Kings River	17,469	1,997	172,411	63,959	2% decrease in entitlement	2
		Siphon	18,410	31,186	-	16,532	Unchanged from 2040 water budget	3
		Tranquillity ID	-	-	-	-		4
		Fresno Slough (Mud Dam)	-	-	-	-		5
		Total	**62,022**	**47,161**	**209,212**	**106,132**		6
	Outflow	Tranquillity ID	-	-	-	-		7
		Kings River (James Bypass)	-	-	119,520	39,840	2% decrease in Kings River runoff	8
		Fresno Slough	-	-	-	-		9
		Other	-	-	-	-		10
		Total	**-**	**-**	**119,520**	**39,840**		11
Precipitation		On Agricultural Land Type	13,091	9,968	22,064	14,862		12
		On Municipal Land Type	548	418	924	623		13
		On Other Land Type	685	522	1,155	778		14
		Total	**14,324**	**10,908**	**24,143**	**16,263**		15
		Inches	6.58	5.01	11.09	7.47	1% decrease in rainfall	16
Use		Evapotranspiration (Applied Irrigation)	54,112	58,140	48,659	53,637	No change in cropping, 1% increase in ET	17
		Evapotranspiration (Precipitation)	11,782	8,971	19,858	13,376	No change in cropping, 1% increase in ET	18
		M&I Consumptive Use	860	1,147	573	860	Based on 2070 propulation projection	19
		Other Consumptive Use	-	-	-	-		20
		Total	**66,754**	**68,258**	**69,090**	**67,873**		21
Groundwater <--> Surface Water	Recharge	Deep Percolation - Precipitation	1,309	997	2,206	1,486		22
		Deep Percolation - Irrigation	2,848	3,060	2,561	2,823		23
		Deep Percolation - Urban/Stormwater	56	42	94	63		24
		Deep Percolation - Other	69	53	117	79		25
		Distribution System Seepage	17,014	15,300	17,996	16,865		26
		Wastewater Disposal	573	573	573	573		27
		Managed Recharge	3,200	-	20,266	7,822	Results in increase in recharge required	28
		Losses - Mendota Pool	2,600	2,600	2,600	2,600		29
		Losses - Wetlands and Sloughs	-	-	-	-		30
		Total	**27,669**	**22,625**	**46,412**	**32,310**		31
	Extraction	James Irrigation District (agricultural)	20,752	31,939	0	17,658		32
		City of San Joaquin (municipal)	1,433	1,720	1,146	1,433		33
		Rural Areas (domestic)	100	100	100	100		34
		Landowners (agricultural)	-	-	-	-		35
		Total	**22,285**	**33,759**	**1,246**	**19,191**		36
Groundwater	Inflow	North Fork GSA	325	-	-	173		37
		McMullin Group GSA	-	-	-	-	Groundwater inflows estimated at historic levels	38
		Westlands WD GSA	-	-	-	-	for each year type. There is insufficient data	39
		Central Delta Mendota GSA	8,550	11,033	2,425	7,413	and/or modeling to calculate groundwater flows	40
		Fresno County GSA	1,375	1,400	1,825	1,500	for future years.	41
		Total	**10,250**	**12,433**	**4,250**	**9,087**		42
	Outflow	North Fork GSA	4,157	4,200	2,125	3,586		43
		McMullin Group GSA	17,425	24,867	10,275	17,007	Groundwater outflows estimated at historic levels	44
		Westlands WD GSA	1,213	1,900	725	1,171	for each year type. There is insufficient data	45
		Central Delta Mendota GSA	-	-	-	-	and/or modeling to calculate groundwater flows	46
		Fresno County GSA	29	1,567	-	377	for the future years.	47
		Total	**22,823**	**32,533**	**13,125**	**22,141**		48
Storage Change	Surface Water	Mendota Pool	-	-	-	-		49
		James ID K-Basin	-	-	-	-		50
		James ID Basin 1	-	-	-	-		51
		James ID Basin 2	-	-	-	-		52
		James ID Basin 3	-	-	-	-	Storage change assumed negligible	53
		James ID C-Basin	-	-	-	-	for water budget analysis.	54
		James ID E-Basin	-	-	-	-		55
		City of San Joaquin Stormwater Basins	-	-	-	-		56
		Total (MEASURED)	-	-	-	-		57
	Groundwater	Recharge less Extraction	5,383	(11,134)	45,166	13,120		58
		Inflow less Outflow	(12,573)	(20,100)	(8,875)	(13,054)		59
		Total (CALCULATED)	**(7,190)**	**(31,234)**	**36,291**	**65**	Calculated values	60

Appendix 4 A Hydrographs

15S16E28A003M

Ground Surface Elevation: 171 ft

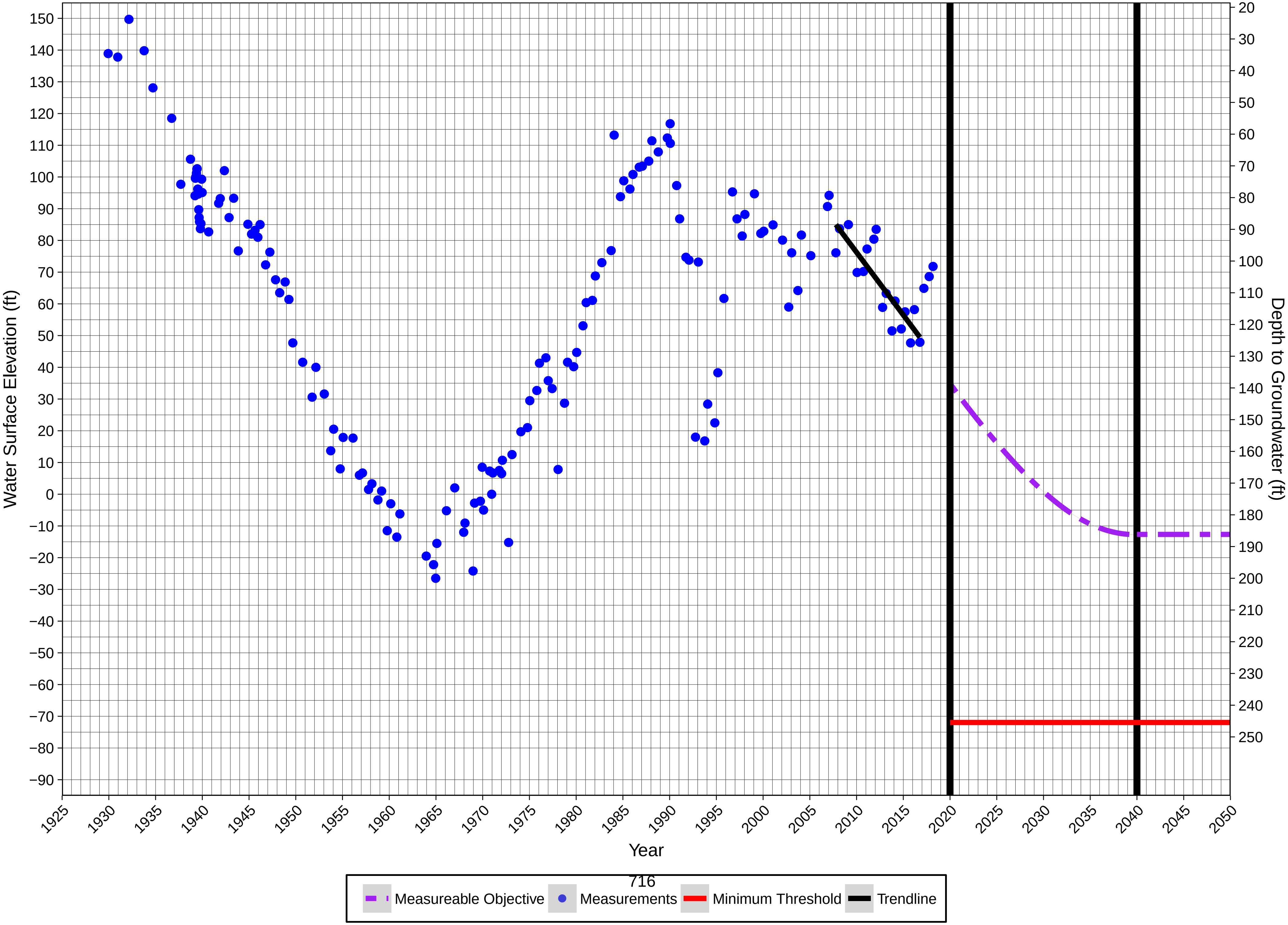
James ID



15S16E29N001M

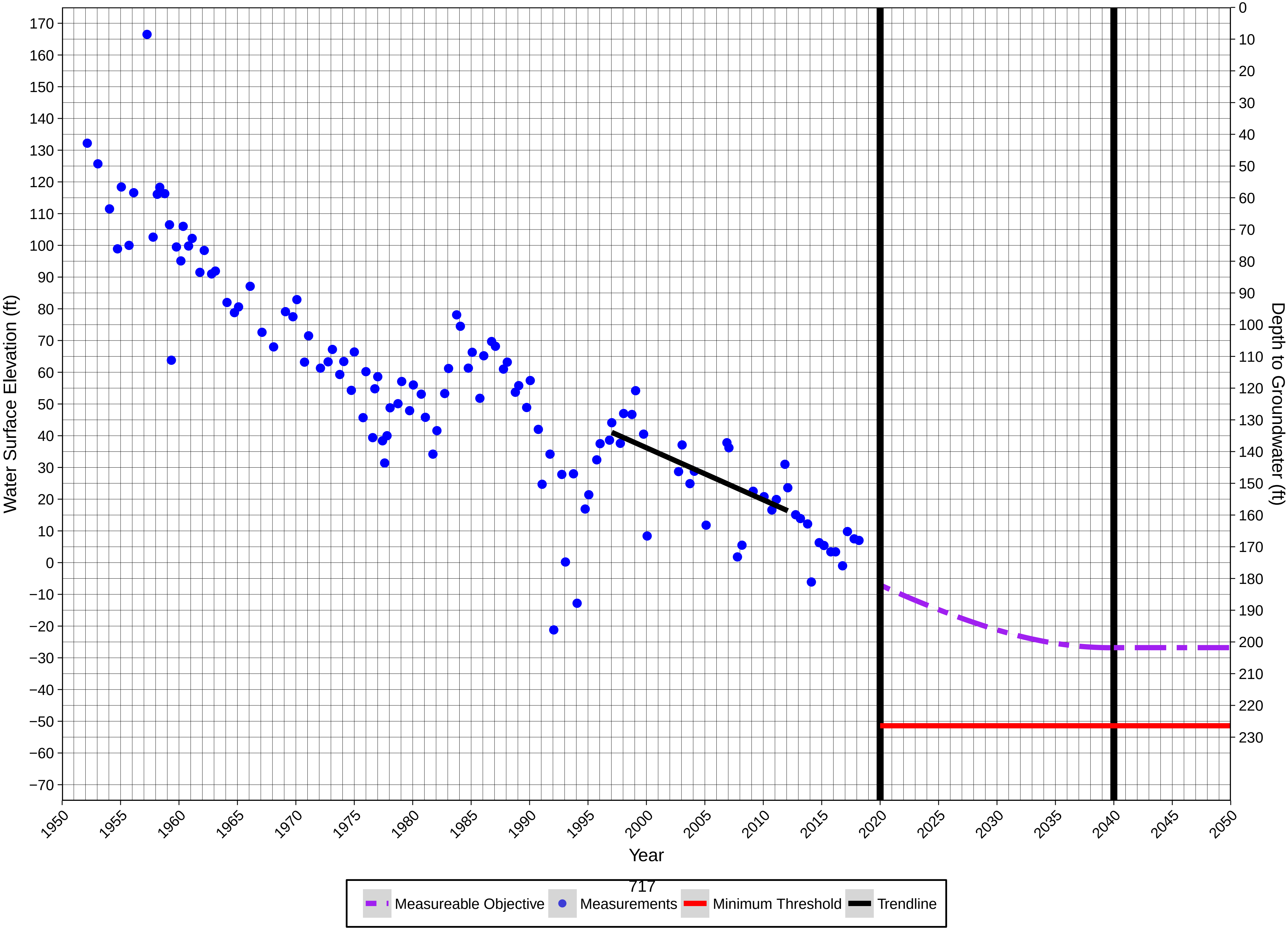
Ground Surface Elevation: 174 ft

James ID



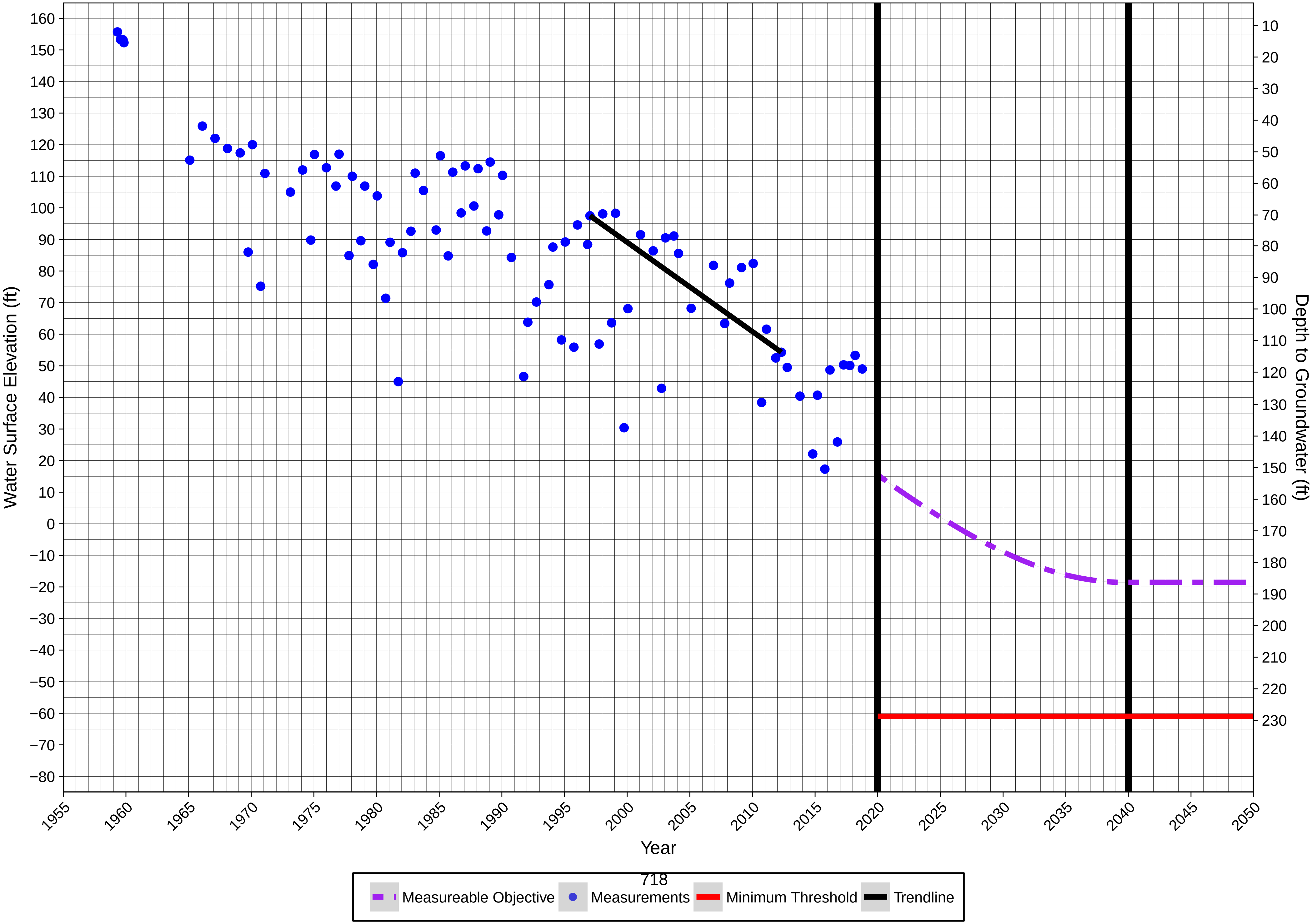
16S17E04P001M

Ground Surface Elevation: 175 ft
James ID



366502N1201782W001

State Well ID: 15S16E01Q002M
Ground Surface Elevation: 168 ft
James ID



Appendix 4 B Groundwater Storage Calculations

Appendix 4B - Estimate of Storage; Minimum Threshold (MT) to Interim Milestones (IM) and from MT to Measurable Objective (MO) - Page 1 of 3

Central Kings GSA

Specific Yield (SY) Unit	SY10to50	SY50to100	SY100to200	SY200to300	SY300to400	Acres in SY Unit	Estimated Storage between IM 2025 & MT			Estimated Storage between IM 2030 & MT			Estimated Storage between IM 2035 & MT			Estimated Storage between MO & MT				
							AVE. DTW in SY Unit @ IM 2025	Storage above 400 ft @ IM 2025	Est. Storage between IM 2025 & MT	AVE. DTW in SY Unit @ IM 2030	Storage above 400 ft @ IM 2030	Est. Storage between IM 2030 & MT	AVE. DTW in SY Unit @ IM 2035	Storage above 400 ft @ IM 2035	Est. Storage between IM 2035 & MT	AVE. DTW in SY Unit @ MO	Storage above 400 ft @ MO	AVE. DTW in SY Unit @ MT	Storage above 400 ft @ MT	Est. Storage between MO & MT
CK047	0.159	0.127	0.085	0.141	0.125	4,747	74.2	182,161	19,470	76.5	180,809	18,118	78.0	179,908	17,217	78.5	179,615	109.8	162,691	16,924
CK049	0.178	0.158	0.104	0.147	0.142	10,333	60.1	471,212	66,533	63.6	465,572	60,892	65.9	461,813	57,134	66.6	460,659	101.3	404,679	55,980
CK050	0.178	0.158	0.104	0.159	0.18	115	25.4	6,525	313	25.3	6,526	314	25.2	6,527	315	25.2	6,528	40.6	6,212	316
CK072	0.13	0.109	0.139	0.117	0.128	1,598	168.6	46,113	9,617	175.4	44,616	8,121	179.8	43,619	7,123	181.3	43,290	214.2	36,496	6,794
CK073	0.138	0.134	0.134	0.142	0.13	13,442	132.2	487,819	77,189	138.3	476,853	66,223	142.3	469,545	58,915	143.6	467,163	175.0	410,630	56,533
CK074	0.138	0.134	0.134	0.145	0.115	19,177	83.6	797,763	96,855	89.2	783,347	82,439	92.9	773,740	72,832	94.1	770,679	121.3	700,908	69,772
CK075	0.173	0.131	0.121	0.157	0.141	20,186	68.2	929,909	113,455	73.6	915,473	99,020	77.3	905,854	89,400	78.4	902,778	112.0	816,454	86,324
CK076	0.127	0.138	0.094	0.134	0.137	9,895	44.3	436,565	35,368	46.3	434,122	32,925	47.6	432,494	31,297	48.0	431,942	70.7	401,197	30,745
CK088	0.155	0.139	0.157	0.12	0.13	3,844	211.0	91,042	29,443	221.8	86,044	24,445	229.0	82,714	21,114	231.3	81,672	274.8	61,600	20,072
CK089	0.122	0.138	0.148	0.139	0.126	17,282	164.6	548,630	141,970	174.3	523,684	117,023	180.8	507,059	100,399	182.8	501,905	221.4	406,660	95,245
CK090	0.155	0.135	0.128	0.143	0.141	17,929	99.8	739,233	120,746	107.8	720,881	102,394	113.1	708,670	90,183	114.8	704,817	152.4	618,487	86,331
CK091	0.156	0.137	0.141	0.148	0.147	20,442	70.8	972,954	120,952	75.2	960,644	108,641	78.2	952,440	100,438	79.1	949,836	113.6	852,002	97,833
CK092	0.147	0.126	0.141	0.131	0.14	4,850	61.5	223,366	23,839	65.2	221,056	21,529	67.8	219,516	19,990	68.5	219,031	100.4	199,527	19,504
CK102	0.104	0.085	0.133	0.111	0.13	7,060	78.6	276,920	43,503	84.7	273,222	39,805	88.8	270,758	37,341	90.1	269,972	132.6	233,417	36,555
							Totals (AF)	6,210,211	899,252		6,092,848	781,889		6,014,657	703,699		5,989,886		5,310,959	678,927

James ID GSA

SY Unit	SY10to50	SY50to100	SY100to200	SY200to300	SY300to400	Acres in SY Unit	Estimated Storage between IM 2025 & MT			Estimated Storage between IM 2030 & MT			Estimated Storage between IM 2035 & MT			Estimated Storage between MO & MT				
							AVE. DTW in SY Unit @ IM 2025	Storage above 400 ft @ IM 2025	Est. Storage between IM 2025 & MT	AVE. DTW in SY Unit @ IM 2030	Storage above 400 ft @ IM 2030	Est. Storage between IM 2030 & MT	AVE. DTW in SY Unit @ IM 2035	Storage above 400 ft @ IM 2035	Est. Storage between IM 2035 & MT	AVE. DTW in SY Unit @ MO	Storage above 400 ft @ MO	AVE. DTW in SY Unit @ MT	Storage above 400 ft @ MT	Est. Storage between MO & MT
JID032	0.100	0.100	0.100	0.100	0.100	1	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0.0	0	0
JID033	0.100	0.100	0.100	0.100	0.100	103	84.5	3,234	268	85.1	3,228	261	85.5	3,223	257	85.6	3222	110.6	2966	256
JID034	0.110	0.110	0.110	0.110	0.110	8,971	126.9	269,465	63,529	136.4	260,069	54,133	142.8	253,808	47,872	144.7	251870	191.3	205936	45,933
JID062	0.100	0.100	0.100	0.100	0.100	1,425	88.0	44,466	2,393	88.3	44,430	2,356	88.4	44,406	2,332	88.5	44399	104.8	42074	2,326
JID063	0.120	0.120	0.120	0.120	0.120	17,595	159.0	508,925	79,363	165.9	494,267	64,705	170.5	484,499	54,937	172.0	481467	196.6	429562	51,905
JID064	0.126	0.126	0.126	0.126	0.126	303	217.0	6,985	2,918	224.4	6,704	2,637	229.3	6,516	2,449	230.8	6457	293.4	4067	2,390
JID067	0.125	0.125	0.125	0.125	0.125	481	203.1	11,829	3,581	208.9	11,476	3,227	212.9	11,240	2,992	214.1	11166	262.7	8248	2,917
JID068	0.130	0.130	0.130	0.130	0.130	180	216.5	4,290	1,882	222.0	4,160	1,752	225.7	4,073	1,666	226.9	4046	297.0	2408	1,638
							Totals (AF)	849,194	153,934		824,333	129,072		807,766	112,505		802,627		695,261	107,366

Kings River East GSA

SY Unit	SY10to50	SY50to100	SY100to200	SY200to300	SY300to400	Acres in SY Unit	Estimated Storage between IM 2025 & MT			Estimated Storage between IM 2030 & MT			Estimated Storage between IM 2035 & MT			Estimated Storage between MO & MT				
							AVE. DTW in SY Unit @ IM 2025	Storage above 400 ft @ IM 2025	Est. Storage between IM 2025 & MT	AVE. DTW in SY Unit @ IM 2030	Storage above 400 ft @ IM 2030	Est. Storage between IM 2030 & MT	AVE. DTW in SY Unit @ IM 2035	Storage above 400 ft @ IM 2035	Est. Storage between IM 2035 & MT	AVE. DTW in SY Unit @ MO	Storage above 400 ft @ MO	AVE. DTW in SY Unit @ MT	Storage above 400 ft @ MT	Est. Storage between MO & MT
KRE025	0.180	0.180	0.180	0.000	0.000	40	17.1	1,301	54	18.4	1,291	44	19.3	1,284	37	19.6	1,283	24.6	1,247	36
KRE049	0.178	0.158	0.104	0.147	0.169	2,275	36.3	119,052	7,029	37.7	118,498	6,475	38.6	118,128	6,105	38.8	118,023	54.1	112,023	6,000
KRE050	0.178	0.158	0.104	0.000	0.000	13,801	24.9	314,201	31,322	25.6	312,471	29,592	26.1	311,319	28,440	26.2	311,066	37.7	282,879	28,187
KRE051	0.180	0.180	0.180	0.000	0.000	1,181	23.8	37,447	3,727	24.9	37,211	3,492	25.6	37,054	3,335	25.8	37,017	41.3	33,719	3,298
KRE052	0.061	0.061	0.061	0.000	0.000	53	45.7	499	103	48.4	490	95	50.2	484	89	50.7	483	77.7	396	87
KRE053	0.130	0.130	0.130	0.000	0.000	55	52.3	1,046	249	55.4	1,024	227	57.5	1,010	212	58.1	1,006	87.5	797	208
KRE054	0.061	0.061	0.061	0.000	0.000	660	58.2	5,712	1,669	61.7	5,571	1,529	64.0	5,477	1,435	64.7	5,448	99.6	4,042	1,406
KRE055	0.125	0.125	0.125	0.000	0.000	2,155	12.8	50,420	2,366	13.8	50,158	2,105	14.4	49,984	1,931	14.6	49,947	21.6	48,054	1,893
KRE056	0.115	0.115	0.115	0.000	0.000	542	20.9	11,162	1,090	23.0	11,030	958	24.5	10,942	870	24.9	10,916	38.4	10,071	845
KRE057	0.078	0.078	0.078	0.000	0.000	668	24.5	9,144	1,127	27.6	8,984	968	29.6	8,878	861	30.2	8,845	46.1	8,016	829
KRE058	0.065	0.065	0.065	0.000	0.000	2,001	44.9	20,167	5,629	48.0	19,774	5,236	50.0	19,512	4,973	50.6	19,427	88.2	14,538	4,889
KRE059	0.070	0.000	0.000	0.000	0.000	7,583	26.9	12,256	12,256	29.5	10,901	10,901	31.2	9,998	9,998	31.7	9,706	61.1	0	9,706
KRE060	0.069	0.090	0.066	0.102	0.130	1,124	69.9	36,542	4,254	73.7	36,158	3,871	76.2	35,903	3,615	77.0	35,823	116.3	32,288	3,536
KRE061	0.069	0.090	0.066	0.000	0.000	2,431	60.1	24,767	10,844	63.7	24,000	10,077	66.0	23,489	9,566	66.8	23,321	113.2	13,922	9,398
KRE075	0.173	0.131	0.121	0.157	0.141	331	38.8	16,674	1,122	42.1	16,485	933	44.3	16,358	806	45.0	16,320	61.1	15,552	768
KRE076	0.127	0.138	0.094	0.134	0.126	12,213	76.7	471,630	51,163	80.3	465,616	45,150	82.6	461,609	41,142	83.4	460,407	110.4	420,466	39,940
KRE077	0.069	0.090	0.066	0.095	0.130	856	83.1	26,208	3,106	86.8	25,929	2,827	89.2	25,743	2,641	89.9	25,686	132.0	23,102	2,584
KRE078	0.069	0.090	0.066	0.000	0.000	20,839	75.1	184,159	78,014	79.4	176,157	70,012	82.3	170,825	64,679	83.1	169,147	122.8	106,145	63,002
KRE079	0.074	0.074	0.074	0.000	0.000	2,497	42.4	29,120	7,737	44.0	28,828	7,445	45.0	28,634	7,251	45.4	28,563	84.3	21,383	7,180
KRE080	0.060	0.000	0.000	0.000	0.000	6,010	53.3	0	0	55.3	0	0	56.6	0	0	57.1	0	98.5	0	0
KRE081	0.069	0.090	0.066	0.000	0.000	2,020	78.6	17,228	6,846	83.5	16,329	5,948	86.8	15,731	5,349	87.9	15,541	122.1	10,382	5,159
KRE082	0.060	0.060	0.060	0.000	0.000	236	66.5	1,887	669	70.3	1,834	615	72.8	1,799	580	73.6	1,787	113.8	1,219	568
KRE091	0.156	0.137	0.141	0.148	0.135	360	39.6	18,328	2,068	43.1	18,130	1,870	45.5	17,998	1,738	46.2	17,959	80.1	16,260	1,699
KRE092	0.147	0.126	0.141	0.000	0.000	18,236	97.4	263,026	148,294	106.2	241,170	126,438	112.1	226,137	111,405	113.9	221,490	155.4	114,732	106,758
KRE093	0.068	0.080	0.055	0.000	0.000	22,806	82.4	157,466	99,647	88.5	146,406	88,586	92.5	139,035	81,215	93.9	136,635	153.9	57,820	78,815
KRE094	0.056	0.080	0.055	0.000	0.000	11,499	79.5	82,123	41,478	86.3	75,885	35,240	90.8	71,727	31,083	92.2	70,436	135.7	40,645	29,791
KRE095	0.074	0.074	0.074	0.000	0.000	7,285	67.1	71,637	27,401	71.3	69,399	25,163	74.0	67,908	23,672	74.9	67,448	117.9	44,236	23,212
KRE102	0.104	0.085	0.133	0.111	0.130	3	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0.0	0	0
KRE103	0.104	0.085	0.120	0.000	0.000	19,983	95.8	247,002	162,420	107.5	221,713	137,131	115.4	202,884	118,302	117.8	197,080	164.7	84,582	112,498
KRE104	0.096	0.086	0.077	0.000	0.000	857	104.7	6,294	3,880	116.6	5,504	3,090	124.6	4,978	2,564	127.0	4,816	163.4	2,414	2,402
KRE105	0.104	0.085	0.120	0.000	0.000	737	121.2	6,966	6,173	131.6	6,049	5,256	138.5	5,438	4,644	140.7	5,245	191.0	794	4,452
KRE106	0.068	0.080	0.055	0.000	0.000	12,058	106.0	62,368	57,847	116.1	55,614	51,093	122.9	51,113	46,592	125.1	49,669	193.2	4,521	45,147
KRE107	0.086	0.102	0.065	0.000	0.000	1,741	99.4	11,430	7,529	110.2	10,163	6,262	117.4	9,346	5,445	119.7	9,091	165.5	3,901	5,190
KRE108	0.068	0.080	0.055	0.000	0.000	7,691	103.2	40,939	25,032	112.8	36,887	20,980	119.2	34,187	18,280	121.2	33,338	162.4	15,907	17,431
KRE109	0.097	0.104	0.079	0.000	0.000	57	117.0	371	277	128.1	321	227	135.6	288	193	137.9	278	178.8	95	183
KRE110	0.074	0.074	0.074	0.000	0.000	295	71.1	2,817	802	78.1	2,665	650	82.7	2,564	549	84.2	2,532	107.8	2,015	517
KRE117	0.074	0.074	0.074	0.000	0.000	14	67.5	140	40	73.9	133	34	78.2	129	29	79.6	127	105.7	100	28
							Totals (AF)	2,361,527	813,264		2,258,780	710,517		2,187,892	639,629		2,165,905		1,548,263	617,643

Specific Yield Sources

- USGS WSP 1469
- Page and LeBlanc 1969
- USGS PP 1401-D
- KRCD/AID
- KDSA
- USBR/OCID
- P&P
- Bedrock

Appendix 4B - Estimate of Storage; Minimum Threshold (MT) to Interim Milestones (IM) and from MT to Measurable Objective (MO) - Page 2 of 3

McMullin Area GSA

							Estimated Storage between IM 2025 & MT			Estimated Storage between IM 2030 & MT			Estimated Storage between IM 2035 & MT			Estimated Storage between MO & MT				
Specific Yield (SY) Unit	SY10to50	SY50to100	SY100to200	SY200to300	SY300to400	Acres in SY Unit	AVE. DTW in SY Unit @ IM 2025	Storage above 400 ft @ IM 2025	Est. Storage between IM 2025 & MT	AVE. DTW in SY Unit @ IM 2030	Storage above 400 ft @ IM 2030	Est. Storage between IM 2030 & MT	AVE. DTW in SY Unit @ IM 2035	Storage above 400 ft @ IM 2035	Est. Storage between IM 2035 & MT	AVE. DTW in SY Unit @ MO	Storage above 400 ft @ MO	AVE. DTW in SY Unit @ MT	Storage above 400 ft @ MT	Est. Storage between MO & MT
MA013	0.155	0.119	0.158	0.133	0.160	171	143.2	6,545	2,353	152.0	6,306	2,114	157.9	6,147	1,955	159.8	6,097	236.0	4,192	1,905
MA014	0.100	0.078	0.081	0.133	0.122	1,166	100.0	39,167	7,206	106.3	38,569	6,608	110.6	38,170	6,209	111.9	38,045	176.3	31,961	6,084
MA015	0.103	0.069	0.088	0.106	0.110	253	86.1	7,944	2,063	90.6	7,865	1,985	93.5	7,813	1,933	94.5	7,797	181.7	5,880	1,917
MA029	0.160	0.160	0.160	0.160	0.160	414	155.2	16,225	5,705	163.5	15,676	5,156	169.0	15,311	4,791	170.8	15,193	241.3	10,520	4,673
MA030	0.134	0.134	0.134	0.134	0.160	6,568	137.6	248,035	64,932	145.2	241,374	58,270	150.2	236,935	53,831	151.8	235,511	211.4	183,104	52,407
MA031	0.128	0.128	0.128	0.128	0.110	10,065	105.0	361,926	78,863	111.6	353,391	70,329	116.0	347,703	64,641	117.4	345,936	166.2	283,062	62,874
MA034	0.110	0.110	0.110	0.110	0.110	4,151	120.1	127,792	26,484	129.8	123,400	22,092	136.2	120,474	19,166	138.2	119,557	178.1	101,308	18,249
MA035	0.110	0.110	0.110	0.110	0.110	1,290	169.9	32,659	5,726	176.9	31,655	4,722	181.7	30,986	4,053	183.1	30,777	210.2	26,933	3,844
MA036	0.115	0.115	0.115	0.115	0.110	19,957	150.3	563,195	69,282	156.2	549,646	55,734	160.1	540,617	46,705	161.4	537,732	180.4	493,912	43,819
MA037	0.116	0.116	0.116	0.116	0.110	0.4	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0.0	0	0
MA038	0.096	0.157	0.160	0.112	0.110	170	131.3	5,657	1,260	132.9	5,611	1,214	134.1	5,581	1,184	134.5	5,569	177.5	4,397	1,172
MA042	0.130	0.109	0.139	0.119	0.000	19	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0.0	0	0
MA063	0.120	0.120	0.120	0.120	0.120	373	196.7	9,108	2,293	207.0	8,650	1,835	213.8	8,345	1,530	215.9	8,251	247.9	6,815	1,436
MA064	0.126	0.126	0.126	0.126	0.126	21,269	220.3	481,577	148,521	229.1	458,015	124,959	234.9	442,314	109,258	236.8	437,438	275.7	333,056	104,382
MA065	0.104	0.104	0.104	0.104	0.090	2,997	200.7	57,925	17,442	209.1	55,302	14,819	214.7	53,554	13,071	216.4	53,020	256.7	40,483	12,537
MA068	0.130	0.130	0.130	0.130	0.130	8,576	258.5	157,725	89,175	270.6	144,278	75,728	278.6	135,317	66,767	281.2	132,460	338.5	68,550	63,910
MA069	0.109	0.109	0.109	0.109	0.130	7,629	257.2	134,804	58,259	269.2	124,764	48,220	277.3	118,074	41,529	279.8	115,958	322.8	76,545	39,413
MA070	0.116	0.116	0.116	0.116	0.120	7,181	240.2	135,989	44,738	249.8	127,971	36,720	256.2	122,628	31,376	258.2	120,963	293.9	91,251	29,712
MA071	0.130	0.109	0.139	0.102	0.101	4,233	179.6	97,918	25,046	186.1	94,103	21,231	190.4	91,561	18,689	191.7	90,802	230.2	72,872	17,930
MA072	0.130	0.109	0.139	0.117	0.119	14,476	181.7	378,408	75,387	187.3	367,247	64,227	191.0	359,810	56,789	192.1	357,488	222.8	303,020	54,467
MA085	0.110	0.110	0.110	0.110	0.110	198	266.4	2,904	1,848	281.4	2,579	1,523	291.3	2,362	1,306	294.5	2,294	351.4	1,056	1,238
MA086	0.116	0.116	0.116	0.116	0.110	1,326	258.6	20,942	11,054	270.4	19,137	9,248	278.2	17,934	8,045	280.7	17,556	332.2	9,888	7,668
MA087	0.116	0.116	0.116	0.116	0.130	1,467	244.3	28,549	10,499	253.0	27,065	9,015	258.9	26,076	8,026	260.7	25,768	305.4	18,050	7,718
MA088	0.155	0.139	0.157	0.120	0.127	6,629	225.4	143,517	40,990	233.5	137,106	34,578	238.8	132,833	30,306	240.5	131,497	276.9	102,527	28,970
							Totals (AF)	3,058,509	789,127		2,939,711	670,328		2,860,544	591,162		2,835,706		2,269,382	566,324

North Fork Kings GSA

							Estimated Storage between IM 2025 & MT			Estimated Storage between IM 2030 & MT			Estimated Storage between IM 2035 & MT			Estimated Storage between MO & MT				
SY Unit	SY10to50	SY50to100	SY100to200	SY200to300	SY300to400	Acres in SY Unit	AVE. DTW in SY Unit @ IM 2025	Storage above 400 ft @ IM 2025	Est. Storage between IM 2025 & MT	AVE. DTW in SY Unit @ IM 2030	Storage above 400 ft @ IM 2030	Est. Storage between IM 2030 & MT	AVE. DTW in SY Unit @ IM 2035	Storage above 400 ft @ IM 2035	Est. Storage between IM 2035 & MT	AVE. DTW in SY Unit @ MO	Storage above 400 ft @ MO	AVE. DTW in SY Unit @ MT	Storage above 400 ft @ MT	Est. Storage between MO & MT
NFK063	0.120	0.120	0.120	0.120	0.120	2,773	148.7	83,627	4,714	154.0	81,853	2,941	157.5	80,671	1,759	158.6	80,301	162.8	78,913	1,388
NFK067	0.125	0.125	0.125	0.125	0.125	16,262	203.1	400,162	86,931	210.6	384,916	71,685	215.6	374,756	61,525	217.2	371,579	245.9	313,231	58,348
NFK068	0.130	0.130	0.130	0.130	0.130	9,547	252.0	183,718	101,733	264.6	168,113	86,129	272.9	157,715	75,730	275.6	154,435	333.9	81,984	72,451
NFK084	0.120	0.120	0.120	0.120	0.120	11,019	229.9	224,964	69,314	239.7	212,005	56,356	246.2	203,369	47,720	248.2	200,668	282.3	155,649	45,019
NFK085	0.110	0.110	0.110	0.110	0.110	16,075	260.4	246,922	131,587	274.9	221,231	105,896	284.6	204,111	88,775	287.6	198,835	334.8	115,335	83,500
NFK086	0.116	0.116	0.116	0.116	0.110	5,237	253.6	85,801	43,180	265.6	78,487	35,866	273.6	73,613	30,992	276.0	72,157	326.0	42,621	29,536
NFK087	0.116	0.116	0.116	0.116	0.130	5,523	243.5	107,981	45,194	255.1	100,532	37,745	262.9	95,568	32,781	265.3	94,004	312.5	62,787	31,217
NFK088	0.155	0.139	0.157	0.120	0.130	1,891	231.7	40,073	16,517	244.8	37,108	13,552	253.5	35,132	11,576	256.2	34,511	304.2	23,556	10,955
NFK089	0.122	0.138	0.148	0.139	0.119	5,778	192.3	155,656	53,328	205.4	144,713	42,385	214.2	137,687	35,359	216.9	135,512	258.2	102,328	33,183
NFK090	0.155	0.135	0.128	0.143	0.113	5,117	136.8	172,406	39,691	146.4	166,128	33,413	152.7	161,945	29,230	154.8	160,611	197.4	132,715	27,896
NFK096	0.130	0.130	0.130	0.130	0.130	2,376	209.0	58,990	24,201	222.2	54,901	20,112	231.0	52,176	17,388	233.8	51,331	287.3	34,788	16,543
NFK097	0.120	0.120	0.120	0.120	0.120	15,060	229.3	308,507	124,788	241.7	286,041	102,322	250.0	271,069	87,350	252.3	266,874	298.3	183,719	83,155
NFK098	0.133	0.133	0.133	0.133	0.120	4,082	232.8	85,451	34,632	245.0	78,867	28,048	253.0	74,479	23,660	255.7	73,045	296.6	50,819	22,225
NFK099	0.114	0.114	0.114	0.114	0.120	3,876	239.8	73,100	31,008	253.8	66,929	24,837	263.1	62,817	20,725	265.9	61,588	309.5	42,092	19,496
NFK100	0.183	0.119	0.133	0.113	0.120	22,931	212.5	501,861	189,585	226.4	465,963	153,688	235.6	442,041	129,766	238.0	435,697	285.7	312,275	123,422
NFK101	0.173	0.162	0.133	0.135	0.129	17,049	153.1	556,425	164,454	163.9	531,976	140,005	171.1	515,684	123,712	173.3	510,595	225.2	391,971	118,624
NFK102	0.104	0.085	0.133	0.111	0.131	3,195	120.0	111,282	27,422	129.0	107,468	23,608	135.0	104,926	21,066	136.9	104,107	184.6	83,860	20,248
NFK111	0.080	0.080	0.080	0.080	0.080	46	210.1	700	538	235.6	606	444	252.6	544	381	256.4	530	355.9	163	367
NFK112	0.120	0.120	0.120	0.120	0.120	5,393	210.3	122,782	81,923	232.4	108,449	67,591	247.2	98,898	58,040	251.5	96,128	336.9	40,859	55,269
NFK113	0.150	0.096	0.150	0.133	0.120	6,112	205.7	149,995	65,223	219.3	138,918	54,146	228.4	131,536	46,764	234.2	126,863	285.9	84,772	42,092
NFK114	0.150	0.096	0.150	0.133	0.120	8,485	188.6	229,118	83,163	201.0	213,565	67,610	209.2	204,293	58,338	216.7	195,792	260.9	145,955	49,837
							Totals (AF)	3,899,520	1,419,128		3,648,769	1,168,378		3,483,029	1,002,638		3,425,163		2,480,392	944,771

Specific Yield Sources

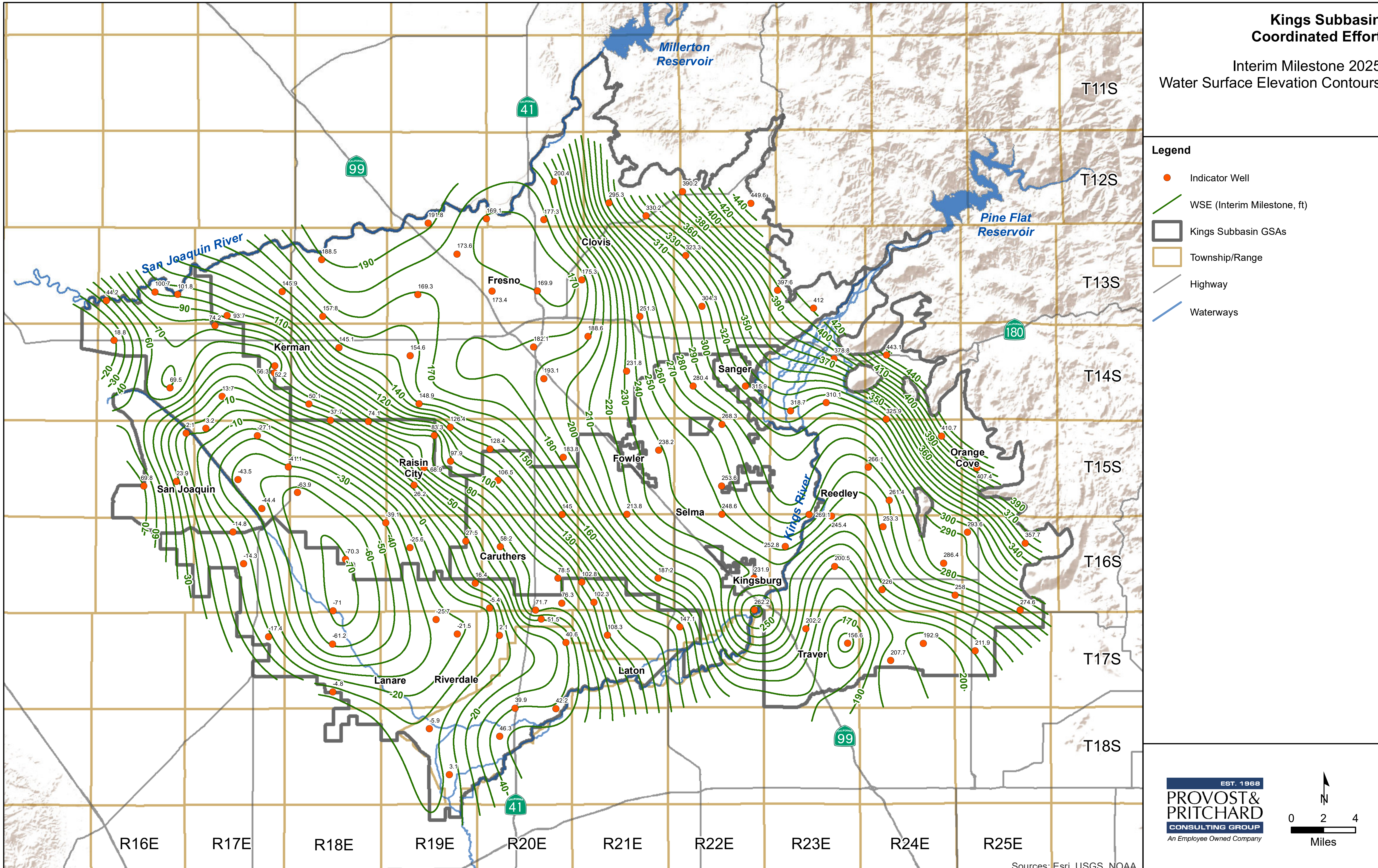
- USGS WSP 1469
- Page and LeBlanc 1969
- USGS PP 1401-D
- KRCD/AID
- KDSA
- USBR/OCID
- P&P
- Bedrock

Appendix 4B - Estimate of Storage; Minimum Threshold (MT) to Interim Milestones (IM) and from MT to Measurable Objective (MO) - Page 3 of 3

North Kings GSA							Estimated Storage between IM 2025 & MT			Estimated Storage between IM 2030 & MT			Estimated Storage between IM 2035 & MT			Estimated Storage between MO & MT				
Specific Yield (SY) Unit	SY10to50	SY50to100	SY100to200	SY200to300	SY300to400	Acres in SY Unit	AVE. DTW in SY Unit @ IM 2025	Storage above 400 ft @ IM 2025	Est. Storage between IM 2025 & MT	AVE. DTW in SY Unit @ IM 2030	Storage above 400 ft @ IM 2030	Est. Storage between IM 2030 & MT	AVE. DTW in SY Unit @ IM 2035	Storage above 400 ft @ IM 2035	Est. Storage between IM 2035 & MT	AVE. DTW in SY Unit @ MO	Storage above 400 ft @ MO	AVE. DTW in SY Unit @ MT	Storage above 400 ft @ MT	Est. Storage between MO & MT
NK003	0.103	0.108	0.130	0.105	0.110	99	72.8	3,699	190	74.4	3,681	173	75.5	3,670	161	75.8	3,667	90.6	3,509	158
NK004	0.156	0.151	0.103	0.155	0.131	3,613	131.1	128,949	9,543	135.6	127,280	7,874	138.6	126,168	6,762	139.5	125,819	156.8	119,406	6,413
NK005	0.135	0.117	0.153	0.145	0.113	13,847	160.5	440,980	65,449	165.9	429,532	54,001	169.5	421,903	46,372	170.6	419,472	191.4	375,531	43,941
NK006	0.112	0.131	0.139	0.000	0.000	12,544	89.6	191,371	41,345	93.6	184,894	34,868	96.2	180,578	30,552	97.0	179,215	114.0	150,026	29,189
NK008	0.076	0.076	0.076	0.000	0.000	7,640	50.4	86,864	14,341	53.6	85,031	12,508	55.7	83,809	11,286	56.3	83,441	75.1	72,523	10,917
NK009	0.060	0.000	0.000	0.000	0.000	4,122	40.4	2,380	2,380	44.5	1,366	1,366	47.2	690	690	48.0	484	67.6	0	484
NK011	0.090	0.000	0.000	0.000	0.000	3,268	17.5	9,568	6,451	18.3	9,337	6,221	18.8	9,183	6,067	18.9	9,140	39.4	3,116	6,023
NK015	0.103	0.069	0.088	0.106	0.110	13,899	89.4	432,649	84,496	90.7	431,401	83,248	91.6	430,569	82,416	91.9	430,312	160.8	348,153	82,159
NK016	0.118	0.102	0.126	0.117	0.124	20,498	74.5	805,627	88,390	75.6	803,310	86,074	76.3	801,767	84,530	76.5	801,333	113.6	717,237	84,096
NK017	0.145	0.135	0.143	0.143	0.133	22,802	109.4	924,646	97,908	113.7	910,706	83,968	116.6	901,417	74,679	117.4	898,561	139.5	826,738	71,823
NK018	0.106	0.122	0.109	0.134	0.132	21,788	151.1	695,766	91,128	157.8	679,853	75,215	162.2	669,248	64,610	163.6	665,918	189.4	604,638	61,281
NK019	0.084	0.070	0.064	0.069	0.140	1,220	129.7	30,979	2,189	134.8	30,583	1,793	138.1	30,319	1,529	139.2	30,234	157.7	28,790	1,444
NK020	0.106	0.122	0.109	0.100	0.101	11,846	120.0	341,380	63,495	128.5	330,460	52,575	134.1	323,183	45,298	135.9	320,878	169.2	277,884	42,994
NK021	0.084	0.070	0.064	0.000	0.000	11,243	93.6	76,990	27,844	100.3	71,748	22,601	104.7	68,542	19,395	106.1	67,536	131.7	49,147	18,389
NK022	0.074	0.075	0.044	0.000	0.000	23,051	49.4	188,868	55,614	53.6	181,695	48,441	56.3	176,906	43,652	57.2	175,454	81.6	133,254	42,200
NK023	0.143	0.143	0.143	0.000	0.000	656	18.5	17,033	2,175	18.8	16,999	2,140	19.1	16,976	2,117	19.1	16,970	41.6	14,859	2,112
NK024	0.122	0.122	0.122	0.000	0.000	57	19.0	1,259	118	19.4	1,256	114	19.8	1,253	112	19.8	1,253	35.9	1,141	112
NK025	0.180	0.180	0.180	0.000	0.000	894	18.9	29,138	1,905	20.1	28,943	1,711	20.9	28,813	1,581	21.1	28,781	30.7	27,232	1,549
NK026	0.060	0.000	0.000	0.000	0.000	1,542	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0.0	0	0
NK027	0.060	0.060	0.060	0.000	0.000	2,078	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0.0	0	0
NK031	0.128	0.128	0.128	0.128	0.110	557	109.7	19,700	4,558	113.6	19,421	4,278	116.2	19,234	4,092	117.0	19,174	173.6	15,142	4,032
NK036	0.115	0.115	0.115	0.115	0.110	1,750	149.4	49,544	7,407	153.1	48,797	6,660	155.6	48,299	6,162	156.4	48,141	186.2	42,137	6,003
NK037	0.116	0.116	0.116	0.116	0.110	204	151.1	5,760	849	154.2	5,686	775	156.3	5,636	725	156.9	5,622	187.0	4,911	711
NK038	0.096	0.157	0.160	0.112	0.110	4,346	139.5	138,598	34,932	140.7	137,740	34,074	141.5	137,168	33,503	141.8	136,956	189.7	103,665	33,290
NK039	0.096	0.157	0.160	0.115	0.103	15,591	106.6	572,883	136,928	107.2	571,403	135,449	107.6	570,417	134,463	107.7	570,066	161.5	435,954	134,112
NK040	0.130	0.109	0.139	0.115	0.090	4,754	132.6	142,018	36,620	135.7	139,962	34,565	137.7	138,592	33,195	138.4	138,189	188.0	105,397	32,791
NK041	0.145	0.135	0.143	0.118	0.112	2,350	94.8	89,308	15,091	96.7	88,704	14,487	98.0	88,301	14,084	98.3	88,179	140.0	74,217	13,963
NK042	0.130	0.109	0.139	0.119	0.110	20,571	91.3	776,610	121,242	93.6	771,445	116,078	95.1	768,004	112,636	95.6	766,951	135.5	655,367	111,583
NK043	0.159	0.127	0.085	0.125	0.118	14,993	92.6	505,825	52,072	97.1	497,213	43,460	100.2	491,575	37,822	101.1	490,353	129.8	453,753	36,601
NK044	0.106	0.122	0.109	0.134	0.140	359	114.9	13,160	852	118.2	13,031	723	120.4	12,944	637	121.1	12,917	136.7	12,308	610
NK045	0.084	0.070	0.064	0.083	0.126	7,694	111.2	204,520	11,926	115.3	202,498	9,903	118.0	201,150	8,556	118.9	200,716	135.4	192,595	8,121
NK046	0.084	0.070	0.064	0.104	0.116	5,190	103.0	146,371	11,911	108.6	144,511	10,050	112.4	143,271	8,810	113.6	142,872	138.9	134,461	8,411
NK047	0.159	0.127	0.085	0.141	0.114	13,232	86.3	472,917	45,024	89.4	467,701	39,809	91.5	464,225	36,333	92.1	463,098	119.6	427,892	35,205
NK048	0.074	0.075	0.044	0.105	0.120	315	69.3	9,210	833	74.7	9,083	706	78.3	8,998	622	79.3	8,973	107.8	8,377	597
NK049	0.178	0.158	0.104	0.147	0.115	6,571	51.7	290,652	35,338	54.6	287,627	32,313	56.6	285,611	30,297	57.1	285,023	85.7	255,314	29,709
NK050	0.178	0.158	0.104	0.000	0.000	1,863	20.4	43,920	4,873	20.7	43,802	4,754	21.0	43,723	4,676	21.0	43,712	35.1	39,047	4,665
NK064	0.126	0.126	0.126	0.126	0.126	753	174.9	21,345	3,968	178.7	20,987	3,610	181.2	20,748	3,371	181.9	20,678	216.8	17,377	3,301
NK065	0.104	0.104	0.104	0.104	0.090	1,981	163.2	46,009	9,961	166.1	45,407	9,359	168.0	45,006	8,958	168.6	44,889	211.5	36,048	8,841
NK071	0.130	0.109	0.139	0.102	0.090	9	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0.0	0	0
NK072	0.130	0.109	0.139	0.117	0.129	6,406	131.0	219,038	40,598	134.6	215,830	37,390	137.0	213,692	35,252	137.7	213,016	176.6	178,440	34,577
NK073	0.138	0.134	0.134	0.142	0.124	9,589	101.5	381,602	58,880	105.7	376,186	53,464	108.5	372,576	49,855	109.4	371,430	147.3	322,722	48,709
NK074	0.138	0.134	0.134	0.145	0.110	2,386	84.5	97,794	10,271	87.5	96,817	9,294	89.5	96,166	8,643	90.2	95,951	116.6	87,523	8,428
							Totals (AF)	8,654,928	1,299,096		8,531,923	1,176,091		8,450,333	1,094,501		8,425,375		7,355,832	1,069,542

South Kings GSA							Estimated Storage between IM 2025 & MT			Estimated Storage between IM 2030 & MT			Estimated Storage between IM 2035 & MT			Estimated Storage between MO & MT				
SY Unit	SY10to50	SY50to100	SY100to200	SY200to300	SY300to400	Acres in SY Unit	AVE. DTW in SY Unit @ IM 2025	Storage above 400 ft @ IM 2025	Est. Storage between IM 2025 & MT	AVE. DTW in SY Unit @ IM 2030	Storage above 400 ft @ IM 2030	Est. Storage between IM 2030 & MT	AVE. DTW in SY Unit @ IM 2035	Storage above 400 ft @ IM 2035	Est. Storage between IM 2035 & MT	AVE. DTW in SY Unit @ MO	Storage above 400 ft @ MO	AVE. DTW in SY Unit @ MT	Storage above 400 ft @ MT	Est. Storage between MO & MT
SK049	0.178	0.158	0.104	0.147	0.152	3,561	51.1	170,980	17,574	53.0	169,912	16,506	54.3	169,199	15,794	54.7	168,989	82.4	153,406	15,583
SK074	0.138	0.134	0.134	0.145	0.11	1,603	81.8	66,275	6,768	86.6	65,233	5,726	89.9	64,539	5,032	90.9	64,314	113.3	59,507	4,807
SK075	0.173	0.131	0.121	0.157	0.14	2,412	63.4	112,397	14,001	68.5	110,788	12,393	71.9	109,717	11,321	73.0	109,373	108.3	98,396	10,977
SK076	0.127	0.138	0.094	0.134	0.14	48	45.1	2,145	224	47.7	2,129	208	49.4	2,119	198	50.0	2,115	79.0	1,921	194
SK091	0.156	0.137	0.141	0.148	0.139	2,245	66.7	106,343	12,402	70.5	105,167	11,226	73.0	104,383	10,443	73.8	104,139	106.8	93,940	10,199
							Totals (AF)	458,140	50,970		453,229	46,059		449,957	42,786		448,931		407,170	41,760

Specific Yield Sources
USGS WSP 1469
Page and LeBlanc 1969
USGS PP 1401-D
KRCD/AID
KDSA
USBR/OCID
P&P
Bedrock



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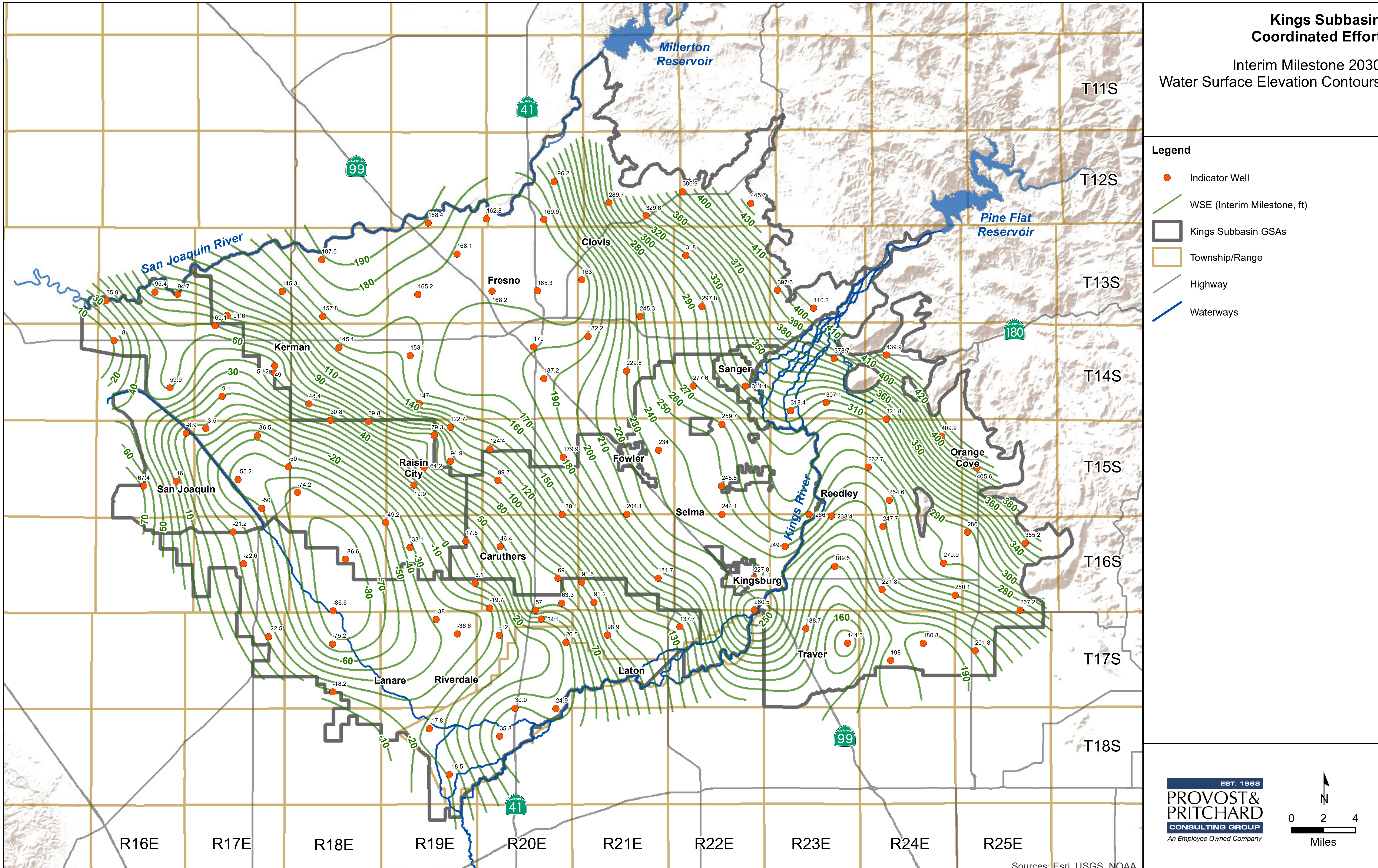

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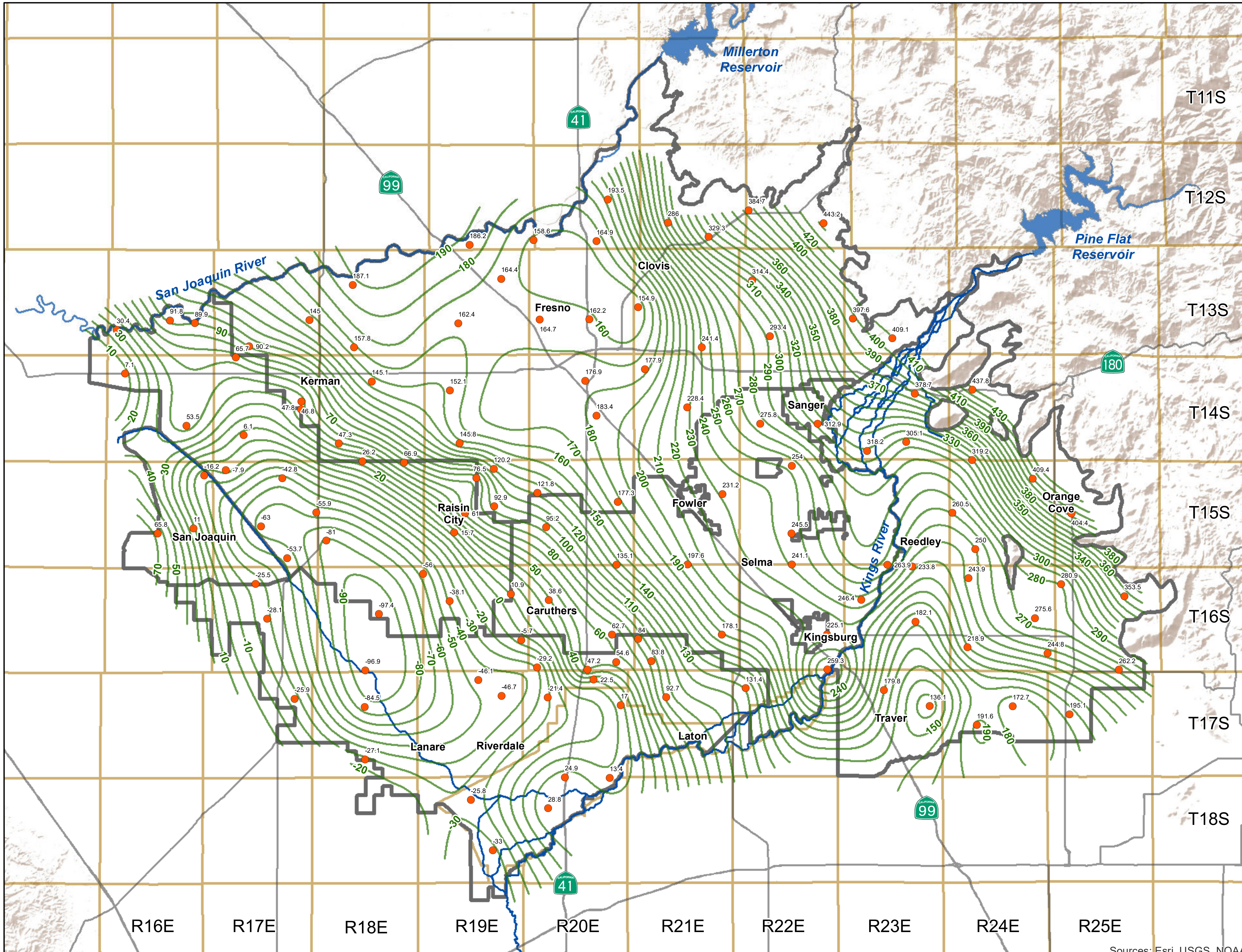
Kings Subbasin Coordinated Effort

Interim Milestone 2035
Water Surface Elevation Contours



Legend

- Indicator Well
- WSE (Interim Milestone, ft)
- Kings Subbasin GSAs
- Township/Range
- Highway
- Waterways

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Miles

Sources: Esri, USGS, NOAA

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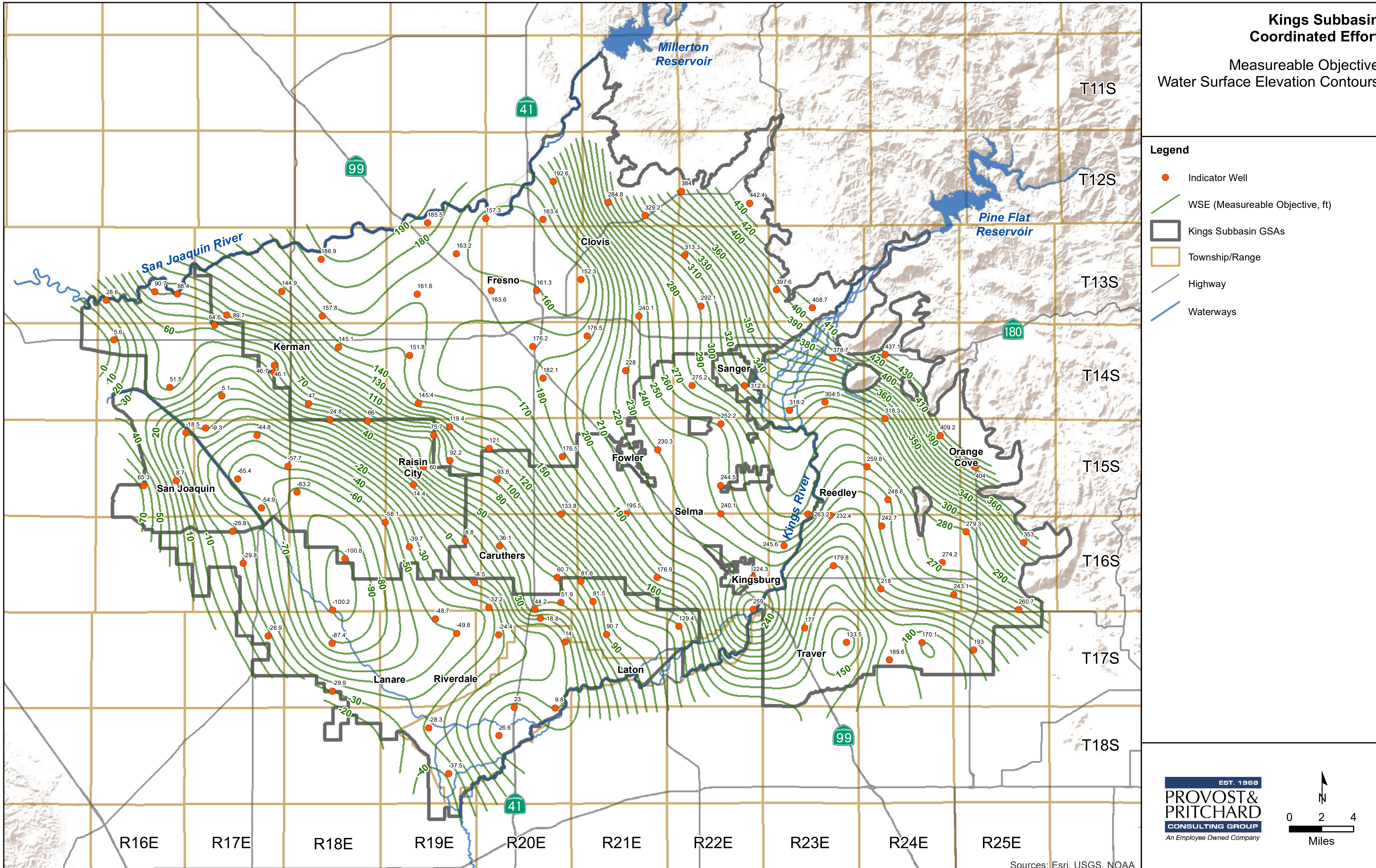

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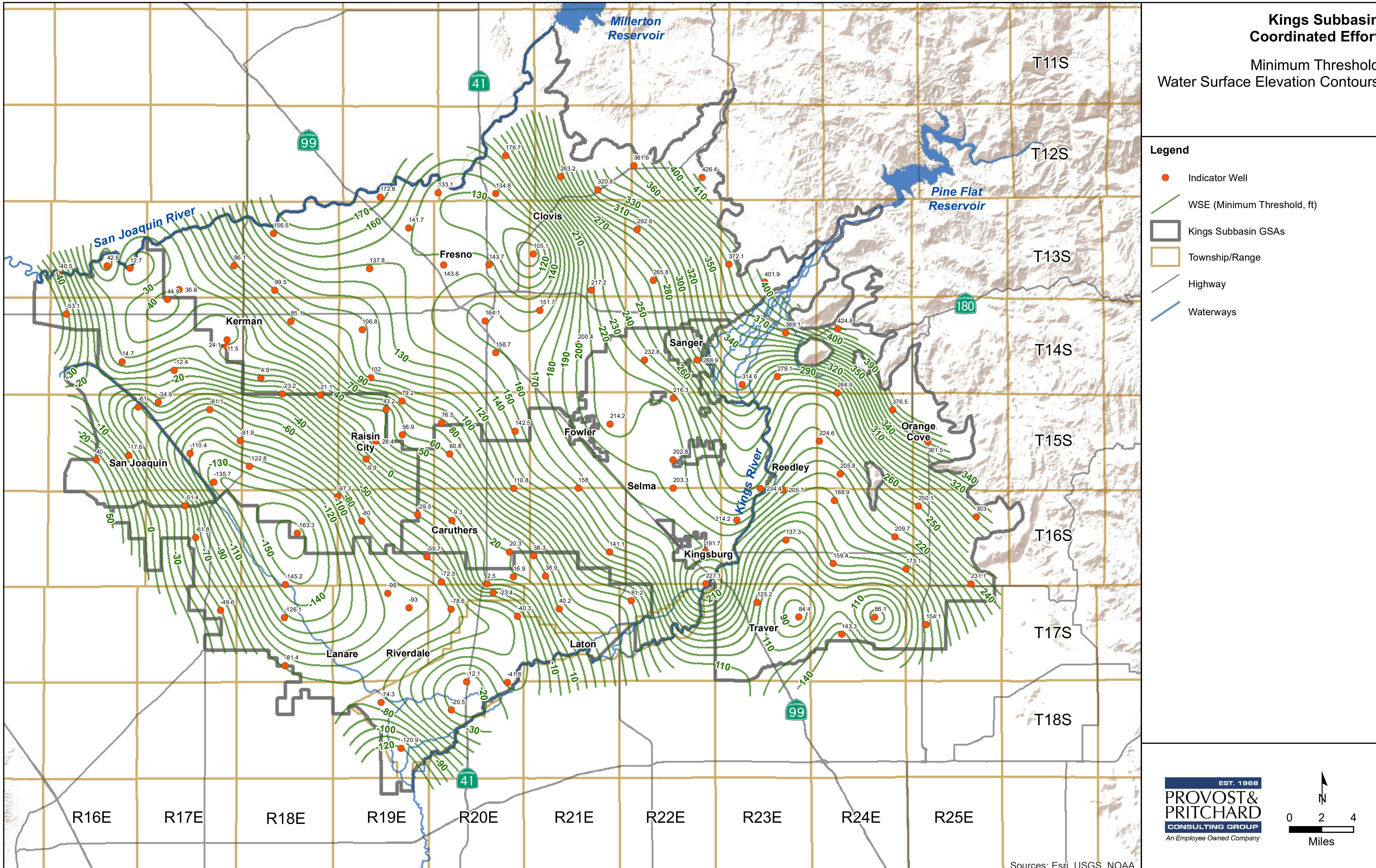
Kings Subbasin Coordinated Effort
Minimum Threshold
Water Surface Elevation Contours
Legend
Indicator Well
WSE (Minimum Threshold, ft)
Kings Subbasin GSAs
Township/Range
Highway
Waterways
Millerton Reservoir
Pine Flat Reservoir
San Joaquin River
Kings River
Clovis
Fresno
Kerman
Sanger
Fowler
Raisin City
Orange Cove
San Joaquin
Reedley
Selma
Caruthers
Kingsburg
Traver
Laton
Lanare
Riverdale
T11S
T12S
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T14S
T15S
T16S
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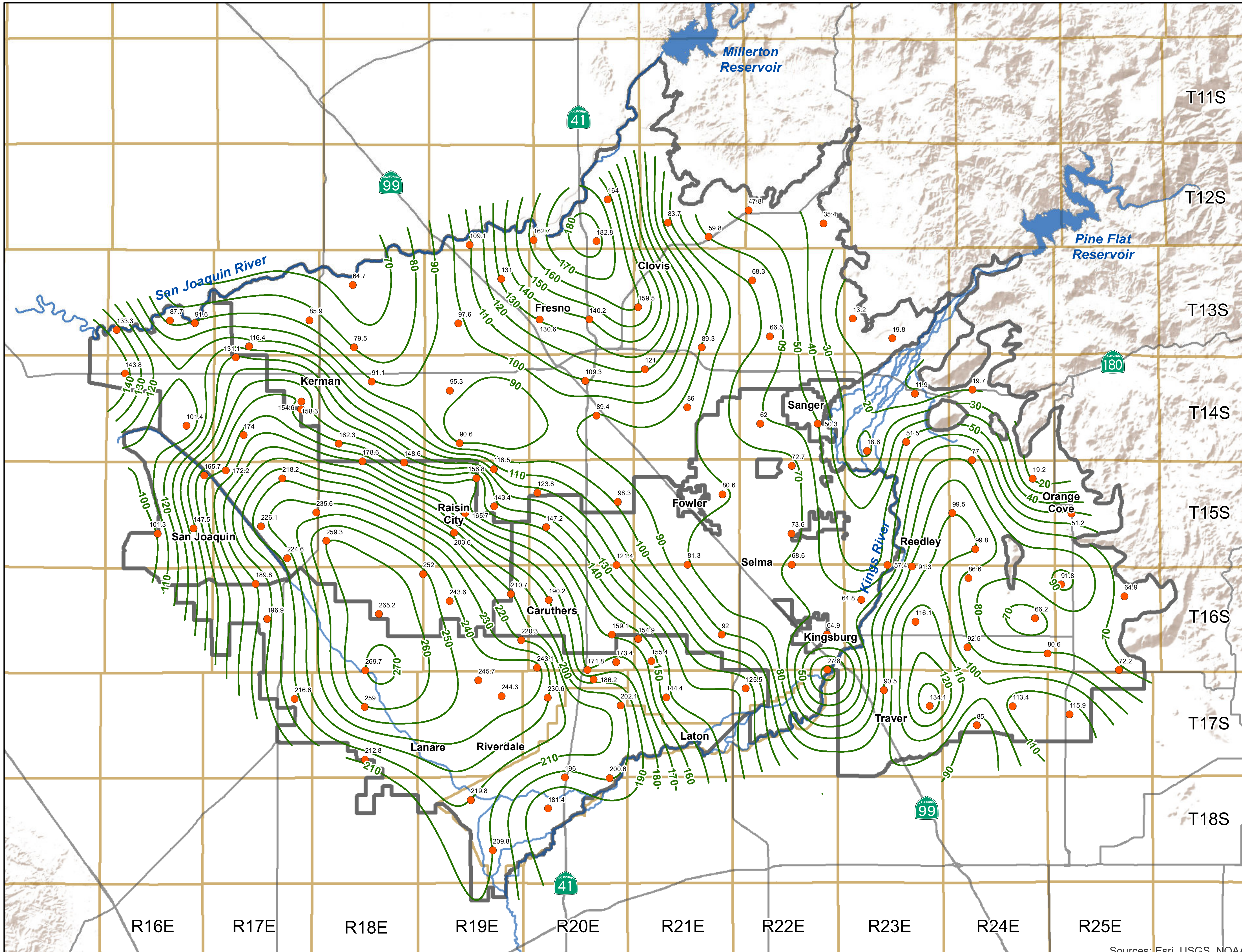
Sources: Esri, USGS, NOAA

Kings Subbasin Coordinated Effort

Interim Milestone 2025 Depth to Water Contours



Legend

- Indicator Well
- DTW (Interim Milestone, ft)
- Kings Subbasin GSAs
- Township/Range
- Highway
- Waterways

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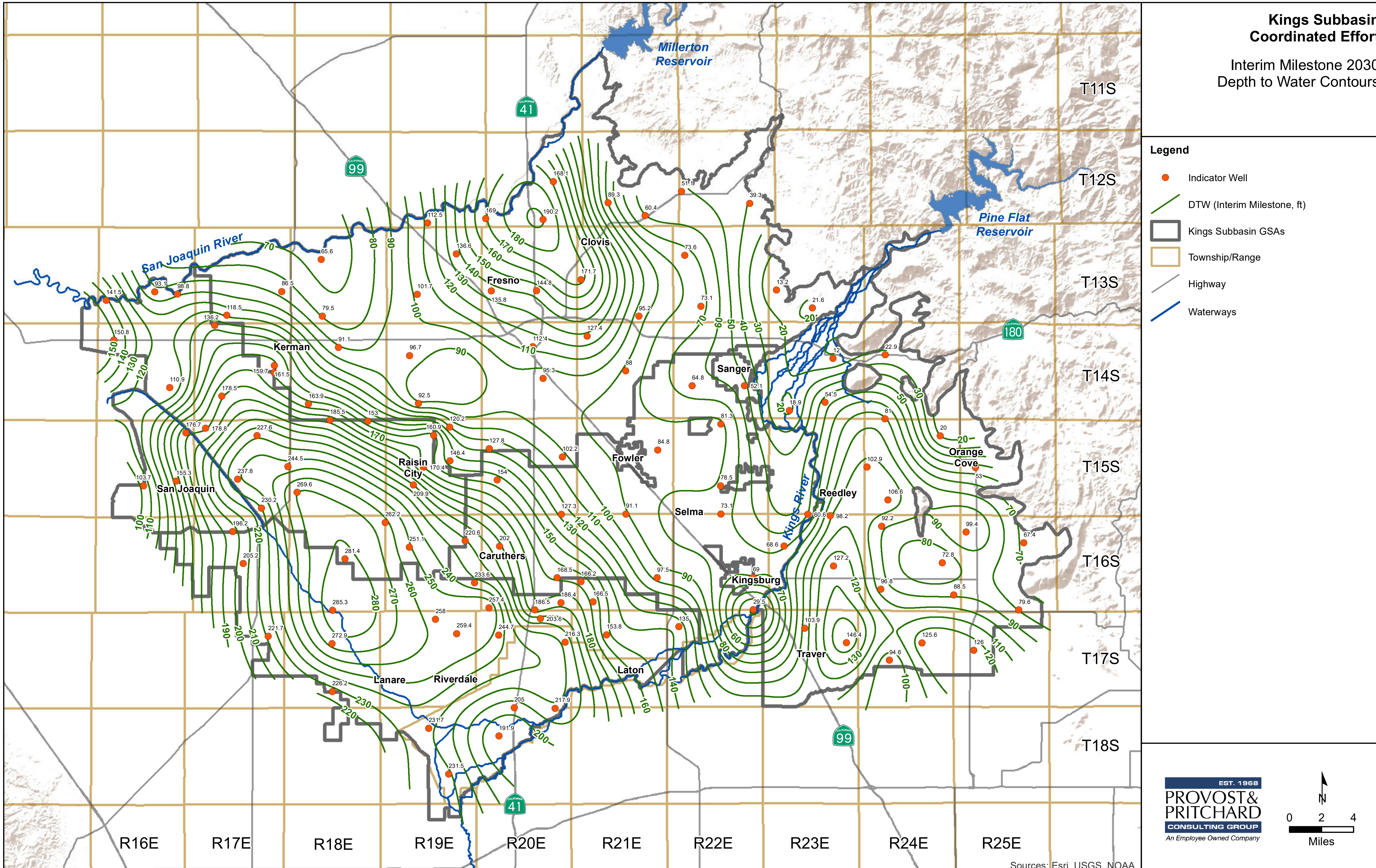

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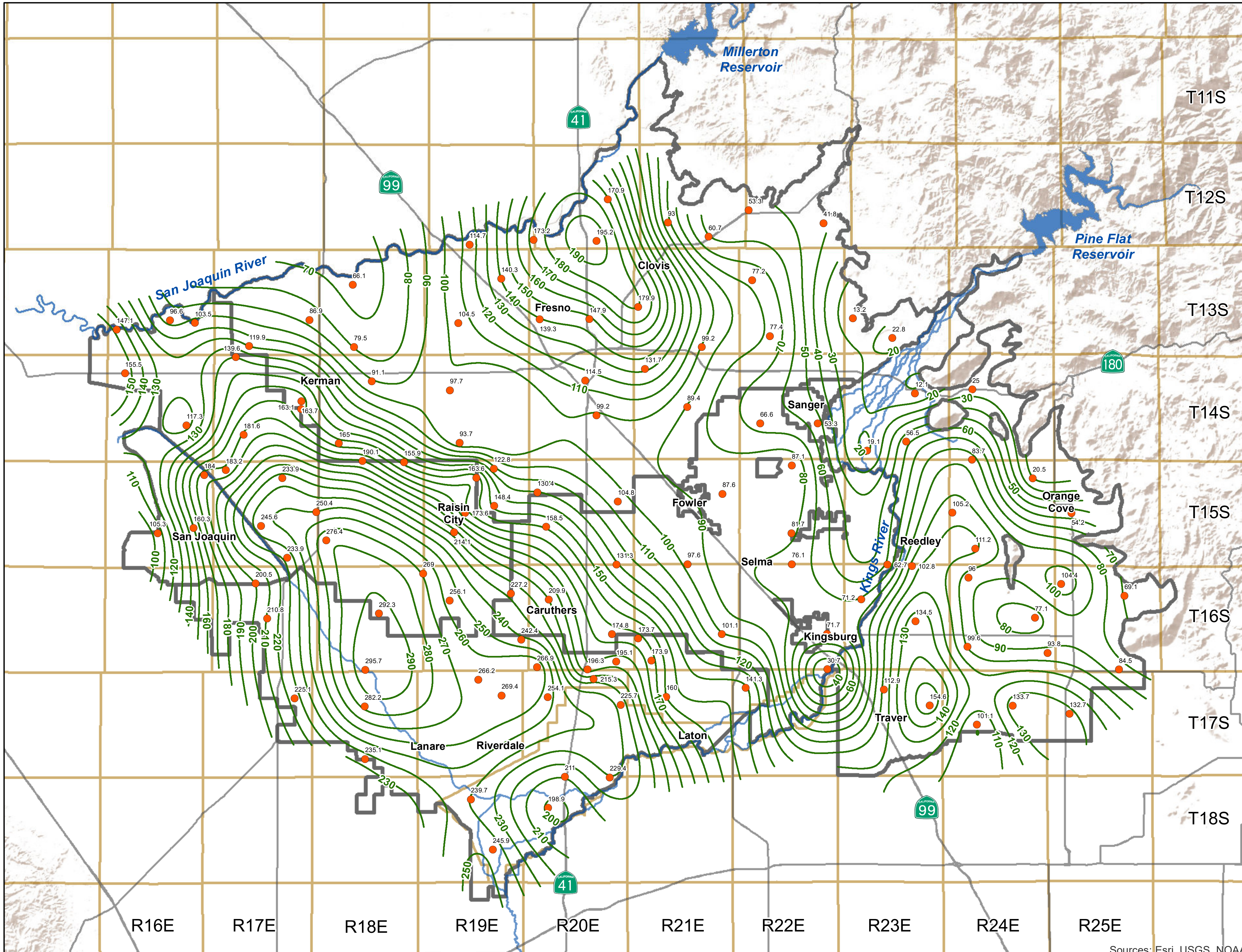
Kings Subbasin Coordinated Effort

Interim Milestone 2035
Depth to Water Contours



Legend

- Indicator Well
- DTW (Interim Milestone, ft)
- Kings Subbasin GSAs
- Township/Range
- Highway
- Waterways

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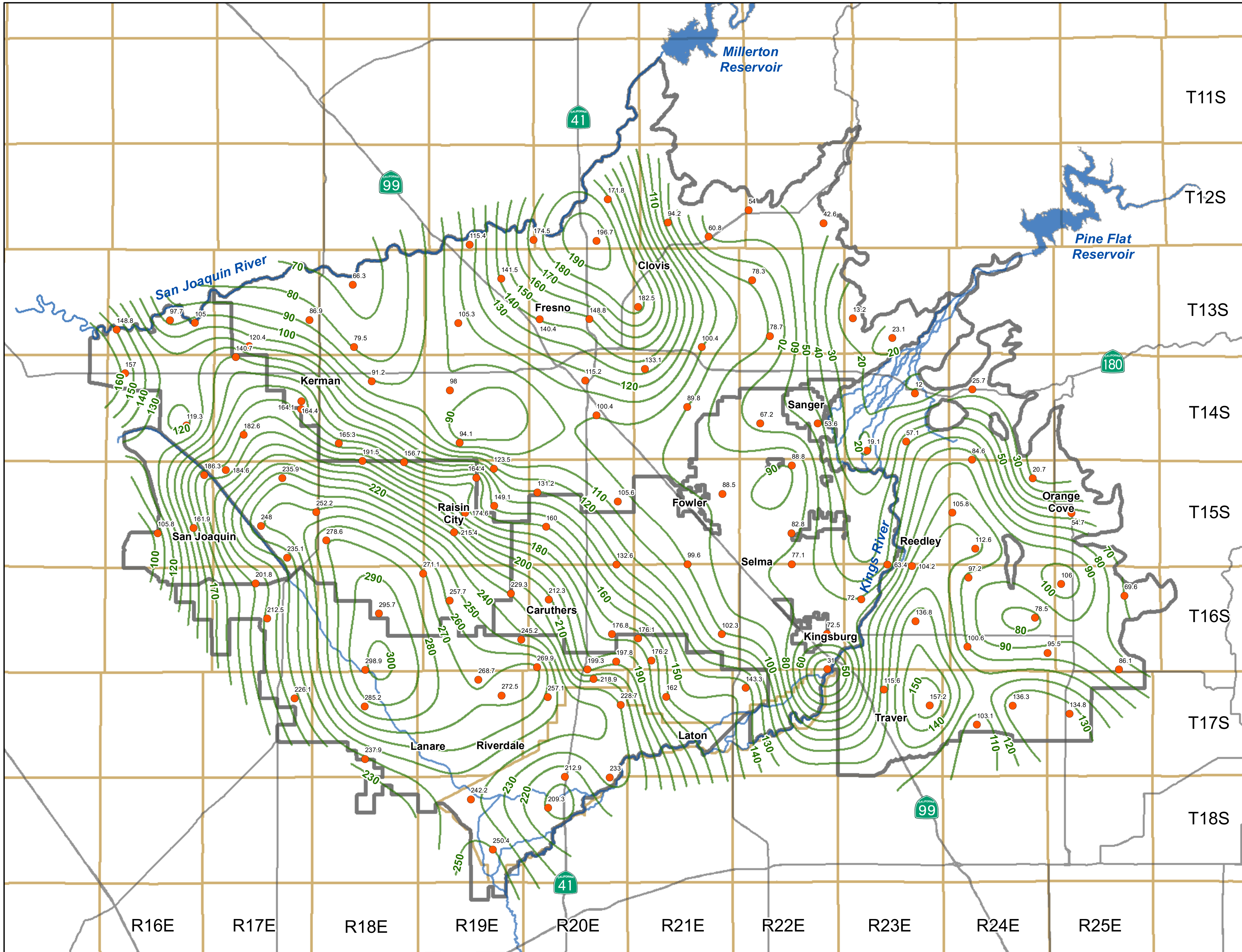
Kings Subbasin Coordinated Effort

Measureable Objective Depth to Water Contours



Legend

- Indicator Well
- DTW (Measureable Objective, ft)
- Kings Subbasin GSAs
- Township/Range
- Highway
- Waterways

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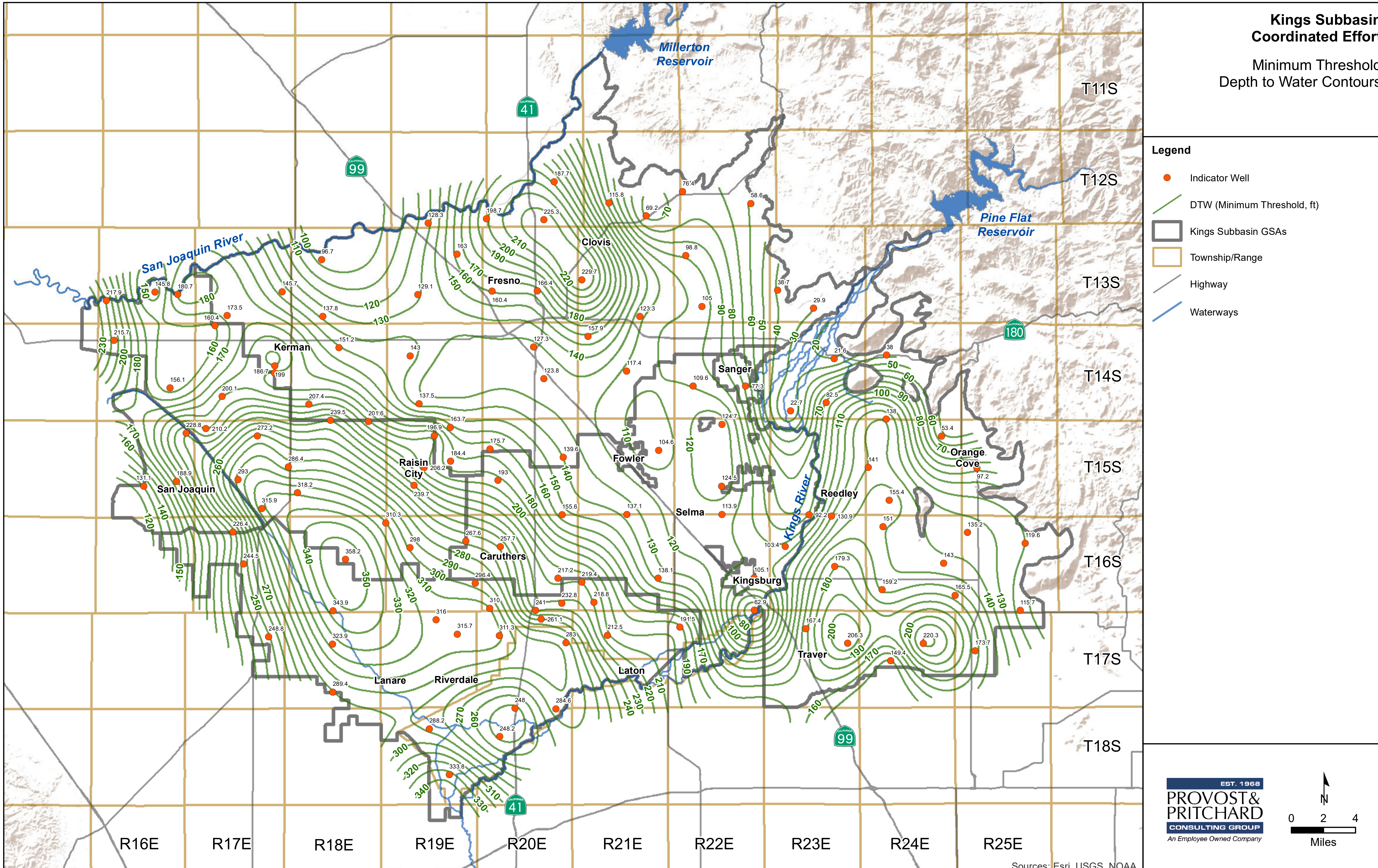

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Appendix 5 A Monitor Well Attributes

MONITOR WELL ATTRIBUTES

Site ID	Well Type	Elevation (feet)	Total Depth (feet bgs)	Perforations (feet bgs)	Aquifer	Monitoring Purpose	Alias	Notes
366502N1201782W001	Non-Domestic	168	520	280-495	Between C and E-Clay	Water Level	C-65	CASGEM Website
16S17E04P001M	Monitoring Well	175	510	270-510	Between C and E-Clay	Water Level	D-40	CASGEM Website
15S16E29N001M	Monitoring Well	174	1147	700-1110	Below E-Clay	Water Level	HORN	DWR WCR
15S16E28A003M	Monitoring Well	171	TBD	TBD	Between C and E-Clay	Water Level	HUGHES	USGS Records (pending)
15S16E23R001M	Monitoring Well	174	400	205-400	Between C and E-Clay	Water Level	CITY	Based on well video
1010034-004	Municipal	174	500	200-500	Between A and E-Clay	Water Quality	M1	GAMA Website
1010034-003	Municipal	174	510	210-510	Between A and E-Clay	Water Quality	M2	GAMA Website
1010034-005	Municipal	174	UNK	UNK	Between A and E-Clay	Water Quality	M3	GAMA Website
1010034-002	Municipal	174	560	284-560	Between C and E-Clay	Water Quality	M4	GAMA Website
1010030-006	Municipal	174	UNK	UNK	Above E-Clay	Water Quality	N1	GAMA Website
S3-MACK-K07	Domestic	165	300	240-300	Between A and C-Clay	Water Quality	N2	USGS DS 1019, Table 1
KING-26	Non-Domestic	174	480	240-480	Between C and E-Clay	Water Quality	N3	USGS DS 351, Table 1
S3-MACK-K05	Domestic	178	260	200-260	Between A and C-Clay	Water Quality	S1	USGS DS 1019, Table 1
KING-31	Monitoring	173	520	280-520	Between C and E-Clay	Water Quality	S2	USGS DS 351, Table 1

Appendix 5 B Section 352.4 California Code of Regulations

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.

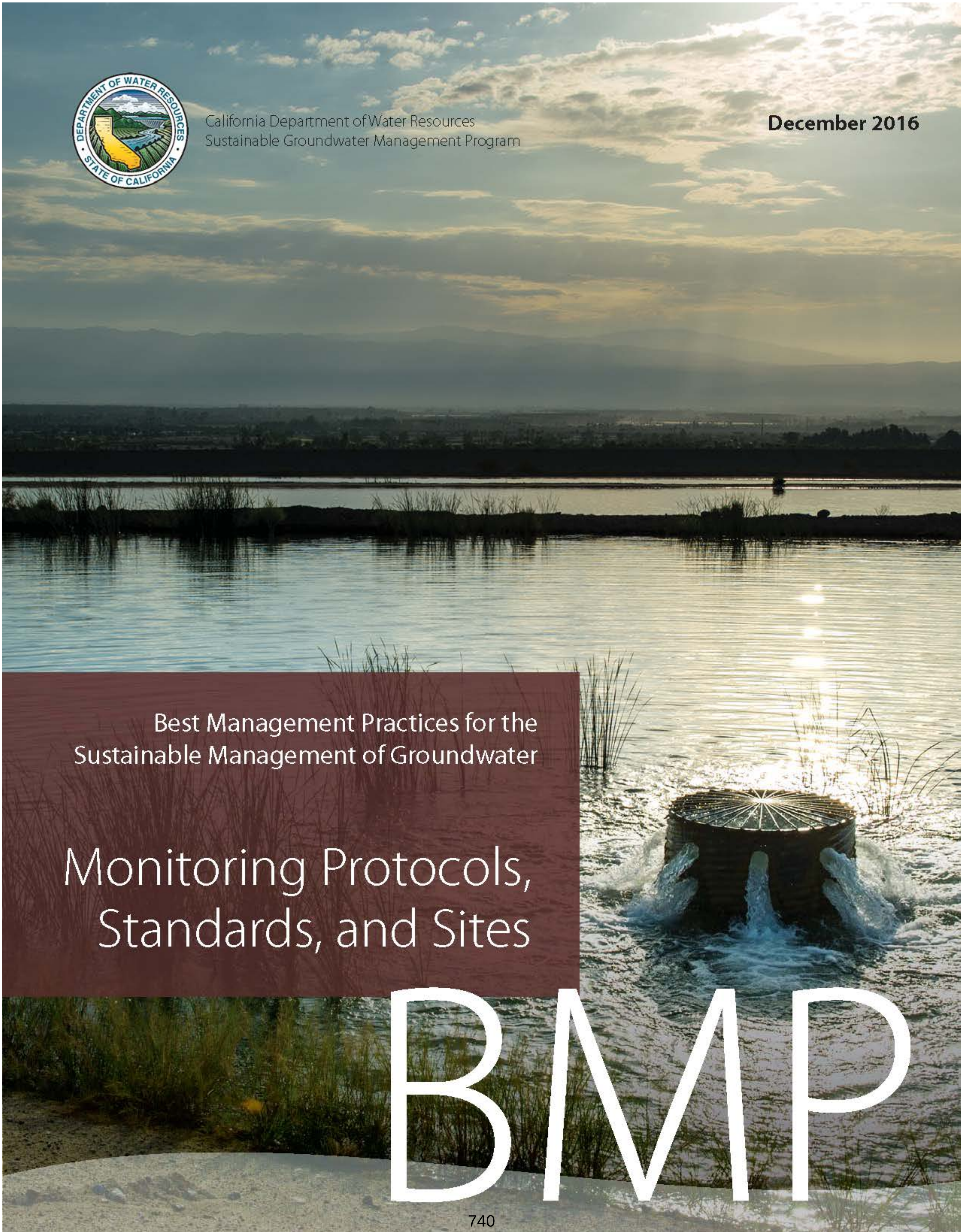
(3) Groundwater and surface water models developed in support of a Plan after the effective date of these regulations shall consist of public domain open-source software.

(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 5 C 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

State of California
Edmund G. Brown Jr., Governor

California Natural Resources Agency
John Laird, Secretary for Natural Resources

Department of Water Resources
Mark W. Cowin, Director

Carl A. Torgersen, Chief Deputy Director

Office of the Chief Counsel
Spencer Kenner

Public Affairs Office
Ed Wilson

Government and Community Liaison
Anecita S. Agustinez

Office of Workforce Equality
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Policy Advisor
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Kathie Kishaba	**Business Operations**
Taryn Ravazzini	**Special Initiatives**

Division of Integrated Regional Water Management

Arthur Hinojosa Jr., Chief

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Prepared by:

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Dan McManus
Mark Nordberg
Heather Shannon
Steven Springhorn

With assistance from:

DWR Region Office Staff

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**.

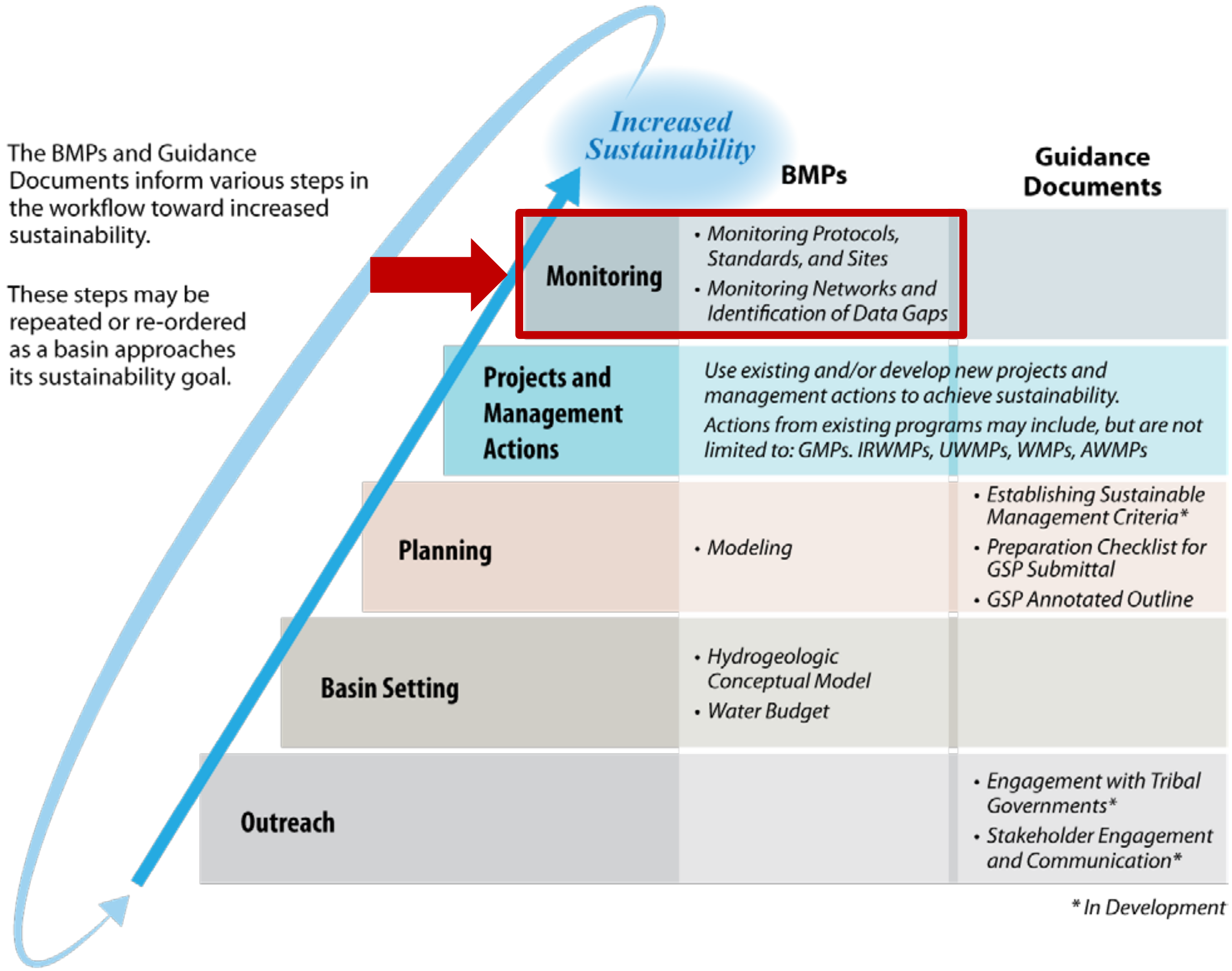

Figure 1 – Logical Progression of Basin Activities Needed to Increase Basin Sustainability

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.

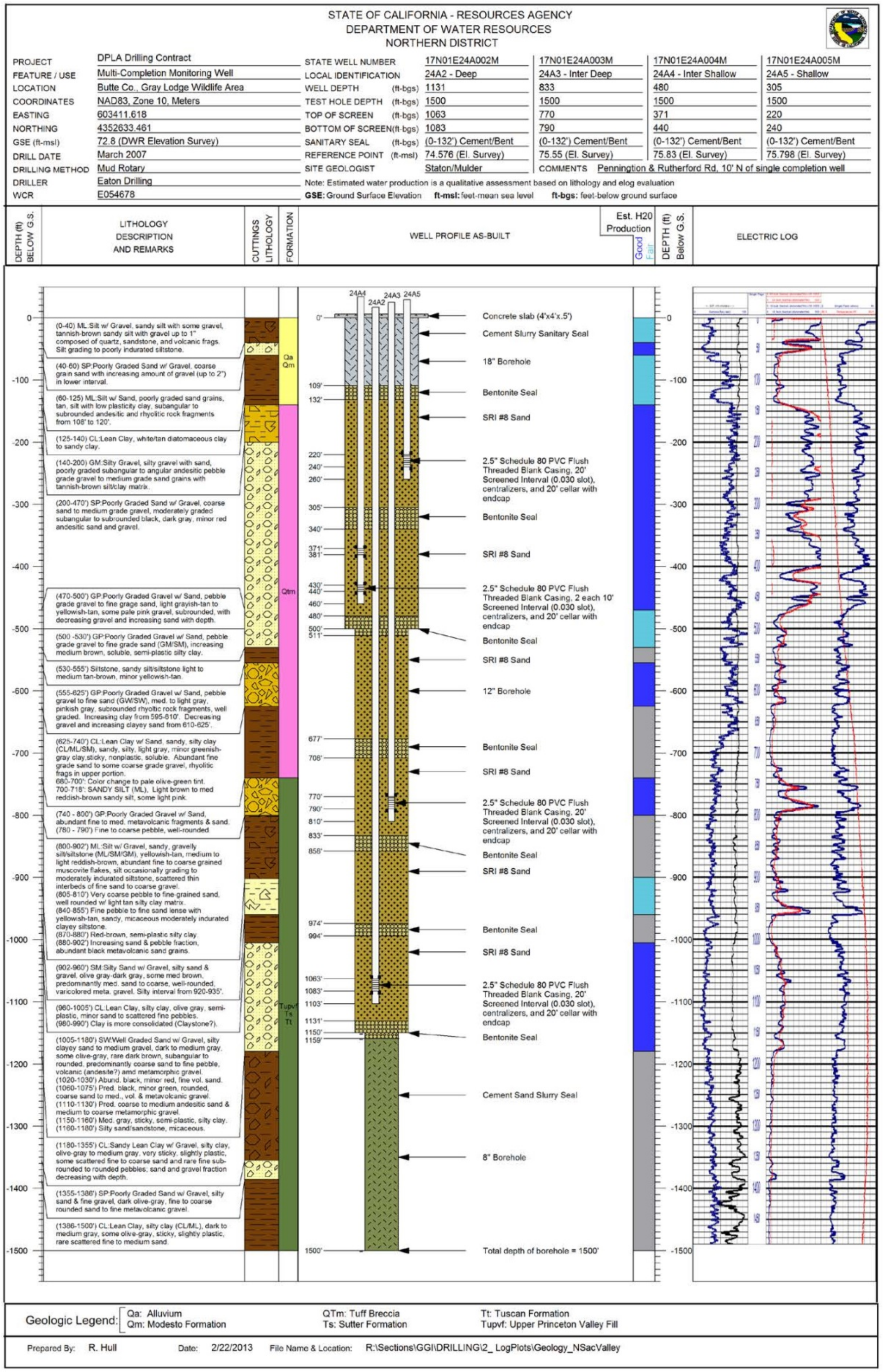

Figure 2 – Example As-Built Multi-Completion Monitoring Well Log

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.

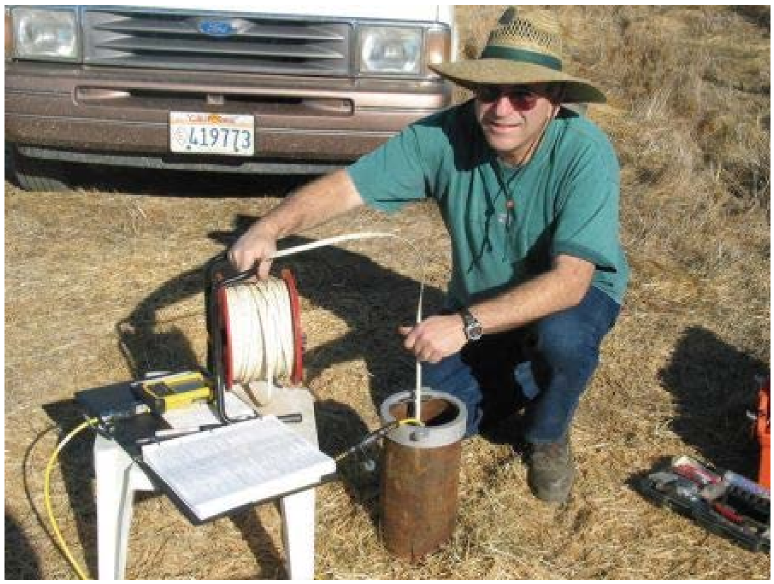

Figure 3 – Collection of Water Level Measurement and Pressure Transducer Download

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	NM	QM	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.

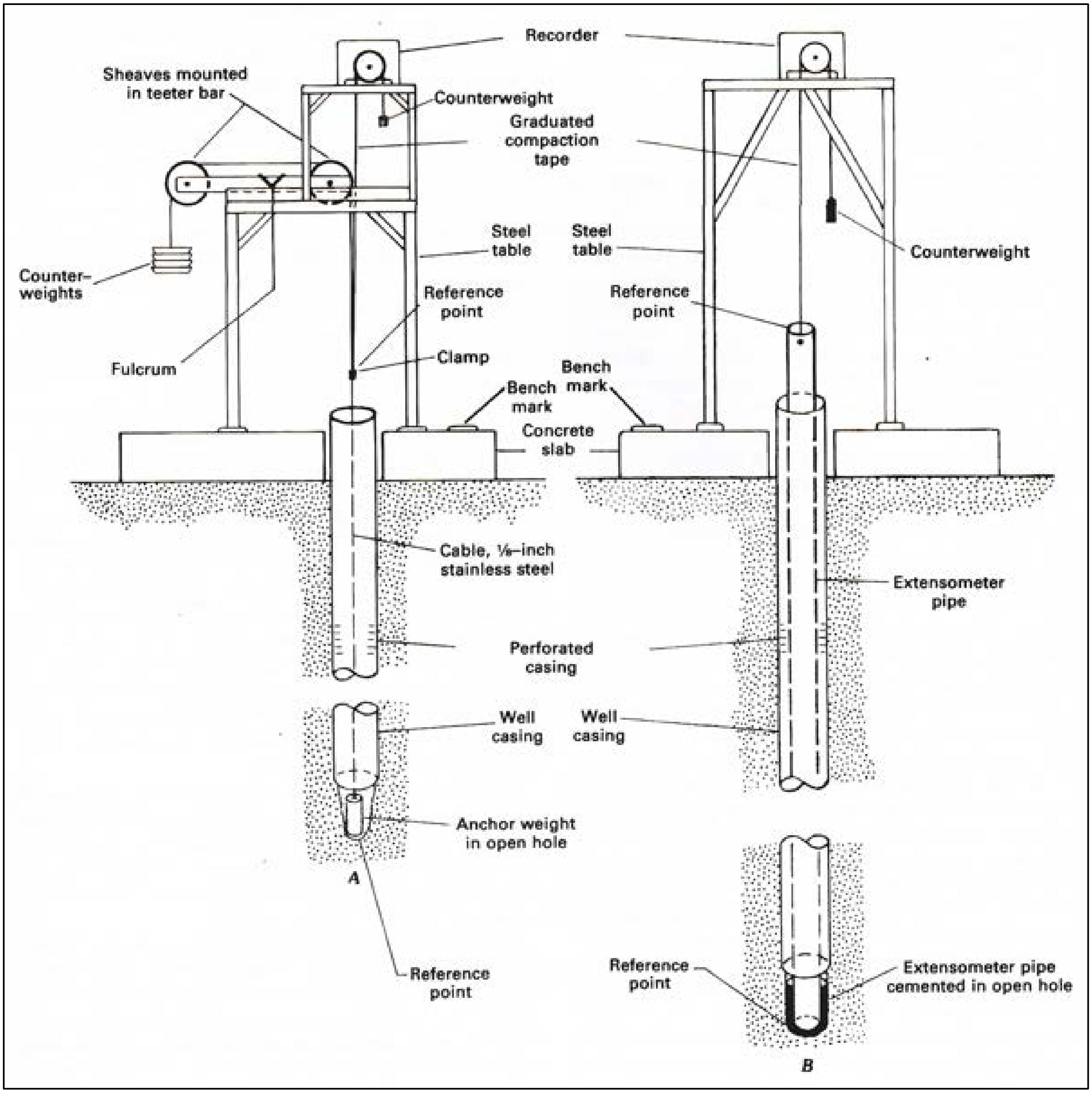

Figure 7 – Simplified Extensometer Diagram

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

CASE STUDIES

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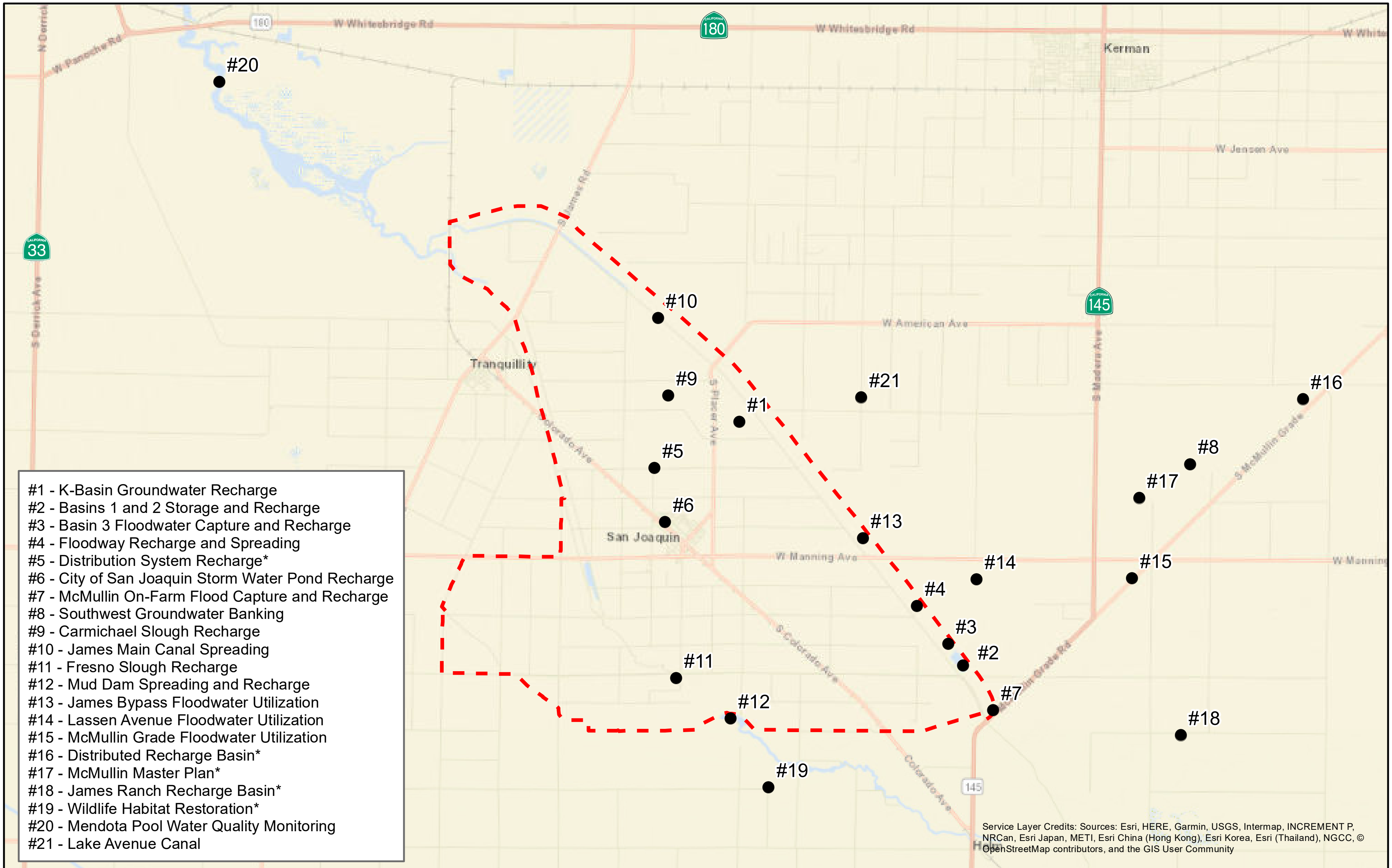
Appendix 6 A Project Location Map



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James GSA

Project Locations

* General Area of Project Location

James GSA

Project Locations

Appendix 6-A

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Appendix 7 A Implementation Cost Estimate

IMPLEMENTATION COST ESTIMATE

ANNUAL IMPLEMENTATION COST SUMMARY

Description		Cost	Notes
Administration	$	60,000	
Monitoring		37,000	see cost detail table below
Outreach		12,000	
Coordination		50,400	
Technical/Legal		86,400	see cost detail table below
Projects - Construction		250,000	annuallized cost from table below
Projects - O&M		283,000	annuallized cost from table below
Total	$	778,800	2019 dollars

ONGOING ANNUAL COST DETAIL

Description		Cost	Notes
Administration	$	60,000	
Monitoring (Water Levels)		6,400	
Monitoring (Water Quality)		6,400	
Monitoring (Subsidence)		12,800	
Monitoring (Adjoining Streams)		6,400	
Outreach and Communications		12,000	
Outside Services (Technical)		50,400	
Outside Services (Legal)		36,000	
Coordination		50,400	
Subtotal	$	240,800	2019 dollars

INITIAL MONITORING COSTS

Description		Cost	Notes
Monitoring (Water Levels)	$	50,000	new monitoring well
Monitoring (Water Quality)		-	
Monitoring (Subsidence)		-	
Monitoring (Adjoining Streams)		50,000	new shallow monitoring wells
Subtotal	$	100,000	2019 dollars
Annuallized Cost	$	5,000	amortized over 20 yrs

PROJECT CONSTRUCTION COSTS

Description		Cost	Notes
Recharge Projects	$	4,000,000	based on estimated needs
Other Projects		1,000,000	based on estimated needs
Subtotal	$	5,000,000	
Annuallized Cost	$	250,000	amortized over 20 yrs

PROJECT OPERATION AND MAINTENANCE COSTS

Description		Cost	Notes
CVP Water (dry year)	$	117,000	water purchased for recharge, typ.
CVP Water (normal year)		117,000	
Other Water (normal year)		49,000	
Other Water (wet year)		-	cost assumed to be negligible
Subtotal	$	283,000	

Appendix 7 B Funding Resolutions

RESOLUTION 2019-03

RESOLUTION
OF THE
BOARD OF TRUSTEES

RECLAMATION DISTRICT NO. 1606

AUTHORIZING FUNDING OF THE JAMES GROUNDWATER SUSTAINABILITY AGENCY

WHEREAS, the Board of Trustees of the RECLAMATION DISTRICT NO. 1606 in consultation with the Board of Directors of the JAMES GROUNDWATER SUSTAINABILITY AGENCY ("JAMES GSA") and the Board of Directors of JAMES IRRIGATION DISTRICT has determined that the JAMES IRRIGATION DISTRICT will fund the JAMES GSA by making direct contributions to the JAMES GSA; and

WHEREAS, it was also agreed to by the aforementioned boards that the JAMES IRRIGATION DISTRICT will fund the entire budget of the JAMES GSA with the understanding that RECLAMATION DISTRICT NO. 1606 will be asked to contribute at a future date if land use or groundwater extraction patterns change significantly from current conditions; and

WHEREAS, the aforementioned boards have also agreed to an approach whereby the JAMES IRRIGATION DISTRICT will administer and manage the JAMES GSA and perform the work required for monitoring, reporting, and implementing projects, programs, and management actions to achieve and maintain groundwater sustainability as set forth by the James Groundwater Sustainability Plan.

NOW, THEREFORE, BE IT RESOLVED by the Board of Trustees of the RECLAMATION DISTRICT NO. 1606 that it concurs with the agreement to have JAMES IRRIGATION DISTRICT fund the entire budget of the JAMES GSA; and

BE IT FURTHER RESOLVED THAT RECLAMATION DISTRICT NO. 1606 will support the JAMES IRRIGATION DISTRICT while it undertakes all necessary activities to implement the Groundwater Sustainability Plan including monitoring, reporting, and implementing projects, programs and management actions; and

BE IT FURTHER RESOLVED THAT this Resolution shall remain in effect until revoked or modified.

The foregoing Resolution was introduced and adopted at a Regular Meeting of the Board of Trustees of the RECLAMATION DISTRICT NO. 1606 conducted September 19th, 2019, on motion of Trustee Jeff Yribarren, and seconded by Trustee Wm. Cory Carvalho, by the following vote:

AYES:	3	(J.Yribarren, W.Carvalho, G.Kinnunen)
NOES:	0	
ABSTAIN:	0	
EXCUSED:	0	
ABSENT:	0	

Gerald W. Kinnunen

Gerald W. Kinnunen , President
BOARD OF TRUSTEES
RECLAMATION DISTRICT NO. 1606

ATTEST:

Donna Y. Hanneman

Donna Y. Hanneman, Secretary
BOARD OF TRUSTEES
RECLAMATION DISTRICT NO. 1606

CERTIFICATION OF SECRETARY

The undersigned certifies that she is the Secretary of RECLAMATION DISTRICT NO. 1606 and that the foregoing Resolution was adopted by the Board of Trustees of said District at a meeting thereof, duly and regularly held on September 19th, 2019, at which meeting a quorum of the Board of Trustees was at all times present and acting.

IN WITNESS WHEREOF, I have set my hand and seal of the Board of Trustees this 19th day of September, 2019.

{ SEAL }

Donna Y. Hanneman

Donna Y. Hanneman, Secretary
BOARD OF TRUSTEES
RECLAMATION DISTRICT NO. 1606

RESOLUTION 2019-04

Resolution
of the
Board of Directors

JAMES IRRIGATION DISTRICT

AUTHORIZING FUNDING OF THE JAMES GROUNDWATER SUSTAINABILITY AGENCY

WHEREAS, the Board of Directors of the JAMES IRRIGATION DISTRICT in consultation with the Board of Directors of the JAMES GROUNDWATER SUSTAINABILITY AGENCY ("JAMES GSA") and the Board of Trustees of RECLAMATION DISTRICT NO. 1606 has determined that it will fund the JAMES GSA by making direct contributions to the JAMES GSA; and

WHEREAS, it was also agreed to by the aforementioned boards that the JAMES IRRIGATION DISTRICT will fund the entire budget of the JAMES GSA with the understanding that RECLAMATION DISTRICT NO. 1606 will be asked to contribute at a future date if land use or groundwater extraction patterns change significantly from current conditions; and

WHEREAS, the aforementioned boards have also agreed to an approach whereby the JAMES IRRIGATION DISTRICT will administer and manage the JAMES GSA and perform the work required for monitoring, reporting, and implementing projects, programs, and management actions to achieve and maintain groundwater sustainability as set forth by the James Groundwater Sustainability Plan.

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the JAMES IRRIGATION DISTRICT that it will fund the entire budget of the JAMES GSA; and

BE IT FURTHER RESOLVED THAT the JAMES IRRIGATION DISTRICT will also undertake all necessary activities to implement the Groundwater Sustainability Plan including monitoring, reporting, and implementing projects, programs and management actions; and

BE IT FURTHER RESOLVED THAT this Resolution shall remain in effect until revoked or modified.

The foregoing Resolution was introduced and adopted at a Regular Meeting of the Board of Directors of the JAMES IRRIGATION DISTRICT conducted October 8^{th}, 2019, on motion of Director Micah Combs, and seconded by Director Robert Barcellos, was hereby authorized by the following vote, to wit:

AYES:	M.Combs, R.Barcellos, T.Chaney, R. Motte, R.Chaney (5)
NOES:	0
ABSTAIN:	0
EXCUSED:	0
ABSENT:	0

RILEY CHANEY, PRESIDENT
BOARD OF DIRECTORS
JAMES IRRIGATION DISTRICT

ATTEST:

STEVEN P. STADLER, SECRETARY
BOARD OF DIRECTORS
JAMES IRRIGATION DISTRICT

CERTIFICATION OF SECRETARY

The undersigned certifies that he is the Secretary of JAMES IRRIGATION DISTRICT and that the foregoing Resolution was adopted by the Board of Directors of said District at a meeting thereof, duly and regularly held on October 8th, 2019 , at which meeting a quorum of the Board of Directors was at all times present and acting.

IN WITNESS WHEREOF, I have set my hand and seal of the Board of Directors this 8th day of October, 2019.

{ SEAL }

STEVEN P. STADLER, SECRETARY
BOARD OF DIRECTORS
JAMES IRRIGATION DISTRICT

Appendix 8 A Comments and Responses

COMMENTS RECEIVED ON THE JAMES GROUNDWATER SUSTAINABILITY AGENCY
DRAFT GROUNDWATER SUSTAINABILITY PLAN

#	Date	Method	Commenter	Comment	Response
1	11/4/2019	E-mail & Letter	Fresno Irrigation District	A cursory review of the James GSA draft GSP for public comment showed that the draft GSP was prepared in accordance with the agreed upon parameters for the GSAs within the Kings Subbasin.	Comment noted.
2	11/4/2019	E-mail & Letter	Fresno Irrigation District	The draft GSP identifies projects to be completed within the GSA to create sustainable conditions within the GSA boundary and the Kings Subbasin.	Comment noted.
3	11/4/2019	E-mail & Letter	Fresno Irrigation District	Given the NKGSA, FID, and the James GSA are within the Kings Subbasin, FID kindly requests that James GSA to consult with the NKGSA on proposed projects.	Comment is a request for future action. It is anticipated that the request will be met while undertaking the ongoing coordination between GSAs that is occurring within the Kings Subbasin.
4	11/4/2019	E-mail & Letter	Fresno Irrigation District	FID encourages the James Irrigation District to continue their efforts to develop new water supplies and projects, such as the Southwest Groundwater Banking project, aimed at improving groundwater conditions in the Kings Subbasin.	Comment noted and will be forwarded to the James Irrigation District.
5	11/4/2019	E-mail & Letter	Fresno Irrigation District	The NKGSA and FID look forward to continuing to collaborate with the James GSA and other GSAs within the Kings Subbasin to create sustainable conditions in the basin.	Comment noted.
6	11/4/2019	E-mail & Letter	North Kings Groundwater Sustainability Agency	A cursory review of the James GSA draft GSP for public comment showed that the draft GSP was prepared in accordance with the agreed upon parameters for the GSAs within the Kings Subbasin.	Comment noted.
7	11/4/2019	E-mail & Letter	North Kings Groundwater Sustainability Agency	The draft GSP identifies projects to be completed within the GSA to create sustainable conditions within the GSA boundary and the Kings Subbasin.	Comment noted.
8	11/4/2019	E-mail & Letter	North Kings Groundwater Sustainability Agency	Given the NKGSA and the James GSA are within the Kings Subbasin, the NKGSA kindly requests that James GSA to consult with the NKGSA on proposed projects.	Comment is a request for future action. It is anticipated that the request will be met while undertaking the ongoing coordination between GSAs that is occurring within the Kings Subbasin.
9	11/4/2019	E-mail & Letter	North Kings Groundwater Sustainability Agency	The NKGSA encourages the Fresno Irrigation District and the James Irrigation District to continue their efforts to develop new water supplies and projects, such as the Southwest Groundwater Banking project, aimed at improving groundwater conditions in the Kings Subbasin.	Comment noted and will be forwarded to the James Irrigation District.

COMMENTS RECEIVED ON THE JAMES GROUNDWATER SUSTAINABILITY AGENCY DRAFT GROUNDWATER SUSTAINABILITY PLAN

#	Date	Method	Commenter	Comment	Response
10	11/4/2019	E-mail & Letter	North Kings Groundwater Sustainability Agency	The NKGSA looks forward to continuing to collaborate with the James GSA and other GSAs within the Kings Subbasin to create sustainable conditions in the basin.	Comment noted.
11	11/5/2019	E-mail Only	Westlands Water District	Attached is the Westlands Water District GSA Comment letter for the James ID GSA Draft GSP. We would like to thank you for the opportunity to provide our comments.	The comment was received on 11/5/19 after the 60-day comment period for the draft GSP expired. The comment indicates that a comment letter was attached; however, no comment letter was attached to the e-mail received from Mr. Solorio at Westlands Water District on 11/5/2019 at 2:21 p.m.