NORTH KINGS GROUNDWATER
SUSTAINABILITY AGENCY



Groundwater Sustainability Plan

Adopted November 21, 2019

Acknowledgements

The North Kings Groundwater Sustainability Agency would like to thank the following members of the Technical Subcommittee and others who made significant contributions to this Groundwater Sustainability Plan:

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Shawn Vaughn - Provost & Pritchard Consulting Group
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Shay Overton - Provost & Pritchard Consulting Group
Sue Ruiz – Landowner, Self-Help Enterprises

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.

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This Plan is a work product of the North Kings Groundwater Sustainability Agency (NKGSA) 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 NKGSA 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.

Prepared by:

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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

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 without causing significant and unreasonable undesirable results related to the six sustainability indicators. Under SGMA, these basins must reach sustainability within 20 years of implementing their sustainability plans to avoid State Water Resources Control Board intervention. For critically over-drafted high priority basins, including the Kings Groundwater Subbasin (Kings Subbasin) that the North Kings Groundwater Sustainability Agency (NKGSA) area is part of, the deadline for achieving sustainability is 2040.

The North Kings GSA is a Joint Powers Authority (JPA) formed for the purpose of developing and implementing the GSP. The JPA consists of the following member and participating agencies:

- Bakman Water Company (Participating Agreement)
- Biola Community Services District (member)
- City of Fresno (member)
- City of Clovis (member)
- City of Kerman (member)
- County of Fresno (member)
- Fresno Irrigation District (member)
- Fresno Metropolitan Flood Control District (Participating Agreement)
- Garfield Water District (member)
- International Water District (member)

Pinedale County Water District and Malaga County Water District are groundwater pumping agencies in the NKGSA that have also participated in GSA and GSP development as Interested Parties. California State University Fresno has also participated.

The NKGSA is governed by a seven-member Board of Directors that has final decision-making authority for the NKGSA. Directors are elected officials by their respective boards, councils, or commissions, or are an authorized representative of a Member, Contracting Entity or Interested Party. The NKGSA has an Executive Officer responsible for day to day management authority.

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. As the NKGSA is approximately 100 miles from the Pacific Ocean, seawater intrusion is not feasible and is therefore not discussed in detail.

Chapter 2 Plan Area

The Kings Subbasin is in the San Joaquin Valley Groundwater Basin in central California. The Kings Subbasin is located primarily in Fresno County, but extends into Kings and Tulare counties. This basin and 12 other basins are in the Tulare Lake hydrologic region. The Kings Subbasin boundary is defined in the Department of Water Resources (DWR) Bulletin 118 as DWR Subbasin No. 5-22.08.

The NKGSA is one of seven GSAs within the Kings Subbasin and is in the northeast portion of the subbasin as shown in **Figure ES-1**. There is no overlap among the GSAs within the Kings Subbasin and there are no adjudicated areas in the groundwater basin. Each of the GSAs within the Kings Subbasin is preparing their own individual GSP. 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 seven GSAs have cooperatively worked together since 2016 to coordinate the formation of the GSAs and develop other required elements of the GSPs. Pursuant to Water Code Section 10727.6, the GSAs are required to use the same data and methodologies for the various assumptions in developing their GSPs, such as groundwater elevations, extraction data, surface water supply, total water use, change in storage, water budget and sustainable yield.

Five other Groundwater Subbasins border the Kings Subbasin as shown in **Figure ES-1,** including the Madera Subbasin, Kaweah Subbasin, Tulare Lake Subbasin, Westside Subbasin and Delta-Mendota Subbasin. The Madera subbasin borders the NKGSA.

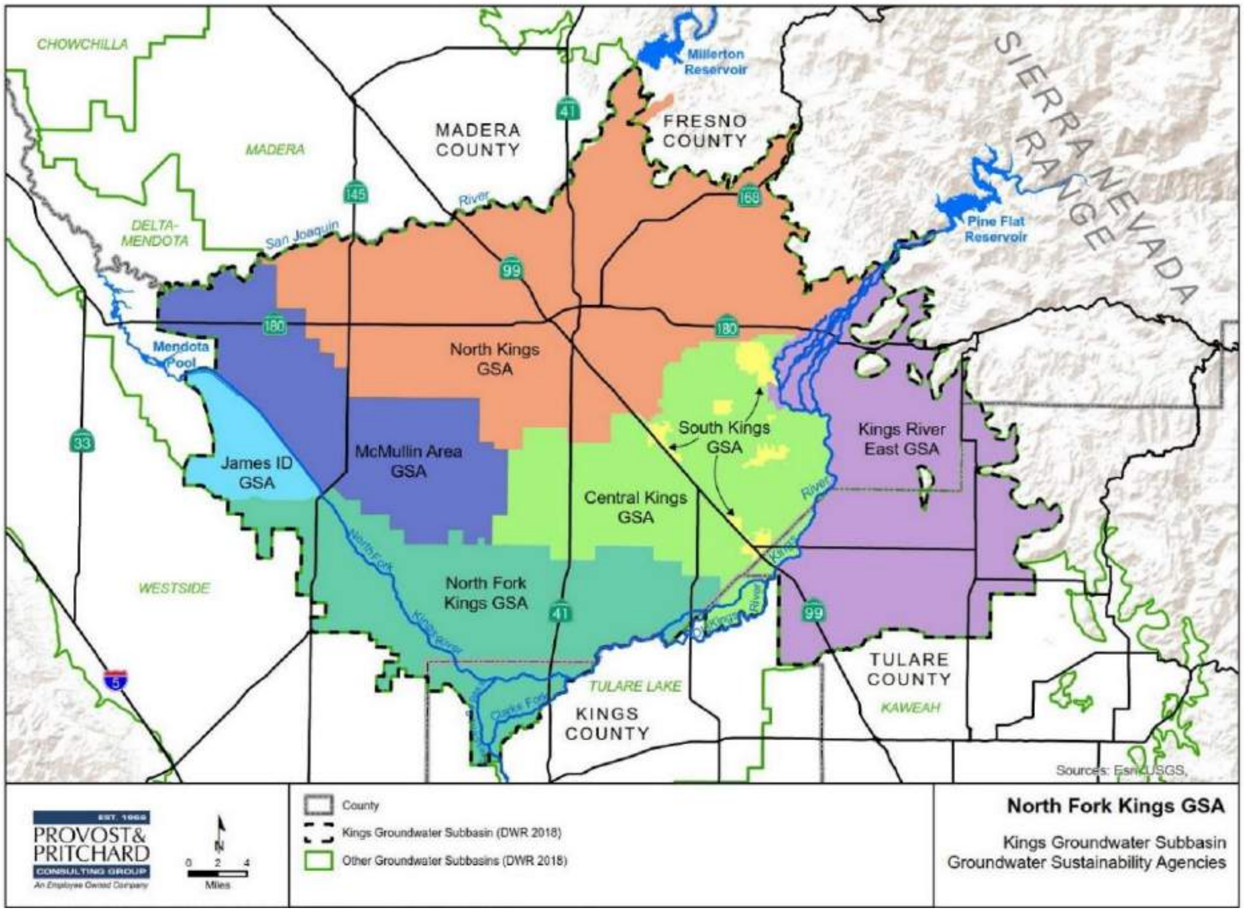

Figure ES-1 Kings Groundwater Subbasin

The NKGSA area is located within Fresno County and outlined by the Fresno Irrigation District border to the south and the Kings Basin boundary, as identified in Bulletin 118, to the north. The Plan area is approximately 311,000 acres and is approximately 40 miles (east-west) by 12 miles (north-south). A map of the NKGSA showing the GSP Participants is included as **Figure ES-1**.

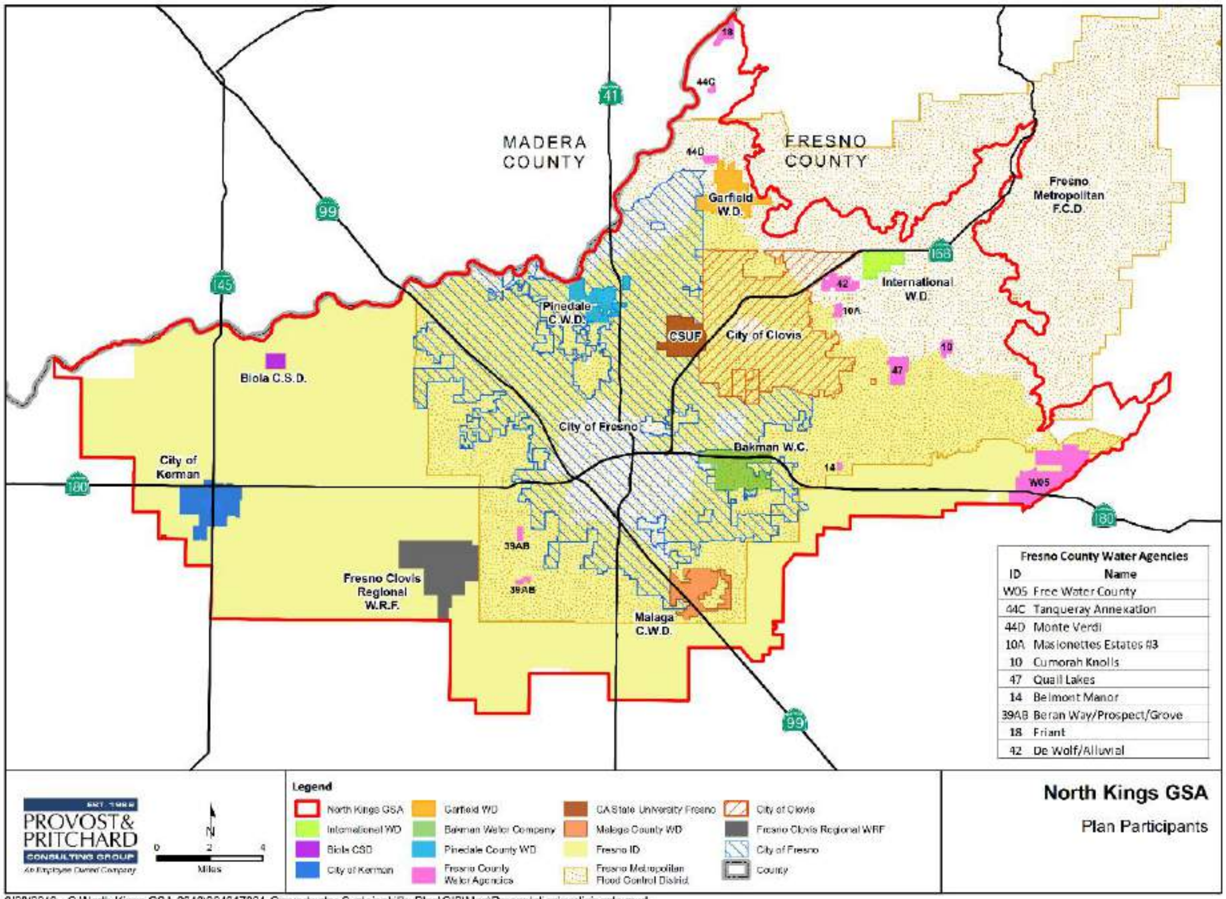

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Figure ES-2 Plan Participants

The Plan area is comprised primarily of agricultural and urban land use designations. The highest percentage land use categories in the NKGSA include Agricultural (Permanent Crops) at 37%, Urban at 27%, and Rural Residential at 10%, Native Vegetation at 8% and Annual Crops at 7%, which account for 89% of the Plan area. The remaining 11% includes other agricultural, commercial, industrial, riparian vegetation, urban landscape, and water surfaces.

The NKGSA is a conjunctive use area, utilizing groundwater resources to supplement available surface water supplies to meet water demands in the future as described in the Water Code as purpose of use. The Kings River is the primary water source for the NKGSA. The Fresno Irrigation District is a Kings River Water Association (KRWA) member and has significant water rights to surface water supplies from the Kings River. 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 4,476,000 acre-feet (267% of average) to a low of 361,000 acre-feet (22% of average). A monthly 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 schedule varies monthly with differing amounts of entitlement specified for each member unit depending on the calendar month and amount of river runoff. FID receives an average annual supply of approximately 450,000 AF from the Kings River. FID, the City of Fresno, International Water

District, and Garfield Water District also have contracts with the United States Bureau of Reclamation (USBR or Reclamation) for additional supplies from the Friant Division of the CVP. The GSA also receives surface water supply from several local creeks. Banking operations exist within the NKGSA for recharge or storage for later recovery, with several sites and approximately 10% of the recharged water is left in the aquifer to account for losses. During the many years that banking operations have been occurring in the NKGSA, banking operations have not included recovery operations every year at every site. In some years, recovery wells operate for a minimal period to exercise the equipment only.

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 lays the foundation for development of water budgets, monitoring networks, and identification of data gaps. The narrative HCM description is for the Kings Subbasin, followed in each section by description applicable specifically to the NKGSA. The HCM has been prepared utilizing published studies and resources and will be periodically updated as data gaps are addressed, and new information becomes available.

The Kings Subbasin is an alluvial basin bounded north and south by the San Joaquin and Kings Rivers respectively, 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 exists. East of the lacustrine clays, locally significant clay beds separate shallower unconfined water 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-3** is a soil map based on textural classification of soils in NKGSA. In general, coarser materials exists and are identified on Older Alluvium, on the fans of the major rivers, in areas mapped as Dune Sands, as well as in areas where recent deposits are found along active stream courses; finer gained soils are found in the area of the compound fan of intermittent streams and in the north and western parts of the Fresno Metropolitan area.

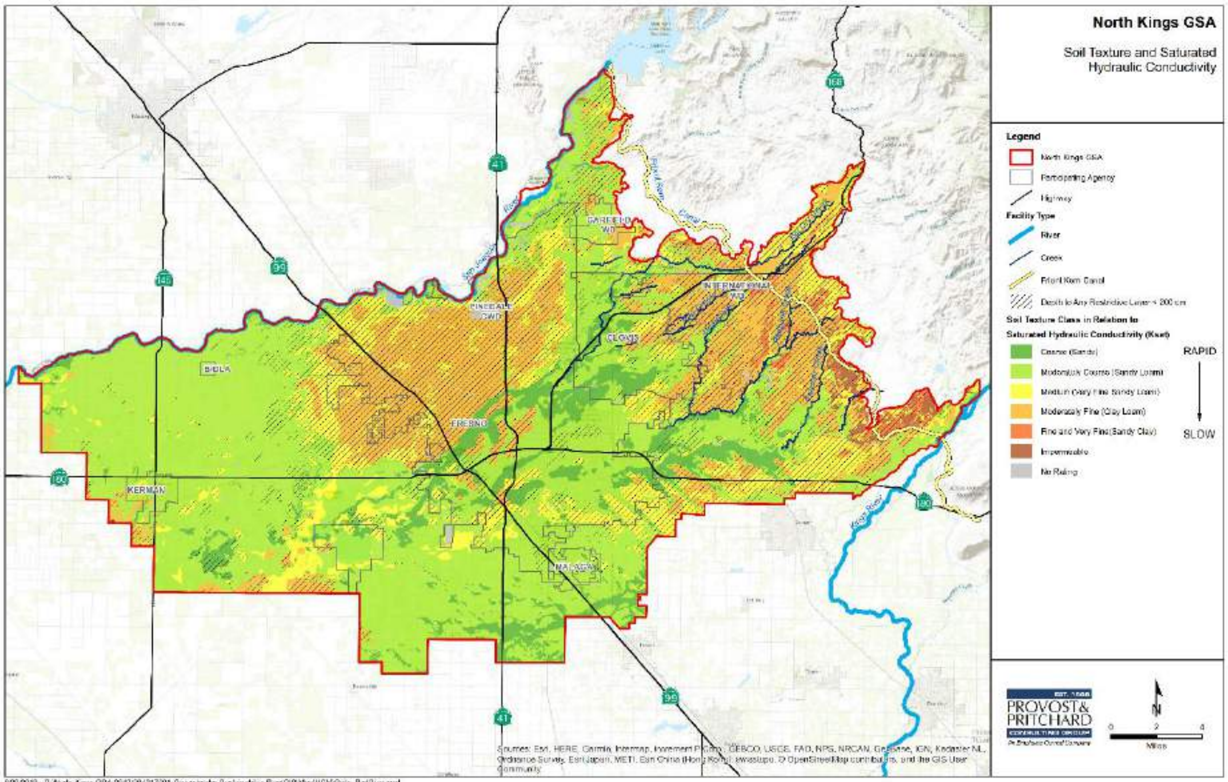


Figure ES-3 NKGSA Soil Texture and Saturated Hydrologic Conductivity

<u>Groundwater Conditions</u>

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. Generally, groundwater flow is to the southwest within 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. In the Fresno-Clovis metropolitan area, significant groundwater pumping has caused a cone of depression which has led to changes in the general southwesterly groundwater flow direction as groundwater now moves radially toward the cone of depression under the urban area (**Figure ES-4** and **Figure ES-5**).

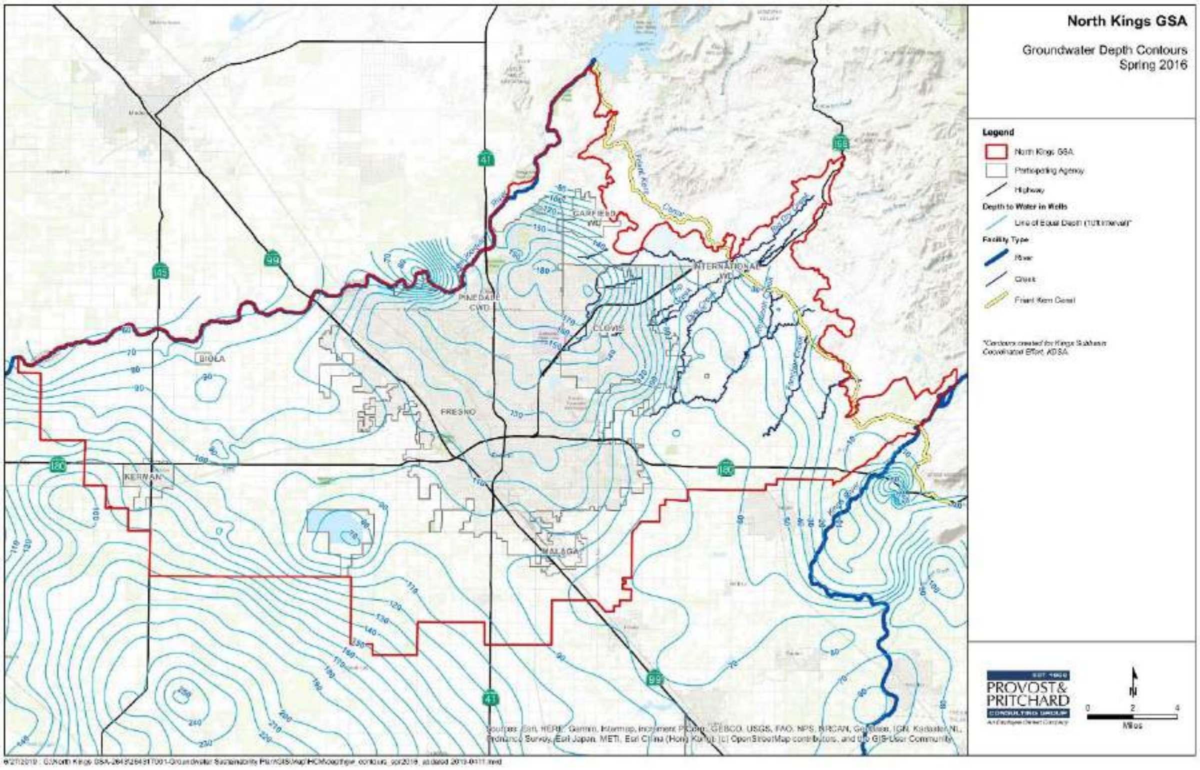
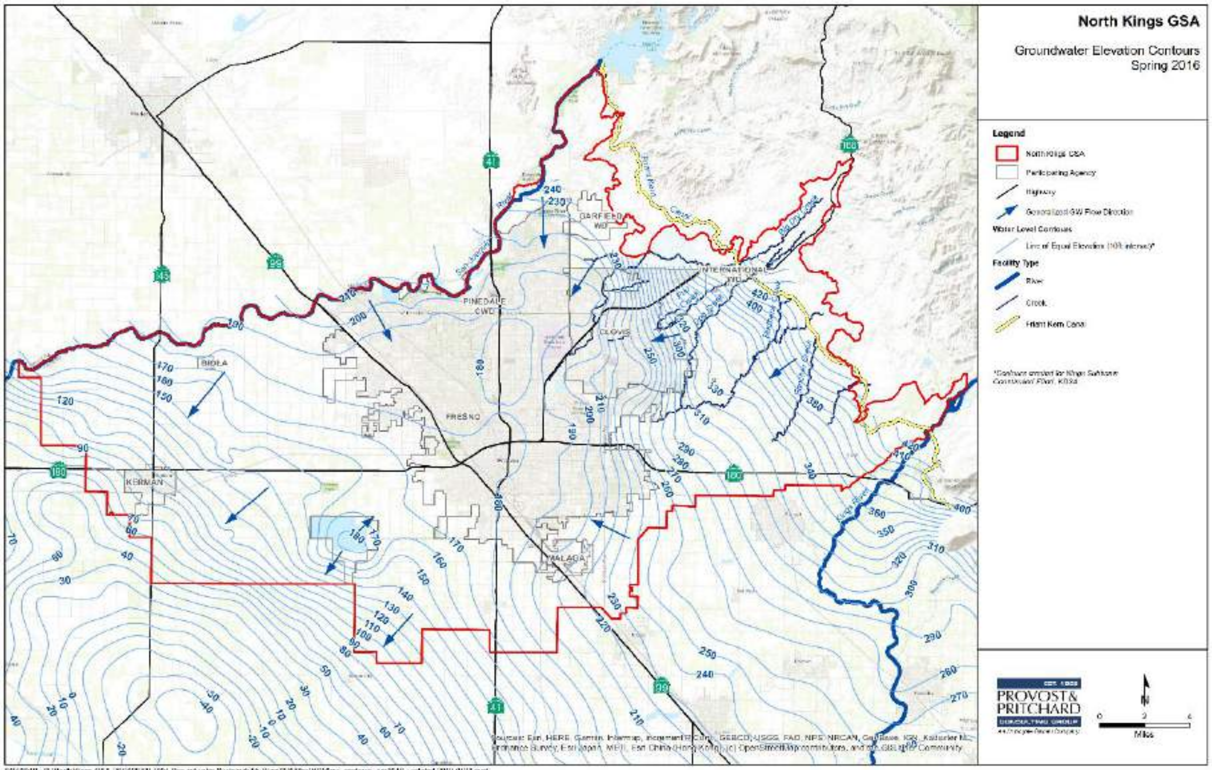


Figure ES-4 Groundwater Depth Contours, Spring 2016



A large cone of depression has also developed due to the large volume of groundwater pumping within the McMullin Area GSA west of the NKGSA, causing increased groundwater flow into the McMullin Area GSA from the NKGSA, estimated at approximately 45,000 AF annually.

Outflows to other GSAs, basins, or sub-basins should not be included as inflow in GSPs for those GSAs, basins, or sub-basins to the extent water users in the NKGSA intend to control, distribute, store, spread, sink, treat, purify, recapture and salvage any such water including but not limited to groundwater, surface water, sewage and storm waters, imported or native return flows, for the beneficial use or uses of the NKGSA's inhabitants or the owners of rights to water in the NKGSA.

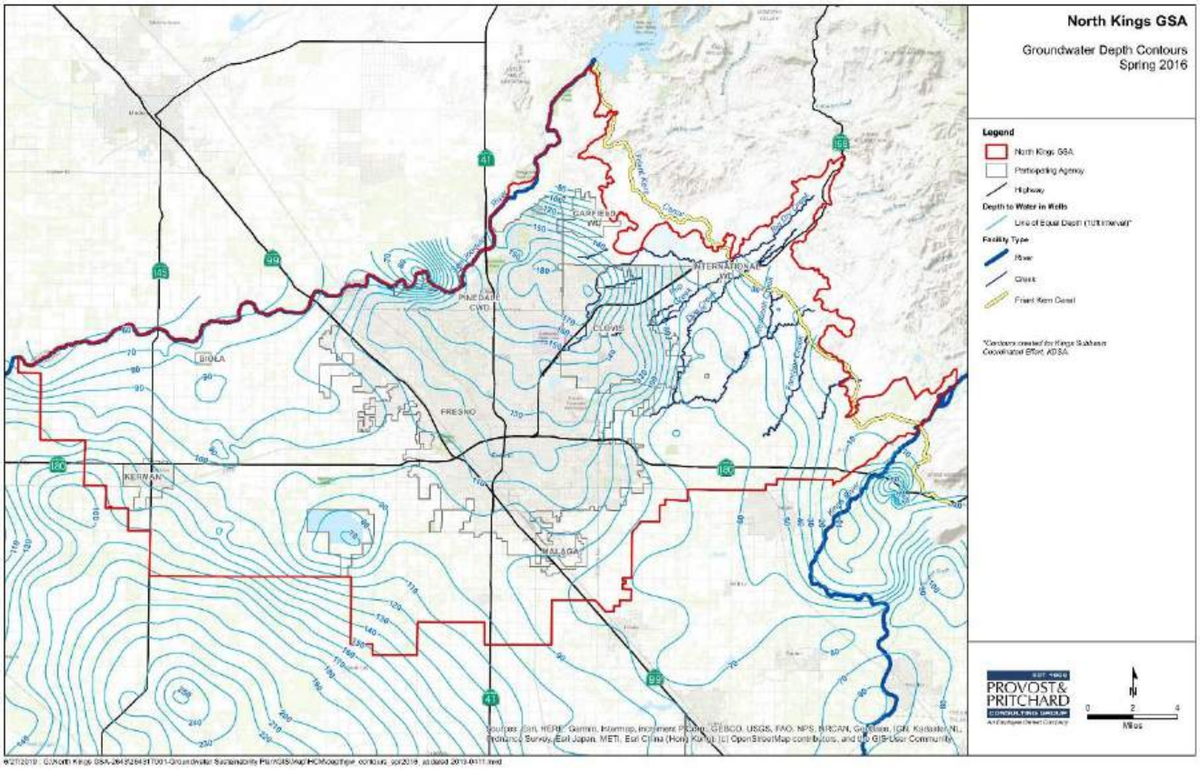


Figure ES-4 Groundwater Depth Contours, Spring 2016

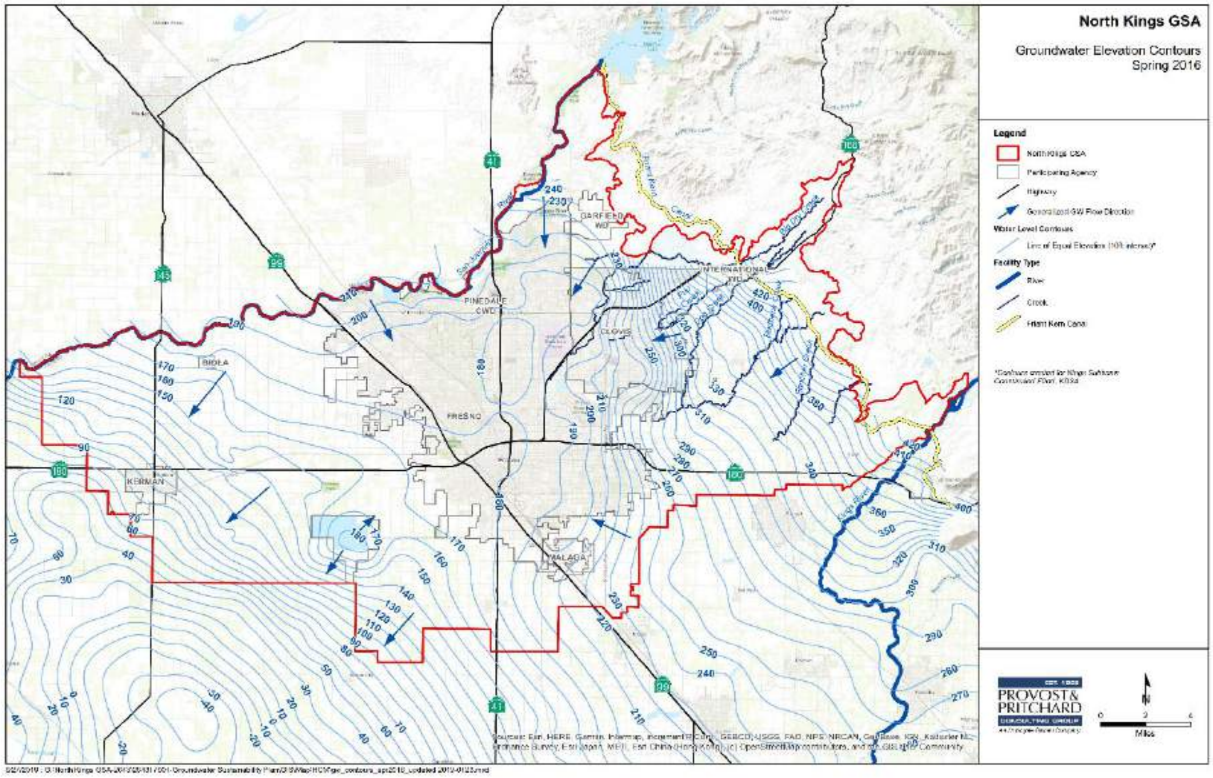


Figure ES-5 Groundwater Elevation Contours, Spring 2016

<u>Groundwater Levels</u>

Groundwater levels have fallen significantly over the last century throughout the San Joaquin Valley including within the NKGSA. This is largely due to extraordinary groundwater extractions in adjacent GSAs. Pictured below in **Figure ES-6** is a typical well hydrograph within the Plan Area. Static or non-pumping water levels are typically measured in the spring and fall each year to capture the seasonal high and low points of the hydrologic cycle. The historic trend line shows water levels declining by approximately 1 to 2 feet per year on average.

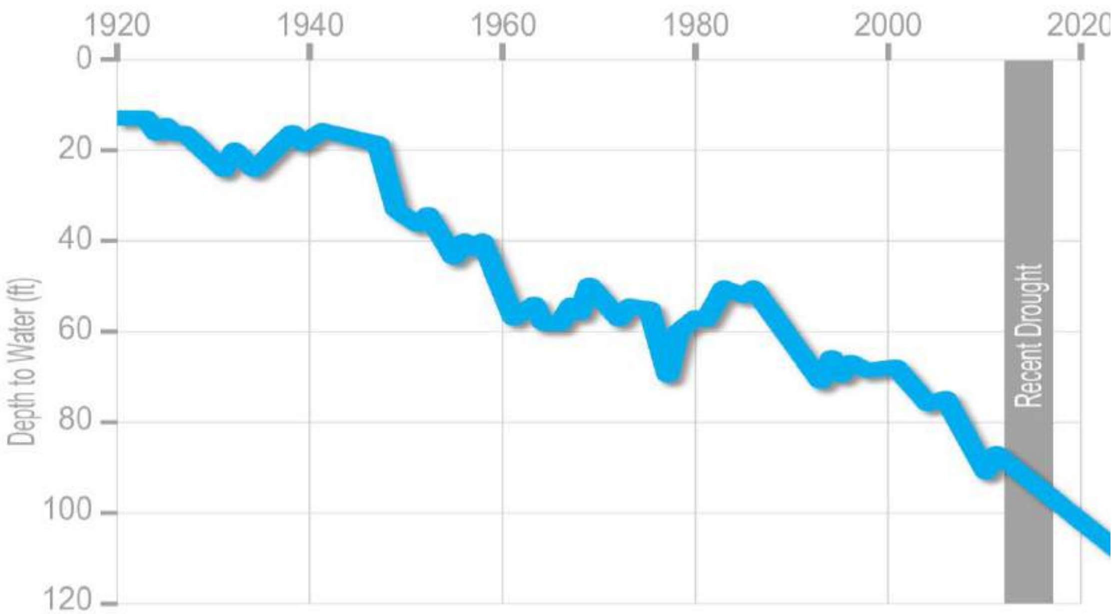


Figure ES-6 Typical NKGSA Well Hydrograph

Groundwater Quality

Groundwater within the NKGSA area is used to meet agricultural, urban, and domestic demands. The groundwater quality assessment for the NKGSA Plan Area has been prepared 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). Additionally, this data set has been augmented with information available from previous scientific investigative data collection and reporting efforts. Specific water quality concerns include nitrate, arsenic, DBCP, 1,2,3-TCP, MTBE, landfill leachate, uranium, and several solvent-related constituents, such as trichloroethylene (TCE) and hexavalent chromium. While some of these constituents are caused by human activity, several are naturally occurring.

Land Subsidence

Land subsidence was first identified and 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. 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 outside the NKGSA. 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. Recent monitoring indicates that there is minimal subsidence occurring in the NKGSA area. The greatest subsidence in the plan area has been located along the western edge of the NKGSA boundary. This seems to correlate with increased pumping outside of the NKGSA and the presence of the Corcoran Clay; the eastern extent of the Corcoran Clay is shown on **Figure ES-7**.

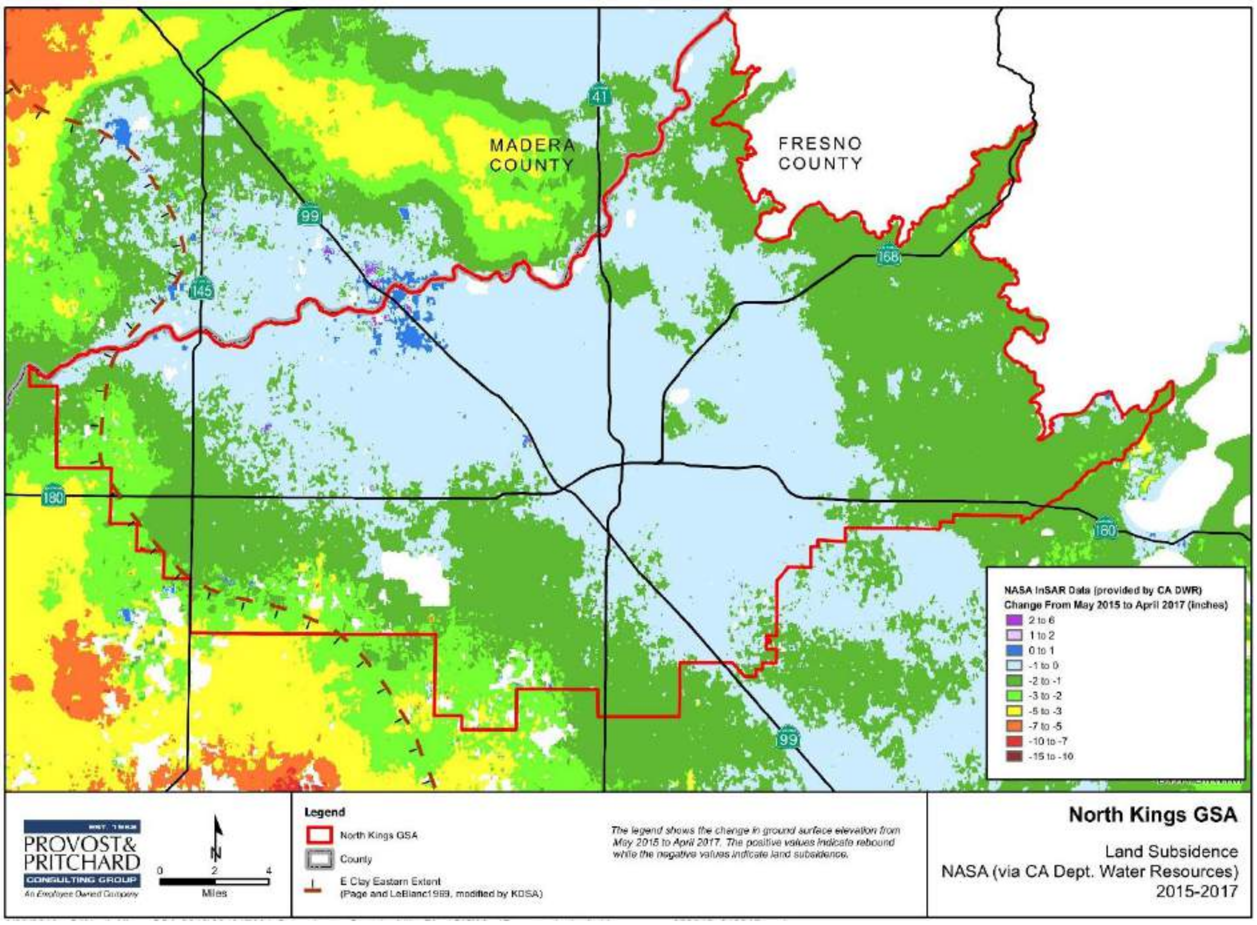


Figure ES-7 Land Subsidence in NKGSA

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 NKGSA.

Water budgets were prepared for a historical period (1997-2011), current period (2016-2017) and future periods (2040 and 2070). The current water budget shows that the NKGSA is currently sustainable if the other GSAs impacting the NKGSA due to boundary flows make correctios to mitigate for those boundary flows. 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 current water budget shows that the NKGSA is currently sustainable but will require projects yielding at least 17,000 AF/year to be sustainable in 2040. The future water budgets are based on numerous assumptions related to climate change, population growth, agency annexations, water conservation, and impacts of boundary flow from neighboring GSAs. These assumptions will likely change over time resulting in different conclusions. Another impact on NKGSA is significant groundwater flows to the west caused by a groundwater pumping depression directly to the west of NKGSA, which is expected to be partially mitigated by projects and programs in McMullin Area GSA. There is uncertainty in several aspects of the water budget, so the results should be viewed as guidelines rather than precise values.

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 of the GSP - the hydrogeologic conceptual model, groundwater conditions, and water budget sections chapters of the NKGSA plan.

The goal of the Kings Subbasin and this GSA is to correct and end the long-term trend of a declining water table, with the 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 over a long-term average period. The sustainable yield varies from one GSA to another due to varying conditions such as surface water supplies.
- 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 over a long-term average period.

- 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 the Section 3 - Basin Setting, 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 storage change within each GSA and sustainable yield. The coordination efforts between the NKGSAs have resulted in agreed initial quantities of storage change for each GSA to correct in order to achieve sustainability. These quantities and each GSAs respective obligation will continue to be monitored, evaluated, and renegotiated at last every five years as additional information is gathered.

Currently, the GSAs in the subbasin have agreed to the following responsibilities:

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

The subbasin's GSAs have also agreed to come back and review these responsibilities no less frequently than every 5 years to determine if changes are necessary.

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 storage change. 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 for each GSA in the basin. Collectively, these projects and programs have been identified to ensure the basin reaches sustainability by 2040 but are dependent on hydrology, management, and capture of local water supplies. 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 to reach sustainability within the basin.

The Basin 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 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.

Water Levels

The GSAs within the Kings Basin have defined the Undesirable Result for groundwater levels to be significant and unreasonable when either the water level has declined to a depth that a new productive well cannot be constructed, or when the water level has declined to a depth that water quality cannot be treated for beneficial use. **Figure ES-8** 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.

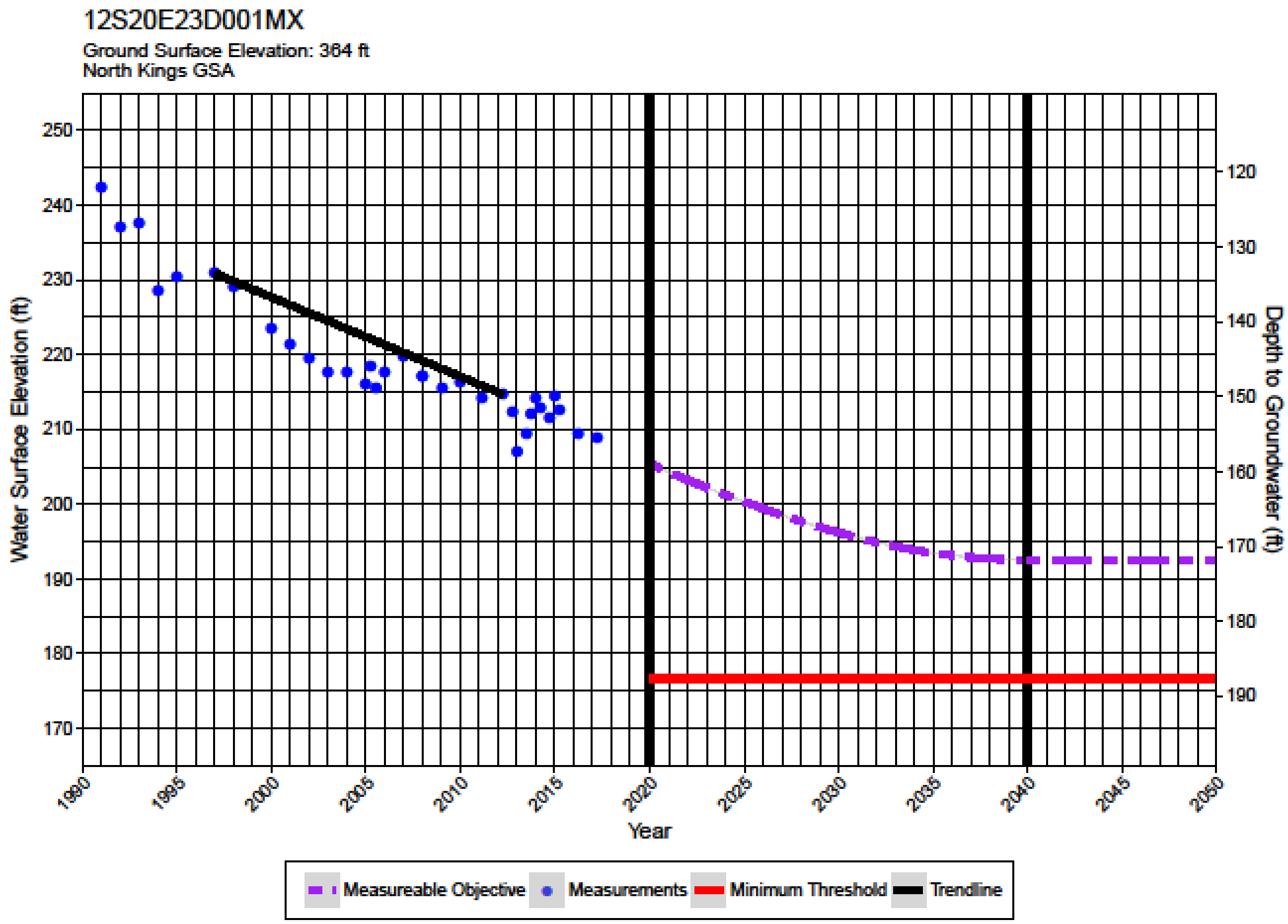


Figure ES-8 Typical NKGSA Well Hydrograph with Phased Mitigation to Reach Sustainability

Storage Change

As part of the coordination of GSAs within the Kings Subbasin, a common method was utilized to estimate the change in groundwater storage for the entire subbasin and within each GSA during the hydrologic average base period, which was identified as the 15-year period from October 1996 to September 2011 based on Kings River surface water diversion into the area. The estimated storage change within the upper, unconfined groundwater of the Kings Subbasin is calculated to be -1.8 MAF during the hydrologic average base period from spring 1997 to spring 2012, or an average of about -122,000 AF/yr. Storage change due to groundwater release from aquifer compaction (caused by land subsidence) was estimated to be 12,000 F/year, resulting in total overdraft of 134,000 AF/year. Estimated storage change in the lower confined aquifer is not possible at this time due to limited or no data from confined wells in the area. In addition, groundwater pumped from the confined portions of the aquifer is captured as storage change in the unconfined aquifer due to vertical leakage through wells and aquitards. The goal, by 2040, is to stabilize, over the long-term, changes in groundwater storage, to prevent groundwater storage from falling below the overall storage represented by groundwater level measurable objectives, and to never allow the groundwater storage to fluctuate below the storage value represented by the groundwater minimum thresholds levels.

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. Groundwater pollution characterization and mitigation are typically enforced by local agencies and state level programs. The State maximum contaminant level (MCL) values, which are protective of human health for the chemicals of concern, will be relied upon as the primary criteria for defining minimum thresholds and undesirable results. Nine specific constituents of concern in the area will be the focus of the SGMA monitoring effort. Groundwater monitoring results from representative community and non-community wells within the NKGSA monitoring network will be reviewed annually for compliance with State MCL values and changes from historical values. The measurable objective is to maintain water quality at potable water standards, below MCLs for the chemicals of concern. In situations where monitoring network wells (either existing or future wells) have a recent history of being above MCLs for contaminants of concern, the measurable objective is for the wells to maintain stable or improving groundwater quality trends.

Land Subsidence

The measurable objective for land subsidence is no more than 2.5 inches per year over an area of at least 36 square miles, with maximum cumulative subsidence of no more than 0.5 feet between 2020 and 2040. These values are based on historical subsidence rates that have shown no negative impacts. The minimum threshold will be 5 inches/year over an area of greater than 36 square miles, and no more than 2 feet between 2020 and 2040.

Surface Water and Groundwater Interconnection

Regional studies appear to show that the San Joaquin River is not connected to groundwater within the NKGSA, however the Kings River is likely interconnected. Existing management programs on both rivers guarantee certain flow rates and water releases to accommodate all river losses (evaporation, seepage, riparian diversions and groundwater pumping induced seepage). Therefore, undesirable results to surface water related to groundwater pumping are not likely to occur. Regardless, the NKGSA has established a groundwater monitoring network along both rivers to monitor for impacts and changes in near-river gradients, and potential impacts to downstream water users will be monitored.

Seawater Intrusion

As the NKGSA is approximately 100 miles from the Pacific Ocean, seawater intrusion is not feasible and therefore does not apply to the Kings Subbasin.

Chapter 5 Monitoring Network

This chapter describes the monitoring network being developed by the NKGSA that will be used to 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 NKGSA management. The results and data from historical monitoring efforts are discussed in Section 3.2 – Current and Historical Groundwater Conditions. 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. A map of the proposed representative monitoring well network that includes monitoring wells near both rivers is shown in **Figure ES-9**.

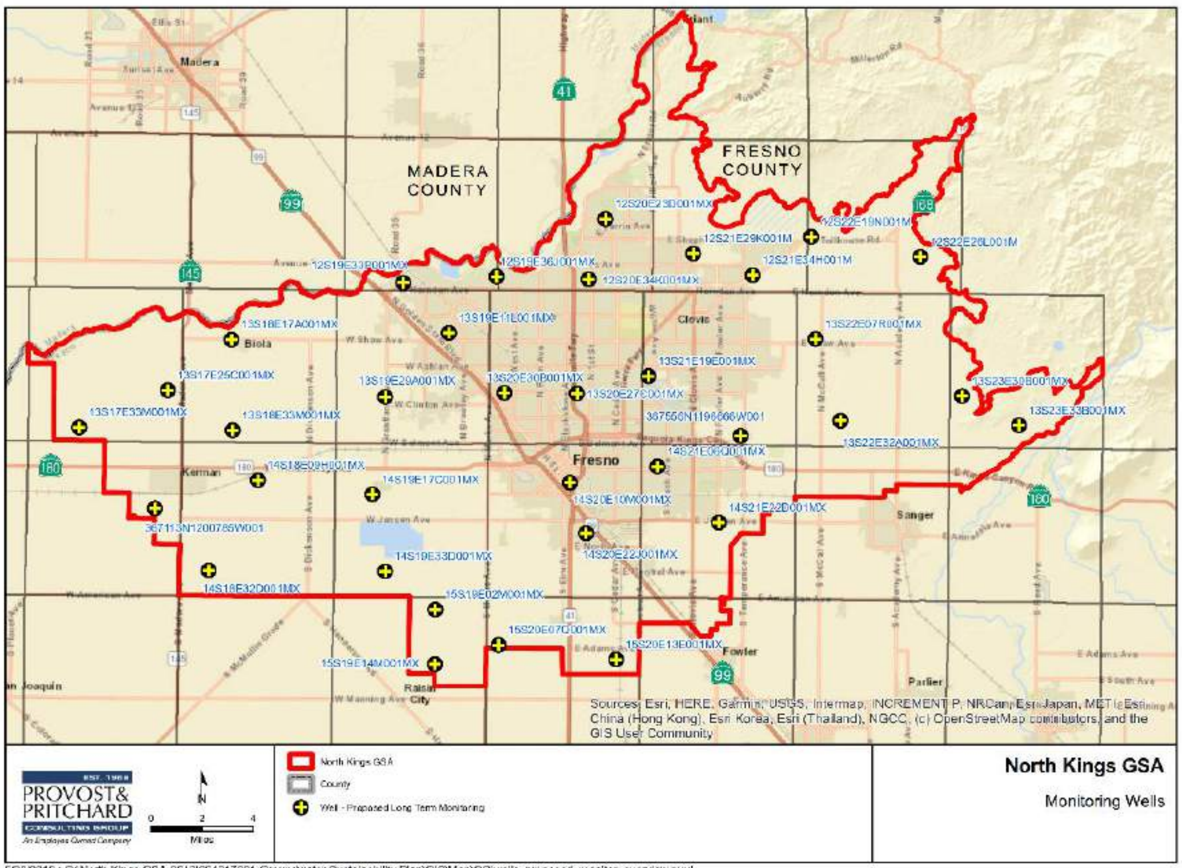


Figure ES-9 NKGSA Representative Monitoring Well Network

The NKGSA 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 for reliable well construction information, and construction of dedicated monitoring wells, the NKGSA plans to fill data gaps as discussed further in Chapter 5.

Additionally, data from a separate network of potable water system wells will be used to evaluate changes in water quality conditions in the GSA. **Figure ES-10** is a map showing these well locations.

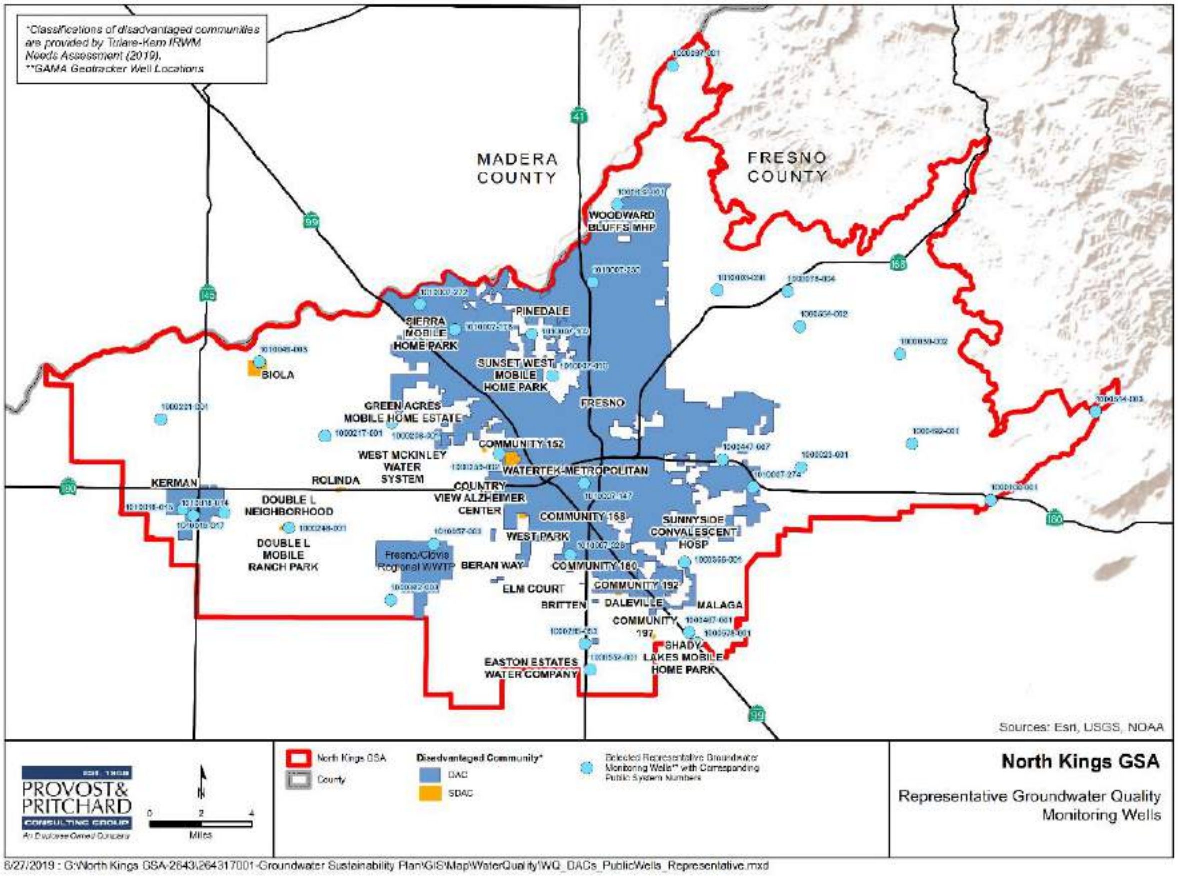


Figure ES-10 Monitoring Well Location

Chapter 6 Projects and Management Actions

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

The NKGSA will reach sustainability by 2040 if groundwater flows from within the NKGSA to neighboring GSAs and basins are reduced and projects are developed to mitigate present and future projected impacts. However within the NKGSA, some agencies have a negative groundwater impact and these agencies have agreed to each initiate mitigation measures to offset negative groundwater pumping impacts. The agencies have focused on water supply augmentation projects to offset these impacts and each agency has identified projects included in Chapter 6. In addition, the agencies within the NKGSA may consider management actions related to demand reduction. Section 6.3 discusses a suite of management actions the NKGSA may consider during implementation of the GSP to achieve sustainability. Some management actions, such as education and outreach, will be initiated early in the GSP implementation phase. Some other management actions are envisioned to be employed if project development is not proceeding sufficiently to achieve interim milestones. The Management Actions that may be considered by the NKGSA are grouped into the following general topics:

- Education and Outreach
- Well Head Requirements
- Groundwater Allocation
- Groundwater Pumping Restrictions

Each of the included projects and management actions are in various stages of planning, implementation, benefit accrual, and ongoing operations and maintenance (O&M). Some projects will be implemented sooner than others. The NKGSA understands there are various levels of uncertainty with project and program implementation, and it is not unusual for project and program implementation to take longer than originally estimated. Depending upon the success or failure of the initial GSP project and management action efforts to increase water supplies, reduce groundwater demands, and improve data collection, the various implementation timelines and benefit accrual may fluctuate over time and will be reevaluated each time this GSP is updated.

Chapter 7 Plan Implementation

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

This chapter includes a preliminary estimate of GSP implementation costs, identifies funding plans, and includes a preliminary implementation schedule for potential projects and management actions. The schedules and budgets presented in the GSP are purely estimates and may need to be altered or eliminated should the NKGSA board deem it necessary.

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 requirements, the objectives of the GSP, and progress toward each identified measurable objective. The NKGSA will report the results of Basin 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 NKGSA has developed a Data Management System to help store and evaluate these groundwater related data. In addition, the NKGSA will amend the GSP at least every five years. The update will include the results of Basin operations, progress in achieving sustainability, 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 with 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. 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

As the GSA is approximately 100 miles from the ocean, seawater intrusion is not feasible. In addition, there are no saline water lakes in or near the NKGSA. As a result, seawater intrusion as a sustainability indicator is not discussed in detail in this GSP.

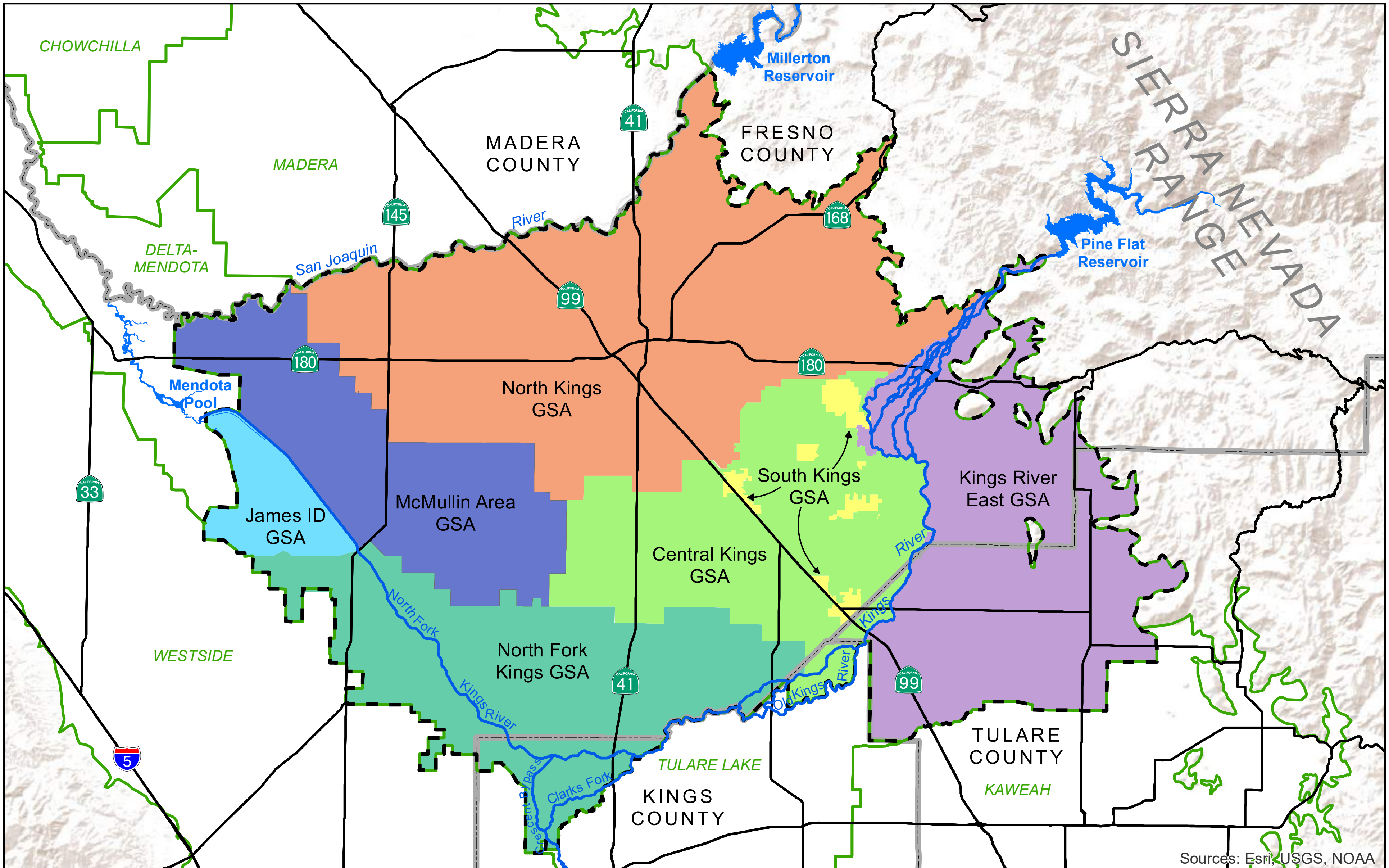
In his signing statement, Governor Brown emphasized that “groundwater management in California is best accomplished locally.” The GSAs within the Kings Subbasin are working to achieve basin-wide sustainability through local efforts and cooperation.

1.2 Sustainability Goal

The sustainability goal of the Kings Basin and this GSA is to ensure that by 2040 the basin is being managed 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 Section 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 have developed other coordination elements of the GSPs. The GSAs entered into a cooperative Memorandum of Understanding for development of the GSPs and grant funding. The GSAs also developed a Coordination Agreement in accordance with section 357.4 of the Regulations. The formalized coordination agreement will help to ensure that: (a) the GSPs have been developed utilizing 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.



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Kings Groundwater Subbasin (DWR 2018)

Other Groundwater Subbasins (DWR 2018)

County

North Kings GSA

Kings Groundwater Subbasin Groundwater Sustainability Agencies

FIgure 1-1

6/27/2019 : G:\North Kings GSA-2643\264317001-Groundwater Sustainability Plan\GIS\Map\Presentation\subbasin_gsa.mxd

1.4 Inter-basin Agreements

There are currently no inter-basin 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 1-1**, the North Kings GSA borders the Madera Subbasin. The North Kings GSA has shared water level data with agencies in the Madera Subbasin for decades to prepare water level contour mapping and groundwater storage estimations. The NKGSA representatives have met with Madera Subbasin representatives during the GSP development process to discuss data sharing and their approach to Sustainable Management Criteria. A data sharing agreement is currently being developed between the agencies.

1.5 Agency Information

Regulation Requirements**:**

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

North Kings GSA
2907 S Maple Ave
Fresno, CA 93725

1.5.1 Organization and Management Structure of the GSA

Regulation Requirements**:**

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

The North Kings GSA is a joint powers authority consisting of the following public agencies:

- Fresno Irrigation District
- County of Fresno
- City of Fresno
- City of Clovis
- City of Kerman
- Biola Community Services District
- Garfield Water District
- International Water District

Contact: Gary Serrato, North Kings GSA
Address: 2907 S. Maple Avenue, Fresno, CA 93725
Phone: 559-233-7161
Email: gserrato@fresnoirrigation.com

A copy of the Joint Powers Agreement is available on the NKGSA's website (www.northkingsgsa.org). The NKGSA also has Participation Agreements with Bakman Water Company, a private water company regulated by the California Public Utilities Commission, and the Fresno Metropolitan Flood Control District. The NKGSA is governed by a seven-member Board of Directors that has final decision-making authority for the NKGSA. Directors are elected officials of their respective boards, councils, or commissions or are authorized representative of a Member, Contracting Entity or Interested Party. All terms are for a period of two years with four seats starting with three-year terms.

To fulfill the mission of the NKGSA, the Board of Directors appoints standing committees and ad hoc committees as it deems necessary. The Board establishes the membership of all standing committees and invites the public and other interested parties to participate. The purpose of the Advisory Committee, a standing committee, is to assist with the development of the necessary processes and programs needed by the Board of Directors to implement the mission of the NKGSA. The NKGSA has an ad hoc Technical Subcommittee that is tasked with development of the Groundwater Sustainability Plan. The Technical Subcommittee is comprised of a varied group of stakeholders including agency staff, DAC representatives, private landowners, growers, and community members. The NKGSA also has an ad hoc Outreach Subcommittee and Admin/Fiscal Subcommittee. The NKGSA has an Executive Officer responsible for day to day management authority.

1.5.2 Legal Authority of the GSA

Regulation Requirements**:**

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

The North Kings GSA is a Joint Powers Authority formed pursuant to Governmental Code Section 6503.5, and as stated in Section 2.02 of the JPA, the NKGSA has been formed "with the purpose and intent of jointly forming a separate entity to fulfill the role of GSA so that the Members, in consultation with the Contracting Entities and Interested Parties involved in the Authority via a Participation Agreement(s) or one or more Memorandum of Understanding, may collectively develop, adopt and implement a GSP for the sustainable management of groundwater for that portion of the Kings Subbasin underlying the jurisdictional boundaries of the Members, as those boundaries may be amended from time to time." The members and Contracting Entities have agreed to a cost share methodology for the ongoing funding of the NKGSA efforts and implementation of the GSP. The cost estimate and methodology are described in **Section 7.1**.

1.6 GSP Organization and Preparation Checklist

All of the GSPs within the King Subbasin utilize the same GSP outline structure and format with only minor differences in some lower-level subheadings. The GSP is organized in accordance with the GSP Emergency Regulations (i.e., California Code of Regulations section on Groundwater Sustainability Plans) in a format similar to the outline provide 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 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.

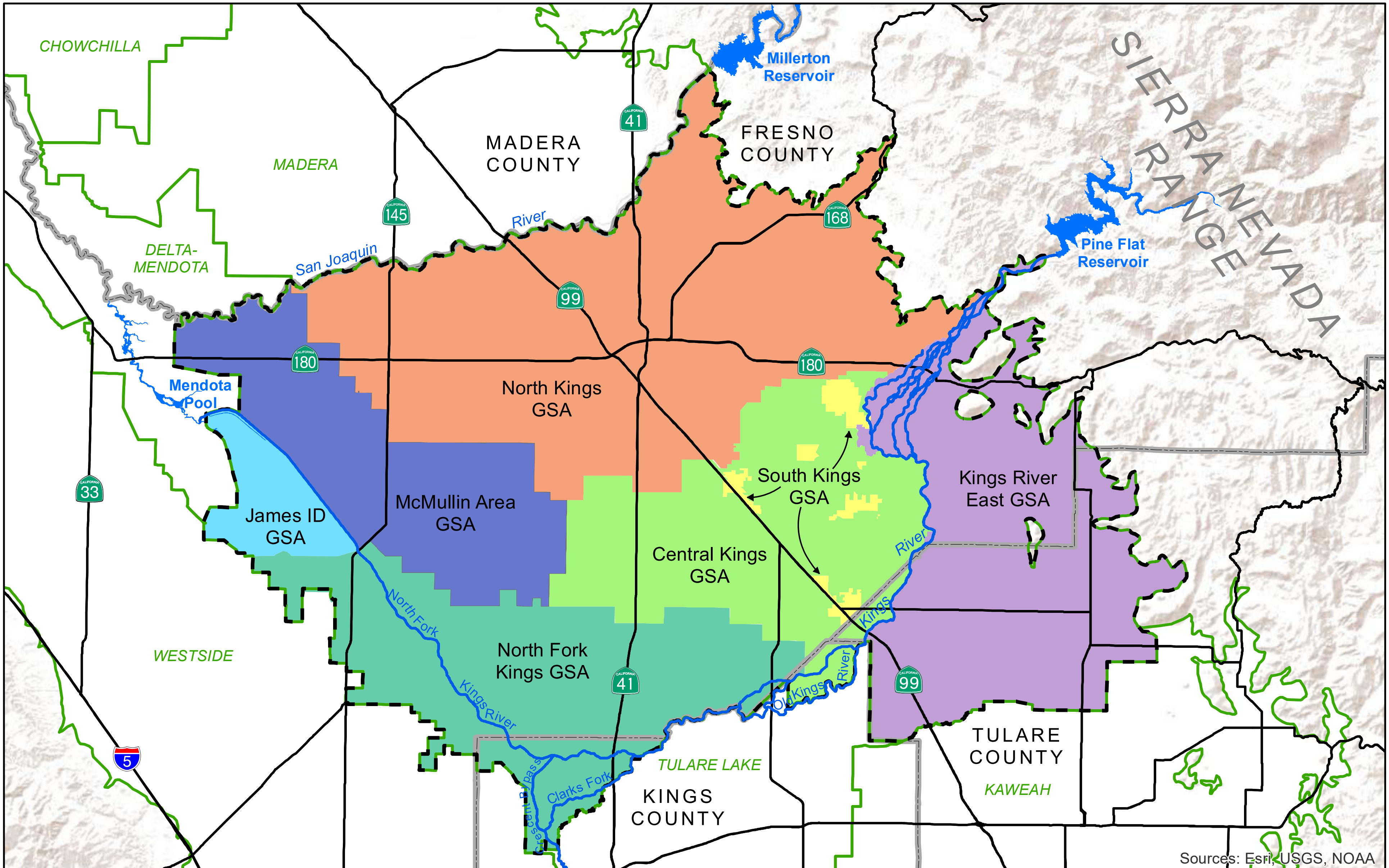
Plan Area and Jurisdictional Boundary

The Kings Basin is located in the southern part of the San Joaquin Valley with the majority of surface water being supplied from the Kings and San Joaquin Rivers. The North Kings Groundwater Sustainability Agency (NKGSA) is one of seven GSAs within the Kings Groundwater Subbasin (Kings Subbasin). There is no overlap among the GSAs and there are no adjudicated areas in the groundwater basin. Pursuant to Water Code Section 10727.6, the GSAs are required to use the same data and methodologies for the various assumptions in developing their GSPs, such as groundwater elevations, extraction data, surface water supply, total water use, change in storage, water budget and sustainable yield. Five other groundwater subbasins border the Kings Subbasin including the Madera Subbasin, Kaweah Subbasin, Tulare Lake Subbasin, Westside Subbasin, and Delta- Mendota Subbasin.
Figure 2-1 shows the bordering subbasins along with the GSAs in the Kings Subbasin.

The only state lands within the NKGSA area are California State University – Fresno and Kearney Park. There are no significant federal, state (except individual buildings and relatively small commercial activities at Campus Pointe), or tribal lands located within the Plan area. The thirteen local entities participating in the North Kings GSP are shown in **Figure 2-2**. The NKGSA includes twelve entities that purvey water supplies plus a flood control district that are involved through a Participation Agreement. The NKGSA encompasses Fresno, the 5th largest city in California.

Land Use

A general land use map for NKGSA is provided in **Figure 2-3**. The Plan area is comprised primarily of agricultural and urban land use designations. **Table 2-1** shows the percent of area for each land use classification with the top five being Agricultural (Permanent Crops) at 37%, Urban at 27%, Rural Residential at 10%, Native Vegetation at 8%, and Annual Crops at 7%, which account for 89% of the Plan area. The remaining 11% includes other agricultural, commercial, industrial, riparian vegetation, urban landscape, and water surfaces.



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North Kings GSA

Kings Groundwater Subbasin
Groundwater Sustainability Agencies

Figure 2-1

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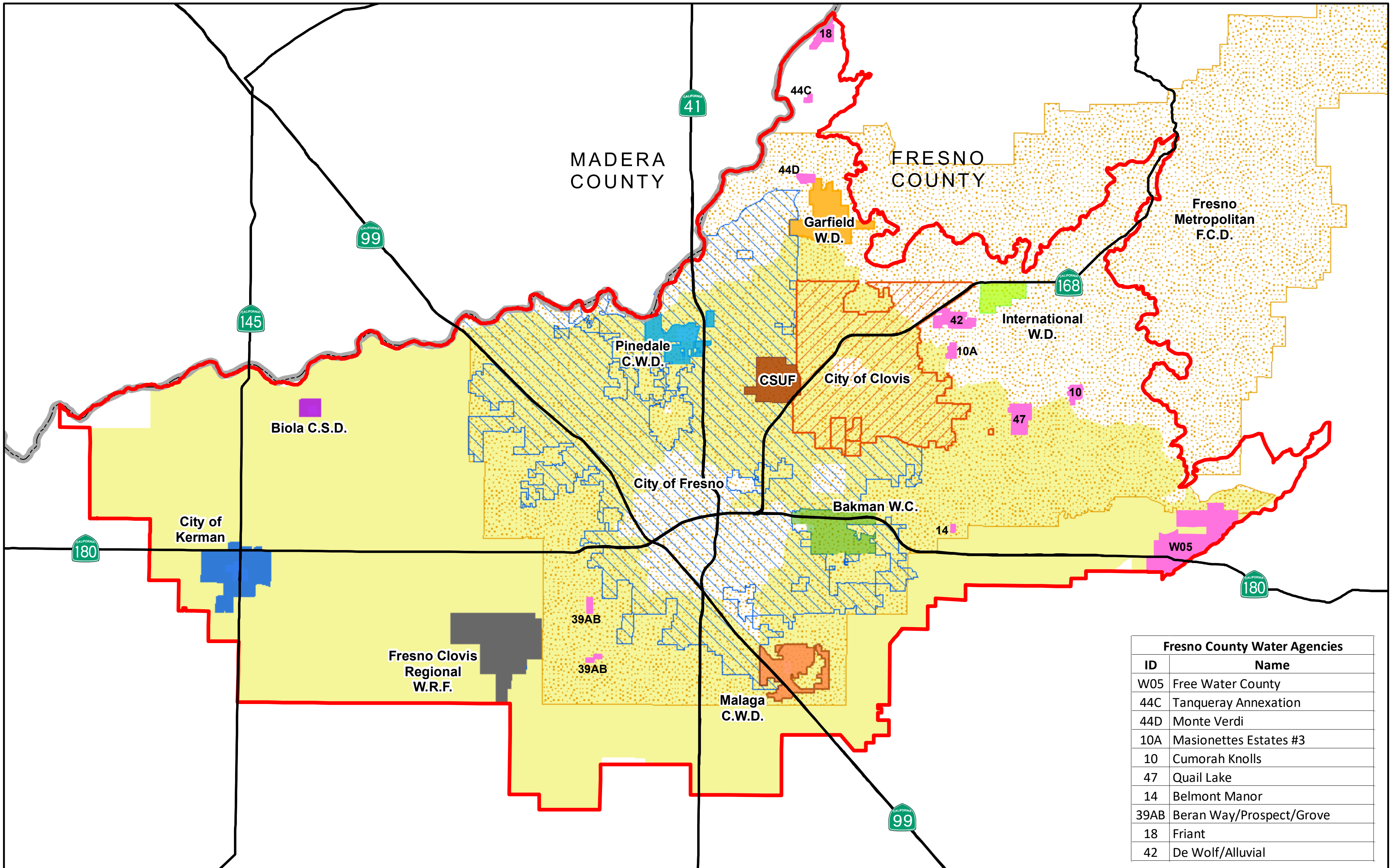

Fresno County Water Agencies	
ID	Name
W05	Free Water County
44C	Tanqueray Annexation
44D	Monte Verdi
10A	Masionettes Estates #3
10	Cumorah Knolls
47	Quail Lake
14	Belmont Manor
39AB	Beran Way/Prospect/Grove
18	Friant
42	De Wolf/Alluvial

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Legend

- North Kings GSA
- International WD
- Biola CSD
- City of Kerman
- Garfield WD
- Bakman Water Company
- Pinedale County WD
- Fresno County Water Agencies
- CA State University Fresno
- Malaga County WD
- Fresno ID
- Fresno Metropolitan Flood Control District
- City of Clovis
- Fresno Clovis Regional WRF
- City of Fresno
- County

North Kings GSA

Plan Participants

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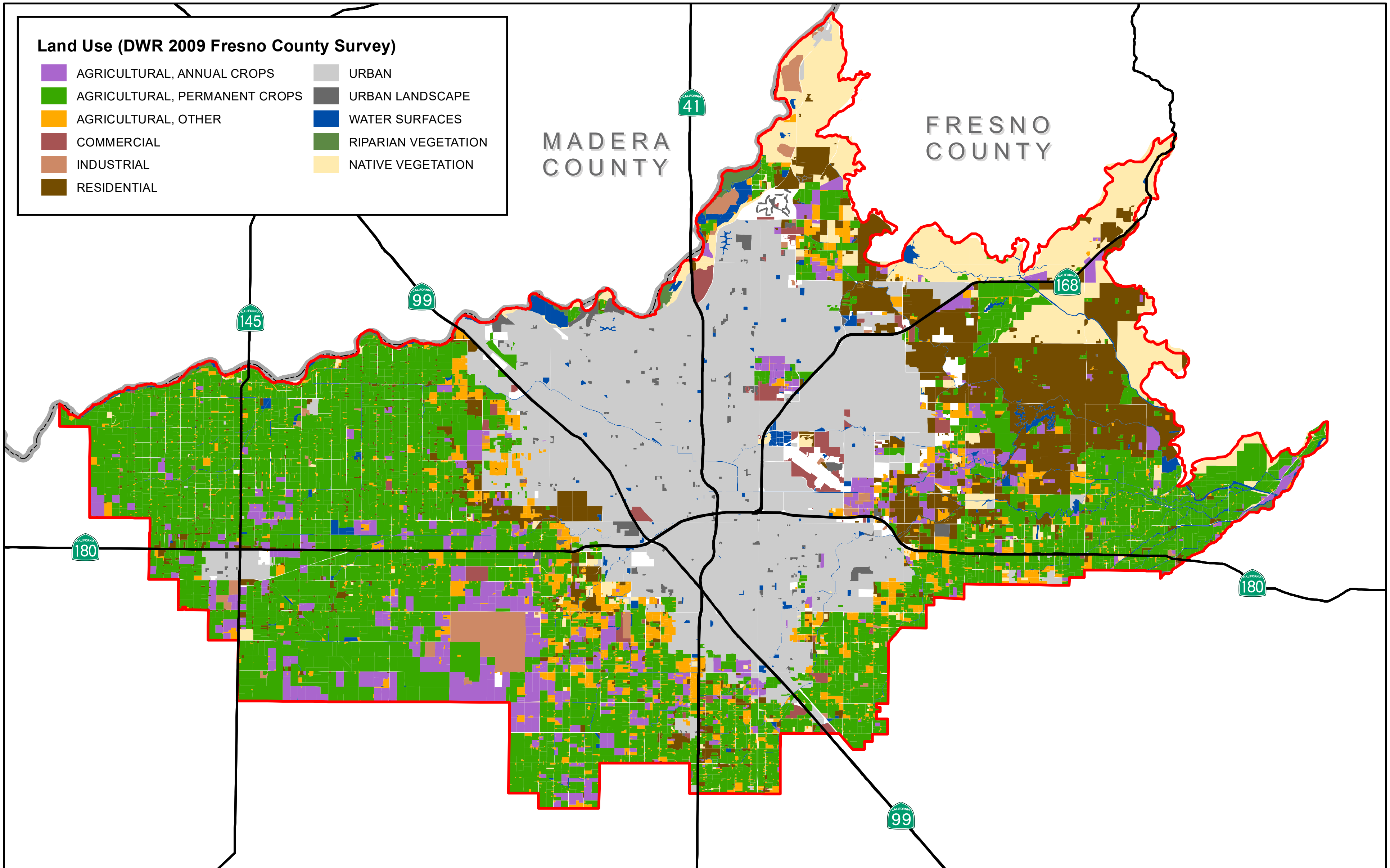

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North Kings GSA

Land Use

Figure 2-3

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Table 2-1 Land Use in North Kings GSA

Land Use Classification	Percent of Total Area
Agricultural, annual crops	7
Agricultural, permanent crops	37
Agricultural, other	5
Commercial	1
Industrial	2
Native vegetation	8
Rural Residential	10
Riparian vegetation	<1
Urban	27
Urban landscape	1
Water surfaces	2
Total	100

Water Sources

As described in the SGMA Act section 10720.5(b), water rights stay with the water rights holder. The State Water Resources Control Board has issued 11 licenses to the Kings River Water Association for the appropriation of Kings River water to its 28 members. Fresno Irrigation District is one of the 28 members and has rights to divert this water. Water supplies are utilized for direct deliveries for crop irrigation, surface water treatment for urban purposes, landscape irrigation, and recharge for future irrigation and urban extraction.

Water use and water source for each Plan participant are shown in **Table 2-2**. The primary water use designations for the cities are residential, commercial, industrial, landscaping, and recharge. The smaller agencies primarily deliver residential water with three also providing water for commercial or industrial customers. All of the agencies and water companies use groundwater but those with access to surface water utilize it whenever available. The surface water supplies come from either the Kings River or San Joaquin River (through the Central Valley Project Friant Division). The region also receives stormwater from several local ephemeral creeks, including Big Dry Creek, Dog Creek, Redbank Creek, Mud Creek, and Fancher Creek (collectively referred to as the Eastside Streams) that are diverted and conveyed to detention and recharge facilities or used directly for irrigation in Fresno Irrigation District. In addition, three of the Plan participants utilize recycled water.

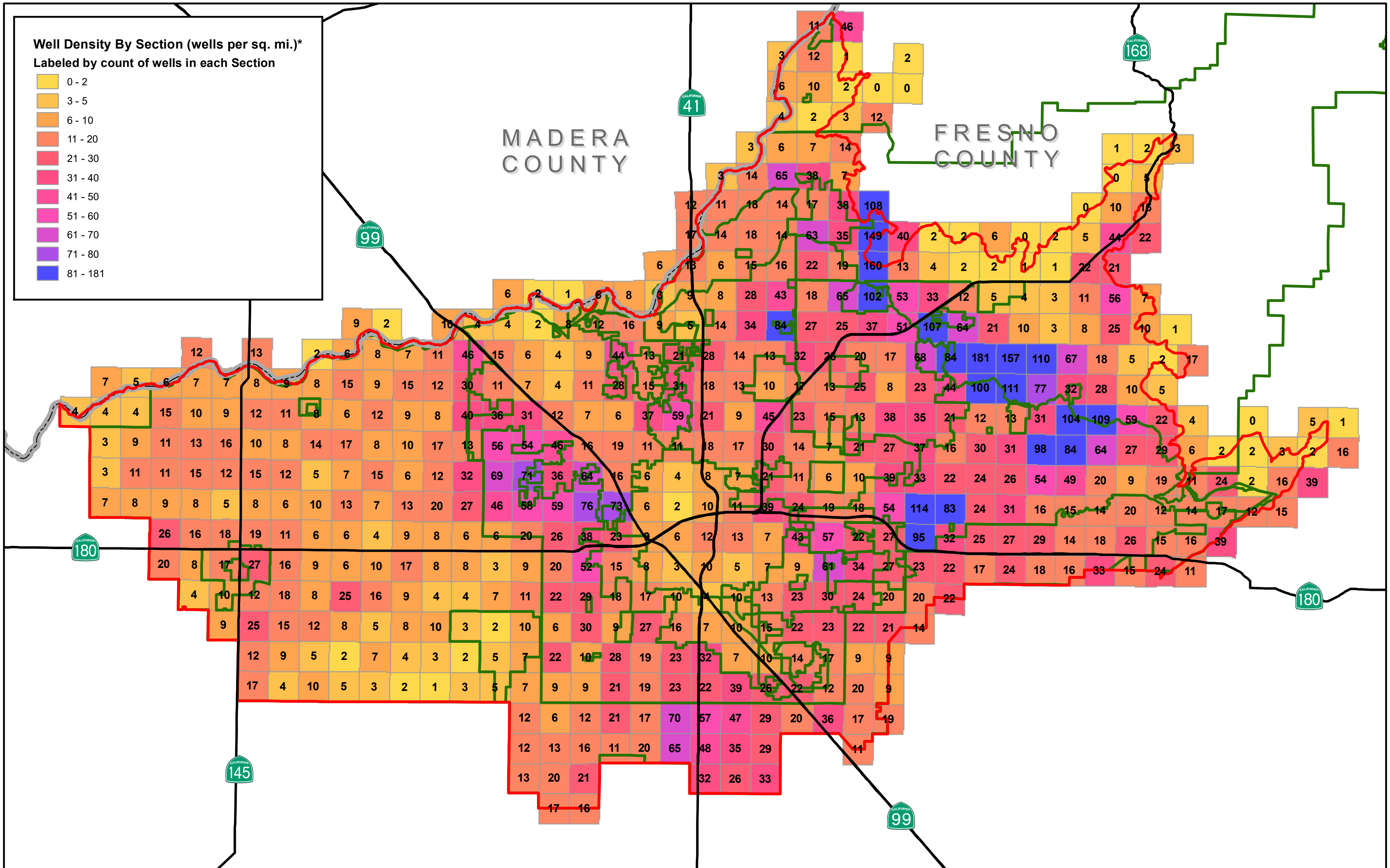
Table 2-2 Water Uses and Water Sources

Agency / Water Company	Water Use	Water Source
Bakman Water Company	Residential Commercial Industrial Recharge	Groundwater Kings River (through FID)
Biola CSD	Residential Industrial	Groundwater
CSUF	Residential Agricultural	Groundwater Kings River (through FID)
City of Clovis	Residential Commercial Industrial Recharge	Kings River (through FID) Groundwater Eastside Streams Recycled Water
City of Fresno	Residential Commercial Industrial Recharge	San Joaquin River Kings River (through FID) Groundwater Eastside Streams Recycled Water
City of Kerman	Residential Commercial Industrial	Groundwater Recycled Water
County of Fresno	Residential	San Joaquin River Groundwater
Fresno Irrigation District[1]	Agricultural Recharge	Kings River San Joaquin River Groundwater Eastside Streams
Fresno Metropolitan Flood Control District	Recharge	Stormwater Eastside Streams
Garfield WD[1]	Agricultural	San Joaquin River Groundwater
International WD[1]	Agricultural	San Joaquin River Groundwater
Malaga CWD	Residential Commercial Industrial	Groundwater
Pinedale CWD	Residential Commercial	Groundwater

1 – These agencies do not directly provide groundwater, but groundwater is pumped from wells owned by private landowners, school districts, cemetery districts, parks, and small communities.

Well Density

Figure 2-4 is a map of well density in the NKGSA area. There are an estimated 9,030 active wells in the NKGSA area. The map is based on best available data including known well locations for each water agency, DWR Well Completion Report records and private well locations provided by Fresno County. The map excludes monitoring wells and test wells. The private wells were mapped by assuming that all wells constructed since 1975 remain active, unless a County permit authorized their destruction. If a well was destroyed without issuance of a County permit, then it will show up on the map as still active. Fresno County did not have information readily available to sort the wells based on domestic or irrigation use. The map does not necessarily show where pumping is concentrated since there is no differentiation between the different well uses. For instance, **Figure 2-4** generally indicates high well densities for the outskirts of the Cities of Clovis and Fresno, but these wells are in rural residential areas where each household has its own domestic well. As a result, the map does show where domestic wells are clustered. However, the map shows very low well densities on the far eastern end of the NKGSA, where bedrock is shallow and groundwater conditions are poor, and along the San Joaquin River, where groundwater levels are higher, and many parcels have riparian water rights.



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Legend

- North Kings GSA
- County
- Participating Agency

**Well density data created from DWR WCR dataset.Sum of Agricultural, Municipal/Industrial, and Domestic wells.*

North Kings GSA

Well Density By Sections

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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.

Groundwater Basin Boundaries

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

Groundwater Sustainability Plan Area

The North Kings Groundwater Sustainability Plan has the same area as the North Kings Groundwater Sustainability Agency, as identified in
Figure 2-1. The Plan area is located within Fresno County and outlined by the Fresno Irrigation District border to the south and the Kings Basin boundary, as identified in Bulletin 118, to the north. The Plan area is 311,831 acres and is approximately 40 miles (east-west) by 12 miles (north-south). The Plan area is comprised of 13 participating agencies and water companies, which are described below. Refer to **Table 2-2** for water use and water source for each agency. In addition, many private domestic and private community wells are used in rural and semi-rural areas throughout the NKGSA.

Bakman Water Company

Bakman Water Company (Bakman), lying west of the Sierra Nevada foothills, was established in 1948. It is located partially within the city limits of Fresno with the remainder in unincorporated Fresno County. The service area includes several "county islands," which are areas surrounded by the City of Fresno and have not been annexed into the City and, therefore, remain under County of Fresno jurisdiction. As a California Public Utilities Commission (PUC) regulated public water utility, Bakman currently provides water service to an area of approximately 1,994 acres and is home to 16,797 residents. The agency has a water demand of about 3,000 AF/year, which is supplied solely through groundwater pumping. Although Bakman receives a surface water allocation from Fresno Irrigation District (FID), it is used only for groundwater recharge. Bakman now has an Agreement with FID whereby FID diverts a variable water allocation into one of Fresno Metropolitan Flood Control District's (FMFCD) storm drain recharge basins on behalf of Bakman. In 2015, Bakman entered into a Cooperative Agreement with FID which transferred control of the water allocations attributed to FID landowner acreages, allowing Bakman to pay the assessments in return for deliveries to recharge facilities within Bakman's service area. Bakman also has an Agreement with FMFCD to utilize a specific recharge basin for recharge purposes. For this basin, Bakman worked with FMFCD and the City of Fresno to change the designation from recreation to recharge and participated in constructing capital improvement facilities to deliver the water from FID conveyance systems to the basin. With 1,049 acres under contract by agreement with FID, Bakman's allocation of water is based on approximately 0.52% acres of land within the Kings River Water Allocation.

Biola Community Services District

The Biola Community Service District (Biola or Biola CSD) was formed in 1962 to provide sewer services for the Biola area of unincorporated Fresno County and water services added when Biola Water Company was purchased in 1976. Biola CSD is located approximately 8 miles west of the City of Fresno in Fresno County. The Biola service area is approximately 242 acres and serves a population of about 1,600. Biola has two groundwater wells to provide water and has a demand of approximately 360 AF/year.

California State University, Fresno

Established in 1911, California State University, Fresno (Fresno State) is the regional university serving Central California. The University has an enrollment of more than 22,000 students. Fresno State's campus includes approximately 1,000 acres of irrigated farmland (called the University Farm Laboratory) and a 300-acre main education center that are collectively an independent water entity within the city boundaries of Clovis and Fresno. Fresno State is also home to the California Water Institute, the Center for Irrigation Technology, and the International Center for Water Technology. Fresno State pumps groundwater to meet water demands and receives FID water to meet some of its agricultural demands. Average annual demands over the past ten years have been approximately 2,500 AF for the University Farm Laboratory and 1,000 AF for domestic purposes on campus.

City of Clovis

The City of Clovis, incorporated in 1912, lies west of the Sierra Nevada foothills and northeast of the City of Fresno in Fresno County. The City encompasses about 23.3 square miles (14,912 acres) and is home to over 117,000 residents. In 1989, the City of Clovis assumed the operation of a small water system, which served an unincorporated county island called Tarpey Village. The unincorporated area is home to approximately 3,890 people. The City provides water to its residents from surface and groundwater sources. The contractual surface water allotment for Clovis from the Kings River averages over 20,000 AF per year (based on hydrologic conditions). In some years, a portion of this water is not able to be utilized by Clovis and is instead utilized by other users within FID or for recharge. The entire entitlement is not available every year, and in some years a portion of the water has gone unused or used for recharged. The City operates a 22.5 MGD surface water treatment plant on the east side of town and has numerous wells throughout the City. Almost all water deliveries are metered. The City delivered approximately 20,030 AF of water in 2015, a very dry year, and has delivered up to 27,000 AF annually to its customers in other years. The City also operates a Sewage Treatment Water Reuse Facility that produces recycled water for use in urban landscape areas and agriculture in FID's service area. Clovis also delivers a portion of its sewage to the Fresno-Clovis Regional Wastewater Reclamation Facility. In addition to providing water, the City recharges groundwater, averaging 9,200 AF annually between 1997 and 2011.

City of Fresno

The City of Fresno, founded in 1885, is located in northern Fresno County. The City encompasses over 128 square miles (81,920 acres) and serves water to a population of over 520,000. The City serves the entire area within its City Limits with the exception of Bakman, Pinedale County Water District, California State University Fresno, and private groundwater users within the county islands.

In 2014, the City adopted an update to its Metropolitan Water Resource Management Plan that outlined a series of projects to reverse it over reliance on groundwater and to enable it to use groundwater sustainably by the Year 2025. In 2012, the City completed a citywide residential meter installation project which dramatically changed water use behavior and realized approximately 43,600-acre feet of demand reduction.

The City currently (2015) delivers 111,700 AF, which is a combination of surface and groundwater and has an average delivery of approximately 145,900AFY of water for 2006-2015. The 2015 delivery was not typical as it was a drought year with significant water conservation measures in place. The City has two surface water supplies: 60,000 AF of Class 1 CVP water from the Friant system and 110,500 AF (average annual) from the Kings River through FID. The City has historically fully utilized its CVP annually available amount, however, has not been able to fully utilize the FID contract in full due to either drought conditions or lack of capacity to treat the contract amount of surface water. Surface water is currently conveyed to and treated at the 30 MGD Northeast Surface Water Treatment Facility, at the 4 MGD T-3 Storage and Surface Water Treatment Facility, and at the newly completed 54 MGD Southeast Surface Water Treatment Facility (SESWTF) which became operational in late 2018. The SESWTF is capable of an ultimate 80 MGD capacity. Surface water is conveyed to the plant through a new raw water, large diameter, pipeline from the Kings River. The City also has water available for groundwater recharge; this is accomplished through 1,200 acres of recharge basins that include FMFCD basins and another 220 acres of basins owned by the City. The City has also just completed construction of a 5 MGD tertiary water reclamation facility, located at the Fresno-Clovis Regional Wastewater Reclamation Facility, which will delivery recycled water throughout the southwest and central region of the city.

City of Kerman

The City of Kerman, founded in 1910, is located approximately fifteen miles west of the City of Fresno and fifteen miles south of the City of Madera and encompasses nearly 2,000 acres. The City is home to approximately 15,495 people and delivers about 3,000 AF of water annually to its customers. The water supply for the City is groundwater. Currently, approximately 930 AF of recycled water is being recharged annually; an effort is also being made to deliver recycled water to agricultural customers in the surrounding area.

County of Fresno

Fresno County, created in 1856, is located near the center of California’s San Joaquin Valley which, together with the Sacramento Valley, forms the Great Central Valley, one of the distinct physical regions of the state. The Coast Range, which form 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. 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. It is the 10th most populous county with an estimated 984,541 residents. Fresno County is home to 15 incorporated communities, all located on the Valley floor. Over 60 percent of the County’s total population resides in the Fresno and Clovis metropolitan area. Within the NKGSA, about 38,500 acres (approximately 12% of the NKGSA area) are located outside of a municipality, irrigation district, or water district service area and rely solely on private groundwater wells.

Fresno County directly provides water to several small county water agencies listed below:

- Water Works District 18 - The District has a contract for 150 AF of Class 1 CVP San Joaquin River Water
- Water Works District 42 - Alluvial & Fancher
- Fresno County Parks Department - Lost Lake Recreation Area
- Service Area 10 - Cumorah Knolls
- Service Area 10a - Mansionette Estates
- Service Area 44d - Monte Verdi
- Service Area 47- Quail Lake Estates

The average annual demand for these water agencies is 1,200 AF/year. Outside of these water agencies, domestic water demands are met by private domestic wells and community wells.

Freewater County Water District

Freewater County Water District (Freewater CWD or Freewater) is an area of approximately 1,800 acres located near the eastern boundary of FID and the town of Centerville. For years, the Freewater CWD had separate Kings River water rights but in 1938, as a result of a court settlement, Freewater had its Kings River water rights assumed by FID in exchange for FID agreeing to provide water to Freewater's headgates. Freewater owns, maintains, and operates its own distribution system. This area had agreements with the Fresno Canal and Irrigation Company, the predecessor to FID, for various rights in exchange for allowing the Fresno Canal to be constructed. After years of litigation in the 1930s, Freewater CWD entitlements were settled by agreement in 1938. As the result of the litigation and settlement, the Freewater CWD had a separate assessment rate from other areas within FID. For a period of years, Freewater has rented storage space in Pine Flat from FID amounting to 1,300 AF per year.

Fresno Irrigation District

Fresno Irrigation District (FID) was organized in 1920 as the successor to the privately owned Fresno Canal and Land Company in accordance with the Irrigation District Law of the California Water Code. FID has a service area of approximately 247,700 acres and diverts Kings River water into the 680-mile canal and pipeline distribution system for both agricultural and municipal water uses. FID has rights to store 120,000 AF in Pine Flat Reservoir and an additional 23,130 AF of storage in upstream reservoirs. This storage and Kings River water are used by FID to deliver an average annual supply of approximately 450,000 AF. FID obtains most of its surface water from the Kings River but also has a contract with the United States Bureau of Reclamation (USBR or Reclamation) for 75,000 AF of Class 2 water from the Friant Division of the CVP. The City of Fresno and FID have collaborative agreements that enable the delivery of the City's 60,000 AF of Class 1 water for beneficial uses, such as groundwater recharge and water treatment for potable uses. Within the District, private agricultural wells supplement surface water deliveries in dry years.

Within FID there are about 6,200 acres of separately annexed lands generally found in the northeast portion of the district. These are called FID Annexed Lands. These lands were annexed under the conditions that they are eligible for CVP Friant Division water but not Kings River water. The CVP water is only available in relatively wet years, so these lands rely on groundwater most of the time.

Fresno Metropolitan Flood Control District

The Fresno Metropolitan Flood Control District (FMFCD) was founded in 1956 to provide flood control, local storm drainage management, water conservation, and recreational services in the Fresno-Clovis area. The district is located in the north-central portion of Fresno County between the San Joaquin and Kings Rivers. FMFCD is authorized to control stormwater within the urban area and the rural foothill watersheds known as the Fresno County Stream Group, covering approximately 400 square miles (256,000 acres). About 270 square miles (172,800) of the service area lies within the area covered by North Kings GSA.

FMFCD's programs are closely integrated and coordinated with FID and the Cities of Fresno and Clovis to provide efficient, comprehensive services. FMFCD does not pump groundwater, deliver or use any water supply, but it recharges stormwater and allows other agencies to utilize its basins for groundwater recharge. Most retention pond facilities in FMFCD are designed for flood control, groundwater recharge, and recreational purposes.

Garfield Water District

The Garfield Water District (Garfield WD) was formed in 1956 to provide irrigation water to land within its boundaries. Garfield WD is located approximately one mile north of the City of Clovis in Fresno County. The District is approximately 1,809 acres and serves 55 landowners. Garfield WD delivers up to 3,500 acre-feet of Class 1 surface water from the Friant-Kern Canal. Private wells are also used to meet water demands. The District has a water demand of approximately 3,000 AF/year.

International Water District

International Water District (International WD) was formed to provide irrigation water for agricultural purposes to one family-owned farm. International WD is located east of the City of Clovis and its service area covers approximately 741 acres. The District does not have any infrastructure and all water acquired by the District is conveyed through the landowner's private facilities. The District has a contract for 1,200 AF of Class 1 CVP water, which is supplemented with private groundwater wells. The agency has a water demand of approximately 1,700 AF/year.

Malaga County Water District

The Malaga County Water District (Malaga CWD) was formed in 1958 to provide water, sewer, solid waste disposal, and parks and recreational services. Malaga CWD is located at the southern edge of the City of Fresno. The District is approximately 1,424 acres and serves a population of about 1,300 people. Malaga CWD has three active groundwater wells and four inactive wells and has a demand of approximately 1,500 AFY. Malaga CWD also has a wastewater treatment plant and ponds that are used to percolate the treated effluent.

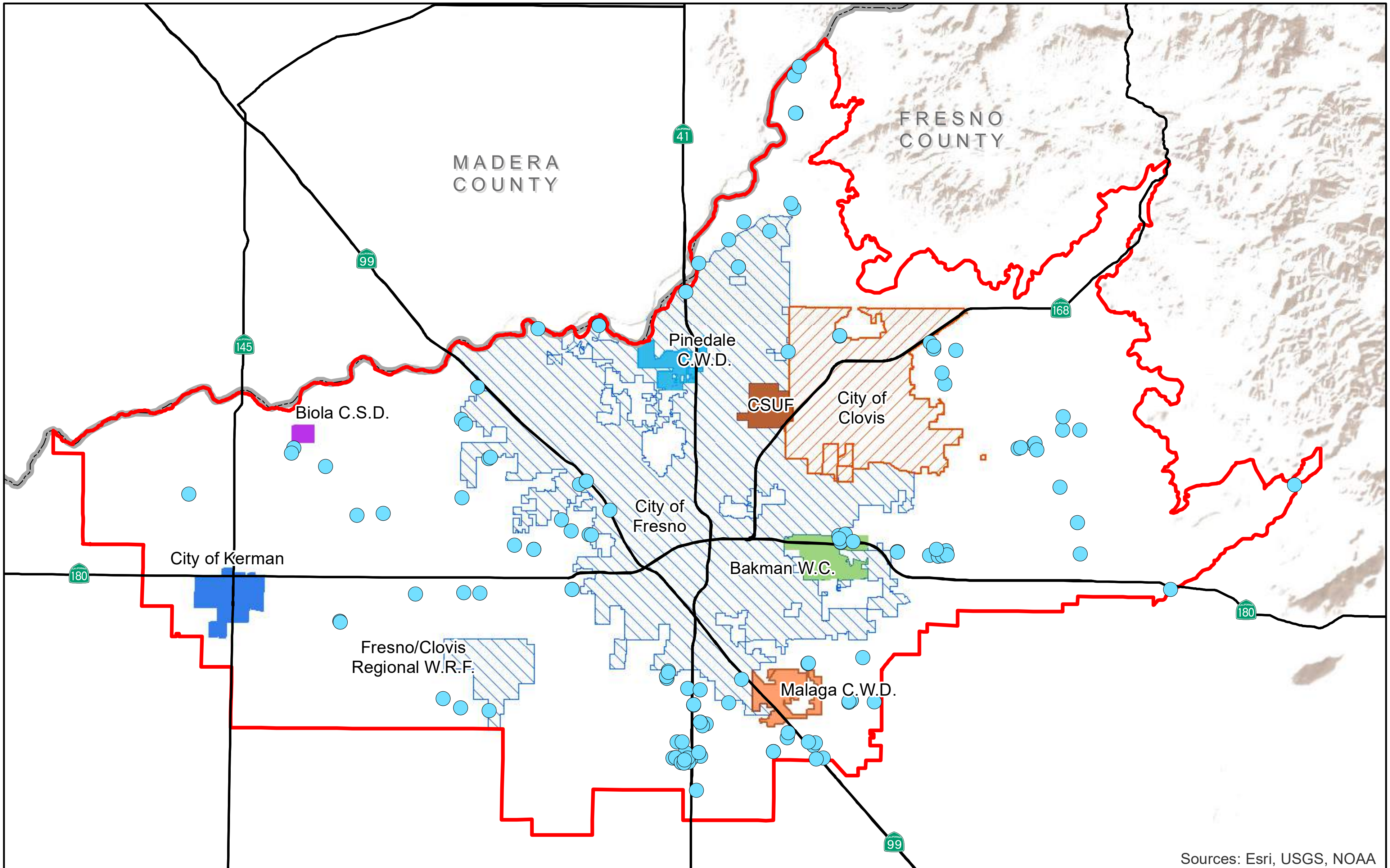
Malaga CWD is composed of a small residential community (about 230 single family residences) that is surrounded by commercial and industrial activity. Approximately 60% of the District's water demand is for commercial and industrial purposes. The groundwater that Malaga CWD delivers from its 900 feet deep wells is supplied to all customers types.

Pinedale County Water District

The Pinedale County Water District (Pinedale CWD) was formed in 1954 and provides water, wastewater conveyance, and solid waste services. Pinedale CWD is located within the City of Fresno north of Herndon Avenue and west of Highway 41. The District is about 886 acres and serves a population of approximately 14,000 to 16,000 people. Pinedale CWD has five wells to provide water to the District customers and has a demand of approximately 2,500 AF/year.

Schools Districts and Other Community Water Systems

Many schools in the NKGSA area have their own wells and operate their own water system. Some schools are connected to local municipal water systems. **Figure 2-5** is a map of the location of the public potable systems outside of the NKGSA member and participating agencies.



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Legend

- North Kings GSA
- County
- Potable Public Water Sources

North Kings GSA

Potable Public Water Sources
Non-Participating Agencies

Figure 2-5

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2.2 Water Resources Monitoring and Management Programs

2.2.1 Monitoring and Management Programs

Regulation Requirements:

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

Following are discussions of several monitoring and water management programs in the NKGSA. More details on monitoring can be found in Chapter 5 – Monitoring Network.

Groundwater Level Monitoring

All of the agencies within the NKGSA that pump groundwater perform periodic groundwater level monitoring. FID developed a groundwater-monitoring program in 1920 to quantify changes in groundwater depth within the District. FID currently collects groundwater levels twice per year and gathers data from other agencies including City of Fresno, City of Clovis, Malaga CWD, Bakman, Pinedale CWD, City of Kerman, as well as agencies adjacent to the District. Fresno County collects data from wells located within its CSAs and WWDs. Most of the agencies within the NKGSA were a part of the Fresno Area Regional Groundwater Management group that adopted a Groundwater Management Plan for the region. This group prepares Annual Groundwater Reports including groundwater contour maps and estimated change in groundwater storage. To comply with SGMA, this program is being expanded to include groundwater levels from all of the member entities with continued preparation of an annual groundwater report. The Fresno Area Regional Groundwater Management Group has ceased to exist and is being replaced by the NKGSA.

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

Groundwater Extraction Monitoring

Most water agency wells are metered, and the pumping volume is recorded. On the other hand, most private wells are not metered, and the volume pumped is not known. In these cases, the volume pumped must be estimated based on typical demands, such as per capita water use or crop water demands per acre. This results in groundwater extraction estimates with varying levels of accuracy. Potential future groundwater metering policies are discussed in Section 6 under Management Actions.

Groundwater Quality Monitoring

Groundwater quality is monitored at municipal wells and other areas of specific concern. There are several contaminant plumes in the Plan area that are being monitored. The domestic water purveyors perform routine water quality testing as required by the State Water Resources Control Board - Division of Drinking Water (DDW). The requirements for testing are based on the public water system classification and size. Additional testing may be done if a site has specific constituents of concern that need to be monitored. Some limited data is available in smaller communities that includes clusters of domestic wells.

Land Surface Subsidence Monitoring

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

Surface Water Monitoring

Surface water in the area is monitored by numerous agencies. FID maintains daily surface water diversion records and compares surface water diversions within its boundary to groundwater level changes. The Cities of Fresno and Clovis monitor surface water deliveries to their water treatment facilities. Kings River Water Association (KRWA) monitors surface water in the Kings River and its watershed including snowpack, reservoir stage, reservoir inflow and outflow, Kings River flows, and Kings River diversions. The Friant Water Authority monitors San Joaquin River water delivered through the Friant-Kern Canal. Garfield WD and International WD monitor surface waters in their own districts.

Irrigated Lands Regulatory Program

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

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

GSP Monitoring and Management Plans

The individual agencies located within the Plan area will be responsible for collecting data for any monitoring or management plan for which they are already collecting data. As needed, the agencies will report the water quality and water supply data to the NKGSA. The monitoring program is described later in this GSP in Section 5 – Monitoring Network.

2.2.2 Impacts to Operational Flexibility

Regulation Requirements:

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

Several existing water management constraints impact operational flexibility and water operations. These programs are illustrated in **Figure 2-6** below, followed by a description of each program and possible measures to adapt to them.

Figure 2-6 Impacts to Operational Flexibility

Contaminant Plumes

Groundwater within the Plan area is generally of good quality, however, some contaminant plumes present specific problems because they pose health risks or do not meet drinking water standards. Most of the groundwater contaminants in the Plan area are being addressed by responsible parties through remediation, wellhead treatment, or avoidance. In some small communities, many domestic wells exceed water quality standards and residents continue to use the water due to lack of alternatives.

Some of the primary constituents of concern include: Dibromo-Chloropropane (DBCP), Ethylene-Dibromide (EDB), 1,2,3-Trichloropropane (TCP), Methyl Tert-butyl Ether (MTBE), landfill leachate, uranium, arsenic, chrome-6, nitrates, and petroleum hydrocarbons.

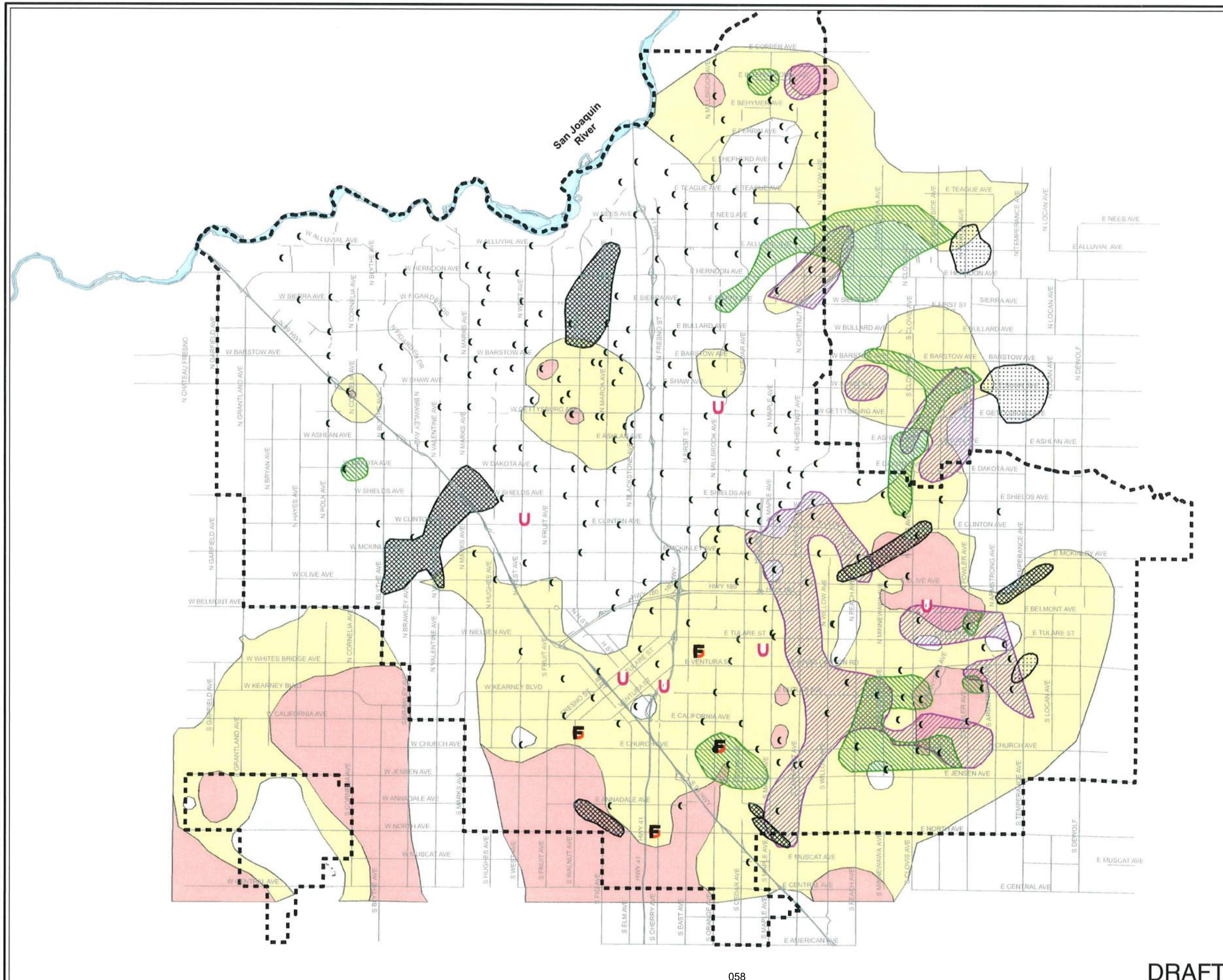
Figure 2-7 is the most recently available map of major contaminant plumes in the Fresno Metropolitan area. Similar maps for the rest of the NKGSA area are not known to exist. These plumes cause several impacts to operational flexibility. In certain areas, the following problems are encountered:

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

The existing plumes must be carefully managed to prevent migration. Some are being treated through remediation projects which often take years or decades to complete. Maintaining a current map of known plumes is important for the region.

City of Fresno Metropolitan Water Resources Management Plan Update

REGIONAL GROUNDWATER CONTAMINATION



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Scale in Miles

NOTES:

LEGEND:

- City of Fresno Sphere of Influence
- Active City Wells
- Superfund Site (Old)
- Gasoline Case (Old)
- EDB Plume (Old)
- Point Source Plume (Old)
- DBCP Plume (> 0.1 ppb)
- TCP Plume (> 0.01 ppb)

Nitrates

- Nitrate > 20 mg/L
- Nitrate > 40 mg/L

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Flood Control Operational Limitations

The Fresno Metropolitan Flood Control District provides flood control and urban drainage throughout much of the Plan area. Refer to **Figure 2-2** for a map showing their jurisdictional area. The District's urban drainage system consists of storm drains, detention and retention basins, and pump stations. The system is designed to retain and infiltrate as much stormwater and urban runoff as possible. The District's flood control program consists of a system of rural facilities that control the flows from several low-elevation, foothill streams between the San Joaquin and Kings Rivers. These streams are collectively referred to as the Fresno County Stream Group (or Eastside Stream Group). When feasible, water is also stored in these facilities and released to maximize recharge in downstream urban basins.

The District is responsible for operating the flood control system, but it must follow US Army Corps of Engineers (USACE) operational procedures. These include limits on how much water can be stored and how quickly it must be drawn down at the primary rural reservoirs in the system. Floodwaters often arrive during short time periods, and the ability to store them longer could allow FMFCD to slowly release water to groundwater recharge and stormwater basins, and even to water treatment plants, rather than release it to canals and streams that flow out of the area. USACE has been hesitant to allow changes to the operational plan for the system.

FMFCD and several local agencies are interested in evaluating different operational scenarios and facility improvements that could improve the beneficial use of stormwater with operational changes. Modifying the operations of eastside reservoirs would require review and approval from the USACE and would be subject to operational analysis evaluation and some anticipated facility improvements.

Kings River Fisheries Program

A partnership has been forged between Kings River Conservation District, the Kings River Water Association, and the California Department of Fish and Game to create the Kings River Fisheries Management Program (Program). The Program includes numerous measures to benefit the Kings River fisheries, including year-round flows, improved temperature control, and additional monitoring. However, this comes at the expense of some operational flexibility for Kings River water users. Within the NKGSA area, FID delivers Kings River water for irrigation, recharge, and potable use via the cities of Clovis' and Fresno's surface water treatment facilities. The Kings River provides the majority of the surface water used in the NKGSA area.

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

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

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

San Joaquin River Restoration Program

In 2006, after an 18-year court battle, the Central Valley Project (CVP), Friant Division contractors entered into the San Joaquin River Restoration (SJRR) settlement agreement. The agreement increases flows to the River to benefit fisheries resulting in a significant reduction in water deliveries to the Friant Contractors. Within the NKGSA area, Fresno ID, City of Fresno, Garfield WD, International WD and Fresno County have contracts for San Joaquin River water.

Restoration water supply impacts to the Friant contractors were estimated by Provost & Pritchard (2009). **Table 2-3** summarizes the estimated impacts to the NKGSA members. The values include average-annual impacts to Class 1, Class 2, and Section 215 floodwater deliveries.

Table 2-3 Estimated Reduction in Water Deliveries

Agency	Estimated Annual Reduction in Deliveries
Fresno Irrigation District	9,000 AF
City of Fresno	3,600 AF
Garfield Water District	200 AF
International Water District	100 AF
Total	12,900 AF

Notes: Fresno County has a CVP contract for 150 AF and impacts are expected to be negligible

The SJRR project is currently in the development phase. The San Joaquin River Restoration Program Revised Framework for Implementation 2015 (USBR, 2015) estimates full restoration flows will begin between 2025 and 2029. Hence, the impacts in **Table 2-3** are not expected to be fully realized until 2025 or later.

Several mitigation programs were established as part of the restoration settlement. These are intended to partially reduce the water supply impacts from the river restoration, and include the following:

1. **Recirculated Water**: Some restoration flows could be recaptured in the Lower San Joaquin River or Delta for use by the Friant Contractors. These waters will either be sold, exchanged for other water supplies, or, when feasible, delivered directly back to some Friant contractors.
2. **Part 3 Water (formerly Title 3 or T3 water)**: Part 3 water is generated out of the facilities and programs built to increase groundwater recharge and recovery using the $50 million authorized as part of Title III of the San Joaquin River Restoration Act.
3. **16(b) Water (also known as $10 water)**: This program allows the impacted parties to buy floodwater at $10/AF to the extent they have been impacted. This is less than the cost of purchasing other floodwaters from the San Joaquin River.
4. **Unreleased Restoration Flows**: Designated restoration flows that are not used will be sold to the Friant contractors, who can use them directly for irrigation or domestic use. Restoration flows may not be used for a variety of reasons, including operational limitations, flood control releases, facility maintenance and construction, etc.

The Friant contractors have no control over the implementation of the San Joaquin River Restoration. However, they can utilize the mitigation programs as much as feasible. These programs will only partially compensate for the water losses, so Friant contractors can attempt to develop new water supplies through water transfers, recharge, recycling, reuse, and conservation to make up for the reduced water deliveries. The construction of new storage projects, including the Temperance Flat reservoir on the Upper San Joaquin River, can help to mitigate the impacts of the river restoration and restore some operational flexibility.

2.2.3 Conjunctive Use Programs

Regulation Requirements:

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

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

Conjunctive use can include using surface water when it is available and relying on groundwater when surface water supplies run out in the late summer or are limited during droughts. Conjunctive use also includes cyclic storage where surplus surface waters are recharged during wet years and groundwater is pumped during dry periods. Conjunctive use should also include a robust monitoring program to help prevent negative impacts and verify the quantity of water in storage.

Both the City of Clovis and City of Fresno have surface water treatment plants to maximize the use of available surface water.

Surface water is also used for groundwater banking (recharge) in areas that allow surface water to be stored in the aquifer for use at a later date. FID has four groundwater banking facilities including Boswell, Waldron, Empire, and Lambrecht. Typically, 10% of the banked water is left in the aquifer to account for losses and to help mitigate local impacts due to operations.

Several agencies within the NKGSA have extensive groundwater recharge programs to help offset groundwater pumping. Part of these efforts involve using the FID's system to deliver portions of the Fresno and Clovis water allocations to certain FMFCD basins for recharge during the summer when the basins are not needed to control urban storm runoff. Fresno and Clovis both also own and operate significant recharge facilities to which a portion of each cities' water allocations is also delivered using the FID system. This program also contains elements designed to protect the quality of groundwater in the area. Bakman's surface water allocations are utilized for groundwater recharge through cooperation with other agencies in accordance with FID and FMFCD Board Ratified Agreements. Other agencies such as the City of Kerman and Malaga also replenish the groundwater through stormwater, recycled water, and wastewater effluent ponds.

Outflows to other GSAs, basins, or sub-basins should not be included as inflow in GSPs for those GSAs, basins, or sub-basins to the extent water users in the NKGSA intend to control, distribute, store, spread, sink, treat, purify, recapture and salvage any such water including but not limited to groundwater, surface water, sewage and storm waters, imported or native return flows, for the beneficial use or uses of the NKGSA's inhabitants or the owners of rights to water in the NKGSA.

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 consists of a statement of development policies and includes diagrams and text setting forth objectives, principles, standards, and plan proposals. It is a comprehensive long-term plan for the physical development of the county or city. In this sense, it is a blueprint for development.

The General Plan must contain eight (8) state-mandated elements. It may also contain any other elements that the legislative body of the county or city wishes to adopt. The eight (8) mandated elements are: Land Use, Open Space, Conservation, Housing, Circulation, Noise, Safety, 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. The following agencies within the Plan area have general plans:

- City of Clovis - 2014 General Plan
- City of Fresno - 2014 General Plan
- City of Kerman - 2007 General Plan
- Fresno County - 2000 General Plan

2.3.2 Impact of GSP on Water Demands

Regulation Requirements:

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

All of the General Plans in the Plan area were adopted prior to the development of the NKGSA and this GSP, and the General Plans did not consider the impacts of this Plan's implementation. The Fresno, Clovis, and Kerman land use plans make assumptions for urban development.

The assumed land use changes and growth rate are addressed in the Urban Water Management Plans for each of the cities. This GSP used each agency's land use change assumptions and associated water demand in the water budget, described later in this GSP. The growth projections were used in determining the future water budget and targeted amount of mitigation required for each agency. Each agency within the NKGSA is required to mitigate for its estimated groundwater impacts based on, among other factors, land use changes and associated water demands. A description of this process is included in Section 3.3.

As explained in **Chapter 6** – Projects and Management Actions, the NKGSA will initially focus on project development for water supply augmentation to meet groundwater sustainability goals.

However, if project development is not sufficient to achieve the sustainability required to meet the interim milestones, then management actions or programs will need to be employed. Some of the management actions that may be considered will focus on reducing water demand.

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.

In general, all future land use changes will need to consider the net groundwater impact to the NKGSA. Planned future updates to agency General Plans should consider this GSP and the responsibility of each member and participating agency. A discussion of some potential management actions, including policy changes are described in Section 6.3.

As mentioned earlier (Section 2.1.4), there are four General Plans within the Plan area. The General Plan sections that cover water supply are summarized below. As noted, all of these plans were developed prior to the development of the GSP.

<u>City of Clovis General Plan</u>
The Public Facilities and Services Element of the Clovis General Plan discuss various topics including water supply. The primary water supply goal in this Plan is for reliable and cost-effective infrastructure systems that permit the city to sustainably manage its diverse water resources and needs. The relevant policies are listed below:

- PF Policy 1.2 - Water Supply. Require that new development demonstrate contractual and actual sustainable water supplies adequate for the new development's demands.
- PF Policy 1.3 - Annexation. Prior to annexation, the city must find that adequate water supply and service and wastewater treatment and disposal capacity can be provided for the proposed annexation. Existing water supplies must remain with the land and be transferred to the City upon annexation approval.
- PF Policy 1.5 - Recycled water. Use recycled water to reduce the demands for new water supplies. Support the expansion of recycled water infrastructure throughout Clovis and require new development to install recycled water infrastructure where feasible.
- PF Policy 1.7 - Groundwater. Stabilize groundwater levels by requiring that new development water demands not exceed the sustainable groundwater supply.

<u>City of Fresno General Plan</u>
Public Utilities and Services, Chapter 6 of the Fresno General Plan, discusses the planning, provision, and maintenance of water, wastewater, solid waste systems, and other facilities operated by the City. The objective of Section 6.4 is to "*manage and develop the City's water facilities on a strategic timeline basis that recognizes the long life cycle of the assets, and the duration of the resources, to ensure a safe, economical, and reliable water supply for existing customers and planned urban development and economic diversification*." The relevant policies are listed below:

- PU-7-c- Wastewater Recycling. Pursue the development of a recycled water system and the expansion of beneficial wastewater recycling opportunities, including a timely technical, practicable, and institutional evaluation of treatment, facility siting, and water exchange elements.
- PU-8-b- Water Supply. Prepare for provision of increased potable water capacity (including surface water treatment capacity) in a timely manner to facilitate planned urban development consistent with the General Plan.
- PU-8-f- Water Quality. Continue to evaluate and implement measures determined to be appropriate and consistent with water system policies, including prioritizing the use of groundwater, installing wellhead treatment facilities, construction of above-ground storage and surface water treatment facilities, and enhancing transmission grid mains to promote adequate water quality and quantity.
- PU-8-g- Review Project Impact on Supply. Mitigate the effects of development and capital improvement projects on the long-range water budget to ensure an adequate water supply for current and future uses.

<u>City of Kerman General Plan</u>
Chapter 4 of the Kerman General Plan (conservation, open space, parks and recreation) discusses the conservation, development and utilization of natural resources, including water, forests, soils, rivers and other waters, wildlife, and other natural resources. The relevant policies are listed below:

- Policy 3 (page 4-18) - Allow for adequate groundwater recharge by developing storm ponding and retention basins where feasible. In some areas these ponds or basins can be incorporated into a recreational area or used as wildlife habitat area.
- Policy 4 (page 4-19) - The City should develop a secondary water source system ("purple pipe system") that can be incorporated into new development in order to use less potable water for the irrigation of parks, schools, and public landscaping.

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

- Policy PF-C.12 - The County shall approve new development only if an adequate sustainable water supply to serve such development is demonstrated.
- Policy PF-C.13 - In those areas identified as having severe groundwater level declines or limited groundwater availability, the County shall limit development to uses that do not have high water usage or that can be served by a surface water supply.
- Policy PF-C.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.

Implementation of the GSP will not be inconsistent with the policies described above. In fact, several of the plans reference a requirement for sustainable water supplies.

2.3.4 Permitting New or Replacement Wells

Regulation Requirements:

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

The following Fresno County General Plan policies (2000) pertain to the process of permitting new or replacement wells in Fresno County:

- Policy LU-E.6 The County shall allow planned residential developments consisting of a minimum two (2) acre lot in areas designated for rural residential development subject specified conditions.
- Policy LU-E.8 The County shall not allow further parcelization of uncommitted Rural Residential areas lying northeast of the Enterprise Canal due to potential groundwater supply problems, subject to rezoning following specific criteria.
- Policy PF-C.20 The County shall not permit new private water wells within areas served by a public water system. Additionally, SB1263 prohibits the formation of new public water systems where there is an existing public entity within 3 miles that will agree to provide water service.
- Policy PF-C.21 The County shall promote the use of surface water for agricultural use to reduce groundwater table reductions.

The following City of Fresno municipal codes pertain to permitting well drilling activities within the City:

- Fresno Municipal Code, Chapter 6 – Municipal Services and Utilities, Article 4 – Wells:
  - Section 6-402 – Well Drilling Prohibition, prohibits the drilling of wells, except for specific purposes, within the City of Fresno.
  - Section 6403 – Permits Required, stipulates a City issued permit is required for wells that are allowed to be constructed within the City.
  - City of Fresno Standard Drawings, Std Dwg. W-45, addresses Well Destruction Requirements

The NKGSA may consider a process for permitting new or replacement wells that is consistent with the county General Plans as described in Section 6.3.2 - Well Head Requirements Management Actions. 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 and destruction 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 to include future member agency policies. 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.

Malaga CWD has special legislation for its groundwater supply that allows the District to protect its groundwater resources. As such, the District requires Fresno County Public Health to route new well permits through Malaga CWD for pre-approval. New well permits are generally not approved except for special circumstances. Additionally, the City of Clovis has well ordinances and in rare circumstances will permit the drilling of new wells.

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.

The relevant land use plans located outside the North Kings GSA include the following:

Fowler General Plan

The City of Fowler is within the South Kings GSA, however the sphere of influence does extend into the NKGSA. Land Use, Section 4 of the Fowler General Plan, discusses the land use, zoning, open space, public, and institutional land use. The relevant policies are listed below:

- Open Space for Managed Resource Production, Policy 4 - Expand programs to recharge the groundwater supply.
- Open Space for Managed Resource Production, Policy 5 - Water Conservation programs shall be continued and enhanced.
- Goal 5-6, Policy 2- Encourage the use of drought-tolerant native plants and the use of recycled water for roadway landscaping.

City of Sanger

The City of Sanger is within the South Kings GSA; however the sphere of influence does extend into the NKGSA. Conservation, Section 7 of the Sanger General Plan, discusses hydrology and water quality, wastewater and storm drainage, natural water bodies, geology and soils, vegetation and wildlife, and cultural resources. The goal of hydrology and water quality is to manage the City's water resources to provide for urban uses while protecting the environment. The relevant policies are listed below:

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

Madera County

Public Facilities and Services, Section 3 of the Madera County General Plan, discusses water supplies, water quality, and groundwater use. The goal for water supply and delivery is to ensure the availability of an adequate and safe water supply and the maintenance of high quality water in water bodies and aquifers used as sources of domestic and agricultural water supply. The goal of Water Resources, Section 5C, is to protect and enhance the natural qualities of Madera County's streams, creeks, and groundwater. The relevant polices are listed below:

- Policy 3.C.1 - The County shall approve new development only if an adequate water supply to serve such development is demonstrated.

- Policy 3.C.7- The County shall promote the use of reclaimed wastewater to offset the demand for new water supplies.
- Policy 3.C.8 - The County shall support opportunities for groundwater users in problem areas to convert to surface water supplies.
- Policy 3.C.12- The County shall support programs for the agricultural re-use of reclaimed water.
- Policy 5.C.8 - The County shall protect groundwater resources from contamination and further overdraft by encouraging water conservation efforts and supporting the use of surface water for urban and agricultural uses whenever feasible.

None of the aforementioned policies are expected to impede the ability of the NKGSA to achieve sustainability. Several of the policies will support the goal of sustainability. Additional policies in the areas will likely be needed to ensure compliance with SGMA.

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.

Following are discussions on several groundwater management topics including:

- Saline water intrusion
- Wellhead protection
- Migration of contaminated groundwater
- Well abandonment/well destruction program
- Replenishment of groundwater extractions
- Well construction policies
- Groundwater projects
- Efficient water management practices
- Land use planning
- Impacts to groundwater dependent ecosystems

Most of these topics were previously required in local Groundwater Management Plans. These topics are relevant to protecting groundwater quality and preserving groundwater levels.

2.4.1 Saline Water Intrusion

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

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

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

2.4.2 Wellhead Protection

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

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

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

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

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

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

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

2.4.3 Migration of Contaminated Groundwater

Groundwater contamination can be human induced or caused by naturally occurring processes and chemicals. Sources of groundwater contamination can include irrigation, dairies, pesticide applications, septic tanks, industrial sources, stormwater runoff, and disposal sites. Contamination can also spread through improperly constructed wells that provide a connection between two aquifers or improperly abandoned/destroyed wells that provide a direct conduit of contaminants to aquifers. Groundwater within the NKGSA Area is generally of excellent 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 voluminous, particularly for those plumes that have been assessed and are in various stages of remediation. Therefore, specific information on the plumes is not provided here. However, some of the main constituents of concern include nitrate, DBCP, TCP and gasoline. **Figure 2-7** is the most recently available map of major contaminant plumes in the Fresno Metropolitan area. These plumes either require remediation, require wellhead treatment, or limit which areas can be pumped or recharged so the plumes do not migrate.

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

<u>California Water Resources Control Board</u>
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.

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

Groundwater Ambient Monitoring and Assessment Program

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

2.4.4 Well Abandonment/Well Destruction Program

Well abandonment generally includes properly capping and locking a well. 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. The City of Fresno and Clovis both require that wells no longer being used in their City limits be properly destroyed.

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

2.4.5 Replenishment of Groundwater Extractions

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

As noted, there is significant groundwater recharge activity within the NKGSA. For more information, refer to Conjunctive Use Programs Section 2.2.3. Refer to Section 3.3 - Water Budget Information 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 of the member agencies follow state standards (DWR Bulletin 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 assure 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.

The municipal water agencies do not allow construction of private wells in their water service boundary, except under very limited circumstances. The purpose of these regulations is to keep the water system under central control by the municipal water agency. Outside of these areas, 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. Well construction policies intended to ensure proper wellhead protection are discussed in Section 2.4.2 – Wellhead Protection.

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

2.4.7 Groundwater Projects

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

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

2.4.8 Efficient Water Management Practices

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

2.4.9 Relationships with State and Federal Agencies

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

Kings River Water. The Kings River provides the majority of the surface water used in the area. Kings River water is impounded by Pine Flat Dam, which is owned and operated by the USACE. The water rights permits were obtained from the State Water Resources Control Board (SWRCB), although allocation and management of water is largely handled by the Kings River Water Association (KRWA). As needed, the member agencies work with the USACE and SWRCB to oversee and manage their Kings River water. The local agencies also developed and continue to implement the Kings River Fisheries Program in partnership with the California Department of Fish and Wildlife (CDFW).

San Joaquin River Water. Several member agencies receive San Joaquin River water from the Friant Division of the Central Valley Project. The Friant Dam is owned and operated by USBR. The USBR is also the lead agency for the San Joaquin River Restoration, which has resulted in delivery curtailments to Friant contractors. The member agencies communicate often with USBR staff on water deliveries, water allocations, progress on the San Joaquin River Restoration Program (SJRRP), and the Water Management Program for the SJRRP that is intended to help mitigate water losses to Friant contractors.

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

2.4.10 Land Use Planning

Some of the member agencies have direct land use planning authority while others do not. However, all of the member agencies have an interest in land use planning policies and how it will impact their continued development and water supplies. **Figure 2-3** is a map showing land use in the NKGSA 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. 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 (GDEs) are defined under SGMA as "*ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface*" (23 CCR § 351(m)). The Kings Subbasin coordinated effort conducted a GDE evaluation based on depth to water and proximity to surface water bodies within the subbasin. See **Section 3.2** for additional information on methodology and figures depicting the possible GDEs in the Kings Subbasin.

2.5 Notice and Communication

2.5.1 Beneficial Uses and Users

Regulation Requirements:

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

Beneficial uses of groundwater within North Kings GSA primarily include agricultural water supply; industrial process supply, and municipal and domestic water supply. Beneficial users of groundwater were identified and engaged by North Kings GSA based on the place-based and interest-based categories described in SGMA and codified in Water Code §10723.2:

- Citizens Groups
- General Public
- Disadvantaged Communities[1]
- Agricultural Well Owners
- Domestic Well Owners
- Commercial and Industrial Self-Supplied
- Private and Public Water Purveyors
- Surface Water Users[2]
- Governmental and Land Use Agencies
- Tribal Governments and Communities
- Environmental and Ecosystem Interests
- Remediation and Groundwater Cleanup

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

Agricultural Users

Agriculture represents 49 percent of the North King GSA's area. This includes agricultural and rangeland land use (see **Table 2-1** Land Use in North Kings GSA). Representatives from the agricultural community serve on North Kings GSA committees and subcommittees. In addition, agricultural users are represented by member agencies on the North Kings GSA Board of Directors.

[1] Includes those served by private domestic wells or small community water systems (Water Code §10723.2(i)
[2] If there is a hydrologic connection between surface and groundwater bodies (Water Code §10723.2(g))

Other types of parties representing agricultural users include county farm bureaus, agricultural-based interest organizations, and individual growers and ranchers.

Private Domestic Well Owners

Private domestic well owners within the North Kings GSA are located in rural residential regions within the unincorporated area of Fresno County, and in agricultural water districts. These areas cover about 65% of the GSA.

Municipal and Industrial Well Operators

Municipal and industrial (M&I) water providers within the North Kings GSA account for 31 percent of the land area and are a blend of local public agencies and a California Public Utilities Commission (CPUC) regulated water utility: Bakman Water Company. Local public agencies representing their M&I customers as a member agency are the cities of Clovis, Fresno and Kerman, and Biola Community Services District. Bakman Water Company was invited to participate as a member agency through execution of a Participation Agreement. The remaining M&I water purveyors in the area are Malaga County Water District (CWD) and Pinedale County Water District. Malaga and Pinedale CWD's were part of the development and formation process of the North Kings GSA and its Joint Powers Agreement (JPA), but their respective governing bodies elected not to sign the JPA. Both agencies have remained active participants during GSP development and are subject to decisions made by the North Kings GSA.

Other Public Water Systems

Other public water systems within the North Kings GSA include 10 County water agencies that deliver groundwater for domestic and landscape uses. These CSAs are managed and represented on the NKGSA by the County of Fresno. These communities are (See **Figure 2-2**):

- CSA 10 – Cumorah Knolls
- CSA 10A – Mansionette Estates
- CSA 14 – Belmont Manor
- CSA 18 – Friant
- CSA 39AB – Beran Way/Prospect Way
- WWD 42 – DeWolf/Alluvial
- CSA 44C – Tangueray Annexation or "Riverview Ranch"
- CSA 44D – Monte Verdi
- CSA 47 – Quail Lakes
- W05 – Free Water County

Local Land Use Planning Agencies

Land use planning agencies in North Kings GSA include the County of Fresno and Cities of Fresno, Clovis, and Kerman. All of these agencies have an opportunity to serve on the Board of Directors. Parties to these agencies included city staff, planning commissions, county board of supervisors, and city councils.

California Native American Tribes

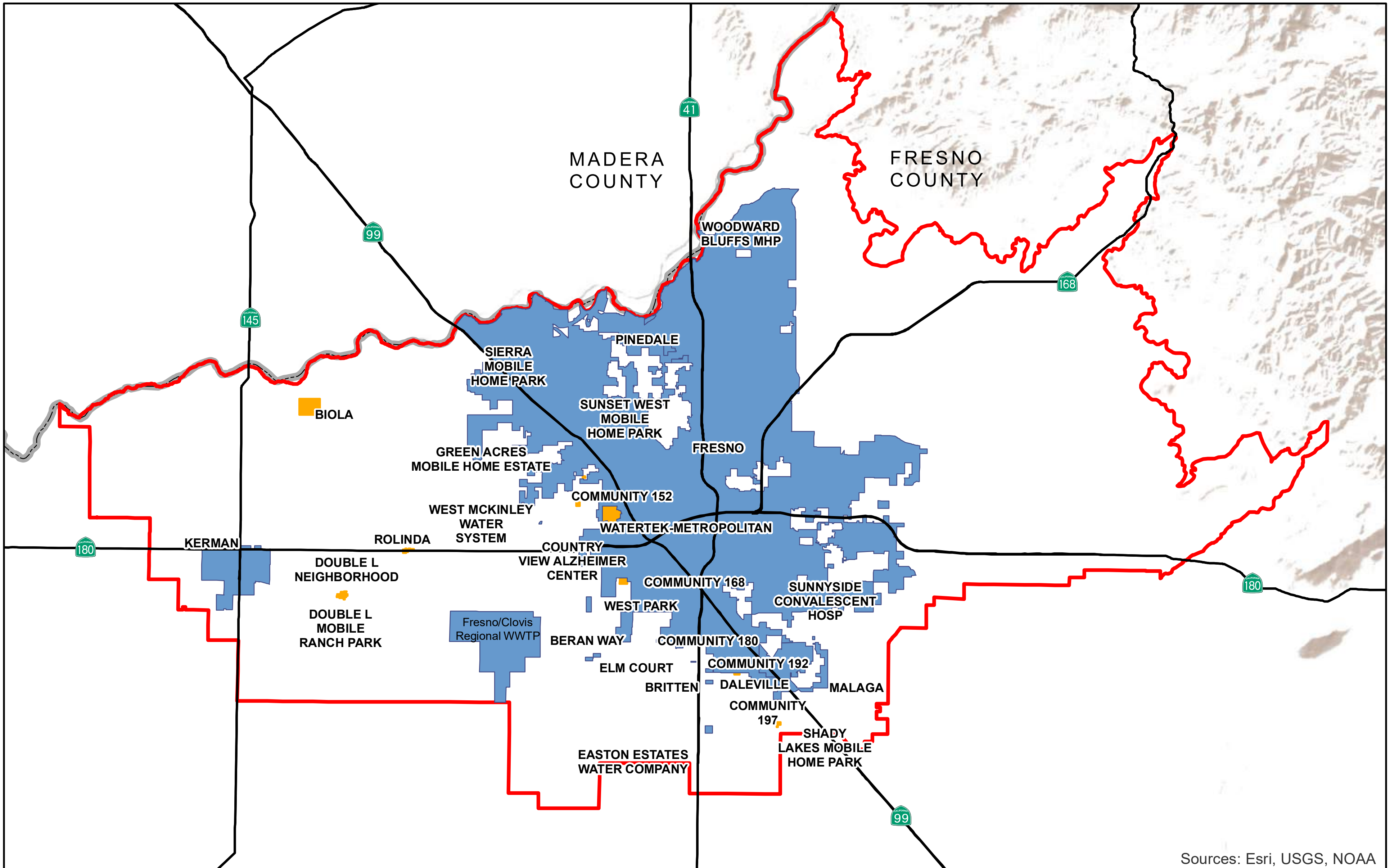
As part of the North King GSA's formation process, the NKGSA submitted a Sacred Lands and Tribal Contact List request to the California Native American Heritage Commission (NAHC). The NAHC's Sept. 9, 2016, reply indicated that no Native American Tribe had filed a Sacred Land concern for an area within North Kings GSA's jurisdictional boundary. The NAHC letter included several tribes with a potential traditional or cultural interest in the geographic area. Engagement with these parties would occur during implementation of projects subject to CEQA.

Disadvantaged Communities

As shown in **Figure 2-8** Disadvantaged and Severely Disadvantaged Communities in the North Kings GSA, much of the urban areas within North Kings GSA boundaries is designated as a disadvantaged community (DAC) based on American Community Survey Median Household Income data. These areas include the City of Kerman, City of Fresno, and the unincorporated communities of Biola, West Park, Calwa, Easton, Malaga, Pinedale, and Friant. Additionally, Bakman Water Company services an area defined as a Disadvantaged Community.

The NKGSA area includes seven DWR designated DACs (i.e., Fresno, Kerman, Biola, Calwa, Malaga, Mayfair, and West Park) reliant on groundwater for drinking water use, including several communities dependent on private wells, such as the community of Easton whose population is over 2,300 people. Other severely disadvantaged communities include Rolinda, Double L Neighborhood, Centerville, Britten, Daleville, and Communities 152, 168, 180 and 192. The NKGSA population is also diverse, including a significant non-English speaking population and an active Southeast Asian population including Hmong growers.

These communities have been directly or indirectly represented on the North Kings GSA Board of Directors by a member agency or by a representative of a disadvantaged community advocacy group. Such advocacy groups with active or periodic participation in the NKGSA include Self-Help Enterprises, Leadership Counsel for Justice and Accountability, and the Community Water Center.



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0 2 4 Miles

Legend

North Kings GSA

County

Disadvantaged Community*

DAC

SDAC

*Classification of Disadvantaged Communities are provided by Tulare-Kern IRWM Needs Assessment (2019)

North Kings GSA

Disadvantaged Communities

Figure 2-8

6/28/2019 : G:\North Kings GSA-2643\264317001-Groundwater Sustainability Plan\GIS\Map\DAC Review\NKGSA_DACs.mxd

Groundwater Elevation Monitoring and Reporting Entities

Groundwater elevation monitoring and reporting entities in the North Kings GSA is primarily led by Fresno Irrigation District as a continuation of the Fresno Area Regional Groundwater Management Group, an entity that developed and adopted a Groundwater Management Plan in 2006. Members of this group include nine public agencies and one private water company in the Fresno-Clovis Metropolitan Area. With the exception of International Water District, the members of this group include all North Kings GSA member agencies, Malaga County Water District, Pinedale County Water District, and Fresno Metropolitan Flood Control District.

2.5.1.1 Nature of Consultation

Notification and communication activities for development of this GSP were guided by the North Kings GSA Public Outreach Plan (**Appendix 2-A)**, a document authored by the North Kings GSA's Communication and Engagement Subcommittee in May 2018. The Public Outreach Plan served to identify notification and communication activities that would meet or exceed the requirements and intent of the State legislature in passage of SGMA.

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

- Group 1: *Collaborated (Inform + Consult + Collaborate)* – This group was closely engaged during the planning process through direct engagements aimed at sharing information and encouraging two-way communication. These types of engagements seek to gather information and work toward solutions to existing and emerging issues.
- Group 2: *Consulted (Inform + Consult)* – This group was engaged during planning through written informational materials and scheduled presentations, held by request of North Kings GSA. Attendees were invited to provide feedback to presented materials.
- Group 3: *Connected (Inform)* – This group was engaged during planning through written informational materials and prepared informational presentations, held upon request to the North Kings GSA.

Stakeholder groups and individuals were initially assigned to a group by the Communication and Engagement Subcommittee with the anticipation that each stakeholder's involvement would change based on consultation with stakeholders and GSP 's content needs. Engagement activities were tracked in a Community Engagement and Activities Database, consistent with DWR Emergency Regulations §354.10 (b) and 354.10 (d) and summarized below (see **Appendix 2-B**). A baseline element applied to engagements across all stakeholder groups was the need to establish awareness and raise understanding of North Kings GSA, SGMA, and content of the GSP. Specific outreach activities to parties representing beneficial users are included following sections.

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.

North Kings GSA was formed by a Joint Powers Agreement (JPA). The decision-making structure of the North Kings GSA is delivered through a hierarchical structure where subcommittees, committees and executive staff advise, and request direction from, the Board of Directors on important topics and issues. **Figure 2-9** North Kings GSA Management Structure provides the decision-making structure of North Kings GSA.

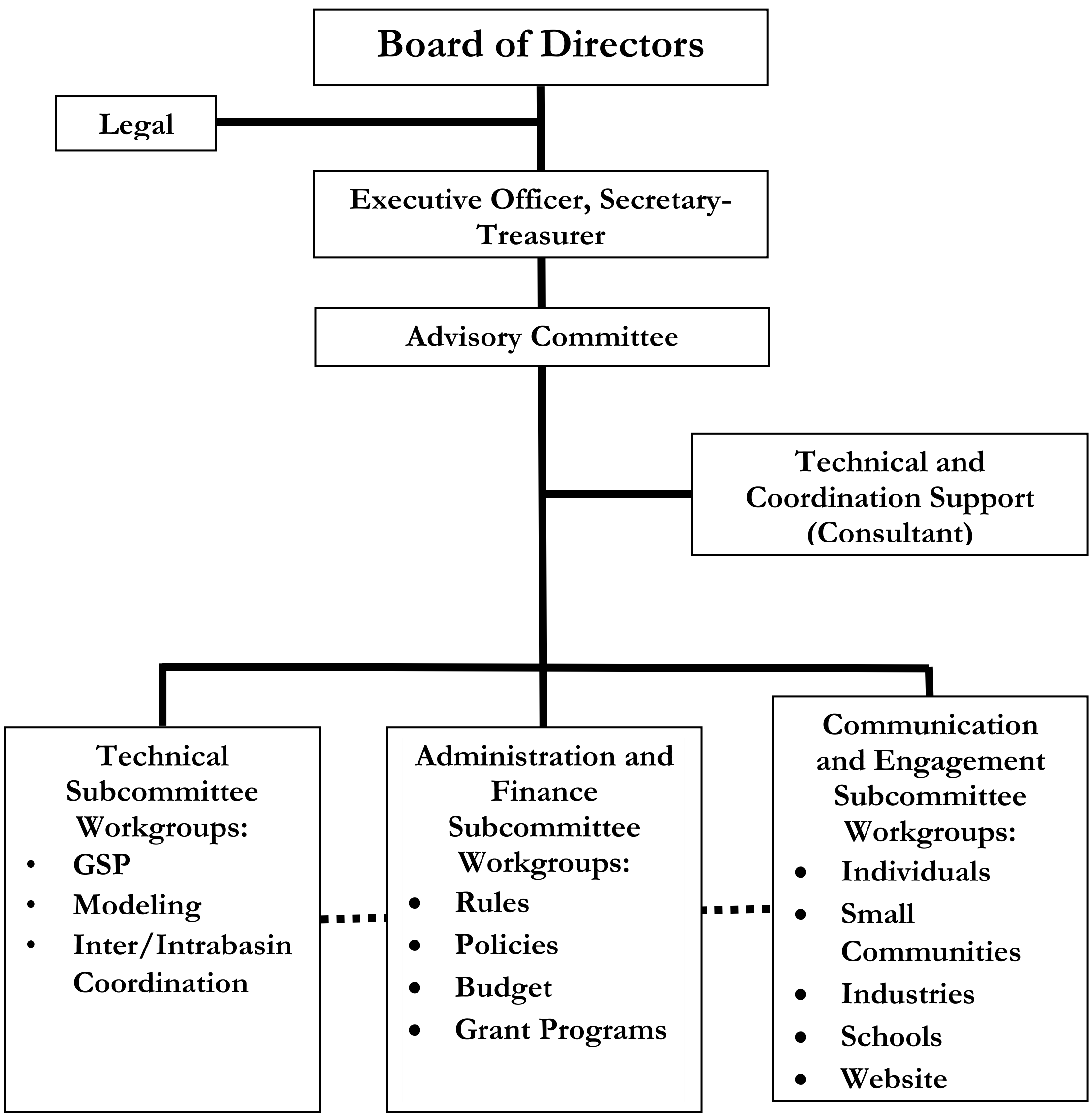


Figure 2-9 North Kings GSA Management Structure

The governing body of the JPA consists of a seven-member Board of Directors that includes Members, Contracting Entities, and Interested Parties as identified in the JPA. Directors are elected officials that have been appointed to serve on the NKGSA's Board of Directors by their respective boards, councils or commissions, or are the authorized representatives of a Member, Contracting Entity, or Interested Party. All decisions require a majority vote of the present and voting Board of Directors with the following exceptions:

Table 2-4 GSA Voting Requirements

Key Authority	Threshold
Adoption of or amendments to the GSP	Unanimous vote of all Directors
To incur debts, liabilities, or obligations on behalf of the Authority	Five Affirmative votes by Directors
Adoption of or revisions to policies of the Authority	Five Affirmative votes by Directors
GSA Enforcement	Five Affirmative votes by Directors
Authorization to obligate the Authority to participate in litigation or other legal proceedings	Five Affirmative votes by Directors
Amendment of the Agreement	Unanimous votes of all Directors, subject to ratification by all Members
Any Assessment or Fees levied or imposed by theNK	Unanimous vote of all Directors
Budget allocation among parties for GSA operations after initial GSP	Five Affirmative votes by Directors
Removal of a Member from the GSA	Five Affirmative votes by Directors

2.5.3 Public Engagement in GSP Development

Regulation Requirements:

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

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

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

Various methods of public engagement were used in the development of the GSP. These methods are summarized in the **Figure 2-10** and described in more detail below.

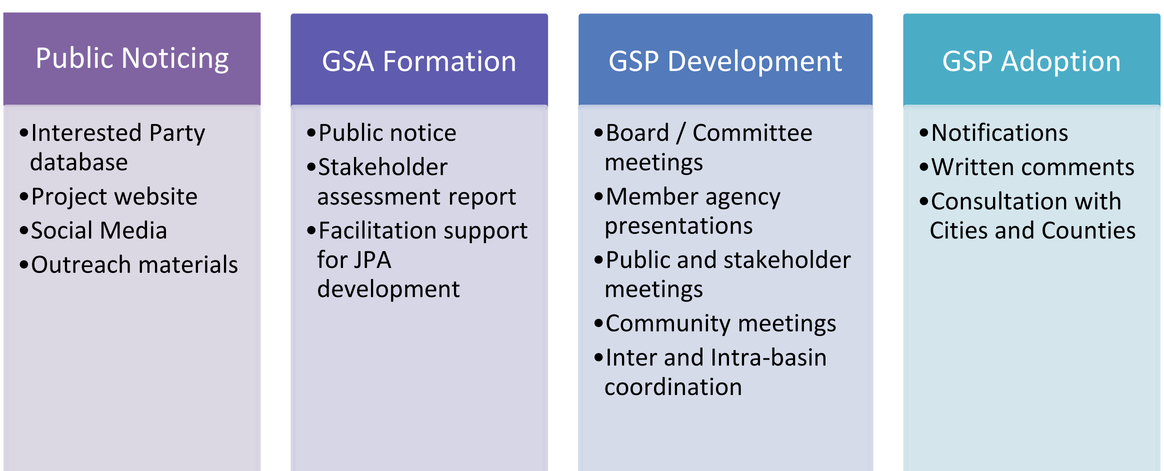


Figure 2-10 Methods of Public Engagement

2.5.3.1 Public Noticing and Information

The North Kings GSA developed and used several tools to inform members of the public about GSP development activities and promote opportunities for public engagement. These tools include the following:

- **Interested Party Database**: Pursuant to the Water Code Section 10723.4, the North Kings GSA developed and maintains a database of persons interested in receiving notices about GSP preparation and NKGSA activities. The Interested Party Database was used to distribute notices about public meetings and workshops, provide GSP development updates, give notice of draft plans and documents, and identify other opportunities for public engagement. At the time of writing, there were 469 interested persons in the database.
- **Project Website**: The North Kings GSA website – www.NorthKingsGSA.org – serves as the primary location for information related to NKGSA and GSP development, as well as repository for meeting agenda and packets, workshop materials, and outreach information. Pursuant to California Code of Regulations Section 353.6, the North Kings GSA also used the website to post information relevant to the initial notification of GSP development.
- **Social Media**: The North Kings GSA Facebook page serves as a tool to promote public meetings and workshops and notify members of the public about GSP development milestones. In addition, North Kings GSA member agencies conducted additional outreach related to SGMA through their existing social media platforms.
- **Outreach Materials**: The North Kings GSA developed a suite of materials in English and Spanish to educate and inform members of the public about SGMA, the NKGSA and the GSP. These materials included bilingual fact sheets, frequently asked questions, and workshop materials. These materials were made available on the North Kings GSA website, as well as distributed during meetings, workshops and other outreach activities.

2.5.3.2 Public Engagement in GSA Formation

Beneficial users and interested parties were invited to consult and comment on the formation of North Kings GSA, which culminated in a written notification to the California Department of Water Resources (DWR) by North Kings GSA pursuant to Water Code §10723.8 on January 3, 2017. Submittal of this notification followed a December 7, 2016, public hearing held in accordance with Water Code §10723(b). Proof of publication of the notice of public hearing in accordance with Government Code §6066 was provided to DWR with its January 2017 notification.

To assist in development of North Kings GSA, the founding members sought and received a Facilitation Support Services grant from DWR on January 14, 2016 (DWR Contract No. 4600010401, Work Order SGMP-01, Project No. 010, MWH Americas). Major components requested in this work order included an initial stakeholder assessment, support to Fresno area GSA formation, and facilitation support in development of a JPA. The Stakeholder Assessment, conducted in the first quarter of 2016, included 16 interviews with 22 individuals representing 20 agencies and organizations. Interviewees represented six general stakeholder classifications:

- Cities
- Special Districts
- Regional Agencies
- Agricultural Water Providers
- Independent Groundwater Extractors
- Disadvantaged Community Advocates

Results of the assessment were compiled in the *North Kings Subbasin Groundwater Sustainability Agency Final Stakeholder Assessment* (April 21, 2016). Results of this effort contributed to development and execution of the North Kings GSA JPA on October 25, 2016, and development of the GSA's Public Outreach Plan.

2.5.3.3 Public Engagement in GSP Development

Opportunities for beneficial users and interested parties to engage and consult with North Kings GSA during development of the GSP included the standing board and committee meetings, member agency presentations, public and stakeholder meetings, community presentations, and inter- and intra-basin coordination activities. These activities are summarized below and identified in the Communication and Engagement Database, included as **Appendix 2-B**.

Board and Committee Meetings – Regularly scheduled, public meetings of North Kings GSA Board of Directors and its Advisory Committee served as key opportunities for beneficial users and stakeholders to engage and consult in development of this GSP and track its progress. Notification of these meetings were consistent with the Brown Act. Written notification of each meeting was posted on the North Kings GSA website and via email to all parties that subscribed to the Interested Parties Database. Notifications were additionally posted for public review at the meeting location, as required by the Brown Act. The schedule of these meetings is available on the North Kings GSA website.

Member Agency Presentations – Member agencies of the North Kings GSA held periodic meetings with elected and appointed officials, and their constituents, to provide updates and consult on the content of the GSP. These meetings sought to inform beneficial users and interested parties of the status and next steps in development of this GSP and to describe potential GSP implementation obligations of member agencies consistent with the North Kings GSA JPA. During GSP implementation, North Kings GSA representatives presented to the planning commissions for the cities of Clovis and Kerman; the County of Fresno Planning Commission; the Biola Community Services District Board of Directors; and Kerman City Council. The information associated with these presentations is found in **Appendix 2-C**.

Public and Stakeholder Meetings – North Kings GSA conducted several large-scale workshops and audience-specific meetings during development of this GSP to consult with representatives of beneficial users and other affected parties. These engagements are identified in **Appendix 2-B** and are summarized as follows:

- **County Service Areas** –There are 10 County Service Areas (CSA) with water supply responsibilities subject to SGMA within North Kings GSA's jurisdictional area. In August 2018, North Kings GSA, in partnership with the County of Fresno, developed a bi-lingual informational flyer (Spanish and English) and distributed the flyer to constituents in the CSAs. Representatives of the County of Fresno personally contacted key members of each CSA to offer a presentation on SGMA and North Kings GSA. In addition to these presentations, the County of Fresno provided a presentation to the County Water Works District 42 Community Advocacy Committee in January 2019.
- **Independent Special Districts** – There are three County Water Districts (CWD) within the North Kings GSA. Each organized as an independent special district. These include Malaga County Water District, Pinedale County Water District, and Freewater County Water District. The NKGSA supported presentations to the boards of directors of Malaga CWD

and Pinedale CWD on July 24, 2018, and Aug. 7, 2018, respectively. The purpose of these meetings was to review the status of GSP development and next steps. Beneficial users consulted by these activities included municipal and industrial well operators. Freewater CWD provides surface water from the Kings River to agricultural lands within the district in coordination with Fresno Irrigation District. While Freewater CWD is empowered to provide water, sewer, fire protections, hydroelectric power plant and recreational services, its only purpose is to coordinate with Fresno Irrigation District water contracts.[3]

- **Domestic Well Owners** – On December 13, 2018 and May 2, 2019, the County of Fresno and Fresno Irrigation District, in coordination with North Kings GSA, held meetings in the eastern and western portions of the subbasin to engage private domestic well owners. These meetings were held in the City of Clovis and the community of West Park, a DAC, respectively. Notification for these meetings was completed through the distribution of nearly 5,000 postcards to affected properties, the email announcement to the Interested Party Database, social media posts, and the coordination with partner agencies such as Self-Help Enterprises (SHE) and Asian Business Institute and Resource Center (ABIRC).
- **Agricultural Well Operators** – Member agency Fresno Irrigation District incorporated status updates and next steps of GSP preparation as part of the District's periodic grower meetings held in Clovis, Easton, and Kerman. The schedule of these presentations is found in Appendix 2b.
- **Southeast Asian and Hmong Growers** – North Kings GSA, in coordination with the Fresno County branch of the University of California Cooperative Extension, ABIRC, and Fresno Irrigation District, held a workshop on March 20, 2019, for Southeast Asian and Hmong farmers to discuss SGMA and receive feedback on GSP development. Beneficial users consulted by these activities include agricultural users, domestic well owners, and disadvantaged communities.
- **Tribal Governments** – On August 8, 2018, North Kings GSA representatives held a SGMA orientation meeting with the tribal chairman of the Table Mountain Rancheria, a tribe located between the communities of Friant and Prather and identified in the letter from the NAHC. This tribe is not located in the NKGSA, but rather just outside it on the eastern end.

Community Presentations – North Kings GSA has held several SGMA and GSP overview presentations to a variety of civic and stakeholder groups in the region, including the Building Industry Association, Rotary Clubs, Fresno County Grand Jury, and others. The focus of these presentations is to expand awareness of SGMA and encourage participation at Board of Directors and Committee meetings. The schedule of these presentations is found in **Appendix 2-B**.

Inter- and Intra-basin Coordination – Intra-basin coordination activities of North Kings GSA has included participation at regularly held Kings Subbasin GSA Managers Meetings. During these meetings, NKGSA managers discussed elements and chapters common to the all the GSAs and GSPs in the subbasin, discussed key technical issues, and shared resources. North Kings GSA also conducted one-on-one meetings with GSAs in adjoining subbasins to discuss basin boundary flow concerns. In addition, North Kings GSA presented at several inter-basin coordination meetings which were attended by NKGSA managers, NKGSA technical staff, and stakeholders from throughout the Tulare Lake Basin. These meetings included sessions hosted by fellow GSAs and

[3] http://www.fresnolafco.org/documents/MSRs/Freewater%20Co.%20Water%20District.pdf

DAC such as SHE and the Union of Concerned Scientists. The schedule of these presentations is found in **Appendix 2-B.**

2.5.4 Public Engagement in GSP Adoption

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

This section includes a list of the adoption notifications made by the NKGSA, and a summary of comments received during the public review period for the Draft GSP of the NKGSA.

- On August 15, 2019, the NKGSA Board of Directors approved release of the draft GSP for public comment, and notification of a public hearing to be conducted on November 21, 2019. The agenda of the meeting was posted in advance of the meeting on the NKGSA website.
- On August 16, 2019, the NKGSA announced the release of the public GSP via its website and also sent an email announcement to all interested parties and stakeholders on its interested parties email list. A copy of the announcement is included in **Appendix 2-D**.
- In accordance with the regulation notification requirements, NKGSA sent notification letters to the County of Fresno and cities of Clovis, Fresno and Kerman on August 16, 2019 offering consultation with these agencies. Copies of these letters are included in **Appendix 2-D**. Consultation was not requested by the county or cities, as these agencies have been active participants with GSP development.
- A notification soliciting public comments and announcing the public hearing was placed in the Fresno Bee newspaper on August 28, 2019, September 4, 2019 and September 18, 2019. A copy of the newspaper notification is included in **Appendix 2-D**.
- A 60-day written public comment period was conducted between August 16 and October 18, 2019. A summary of all comments is included in **Appendix 2-E**.
- The NKGSA conducted three open house workshops in different locations within the GSA to discuss the draft GSP and encourage public comment on the draft GSP. The workshops were conducted on September 12, 2019 in Clovis, September 16, 2019 in Sanger and on September 18, 2019 in Easton. Copies of the information presented at the workshops was posted to the NKGSA website and is available for review.
- All comments were reviewed and considered by the Technical Subcommittee that prepared the draft GSP. The Technical Committee recommended certain revisions and additions to the GSP based on the public comments received. A summary of all comments and the changes made to the GSP are included in **Appendix 2-E**.
- The public hearing was conducted on November 21, 2019 during the NKGSA's Board meeting.
- The Board of Directors adopted the GSP on November 21, 2019.

2.5.5 GSP Implementation

Regulation Requirements:

§354.10 (d) 3) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

Following GSP adoption, North Kings GSA will continue to inform beneficial users and interested parties of progress implementing the GSP through Board of Directors and committee meetings, the North Kings GSA website and social media platforms, presentations to community groups, email notification to subscribers to the agency's Interested Parties Database, school district meetings, waterboard meetings, community and relative special district monthly meetings, and periodic public meetings. The GSA will continue to pursue effective methods of communication with stakeholders, including rural domestic pumpers and small farmers, to provide local seasonal and annual groundwater conditions and basic groundwater and well information. Key milestone notification to stakeholders will be the availability of Kings Subbasin Annual Reports each April (GSP Emergency Regulations §356.2). In addition, member agencies will conduct additional noticing activities related to individual projects and management actions. Projects implemented by the North Kings GSA or by its member agencies shall be conducted consistent with CEQA and Assembly Bill 52, as applicable.

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

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

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

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

3.1.2 Lateral Basin Boundaries

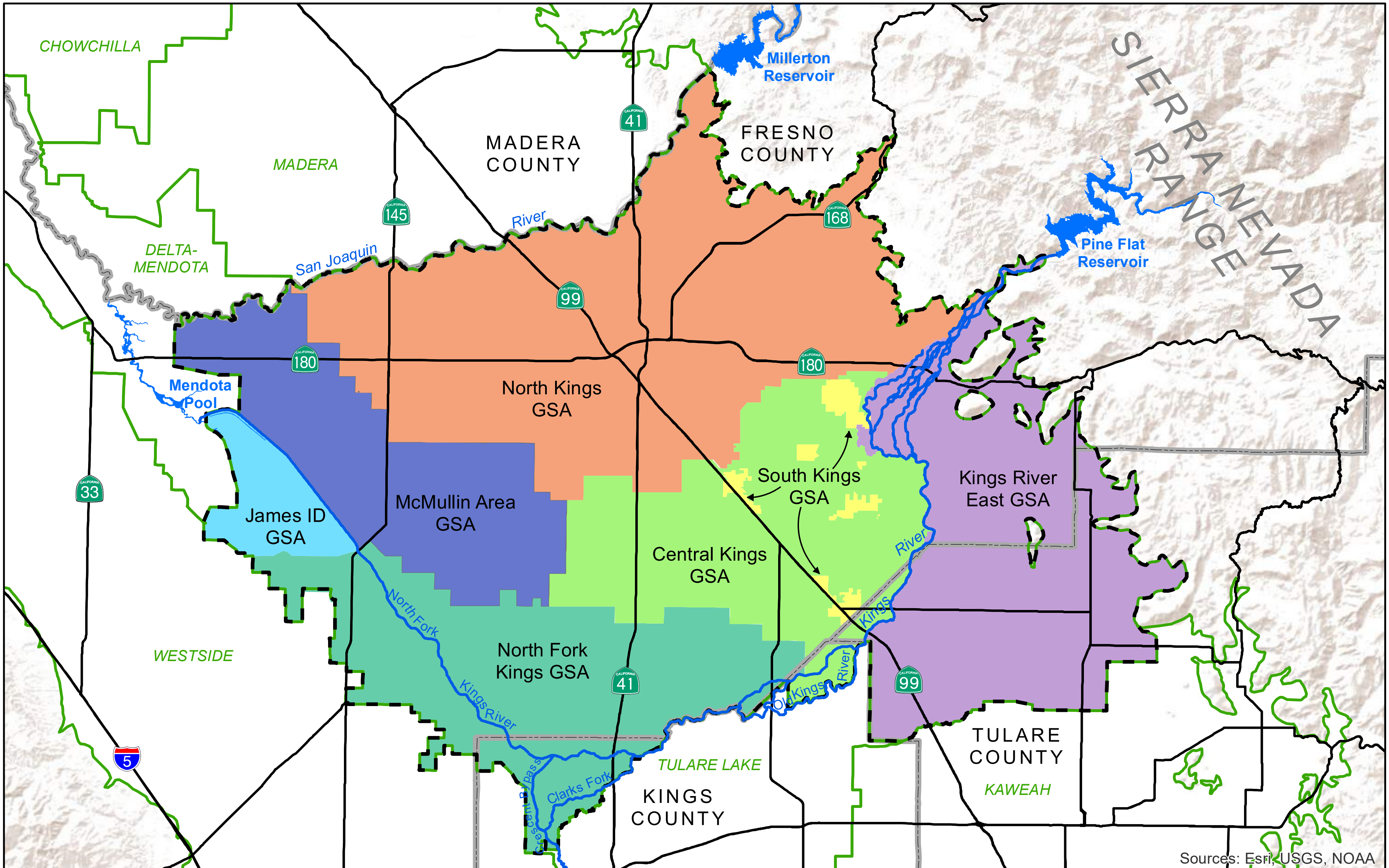
Regulation Requirements:

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

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

As shown in **Figure 3-1**, the North Kings Groundwater Sustainability Agency (NKGSA) area is bounded to the north by the San Joaquin River and to the east by the foothills of the Sierra Nevada, which defines the eastern boundary of the alluvial groundwater aquifer system. The remaining boundaries of the NKGSA area and its underlying aquifer system are defined by political boundaries that generally follow existing irrigation district boundaries. To the west, the NKGSA area is bounded by the McMullin Area GSA. To the south it is bounded by the McMullin Area GSA and the Central Kings GSA, and to the southeast it is bounded by the Kings River East GSA. The major features that affect groundwater flow are the San Joaquin River and the basement complex of the Sierra Nevada Mountains (i.e., bedrock). Minimal amounts of groundwater flow into the NKGSA through fractures in bedrock; however, significant amounts of seepage, termed stream depletion, occur along the San Joaquin River and from a small segment of the Kings River where it borders the NKGSA, and these losses are gains to the area's groundwater aquifers.

The basement complex of the Sierra Nevada and the seepage loss along the San Joaquin River under natural conditions affect the direction of flow in the region as groundwater flows away from both features. As groundwater flows from areas of high hydraulic head to areas of lower hydraulic head, the groundwater map presented in this chapter has been referenced to mean sea-level (msl) elevation to show groundwater flow direction. Groundwater flows to the southwest away from the Sierra Nevada towards the axial trough of the valley. Additionally**,** seepage from the San Joaquin River, and the recharge ridge associated with seepage loss from the river, induce groundwater to flow away from the river to the south and southwest. Mounding of groundwater occurs around the Fresno-Clovis Regional Wastewater Reclamation Facility. Numerous groundwater depressions have also developed as aquifer usage has increased over time, which can cause the direction of groundwater flow to vary locally, but the dominant direction of groundwater flow in the region remains southwest. Groundwater flow directions are discussed in more detail in Section 3.2 below.



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Kings Groundwater Subbasin (DWR 2018)

Other Groundwater Subbasins (DWR 2018)

County

North Kings GSA

Kings Groundwater Subbasin Groundwater Sustainability Agencies

Figure 3-1

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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 bedrock and connate water, and further west and southwest the definable base of the aquifer is the depth to connate water (**Figure 3-16**). East of the 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 NKGSA is included below.

As described by Page and LeBlanc (1969), the geologic structure of the Fresno area can be divided into two basic categories: a basement complex (i.e., bedrock) and overlying sedimentary rocks and deposits. Despite being faulted and jointed, the regional structure of the basement complex is formed from the western slope of the southwest tilted Sierra Nevada (Smith, 1964). Some of the sedimentary deposits overlaying the basement complex have also been folded and/or faulted, but the overriding structure of the sedimentary deposits are homoclinal (i.e., sedimentary deposits that dip uniformly in one direction). The dip of the 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). The buried basement complex near the northeastern edge of the NKGSA area is inferred to be faulted; however, the inferred fault does not have any demonstrated effect on groundwater movement (Page, 1975). The basement complex that crops out along the eastern border of the basin does not provide appreciable amounts of groundwater to the San Joaquin Valley (Page and LeBlanc, 1969).

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 3-2.** The Sierra Nevada and its foothills are located east of the basin, and erosion of these mountains and hills have formed alluvial deposits that slope generally southwest to west toward the axis of the San Joaquin Valley.

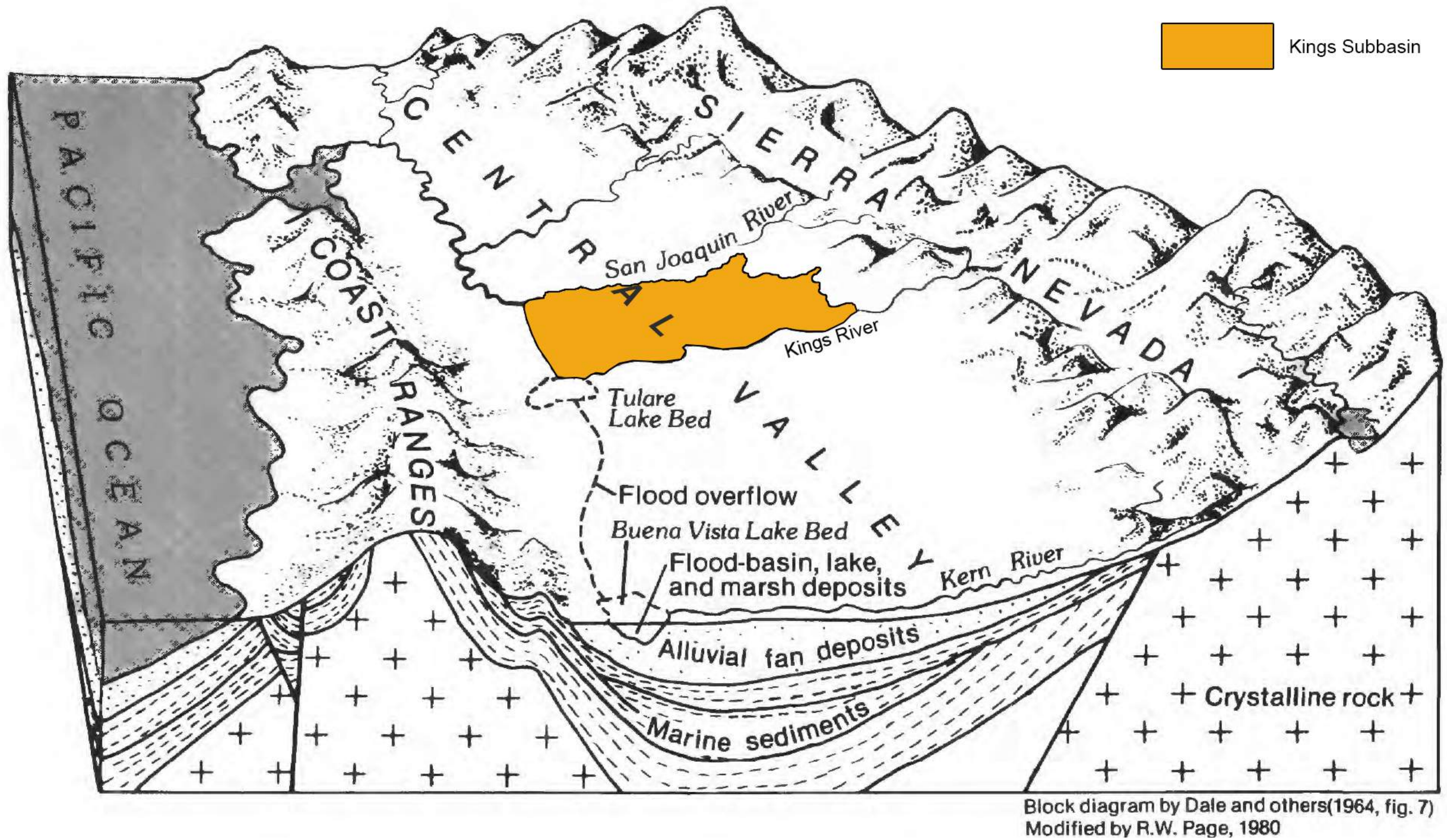

Kings Subbasin
PACIFIC OCEAN
COAST RANGES
CENTRAL VALLEY
SIERRA NEVADA
San Joaquin River
Kings River
Tulare Lake Bed
Flood overflow
Buena Vista Lake Bed
Flood-basin, lake, and marsh deposits
Kern River
Alluvial fan deposits
Marine sediments
Crystalline rock
Block diagram by Dale and others(1964, fig. 7)
Modified by R.W. Page, 1980

Figure 3-2

3.1.4 Topographic Information

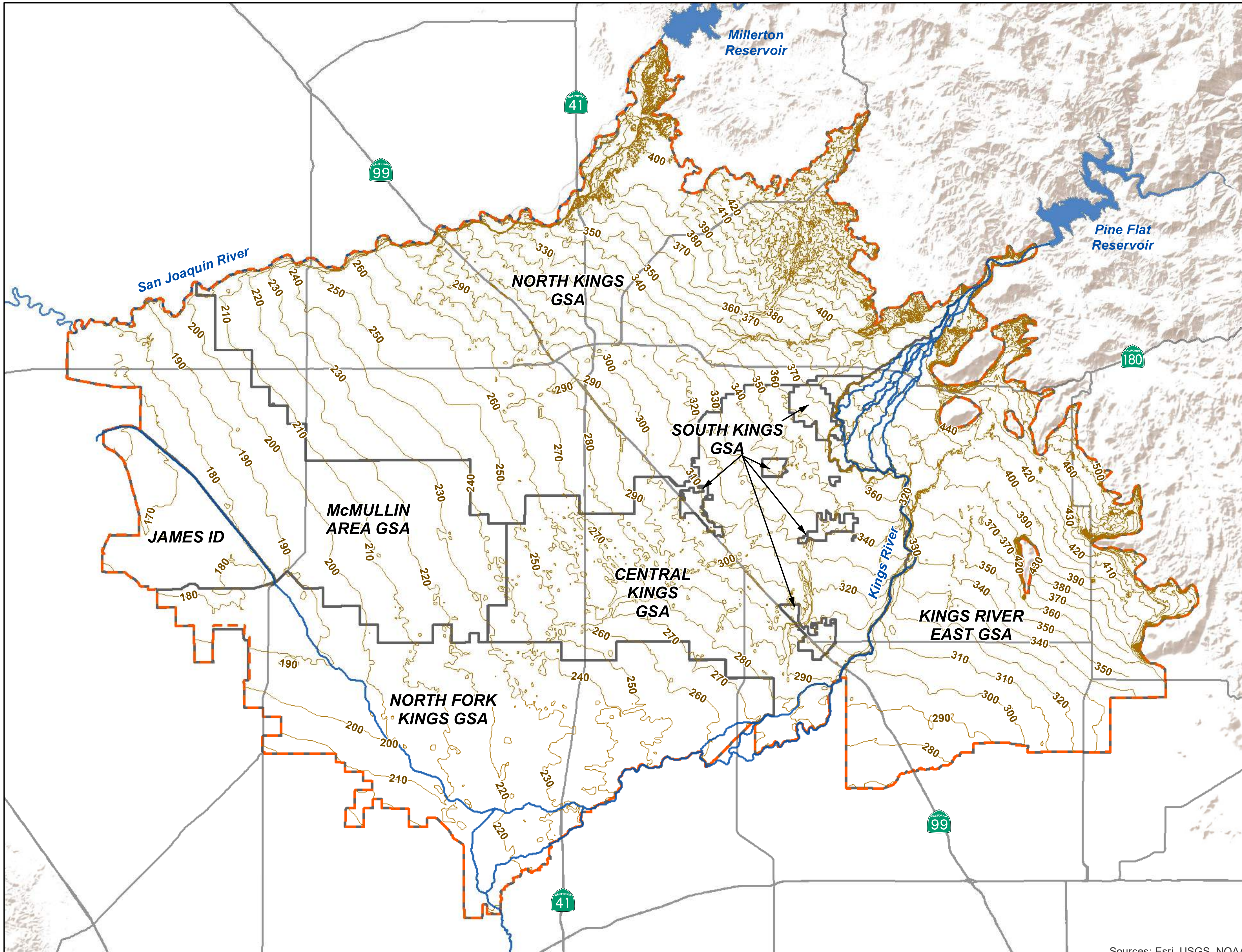
Regulation Requirements:

§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.

A topographic map of the Kings Subbasin is presented as **Figure 3-3**. The highest points in the subbasin are in the east along the boundary of the NKGSA area at the edge of the Sierra Nevada foothills where elevations are as high as 600 to 700 feet above mean seal level (msl). The lowest elevations are in James ID GSA and McMullin Area GSA along their western boundaries where elevations are about 170 feet (msl). The lowest elevation in NKGSA is approximately 210 feet (msl) near the border with McMullin Area GSA. Relatively steep slopes exist in the NKGSA area adjacent to the eastern boundary; however, the overall topography of the Kings Subbasin and the NKGSA slopes gently to the southwest.

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 (**Figure 3-4**). A relatively large area of sand dune deposits is located within the east central portion of the subbasin. Surface elevations in the subbasin range from approximately 700 feet above mean sea level (msl) in the east to as low as approximately 160 feet in the west. Relatively steep slopes exist in the areas adjacent to the Sierra Nevada foothills, however the overall topography of the subbasin slopes gently to the southwest. Additional description of this NKGSA is included below.

Geomorphic features of the NKGSA area and surrounding areas were mapped by Page and LeBlanc (1969). As shown in **Figure 3-4**, the landscape of the NKGSA area is dominated by overlapping alluvial fans of the Kings and San Joaquin Rivers and the compound alluvial fans of the intermittent streams between the two major rivers. In general terms, alluvial fans are fan or cone-shaped deposits of sediment that were laterally accrued by streams on the fan surface through time. Alluvial fans are narrower at the head than at the toe and slope with decreasing gradient from head to toe. The NKGSA area is bounded to the east by the foothills and mountains of the Sierra Nevada which provide the source of the sediment for the alluvial fan deposits.



Kings Subbasin

Topography

Figure 3-3

Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Waterway
- USGS Ground Elevation (USGS DEM, NAVD88, 10ft interval)

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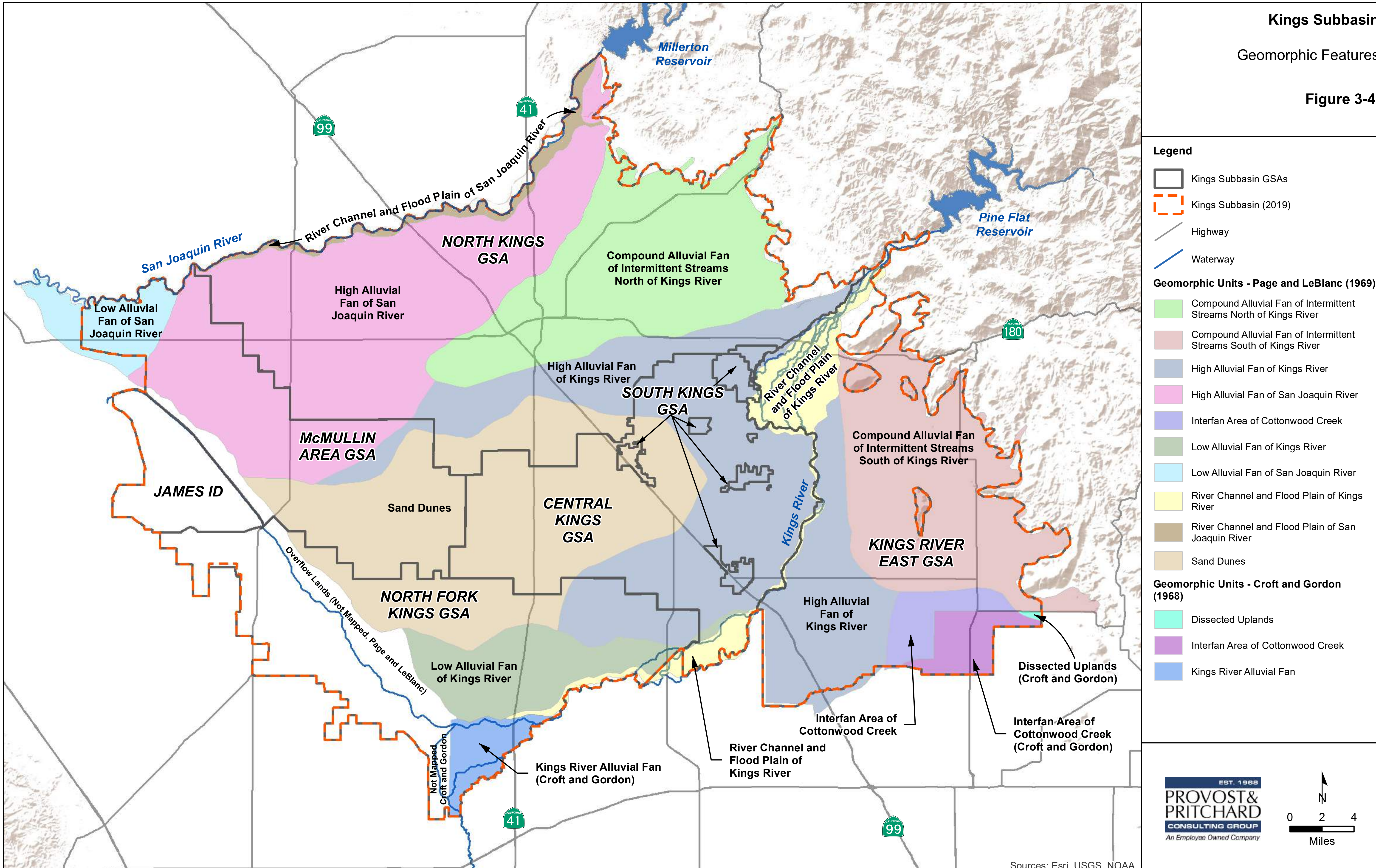


6/28/2019 : G:\Kings River East GSA-2664\266417001-Kings Basin SGMA Coordination\GIS\Map\RegionalHCM\geomorphic_features_kingssub.mxd

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 plutonic and metamorphic rocks commonly referred to as the Sierra Nevada batholith. The basement complex surface slopes gently to the southwest from the foothills 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 3-5** is a map depicting surficial deposits in the Kings Subbasin. More detailed descriptions of this NKGSA are included below.

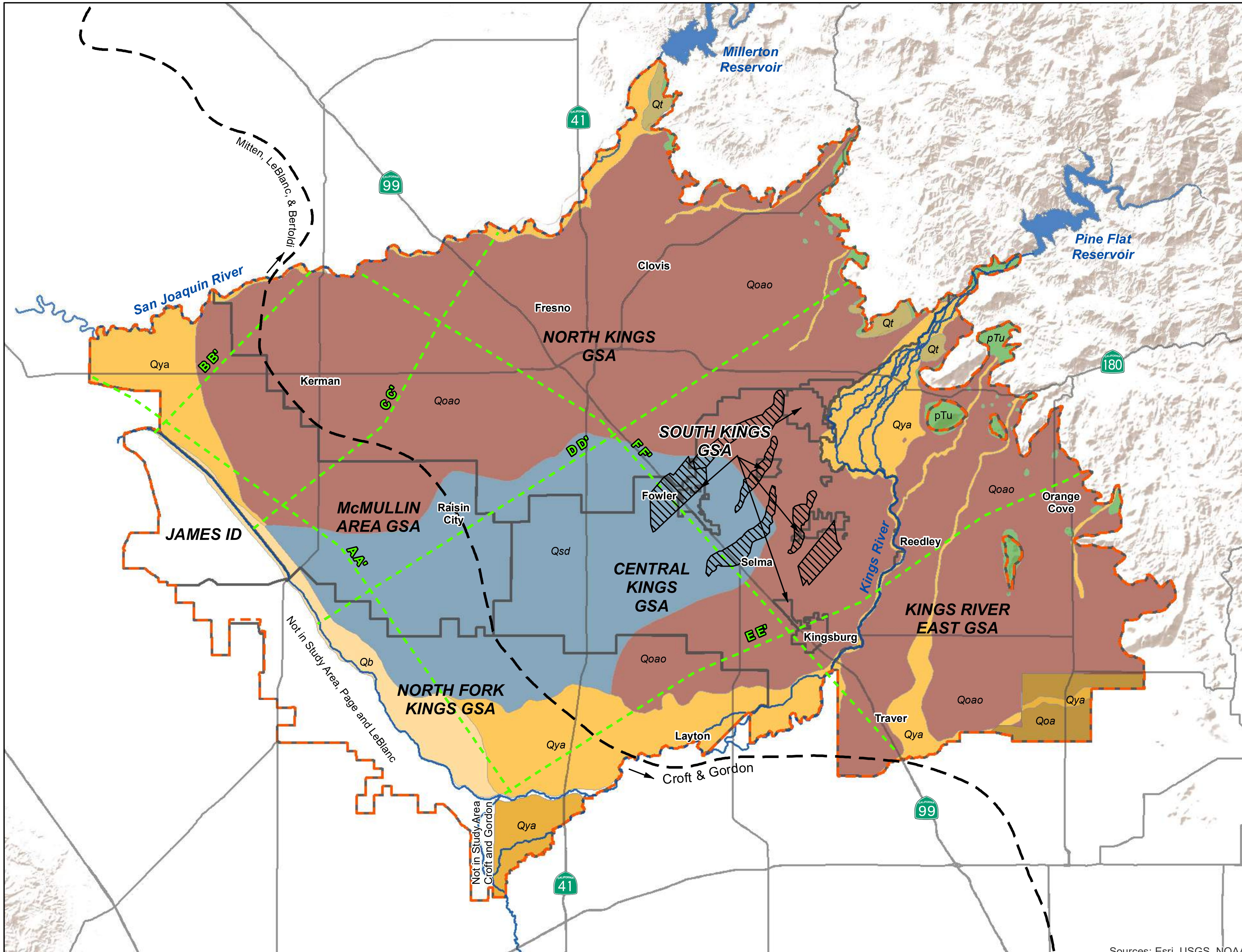
The unconsolidated deposits are of both Tertiary and Quaternary age (2.6 million years ago to the present). As shown on **Figure 3-5**, the basement complex (pTu) crops out along the eastern boundary of NKGSA area. The current basin boundary along the foothills has a few pockets of basement complex mapped within the basin. These pockets of basement complex may be removed from the alluvial basin later through a basin boundary modification. Within the NKGSA area, surface materials are dominated by Quaternary age deposits which have been categorized by Page and LeBlanc (1969) as Quaternary Older Alluvium (Qoao), Quaternary Younger Alluvium (Qya), or Quaternary Sand Dunes (Qsd). Quaternary alluvium within the NKGSA is a result of erosion of the Sierra Nevada range to the east and subsequent deposition on the valley floor. Qoao covers the largest area within the NKGSA area. Thin bands of Qya are located adjacent to modern day stream channels and rivers (i.e., San Joaquin River, Kings River, and the small intermittent creeks that drain the foothills). A relatively large area of sand dunes (Qsd) is in the south central portion of the NKGSA area. Also shown on **Figure 3-5** are several subsurface geologic features of significance, including the eastern limit of the Corcoran Clay, an inferred fault north east of Clovis near the foothills, and buried incised valley fill deposits based on Weissmann et al, 2002, and Cehrs, Soenke, and Bianchi, 1980.

Cross-section locations are shown on **Figure 3-5**. Cross-sections are described later in **Section 3.1.7**.

Kings Subbasin

Surficial Deposits

Figure 3-5



Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Waterway

Geologic Deposits
Page and LeBlanc, 1969

- Basement Complex (Consolidated) (pTu)
- Flood Basin Deposits (Unconsolidated) (Qb)
- Older Alluvium (Unconsolidated) (Qoao)
- Sand Dunes (Unconsolidated) (Qsd)
- Terrace Deposits (Unconsolidated) (Qt)
- Younger Alluvium (Unconsolidated) (Qya)
- Geologic Cross Section

Geologic Deposits
Croft and Gorden, 1968

- Older Alluvium (Qoa)
- Younger Alluvium (Qya)

Subsurface Geologic Features

- Eastern Extent of E-Clay (Corcoran Clay) (Page and LeBlanc, 1969 (Modified by KDSA))*
- Incised Valley Fill (Weissmann et al, 2002 and Cehrs et al, 1980)

*Extent of E-Clay references differ outside of the Kings Subbasin.
- North of the San Joaquin River: Mitten, LeBlanc, & Bertoldi (1970)
- South of the Kings River: Croft & Gordon (1968)

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3.1.6 Soil Characteristics

Regulation Requirements:

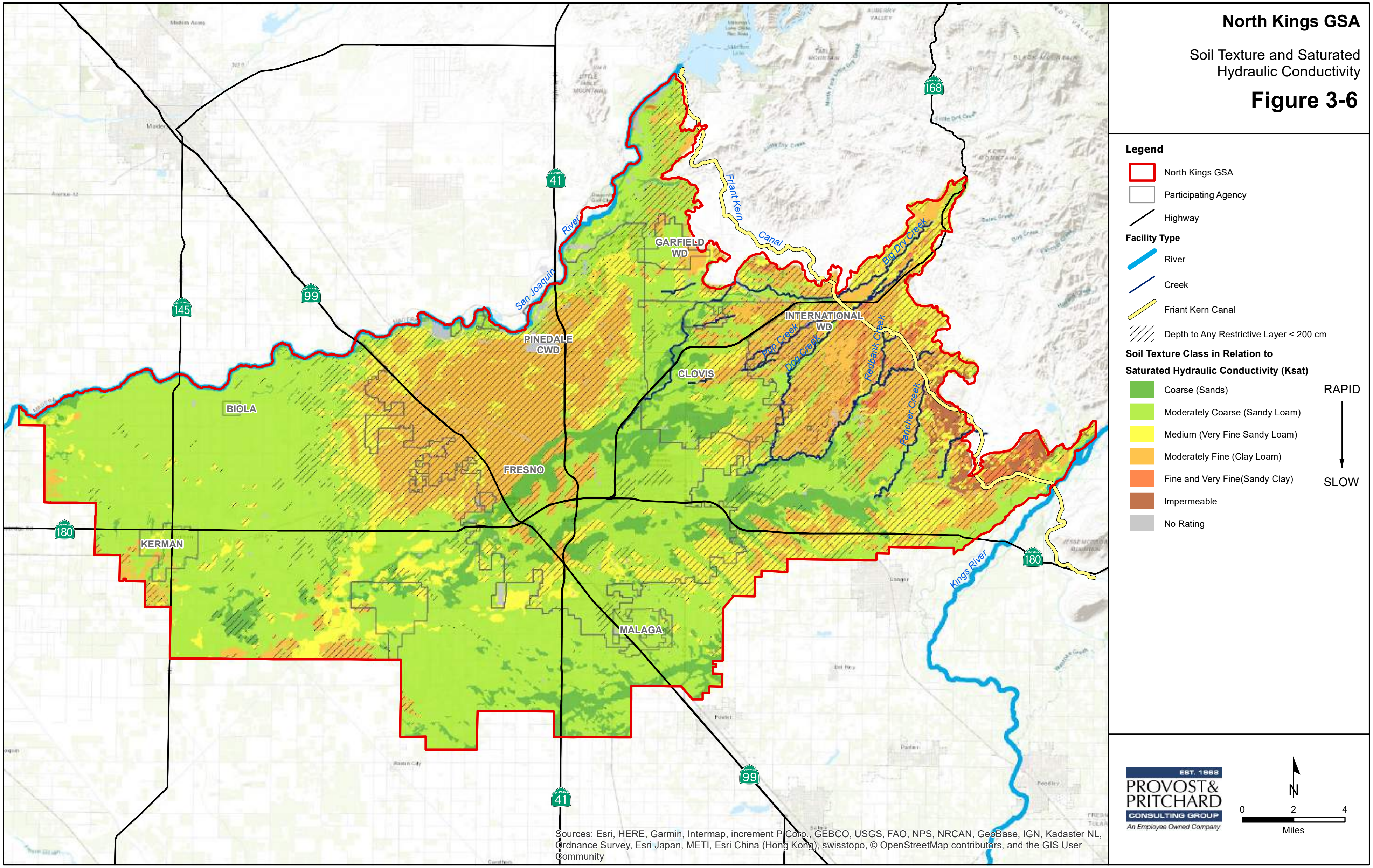
§354.14(d)(3) Physical characteristics of the basin shall be represented on one or more maps that depict soil characteristics as described by the appropriate Natural Resource Conservation Service soil survey or other applicable studies.

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

A soils map based on Natural Resource Conservation Service (NRCS) soil textural classes is presented as **Figure 3-6**. 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 NKGSA area, the NRCS has generally described soils to depths of 5 to 7 feet. The hydraulic conductivity values shown on the map are expressed in general terms ranging from relatively rapid for coarse grained soils to relatively slow for fine and very fine-grained soils.

As shown in **Figure 3-6**, in general, the dominant soil textural class in the north-central, south-central, and western regions of NKGSA area is moderately coarse. Lobes of medium to moderately fine soils are in the approximate north-central and eastern side of the area and fingers of coarse soils trending southwest-northeast are present in the central portion of the area and represent recent alluvial deposits along the area's streams and rivers. Pockets of fine and very fine soils and impermeable soils have been mapped in the southeastern portion of the NKGSA area. Moderately fine to fine and very fine soils are mapped in the compound fan of intermittent streams north of the Kings river. Based on NRCS soil descriptions, restrictive layers (i.e., any abrupt structural or textural change) in the soil column less than 200 cm (about 6.6 ft) in depth have also been mapped on **Figure 3-6**. The mapped restrictive layers are chiefly comprised of duripan soil horizons (i.e., hardpan), which for the purposes of this document are assumed to have largely been broken up through deep tillage related to historic agricultural operations throughout the area.

Figure 3-6 can be useful for initial screening of potential surficial recharge and groundwater banking sites, but the information should be confirmed with on-site investigations before projects are pursued.



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3.1.7 Cross-sections

Regulation Requirements:

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

Geologic cross section from Page and LeBlanc (1969) that transverse the Kings Subbasin are presented as **Figure 3-7** through **Figure 3-12**. Geologic cross section locations are shown on the Surficial Geology Map (**Figure 3-5**). 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 NKGSA are included below. Geologic cross section A-A' and E-E' do not intersect the NKGSA.

Geologic cross-section F-F' transverses northwest-southeast through the NKGSA area and is shown in **Figure 3-12**. Regional cross-sections B-B', C-C', and D-D' transverse northeast-southwest through the NKGSA area, are perpendicular to F-F', and are shown in **Figure 3-7** through **Figure 3-10**, respectively.

Referring to regional cross section F-F' (**Figure 3-12**), the Quaternary Older Alluvium (Qoao) is inferred to exist from the surface to a depth of approximately 900 feet in the northwest and to a shallower depth of approximately 500 feet in the southeast. As shown on regional cross-section D-D' **(Figure 3-10**) the Qoao extends to a depth of approximately 750 feet in the southwest and gradually thins out to the northeast where basement complex crops out along the eastern boundary of the NKGSA. Quaternary and Tertiary age continental deposits (QTc) lie below the Qoao to depths of at least 2,200 feet. The Quaternary Sand Dune deposits (Qsd) located in the south-central portion of the area are inferred to extend to a depth of approximately 50 feet, however Page (1986) reports these deposits can be as deep as 140 feet.

On cross-sections B-B' and F-F' (**Figure 3-8** and **Figure 3-11**), a shallow band of Quaternary Younger Alluvium (Qya) is located at relatively shallow depths immediately adjacent to the San Joaquin River channel in the northwest.

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

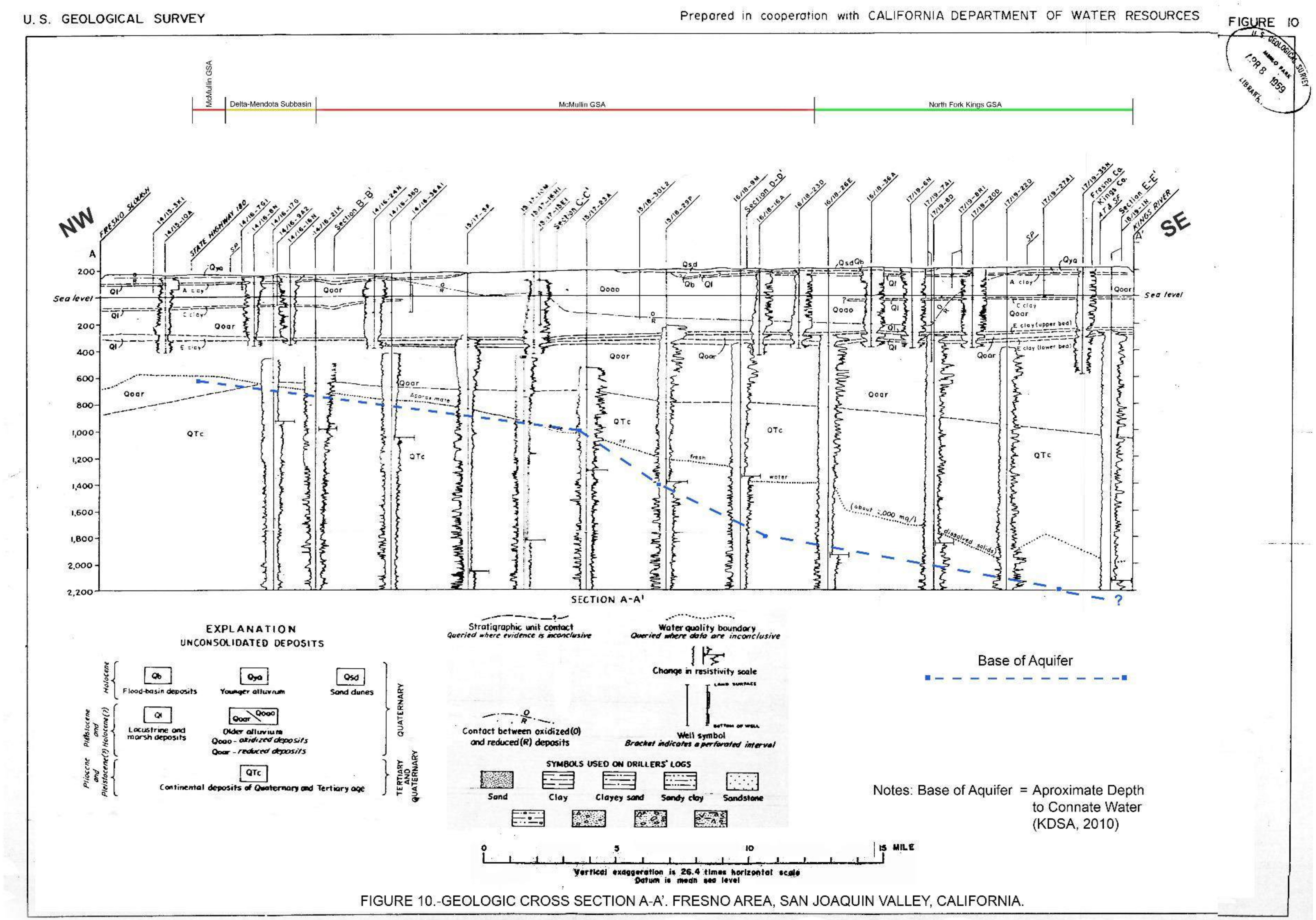


Figure 3-7 Regional Cross-Section A-A'

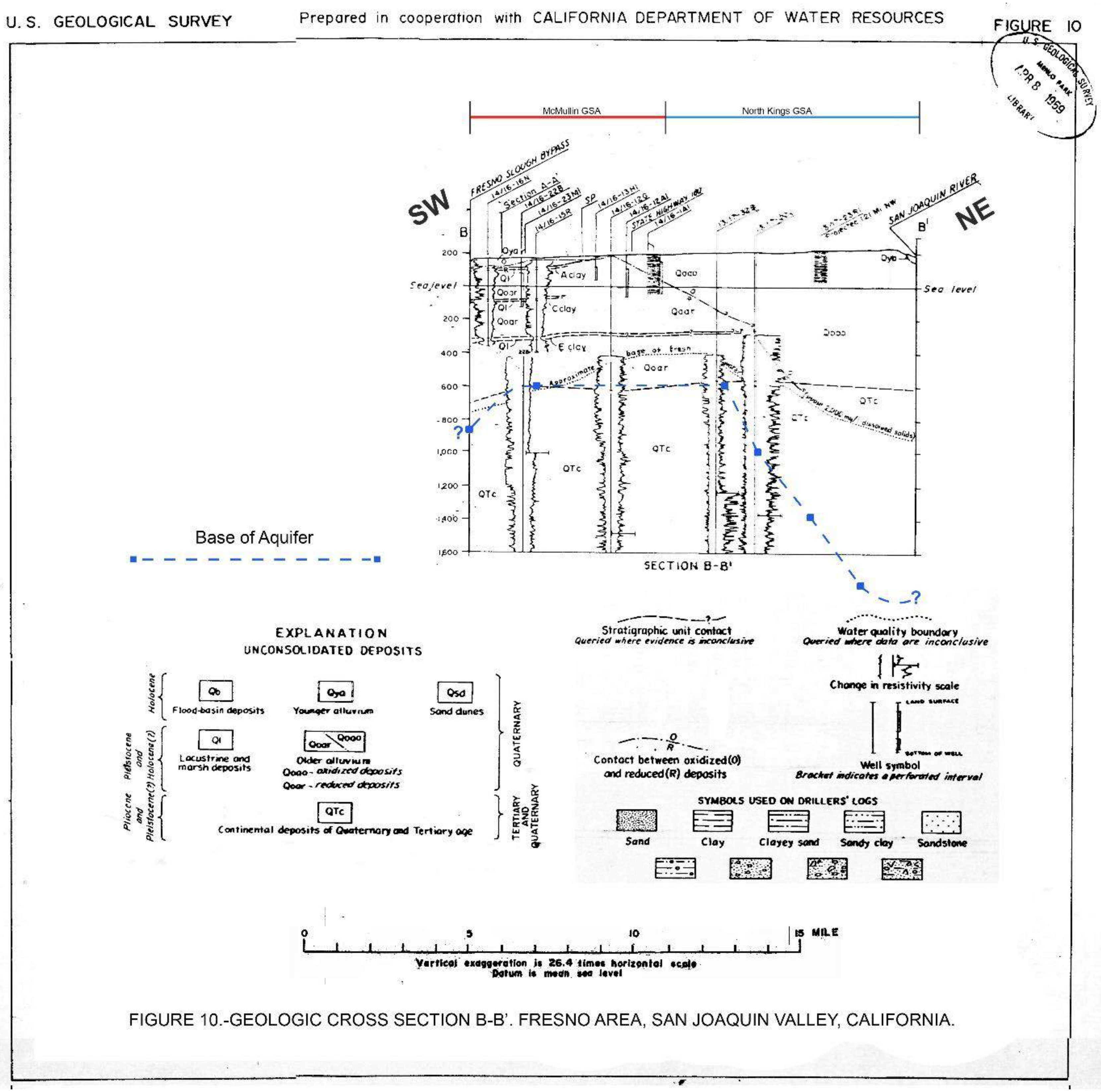


FIGURE 10.-GEOLOGIC CROSS SECTION B-B'. FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-8 Regional Cross-Section B-B'

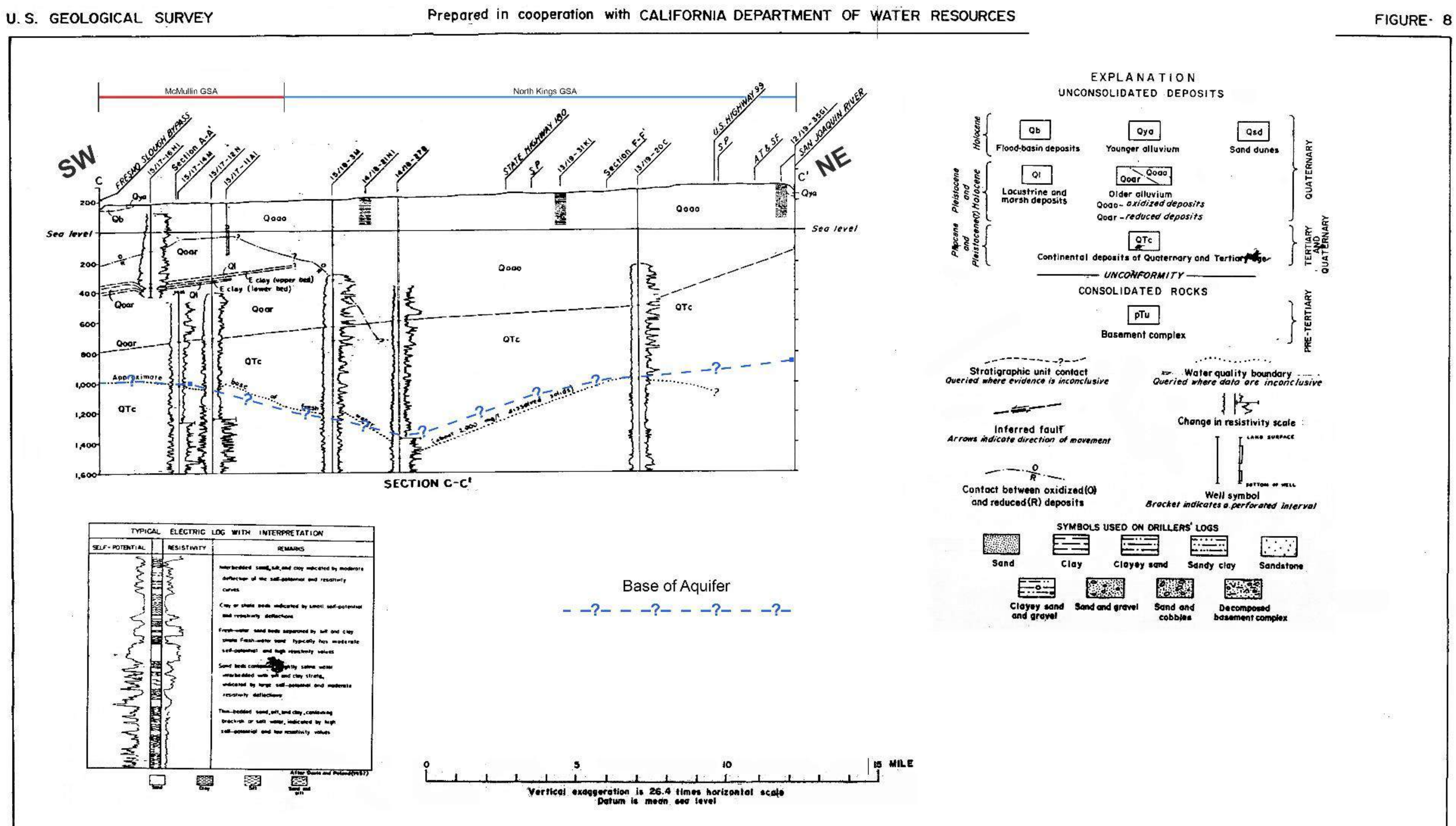


FIGURE 8 GEOLOGIC CROSS SECTIONS C-C'. FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-9 Regional Cross-Section C-C'

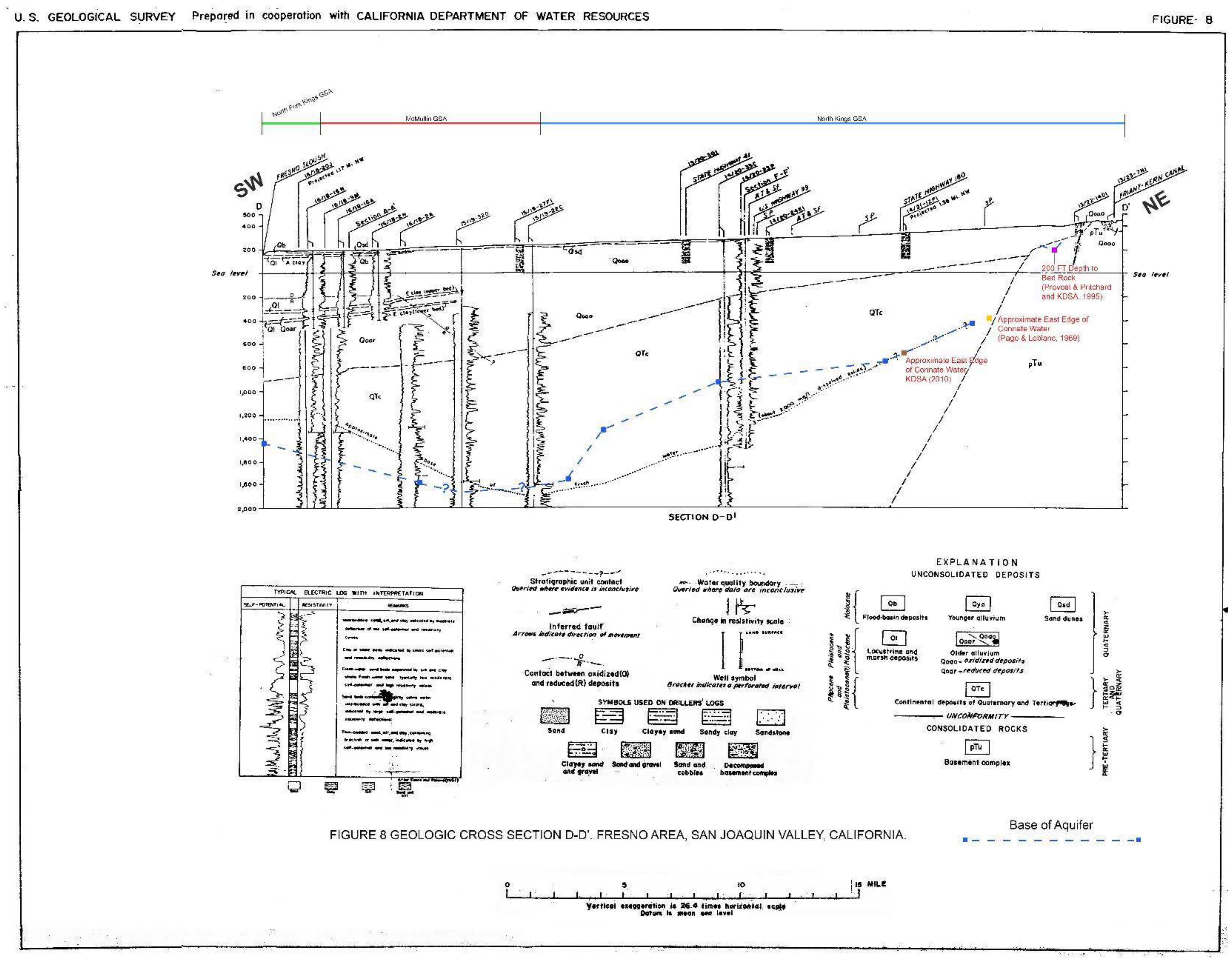


Figure 3-10 Regional Cross-Section D-D'

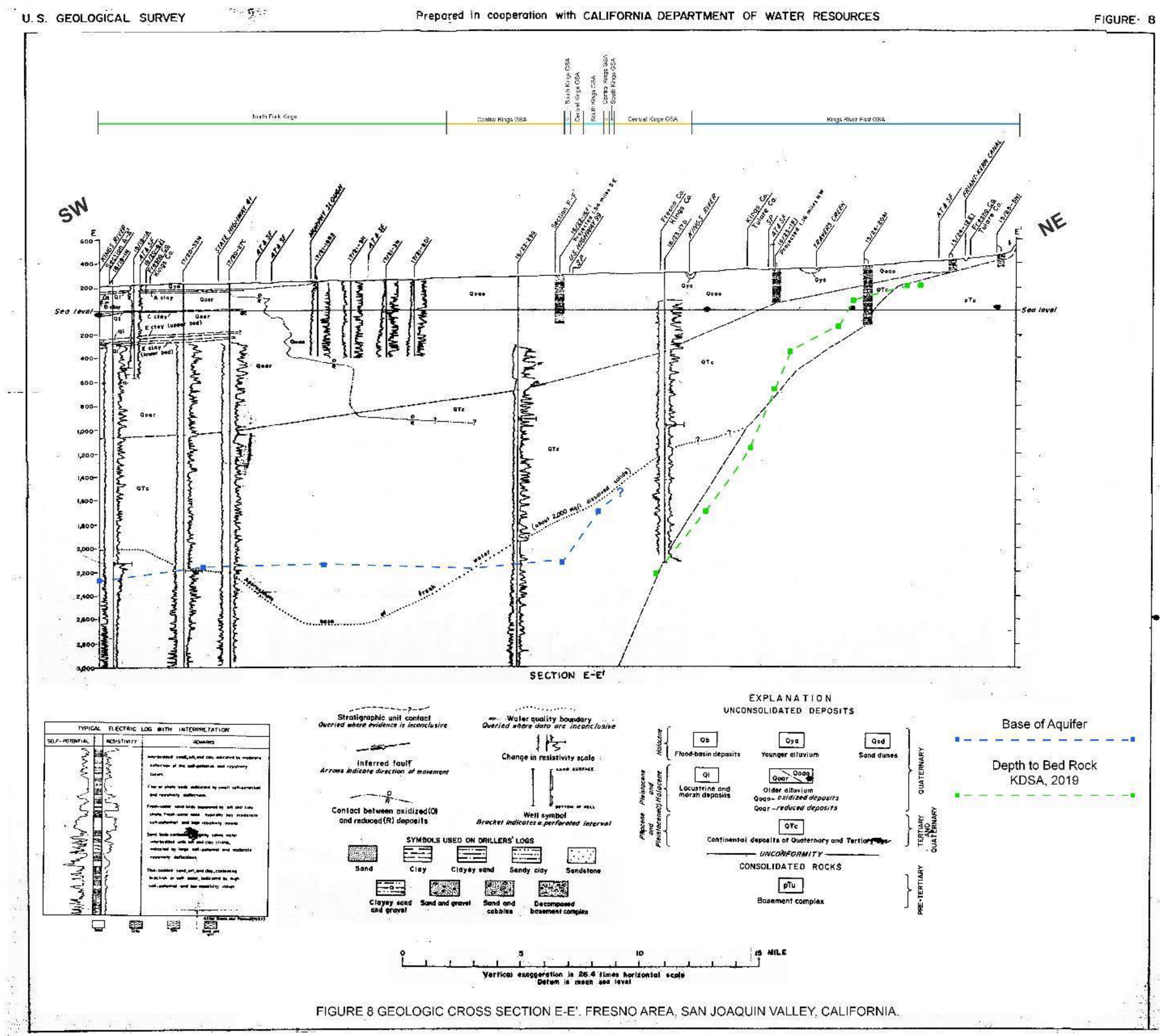


Figure 3-11 Regional Cross-Section E-E'

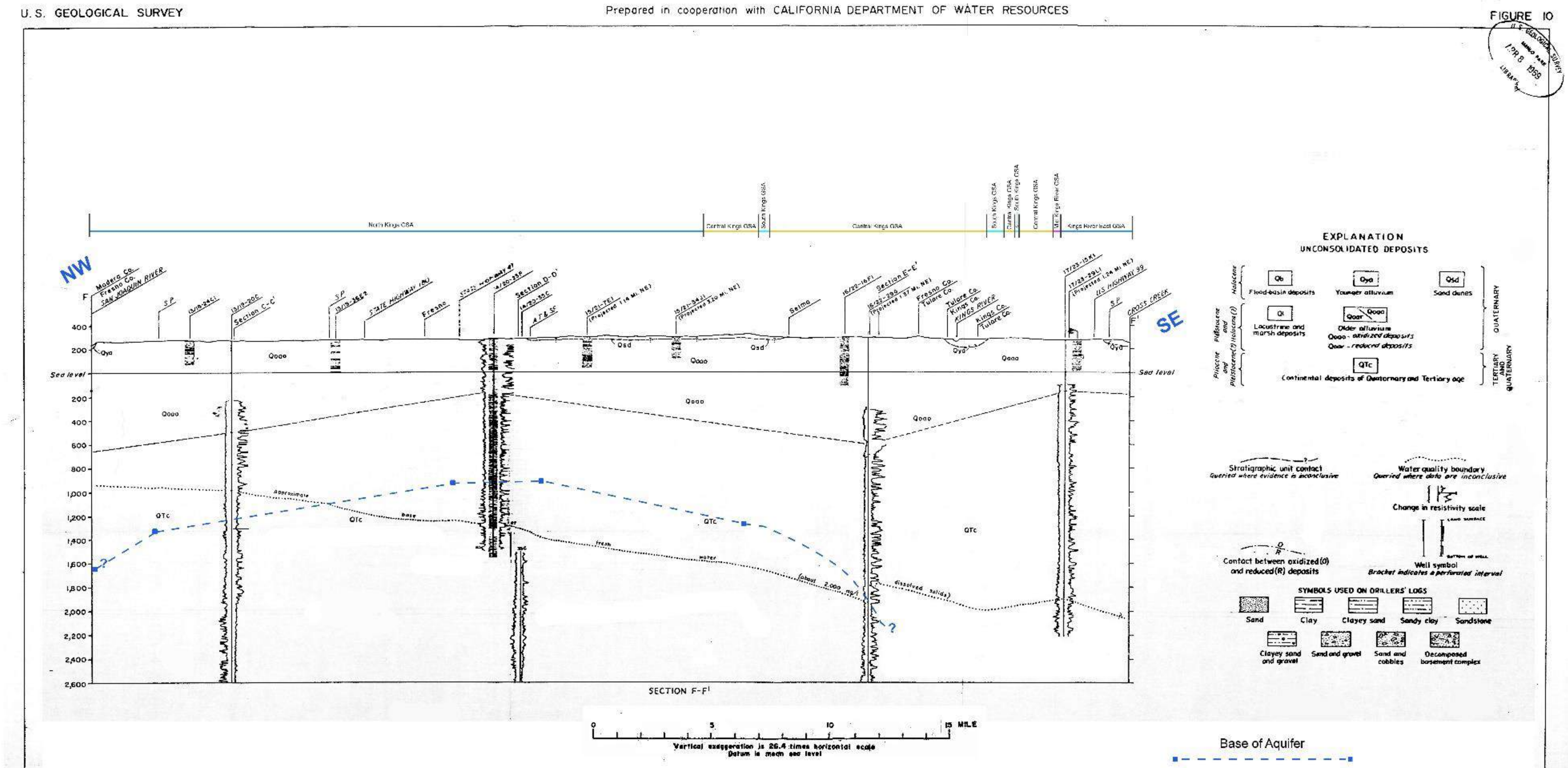


FIGURE 10.-GEOLOGIC CROSS SECTION F-F', FRESNO AREA, SAN JOAQUIN VALLEY, CALIFORNIA.

Figure 3-12 Regional Cross-Section F-F'

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 Requirements:

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

Geologists studying the lithology of the San Joaquin Valley in different areas have used 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. A summary of the formations present in the Kings Subbasin is shown in **Figure 3-13** and **Figure 3-14**, which are conceptual hydrogeologic cross sections. These conceptual hydrogeologic cross sections are included here as they show the vertical and horizontal stratigraphic relationships of the various geologic formations in the Kings Subbasin as interpreted by Brown & Caldwell and WRIME (2006).

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. Scaled geologic cross sections for the NKGSA were discussed above in Section 3.1.7, and more details regarding geologic formations in the NKGSA are provided below.

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

§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, include the A-clay, C-clay and E-clay(Corcoran Clay), which occur in western portions of the subbasin and are major recognized aquitards in the area that separate the unconfined aquifer system above from a confined aquifer system below. These lacustrine clay beds restrict vertical groundwater flow.

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).

The E-clay, or Corcoran Clay, is shown by cross-section B-B' (**Figure 3-8**) to exist at a depth of approximately 500 feet near the northwestern-most portion of the NKGSA area. Cross-section C-C' (**Figure 3-9**) shows the E-clay at a depth of approximately 400 feet at the southwestern-most portion of the area. While the E-clay is present near the western boundary of the NKGSA area, it does not extend, appreciably, into the area and only underlies about 14 square miles (**Figure 3-5**).

Where present, the E-clay is known to have confined groundwater conditions beneath it. It should be noted that newer public supply wells are often drilled and sealed through the quaternary alluvium and then tap into the underlying confined groundwater. Within the Kings Subbasin, less extensive confining units, known as the A-clay and C-clay, exist at shallower depths; however, neither of these confining clay units are mapped or inferred to occur below the NKGSA area.

For many decades, areas east of the E-clay were considered to be one unconfined aquifer. Through a series of studies, including subsurface geologic cross sections, test holes, and geologic logs, Kenneth D. Schmitt & Associates (KDSA) has developed an enhanced concept of the aquifer system located east of the E-clay. Based on geologic logs, electric logs, differences in water quality, and differences in hydraulic head in test holes that KDSA has worked on over the years; KDSA has proposed a two-aquifer system east of the E-clay for most of the Kings Subbasin. This two-aquifers system is comprised of a shallow unconfined groundwater and deeper confined groundwater formed by relatively non-continuous, but locally significant clay layers. A KDSA technical memorandum (Kings Groundwater Subbasin Technical Memorandum 1) with further details on the two-aquifer system and the subsurface geologic cross sections from the various studies in the Fresno-Clovis area is included as **Appendix 3-A** to this document. As shown on **Figure 3-15**, KDSA has mapped the base of unconfined groundwater at depths ranging from approximately 150 feet deep in the east, near the foothills, to 400 feet deep in the west, near the edge of the E-clay. Where the E-clay is present the base of unconfined groundwater extends to the top of it.

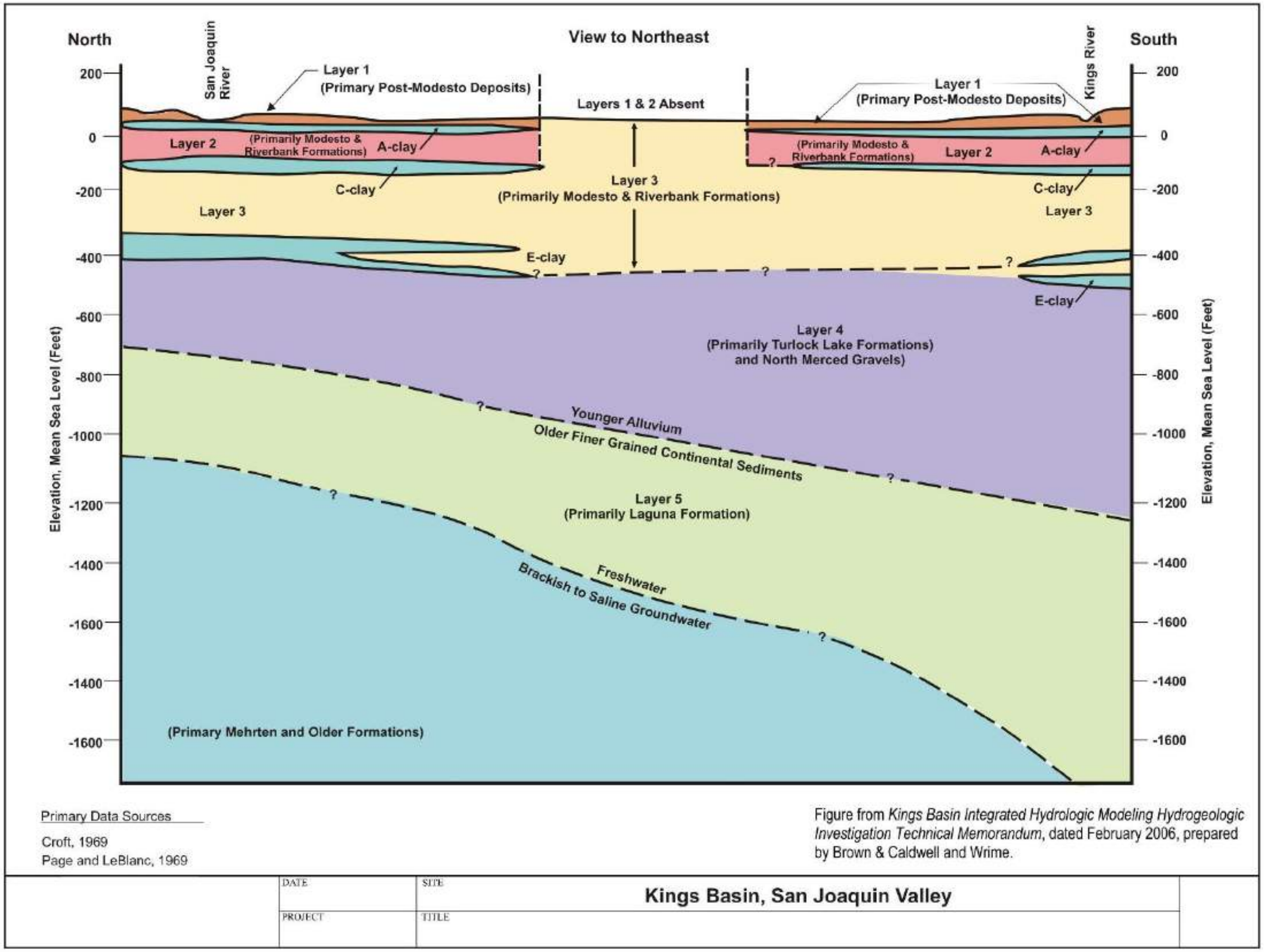


Figure 3-13 Kings Groundwater Subbasin Conceptual Hydrogeologic Cross-Section —Northwest- Southeast

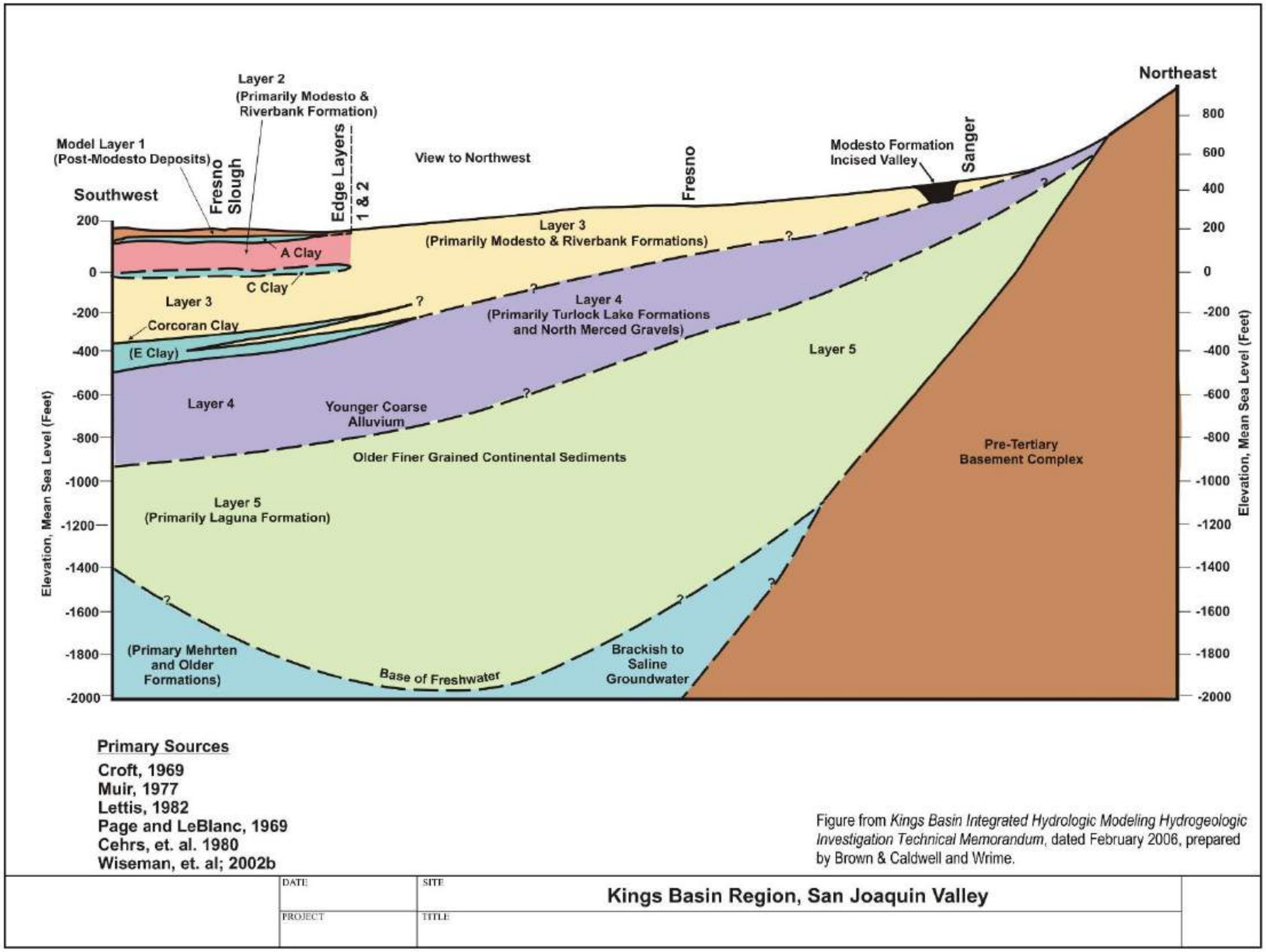
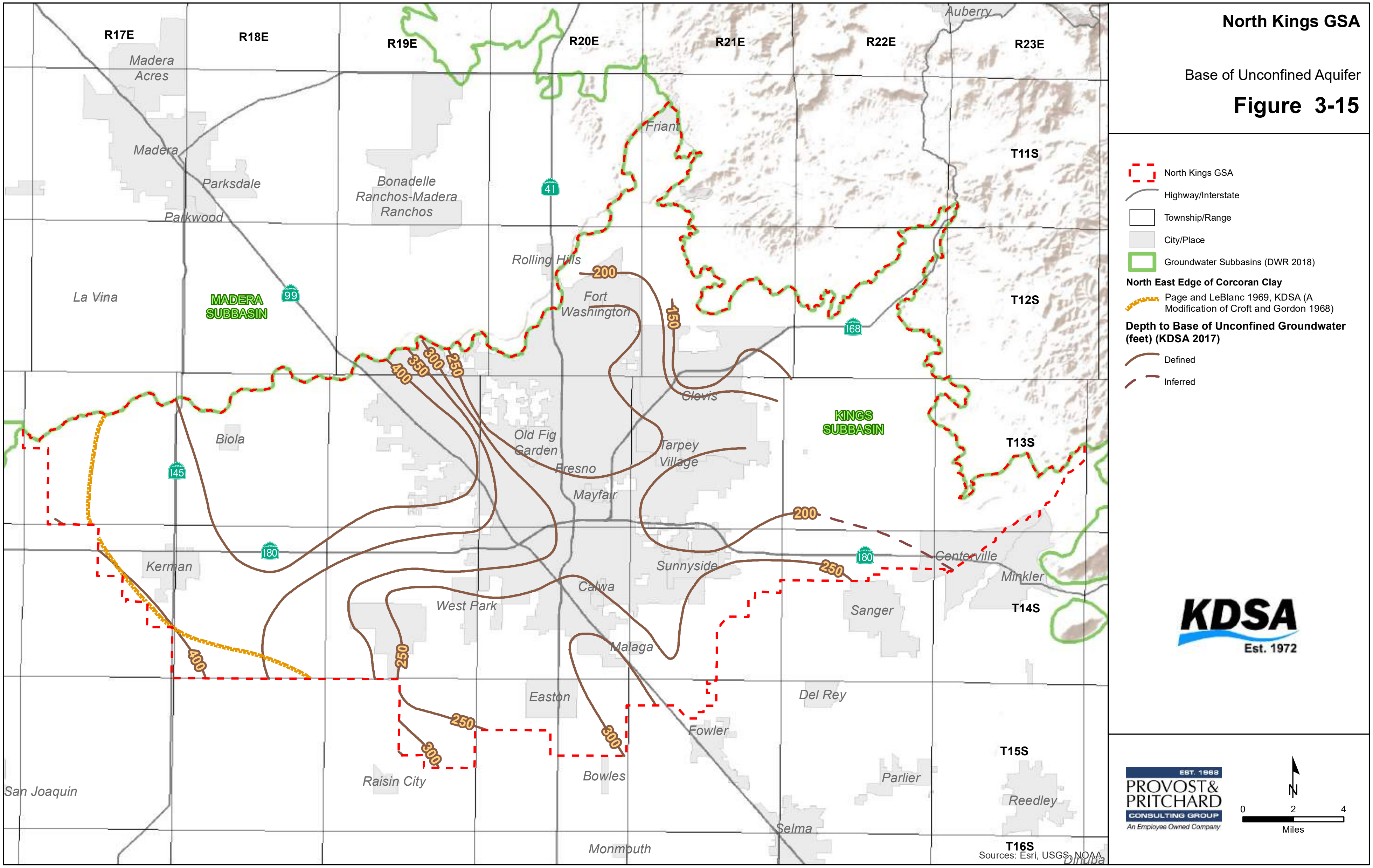


Figure 3-14 Kings Groundwater Subbasin Conceptual Hydrogeologic Cross-Section – Southwest-Northeast



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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 NKGSA are discussed below.

<u>Vertical Extent</u>

The lateral extent of the aquifer system within the NKGSA area is described in Section 3.1.2 of this chapter. The vertical extent (i.e., depth) of the aquifer system is comprised of two separate boundary types and has been mapped by Page and LeBlanc (1969) and KDSA (2010). As shown in **Figure 3-16**, the approximate eastern one-quarter of the NKGSA aquifer system is defined vertically by the top of the basement complex. The depth to the basement complex is zero along the foothills where valley alluvium pinches out and is about 800 feet deep below northeast Fresno-Clovis area. The lower aquifer boundary for the western three-quarters of the NKGSA area is the base of freshwater (connate water), which for the purposes of this HCM, is defined as groundwater with a total dissolved solids (TDS) content of 2,000 milligrams per liter (mg/l). As shown on **Figure 3-16**, the saltwater/freshwater interface is located at approximate depths ranging from 800 feet to 2,000 feet. As shown in the geologic cross-sections, the base of freshwater is chiefly located below the bottom of the Qoao and within the QTc.

<u>Aquifer Characteristics</u>

Aquifer characteristics of importance to the NKGSA 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. Specific yields in the Upper-Kings sub-basin area are closely related to geomorphic units. In the Older Alluvium, fine grained materials predominate near the foothills and near the boundary between the high fans of the rivers where specific yields are lower. The lowest specific yields in the area are found near the foothills. Course grained materials predominate near the heads of the fans where specific yields can be as high as 18 percent (Page and Leblanc, 1969).

Specific Yield of the Deposits

Page and LeBlanc (1969), Davis and others (1959), and Williamson and others (1989) provide estimates of specific yields in the NKGSA based on texture of the deposits. 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 herein 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. Page and Leblanc (1969) assigned estimated specific yield to depths of 300 feet based on the percentage of coarse grained to fine grained materials in the subsurface. Six categories, termed geologic facies, were defined as Facies A to Facies F. The Facies categories were assigned estimated specific yield values that range from as low as 5.3 percent for Facies A to 18.7 percent for Facies F. Individual soil type specific yields were estimated to range from a low of 0.2 percent for a clayey, sandy silt to as high as 36.6 percent for a well sorted, sand and gravel. To calculate storage capacity in the 10 to 50 foot depth, 50 to 100 foot depth, and 100 to 200 foot depth, Davis and others (1959) computed a range of average specific yields, using soil textures from 5.8 percent to 14.6 percent. Williamson and others (1989) estimated specific yields between 6 and 18 percent. CDWR (2006) indicates that Williamson and others used an average of 11.3 percent in the subbasin for computer modeling purposes. Estimates of specific yield discussed in this section are summarized below in **Table 3-1**. **Figure 3-17** is map of recommended specific yields for the NKGSA. Further discussions of specific yield for the NKGSA and the entire Kings Subbasin are presented in a June 27, 2017, Technical Memorandum prepared by Provost & Pritchard Consulting Group (P&P, 2017).

Table 3-1 Summary of Specific Yield Estimates

Publication	Estimated Specific Yield Range (%)	Description/Notes
Page & LeBlanc (1969)	5.3 to 18.7 0.2 to 36.6	Estimates based on percentage of coarse grained materials to 300 feet defining geologic facies A through F. Based on individual texture types for clayey, sandy silt to well sorted mostly sand and gravel.
Davis et al. (1959)	5.8 to 14.6	Based on textures 10 to 50 feet deep, 50 to 100 feet deep, and 100 to 200 feet deep.
Williamson et al. (1989)	6 to 18	Used an average of 11.3% in subbasin area for computer modeling purposes.

Hydraulic Conductivity and Transmissivity

Estimates of hydraulic conductivity and transmissivity are also available from published sources including Williamson and others (1989), Davis et al. (1964), and Nolte et al. (1957) and summarized by Page and Leblanc (1969). Nolte et al. (1957) performed seven aquifer tests, six on City of Fresno wells and one on Fresno County Water Works District 4, Well No. 2, for the Fresno Metropolitan Flood Control District and found that transmissivity in Townships 13S/20E and 14S/20E ranged from a low of 38,700 gallons per day per foot (gpd per ft) to 119,000 gpd per ft for wells completed in the Old Alluvium. Davis et al. (1964) provide information for numerous short-term pump test in the area and provide specific capacity (discharge in gpm divided by drawdown) by Township. Thomasson et al. (1960) developed an empirical relationship between specific capacity and transmissivity, which has also been discussed more recently by Abbott (2015). Transmissivity can be approximated by multiplying specific capacity by a factor of 1,500 for unconfined aquifers and 2,000 for confined aquifers. At the time that these studies were done, it is likely that most wells in the NKGSA area were likely shallow, and the resultant transmissivities are probably more valid for the shallower portion of the aquifer comprised of the Older Alluvium. Based on the data from Davis and others (1964) and the method developed by Thomasson and others (1960), transmissivities around the eastern boundary of the NKGSA range from 9,000 to 58,000 gpd/ft. Transmissivity values increase rapidly, westerly to the approximate middle of the NKGSA area where values as high as approximately 141,000 gpd/ft can be calculated. Towards the western boundary of the NKGSA area transmissivity values taper off slightly to around 96,000 to 114,000 gpd/ft.

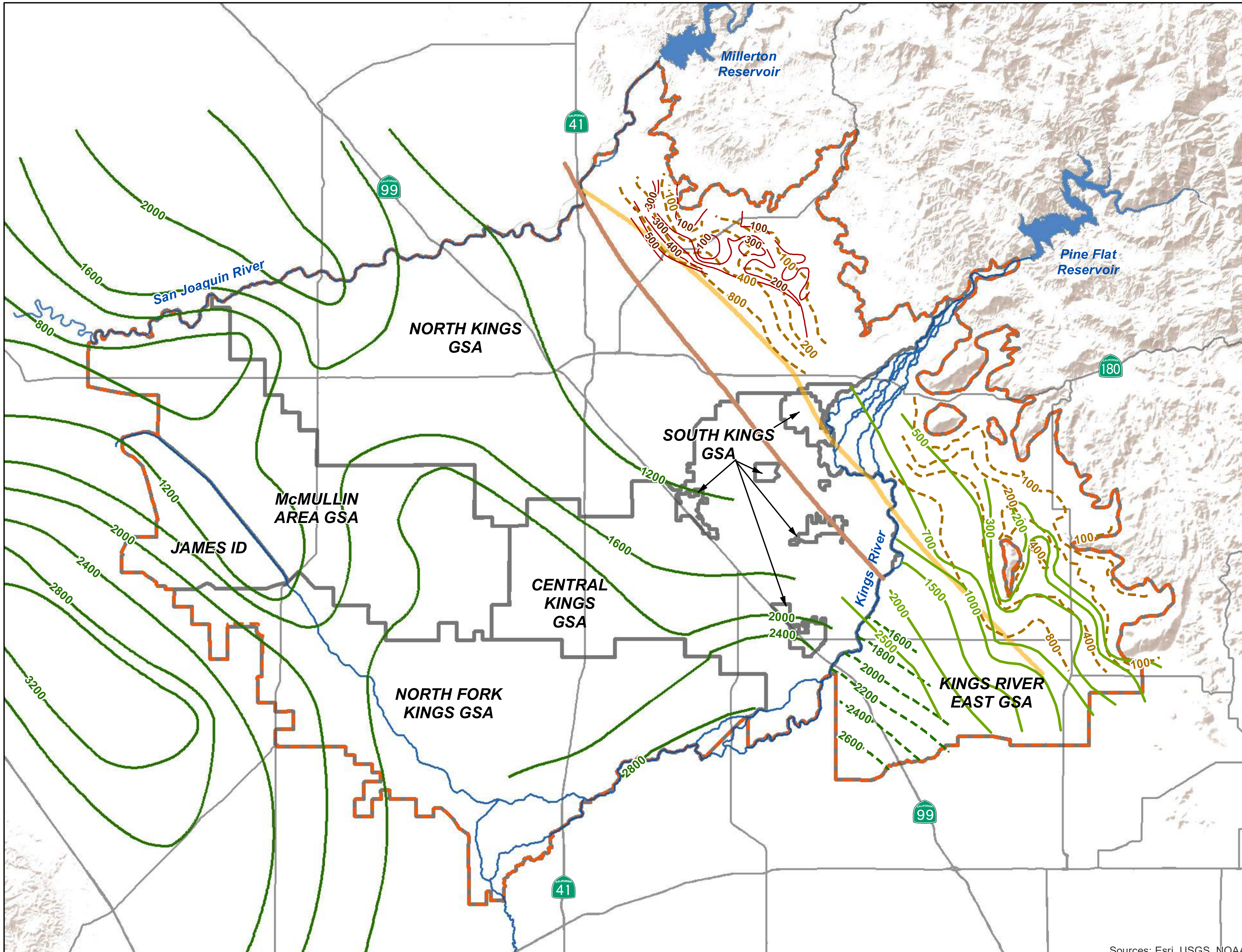
Hundreds of aquifer tests have been performed in the NKGSA area. Kenneth D. Schmidt and Associates (KDSA, 1992, 2004, 2006) have reported transmissivities values from aquifer tests ranging from 39,000 to 100,000 gpd/ft in the "North Fresno Growth Area" (North of Herndon Avenue and east of Freeway 41), 65,000 to 155,000 gpd/ft in southeast Fresno, and 112,000 to 253,000 gpd/ft in northwest Fresno. The highest transmissivities in the Fresno area were noted to be in southeast Fresno, west of Peach and south of McKinley Avenue, where KDSA estimates of transmissivity range from 57,000 to 369,000 gpd/ft

Estimates of transmissivity discussed in this section are summarized in **Table 3-2**.

Table 3-2 Summary of Transmissivity Estimates

Publication	Estimate of Transmissivity (gpd/ft)	Description/Notes
Nolte et a. (1957)	38,700 to 119,000	Based on aquifer tests on seven wells (six City of Fresno and one Fresno County) completed in older alluvium in Townships 13S/20E and 14S/20E.
Davis et al. (1964)	9,000 to 58,000 in the east to as high as 96,000 to 141,000 in the central and western area of the NKGSA	Based on specific capacity estimates from Davis & Others (1959) and Thomasson and Others (1960) and on empirical relationship between specific capacity and transmissivity.
KDSA (1992)	39,000 to 100,000 13,000 to 75,000 65,000 to 155,000 112,000 to 253,000	Based on aquifer tests in North Fresno Near Herndon Avenue and Shepherd Avenue in Fresno/Clovis Area Southeast Fresno Northwest Fresno
KDSA (2004)	39,000 to 100,000 65,000 to 155,000 112,000 to 253,000	Based on aquifer tests North of Herndon Avenue and East of Highway 41 in Fresno/Clovis Area Based on aquifer tests in southeast Fresno Based on aquifer tests in northwest Fresno
KDSA (2006)	10,000 to 179,000 3,500 to 109,000 15,000 to 135,000 57,000 to 369,000	Fresno North Growth Area East Fresno between Ashland Avenue and Olive Avenue, east of Peach Avenue Southeast Fresno east of Peach Avenue, south of Olive Avenue Southeast Fresno, west of Peach Avenue, south of McKinley Avenue

In general, transmissivity values are higher for the older alluvium than the underlying deposits. Transmissivity values of 50,000 to 250,000 gdp/ft would normally apply for the older alluvium, while transmissivity values of 10,000 to 30,000 gpd/ft would be more representative of the underlying deposits due to the fine-grained texture. Transmissivity values are higher in paleo channel deposits and lower in deposits dominated by finer grained floodplain deposits.



Kings Subbasin

Base of Aquifer

Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- 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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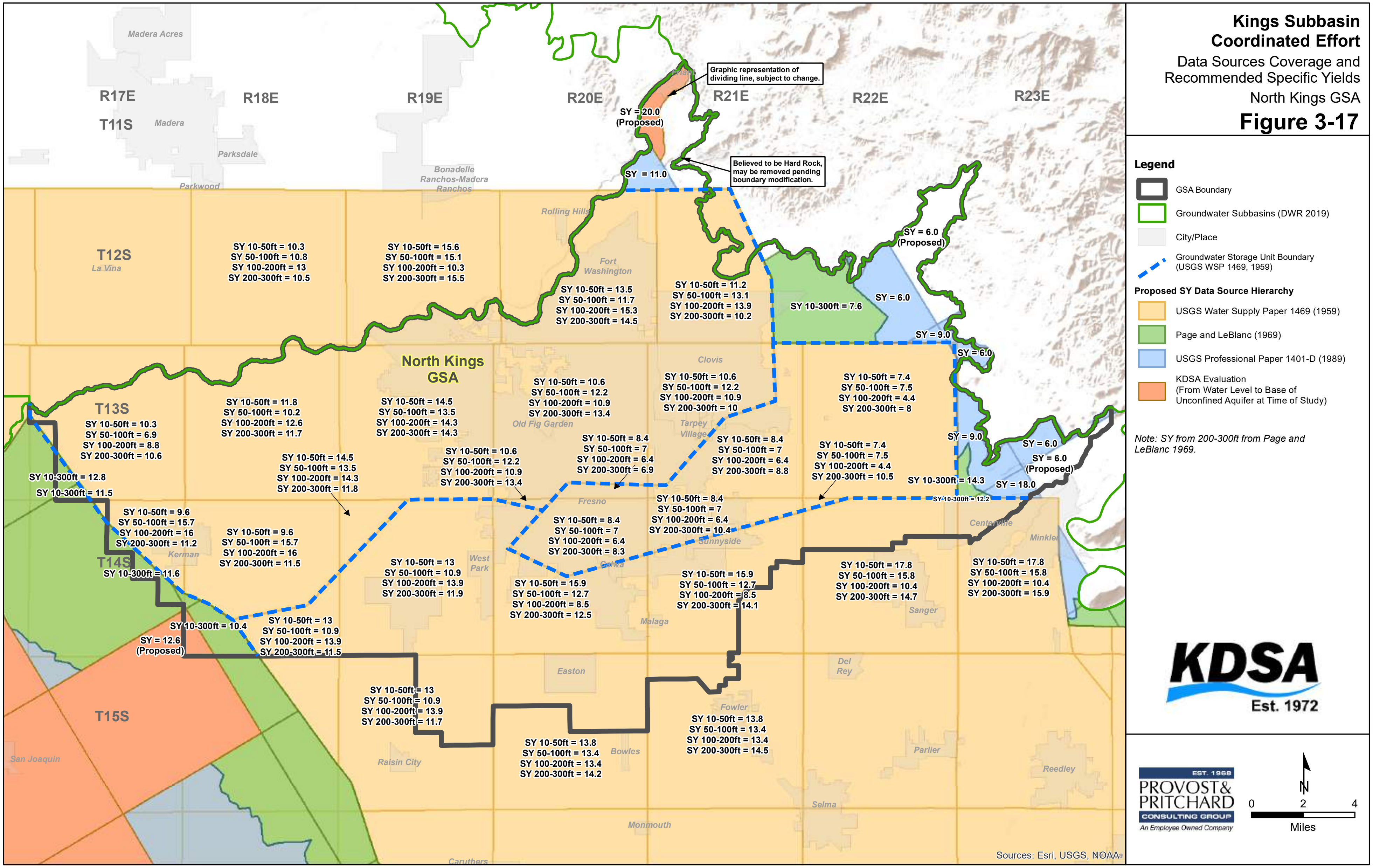

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3.1.8.3 Aquifer Uses

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 through 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 the aquifer, usually below the base of the unconfined groundwater, in efforts to meet MCLs without the need for treatment. More detailed information for the NKGSA is presented below.

The aquifers in the NKGSA are used for domestic, irrigation, industrial, and municipal water supply purposes. Groundwater pumping within the municipal areas is metered and municipal pumping within the NKGSA serving the cities of Fresno, Clovis, Kerman, Pinedale CSD, Malaga CWD, Bakman WD amounted to approximately 104,000 AF in 2015 (Fresno Area Regional GMP Annual Report). These amounts include deliveries for industrial demands within their systems. There is other private domestic pumping within the area for rural residential and private well systems, as well as industrial related pumping within some unincorporated areas. Groundwater pumping for agriculture is not measured and the pumping varies based on the variability of surface water supplies. Agricultural pumping for water years 2016-2017 has been estimated at 146,500 AF/year. Agricultural related pumping is the largest groundwater demand within the NKGSA. 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 a 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 testing of 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 along 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 the GSA. A more detailed discussion on groundwater quality is included in Groundwater Conditions, Chapter 3, Section 3.2.5.

Due to the lack of groundwater quality data within other 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 yielded more than 90 percent, at the time of Page and LeBlanc's study, of groundwater pumped from wells and is the most important aquifer in the area. Groundwater in the NKGSA 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 subbasin where some chloride waters are also found (Page and LeBlanc, 1969).

Groundwater in the Fresno area seldom exceeds 600 mg/L TDS, although at greater depths 2,000 mg/L TDS groundwater has been encountered. A typical range of groundwater quality in the basin is 200 to 700 mg/L TDS. As mapped by Page and LeBlanc, localized pockets of soft groundwater (0-60 mg/L total hardness) are found throughout the NKGSA area.

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 clay beds.

In addition to nitrates, groundwater impairments such as dibromochloropropane (DBCP), a soil fumigant nematicide, can be found in groundwater along the eastern side of the subbasin, and elevated concentrations of fluoride, boron, and sodium can be found in localized areas (CDWR, 2006). Other 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 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 NKGSA are being addressed by responsible parties through remediation, wellhead treatment, or avoidance. In some small communities, many domestic wells exceed water quality standards and residents continue to use the water due to lack of alternatives.

More in-depth discussions of groundwater quality issues related to nitrates and other groundwater impairments and the locations of known groundwater contamination sites and plumes are presented in Section 3.2.5 – Groundwater Quality Issues of the Groundwater Conditions Section.

3.1.10 Surface Water Features

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

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

Surface water features significant to the management of the NKGSA and the Kings Subbasin are shown on **Figure 3-18**. **Figure 3-19** is a more detailed map of surface water features significant to management of the NKGSA as discussed below

The Kings River flows southwest from Pine Flat Lake (located east of the NKGSA) and is the primary source of surface water to the NKGSA, providing as much as 500,000 AF/year or more. There are also river seepage benefits to the region from both the San Joaquin River and the Kings River. Less significant surface water supplies and seepage comes from several intermittent stream channels flowing southwest from the foothills east of the NKGSA. In the NKGSA these intermittent streams include Little Dry and Dry Creeks, Dog Creek, Redbank Creek, and Fancher Creek. Wahtoke Creek, Sand Creek, Cottonwood Creek, and Wooten Creek drain to Kings River East GSA. Hughes, Holland and Mill Creeks drain directly to the Kings River downstream of Pine Flat Reservoir.

The San Joaquin River flows southwest from Millerton Lake (located just north of the NKGSA basin) and defines the northwest boundary of the NKGSA (**Figure 3-19**). This river provides a moderate amount of water to the NKGSA through river seepage, riparian water diversions, and water contracts held by Fresno Irrigation District and the City of Fresno. The City of Fresno has a contract for 60,000 AF of Class 1 water. The total average annual available supply to the City is now lower because of the San Joaquin River Restoration Settlement. Fresno Irrigation District has a contract for 75,000 AF of Class 2 Water, which is generally only available in wetter years. Riparian water right holders own land adjacent to the river at the northern edge of the NKGSA. The Friant-Kern Canal, flowing southeast from Millerton Lake along the approximate eastern edge of the NKGSA, provides surface water from the San Joaquin River through several turnouts.

Surface water treatment plants include the City of Clovis Treatment Plant (22.5 million gallons per day [MGD]), City of Fresno Northeast Surface Water Treatment Plan (30 MGD), T-3 Storage and Treatment Facility (4 MGD), and the Southeast Surface Water Treatment Facility (54-80 MGD, under construction in 2017).

The City of Fresno owns one major groundwater recharge facility, known as Leaky Acres, located near the Fresno Yosemite International Airport. The City of Fresno also owns the Nielsen Recharge Basin. The City of Clovis owns one recharge basin located near the intersection of Alluvial and Clovis Avenues called the Marion Basin. The Cities of Fresno and Clovis have agreements with the Fresno Metropolitan Flood Control District (FMFCD) to use numerous flood control basins during dry months for groundwater recharge. Surface water supplies are also delivered into creek channels for recharge. Flood water is also a critical surface water supply to the NKGSA. Local storm water and flood water from the San Joaquin River, Friant-Kern Canal, Kings River, and the intermittent stream channels are routed through a complex system of canals and pipelines to Fresno Irrigation District, FMFCD, City of Clovis, and City of Fresno basins located throughout the NKGSA area for flood control and groundwater recharge. A more detailed discussion on the facilities and resources owned and operated by the various agencies within the NKGSA is included in the Plan Area chapter (Section 2) of this GSP.

Notable wastewater treatment facilities exist within the NKGSA, including the Fresno-Clovis Regional Wastewater Reclamation Facility, which accepts wastewater from several communities. This facility has a network of reclamation wells that extract water from below the percolation pond area and discharge the water into Fresno Irrigation District canals for use on downstream farmlands. Some of the other significant facilities include the Malaga County Water District Wastewater Plant, the City of Kerman Wastewater Treatment Facility, and the Clovis Sewage Treatment Water Reuse Facility.

The City of Fresno plans to use 25,000 acre-feet per year of recycled water to irrigate open spaces, parks, street medians, golf courses, and groundwater recharge facilities. The City is constructing an advanced treatment facility at the Fresno-Clovis Regional Wastewater Reclamation Facility to process and clean the water to meet state and federal standards and regulations for non-potable use. The initial capacity of the facility will be five million gallons per day with a future capacity of 30 million gallons per day. The new treatment facility will pump water into the new network of recycled water pipelines that will convey recycled water across the City. The route begins in a rural and agricultural area in Fresno County and moves east to high traffic City streets. High traffic volumes, businesses, agriculture, cemeteries, and residences are immediately adjacent to the project route (COF, 2017). Once constructed and operational, the advanced treatment facility and distribution system will enable the City to optimize use of its available water resources.

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.

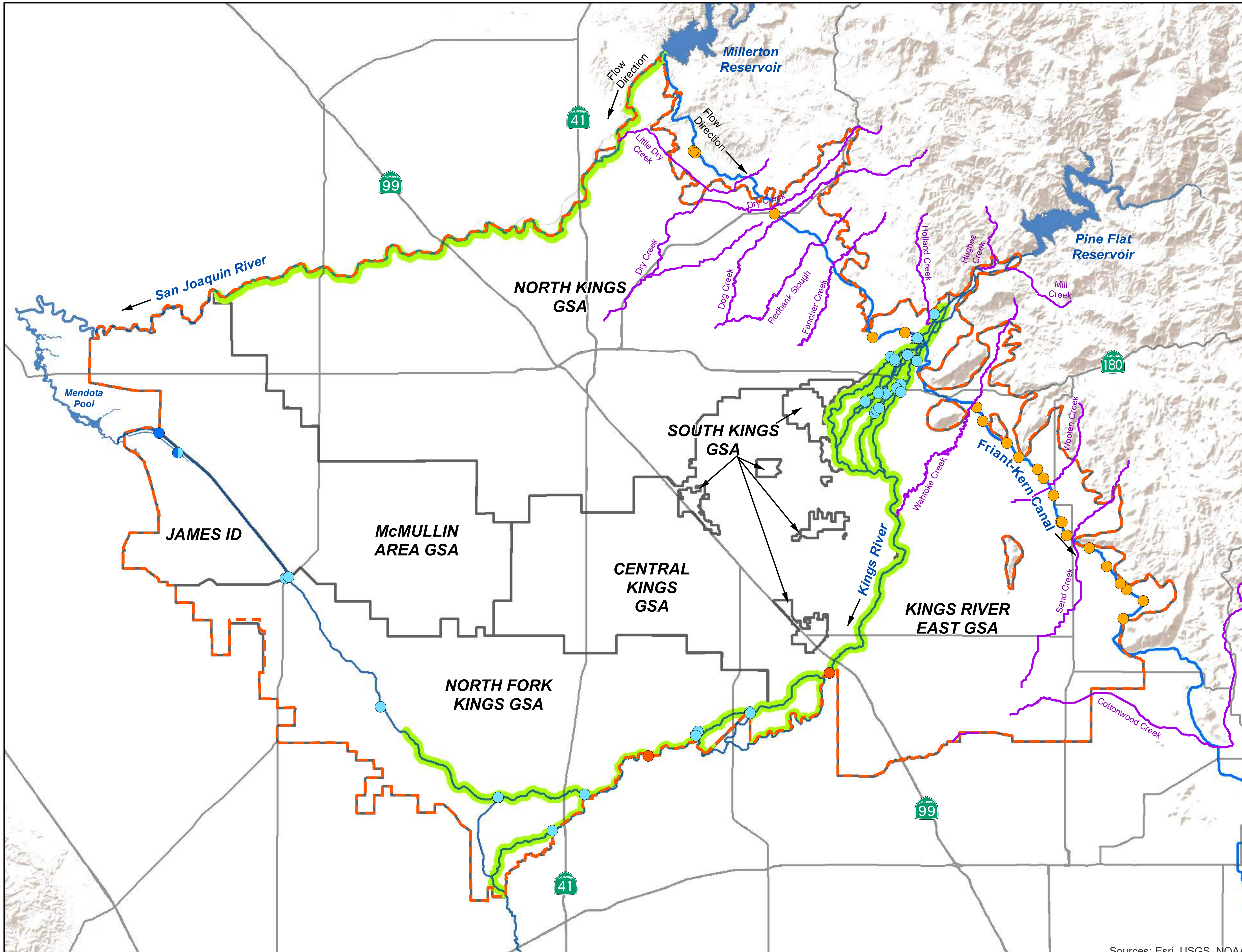
The primary source of surface water for the Kings Subbasin occurs from diversions from the Kings River. Additional sources of surface water occur from diversions from the San Joaquin River via the Friant-Kern Canal, Mendota Pool, and from intermittent streams (**Figure 3-18**). Millerton and Pine Flat Reservoirs and Mendota Pool are the main locations for storage and regulation of surface water supplies for the Kings Subbasin. More detailed information on the surface water features within the NKGSA is discussed below.

Surface water diversions from the San Joaquin River via the Friant-Kern Canal into the NKGSA areas occur; however, the primary source of surface water is diversions from the Kings River. Points of delivery for imported surface water into the area are shown on **Figure 3-19**. No significant groundwater importing program exists within the NKGSA area; however, it is assumed that property owners located along the boundaries of the NKGSA area may pump small amounts of groundwater from within the area to irrigate adjacent parcels located outside of the area. It is also assumed that the opposite is true, resulting in small amounts of groundwater imported into the NKGSA. Also, riparian water right holders exist along the San Joaquin River and the Kings River. The amount of surface water imported into the area from riparian water right holders is not believed to be significant.

Kings Subbasin

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

Figure 3-18



Legend

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

Diversion Into Kings Subbasin

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

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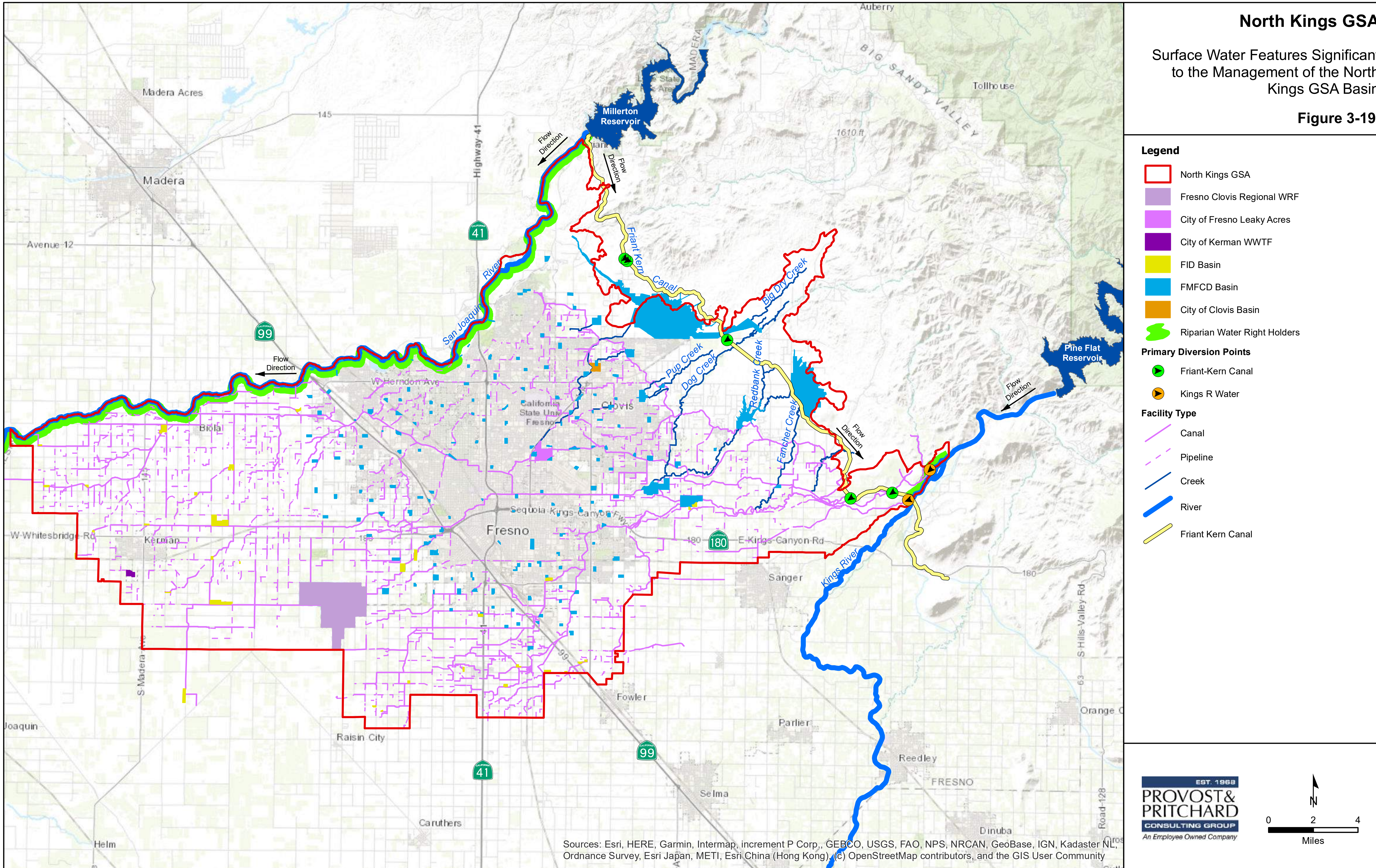
North Kings GSA

Surface Water Features Significant to the Management of the North Kings GSA Basin

Figure 3-19



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3.1.12 Recharge and Discharge Areas

Regulation Requirements:

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

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

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

Existing Recharge Areas

The NKGSA area includes natural recharge areas and constructed recharge basins. Natural recharge occurs from seepage from the San Joaquin River, Kings River, and numerous intermittent streams. Natural recharge from percolation of precipitation is considered minor. Numerous agencies engage in some form of recharge. These include seepage in unlined canals, reservoirs, stormwater basins, wastewater effluent ponds, and recharge basins. Existing recharge facilities in NKGSA are illustrated on **Figure 3-19**. Deep percolation of agricultural and landscape irrigation also makes significant contributions to groundwater recharge.

Potential Recharge Areas

Potential recharge areas can be identified using the soil and geologic maps 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 surficial recharge areas.

Except for Big Dry Creek, within the NKGSA, creeks (i.e., intermittent streams) have not been used for intentional recharge since the mid-1990s. These intermittent streams represent areas with potential for future intentional recharge.

Soils

A soils map based on NRCS soil textural classes in relation to Saturated Hydraulic Conductivity is presented as **Figure 3-6**. This map generally represents soil conditions in the upper 5 to 7 feet. The most permeable soils appear to be fingers travelling in an east-west direction that are likely recent streambed deposits. Refer to **Section 3.1.6** for further discussions on the soils. However, deeper conditions (7 to 50 feet in depth) are also important in the control of surface water infiltration, discussed below.

Geologic Facies
Figure 3-20 shows a map of geologic facies favorable for groundwater recharge in the Kings Subbasin as mapped 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 a subsurface material from contiguous 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 3-20** only shows the facies that are predominantly coarse-grained materials, thus more likely to be favorable for groundwater recharge. It should be noted that the location for groundwater recharge projects should be evaluated and investigated on a site-specific basis, regardless of the mapped geologic facies.

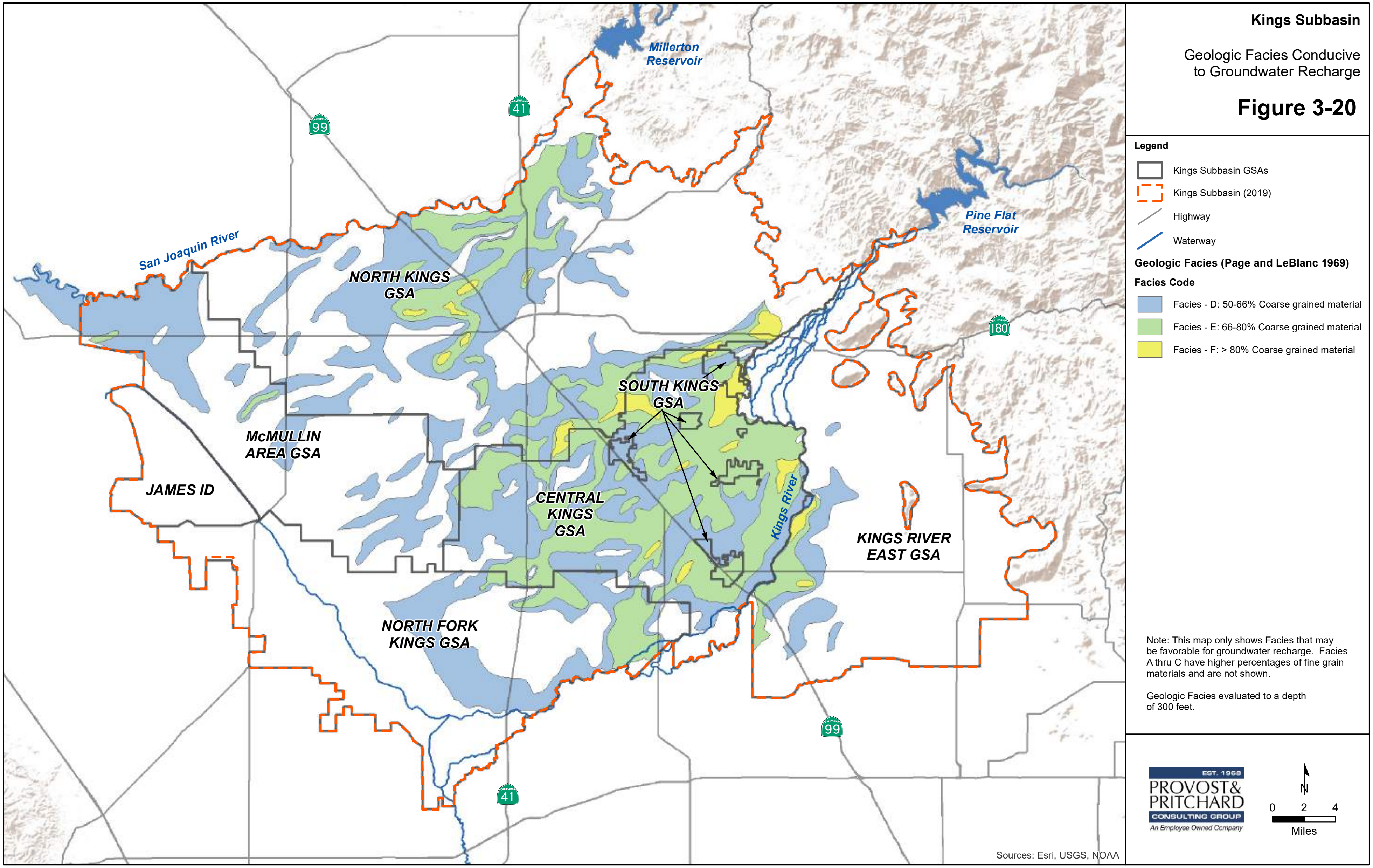
Soil Agricultural Groundwater Banking Index
The Soil Agricultural Groundwater Banking Index (SAGBI) is a composite evaluation of the feasibility of groundwater recharge on agricultural land (also called Irrigation Field Flooding). Irrigation Field Flooding could have significant potential for groundwater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

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.

Proximity to a water conveyance system is not a factor considered in the SAGBI composite evaluation. Each factor is scored on a range and weighted according to significance. Adjustments are then made to reflect soil modification by deep tillage (i.e., shallow hard pan is assumed to have been removed by historic farming activities). **Figure 3-21** illustrates the SAGBI Index for the NKGSA. Ultimately, SAGBI seeks to categorize recharge potential according to risk of crop damage at the recharge site. Usefulness of the index is diminished when evaluating locations for dedicated recharge basins. In these cases, a geologic profile illustrating deep percolation potential may prove to be more useful. As is the case with any model, the SAGBI is best applied in conjunction with other available data and on-site evaluation.

Discharge Areas
There are currently no known groundwater discharges (springs, seeps, etc.) in the area. Springs and artesian wells were common decades ago; however, groundwater levels have declined such that these features are no longer found in the NKGSA area. Groundwater level maps (See Section 3.2.1) show the average groundwater depths well below the surface.

Wetland Areas
Wetland areas from the U.S. Forest service's National Wetland Inventory are shown on **Figure 3-22**. Most wetlands are near the San Joaquin and Kings Rivers. Additional wetlands are associated with intermittent streams between the two major rivers: Redbank Creek, Dog Creek, Pup Creek, and Big Dry Creek. Some of the basins in the Cities of Clovis and Fresno are also mapped as wetlands.



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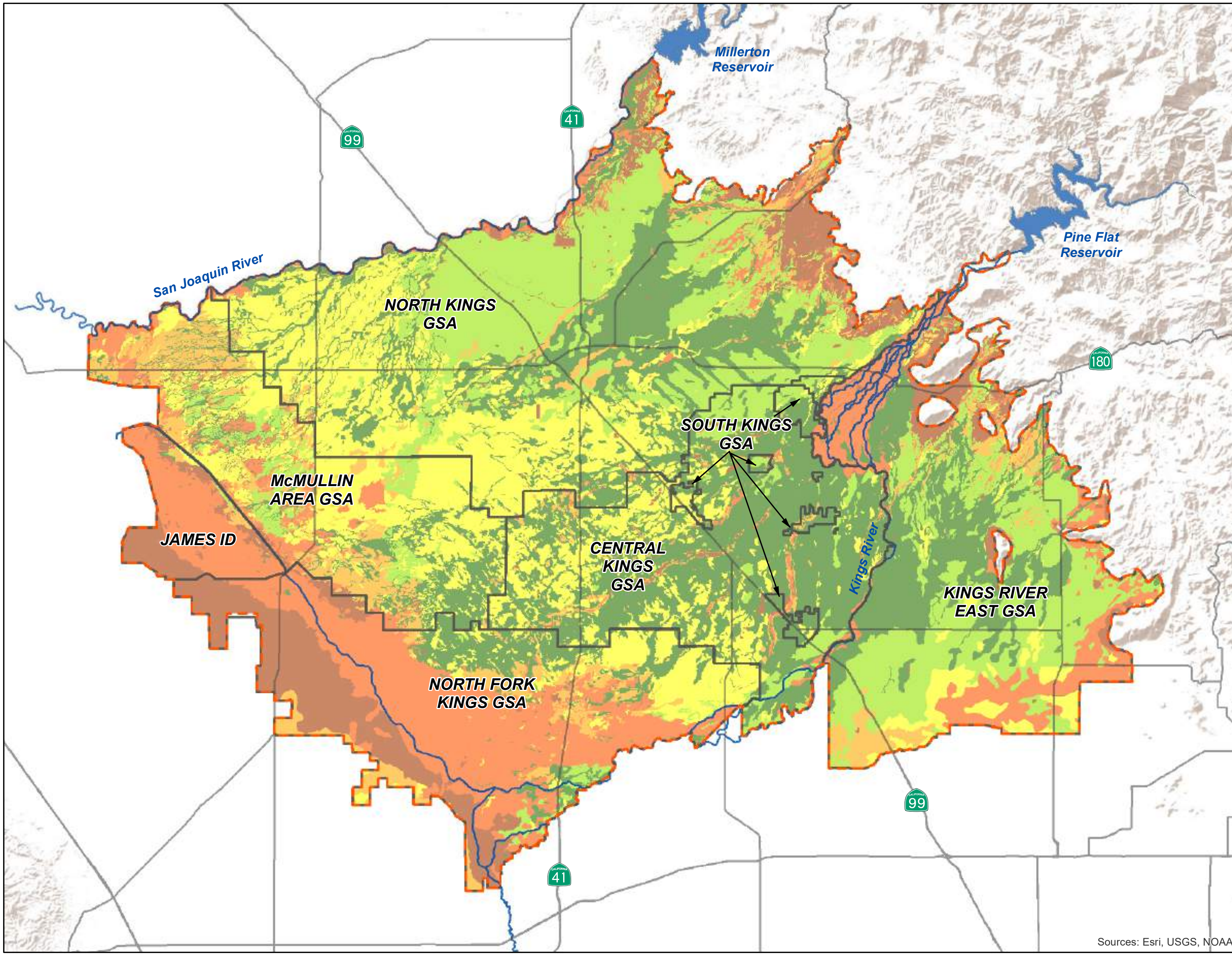

Kings Subbasin

Modified Soil Agricultural Groundwater Banking Index (SAGBI) Rating

Figure 3-21

Legend

- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway
- Waterway

SAGBI Rating - Modified

- 0 -15 Very Poor
- 15 - 29 Poor
- 29 - 49 Moderately Poor
- 49 - 69 Moderately Good
- 69 - 85 Good
- 85 - 100 Excellent

Note: The SAGBI Index evaluates the feasibility of recharging water on already cropped land and considers criteria such as percolation rate, slopes, soil chemistry and other factors.

Modified SAGBI Rating assumes that lands planted with orchard or vineyard crops on soils that have a restrictive layer have been deep tilled.

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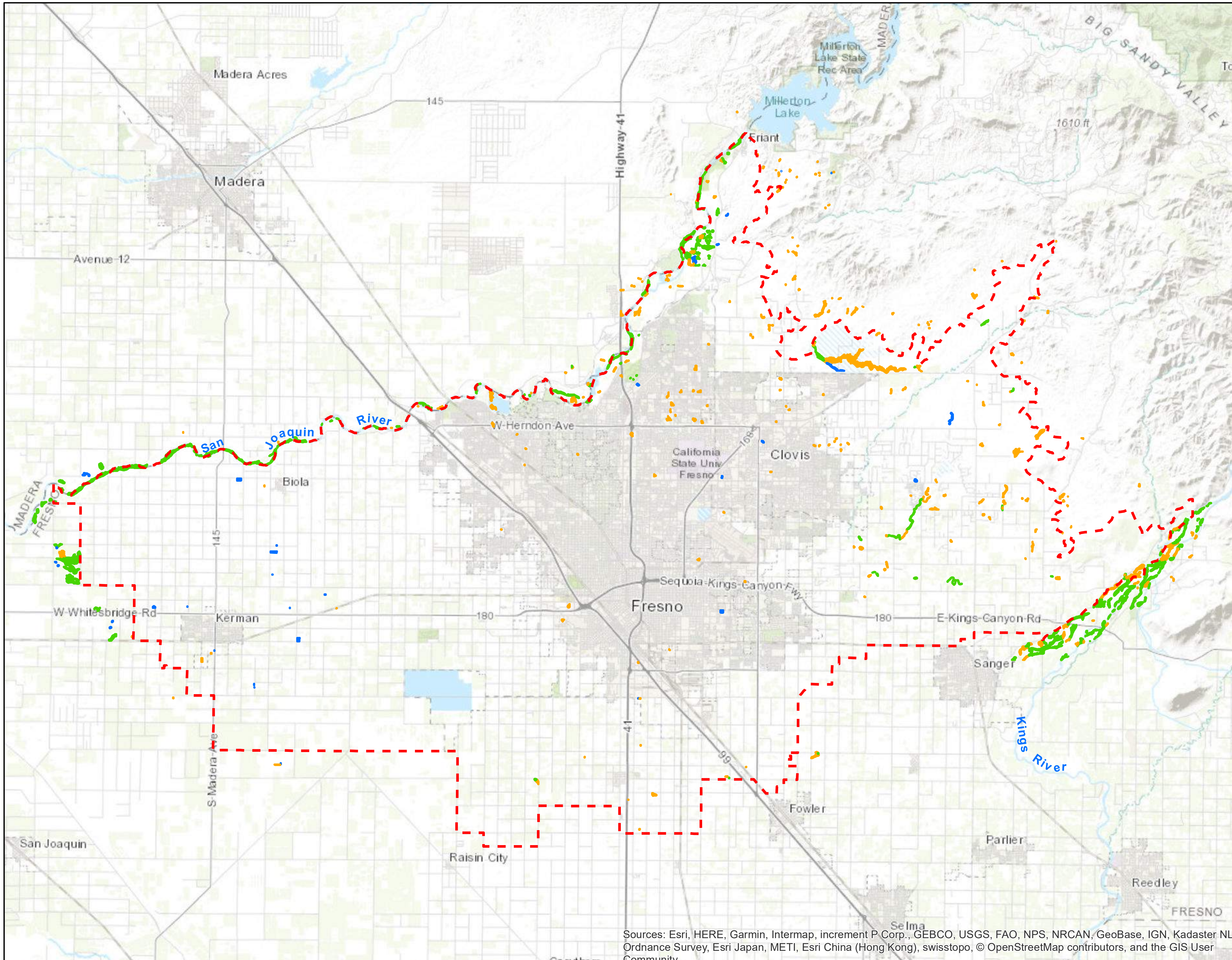

North Kings GSA

Wetlands

Figure 3-22

Legend

North Kings GSA

National Wetland Inventory*

Freshwater Emergent Wetland

Freshwater Forested/Shrub Wetland

Other Wetland

**Wetlands shown within the North Kings GSA area and up to 1 mile outside of the boundary.*

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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 NKGSA, including groundwater levels, storage, and quality; land subsidence, surface water/groundwater interconnections, and groundwater dependent ecosystems, are discussed in the subsequent Subsections.

The data was used to establish groundwater trends in the NKGSA. Topics addressed in this chapter include:

- Groundwater Levels
- Groundwater Storage
- Groundwater Quality
- Land Subsidence
- Surface Water and Groundwater Interconnections
- Groundwater Dependent Ecosystems

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

Unconfined groundwater conditions extend across essentially the entire Kings Subbasin. A map depicting the depth to the base of unconfined groundwater, based on KDSA's enhanced concept of confined groundwater conditions, is shown in **Figure 3-15**. 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, 1972). Currently, confined groundwater conditions still exist below the E and C clays. Groundwater below the A clay no longer appears to be confined. These clays are highly impermeable and restrict the vertical movement of water between more permeable beds wherever they occur. The most extensive and hydrologically important of these aquitards is the E-clay, commonly known as the Corcoran Clay. As shown in **Figure 3-5**, 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.

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.

This section presents groundwater depth maps, groundwater elevation maps, and well hydrographs throughout the NKGSA. These are provided respectively as **Figure 3-23**, **Figure 3-24**, **Figure 3-25** and **Appendix 3-B and Appendix 4-A**. A groundwater depth map, **Figure 3-23**, is a useful way to illustrate groundwater lift levels, a consideration for groundwater users. Groundwater elevation maps, **Figure 3-24**, and **Figure 3-25** are useful for showing the direction of groundwater flow and the locations of pumping depressions. The hydrographs illustrate long-term trends in groundwater levels.

Figure 3-24 shows the current (Spring 2017) groundwater surface elevation contours and general direction of unconfined groundwater flow in the Kings Subbasin for the seasonal high condition. In general, groundwater flow is to the southwest within nearly the entire subbasin with a few notable exceptions where municipal and irrigation pumping in parts of the Kings Subbasin have influenced the direction of groundwater flow or the influence of recharge from basins and the major rivers can be seen. **Figure 3-25** 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, South Kings GSA, and the western and northeast portions of North Kings GSA. Groundwater levels also rose in portions of North Fork Kings GSA near the Kings River and along the border with Westside Subbasin. The northern and southern portion of James ID GSA also had increases in water levels. Groundwater levels generally fell in McMullin GSA but did rise near the border with James GSA and near the intersection of T15S R18E, T15S R19E, 1T6S R18E, and T16S19E.

Several areas show the results of groundwater recharge occurring in 2017. The FID Waldron and Boswell banking facilities show more pronounced groundwater mounds, as well there is a groundwater ridge evident on the Fall 2017 groundwater elevation contour map in Central Kings GSA in an area with favorable geology for recharge and numerous recharge sites that trend southwest through the central portions of that GSA. It is estimated Central Kings GSA recharged on the order of 150,000 to 200,000 AF that year. The Fall 2017 map highlights the importance of surface water supplies in the 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 3-24**). In the Fresno-Clovis metropolitan area, an urban cone of depression is located north-northeast of the intersection of Highways 180 and 41 and has caused changes in the generally southwesterly groundwater flow direction as groundwater now moves toward the cone of depression under the urban area. In the area between southwest Fresno and the Fresno-Clovis Regional Waste-Water Treatment Facility, there is little change in groundwater elevation. In the northeast portion of the Fresno-Clovis urban area, roughly between Highway 168 and Shepherd Avenue and southwest of Big Dry Creek reservoir, groundwater gradient steepens appreciably due to deepening groundwater levels in the greater Fresno area and due to the poorer water bearing properties of subsurface materials in this area associated with the finer-grained deposits in the interfan area between the Kings and San Joaquin Rivers. There is also a general increase in groundwater gradient apparently associated with the finer grained deposits of the compound fan of intermittent streams south of the Kings River in the eastern portion of the Kings River East GSA.

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

Under natural flow conditions, prior to construction of Friant and Pine Flat Dams, 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 2 to 4 miles of the two rivers groundwater flow deviated from the regional southwest direction and flowed towards the river channels. The two rivers and Fresno Slough, being areas of groundwater discharge, were thus gaining streams. Once groundwater pumping, combined with the Friant and Pine Flat Dams, lowered water levels sufficiently, the San Joaquin and Kings Rivers, for the most part, became losing streams and groundwater started flowing away from them. Today groundwater forms ridges beneath both rivers which indicates both rivers are predominantly losing steams (**Figure 3-24** and **Figure 3-25**). A groundwater ridge along the San Joaquin River can be seen on both the Spring and Fall 2017 maps extending approximately the length of the North Kings GSA boundary. 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.

The NKGSA includes confined and unconfined groundwater. The results below are only for the unconfined portion of the aquifer. Sufficient data is not available to prepare accurate potentiometric surface maps for the confined aquifer. This is a data gap, which the NKGSA plans to address in future monitoring efforts.

Irrigation well depths in the eastern portion of the NKGSA (east of the city of Fresno) can be as shallow as 100 feet or less and average depths in this portion of the NKGSA are 100-200 feet. In the western portion of the NKGSA (west of the city of Fresno) irrigation wells can be as deep as 500-600 feet and average depths are 200-300 feet. City of Fresno and Clovis production wells vary in depth from 200-900 feet with average depths being in the 300-400 foot range. City of Kerman production wells are 400-900 feet deep. Biola CSD has two production wells that are 700 feet and 900 feet deep. The cities have drilled deeper wells in recent decades primarily because of water quality concerns. Private domestic wells within the NKGSA generally range in depth between 50 to 300 feet.

Depth to water in spring of 2017 in the NKGSA ranged from 10 feet to 180 feet below the ground surface. **Figure 3-23** shows depth to groundwater in NKGSA as of the spring of 2017. This map is based primarily on measurements from water supply wells and does not necessarily show the shallowest depth to water at any location. Depth to water in the NKGSA generally increases to the southwest. Over seven decades, a large cone of depression has developed under the Fresno/Clovis metropolitan area as the cities relied solely on groundwater for many years. A mound has formed in the area of the Fresno-Clovis Regional Wastewater Reclamation Facility located south and west of the City of Fresno. This mound is caused by percolation of treated effluent in the area.

Ten hydrographs of selected wells in the NKGSA, and a few outside of the NKGSA, are included in **Appendix 3-B**. The locations of the wells with hydrographs are shown on **Figure 3-23**. These hydrographs have a relatively long period of record (several of them have data starting in the 1940s and others have data from the 1950s and 1960s), are regularly measured, and are geographically distributed across the area. Data from these hydrographs provide a good indication of historical groundwater levels in the Kings sub-basin. Groundwater levels in the NKGSA have historically fluctuated seasonally and in response to wet or dry periods; however, all the wells show a long-term trend of declining water levels. The decline is gradual in most wells but does increase in recent years in some of the wells. With few exceptions, the lowest groundwater levels were during the recent drought period with low points around 2015 and 2016. The average decline in all the hydrographs is about 0.9 feet/year. The largest declines are in wells that are just outside (west and southwest) of FID. The intent of the NKGSA is that these wells will be monitored in the future and will remain key components of the monitoring network.

Historical Groundwater Conditions

Groundwater flow patterns in the upper (unconfined) and in lower 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 and Kings 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 3-26, 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 are (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 3-27.** 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 the groundwater levels, of the confined groundwater below the Corcoran Clay, as well as changed flow patterns in the aquifer above the Corcoran Clay (**Figure 3-26, Inset C**). As shown on **Figure 3-27**, 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 considerable 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 3-26, Insets B and C** illustrate this changed flow pattern near the San Joaquin River.

Vertical Gradients

Historically vertical flow gradients in the unconfined and confined portions of the aquifer had an upward component of 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, beginning in the 1950s, caused a change to this historic condition. The development of thousands of wells, perforated in aquifers both above and below the Corcoran clay, has 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 of the available data, 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 the hydraulic head in unconfined groundwater. Information on hydraulic head differences are available from the Fresno Irrigation District groundwater banking facilities, four relatively new wells installed near the border between North Fork Kings GSA and the Westside Subbasin, the regional wastewater treatment facility, and from the as-built diagrams of three 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 ft/ft. This indicates that 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 0 to 10 feet, and 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 at that 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, 40 feet 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 (**Figure 3-23 North Kings GSA Groundwater Depth Contours Spring 2017**). Data from a leaky aquifer test in late September/early October 2017, including a shallow and a deep monitoring well at the FID-Empire banking facility, indicates the difference in static water levels was about 9 feet. The area is underlain by a 55 feet thick aquitard, and the estimated vertical gradient was about 0.16 ft/ft, which is in the range estimated by Page and LeBlanc, 1969. Data from the Waldron facility between shallow monitor wells and deeper monitoring or recovery wells indicates that vertical head differences vary from 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 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 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 8 feet to as much as 40 feet and appear to be about 80 feet when the recovery well is pumping. This data also shows that vertical gradients tend to be less during the winter and early spring and increase during the summer months presumably due to increased groundwater pumping.

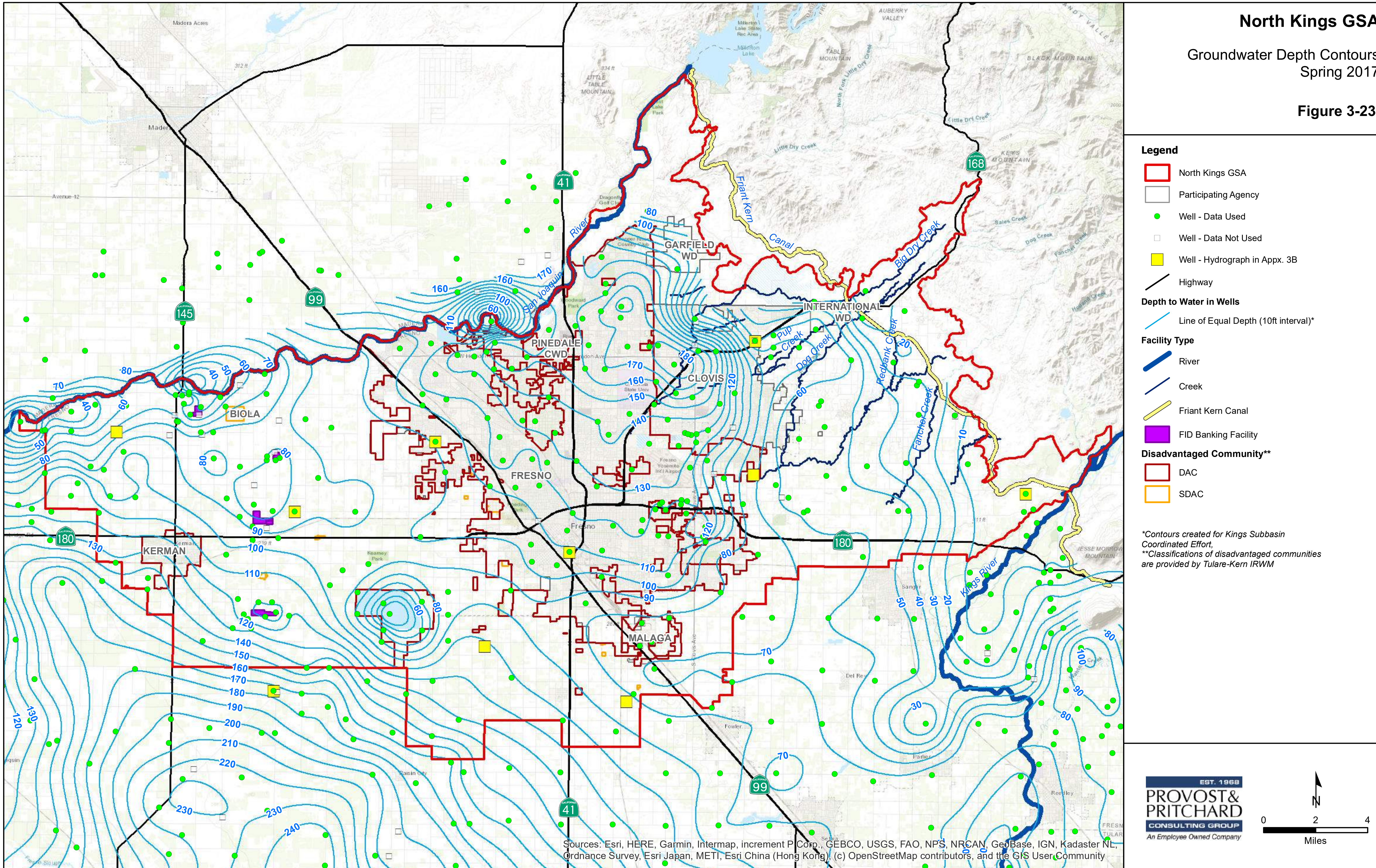
Water levels are available from four nested monitoring wells installed near the boundary between the North Fork Kings GSA and the Westside Subbasin under a DWR DAC grant. These wells have casings perforated above and below the Corcoran clay. Water elevation differences between unconfined and confined groundwater at the sites collected from May 31 to June 1, 2018, after the wells were developed, varied from 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, the data discussed above indicates that vertical gradients vary considerably in the sub-basin. 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 where vertical gradient information is needed.

3.2.2 Groundwater Movement

Figure 3-24 shows the Spring 2017 water surface elevation contours and general direction of groundwater flow within the NKGSA. Groundwater flow is generally to the southwest within the NKGSA. Heavy municipal and irrigation pumping in parts of the area have influenced the direction of groundwater flow. In the Fresno-Clovis metropolitan area, the urban cone of depression is located 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 this area groundwater flows from all directions towards the groundwater depression. In the area between southwest Fresno and the Fresno-Clovis Regional Wastewater Reclamation 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, the 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.

Under natural San Joaquin River flow conditions, the groundwater in most of the area flowed toward the San Joaquin River, which resulted in a gaining stream. Once groundwater pumping lowered water levels sufficiently, the San Joaquin River became a losing stream and groundwater started flowing away from the stream. Additionally, based on the Spring 2017 groundwater elevation contours, there are numerous groundwater pumping depressions interrupting the natural flow pattern. Along the western boundary of NKGSA, groundwater generally flows southwest towards the McMullin and James GSAs. South and southwest of the Fresno-Clovis Regional Wastewater Reclamation Facility the groundwater gradient steepens towards the groundwater depression near Highway 145 and McMullin Grade in the McMullin GSA. On the northwest corner of the NKGSA, along the San Joaquin River, groundwater flows southerly to southwesterly due to seepage from the river towards the McMullin GSA. Along the southern border of the NKGSA, generally to the southwest from the Kings River to about 3 miles west of Highway 41 east of Raisin City, groundwater flows roughly sub-parallel to the NKGSA boundary. Along this segment of the boundary, groundwater still flows in a direction similar to the inferred natural flow direction.



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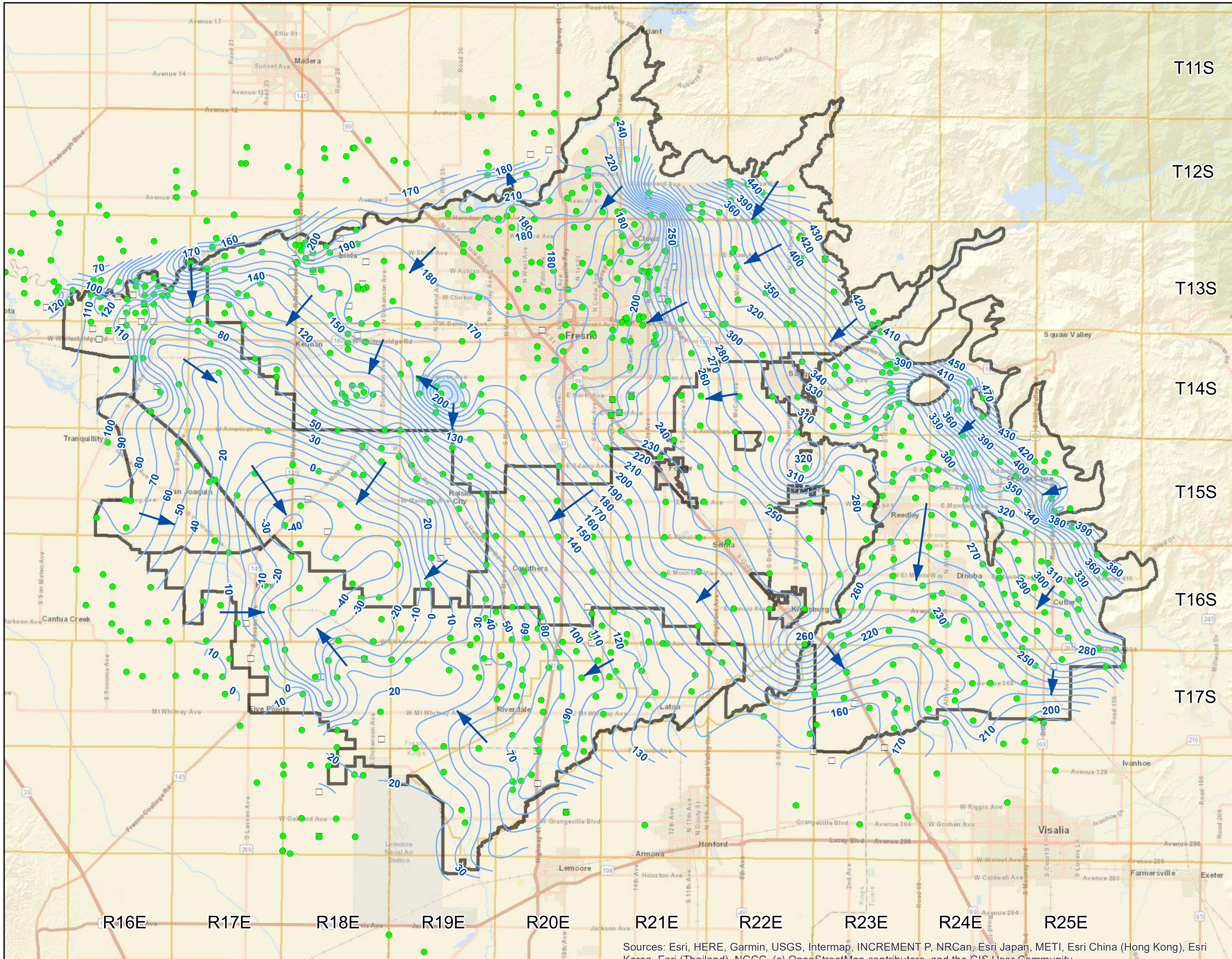
Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2017
Groundwater Elevation Contours
Figure 3-24



Legend

- 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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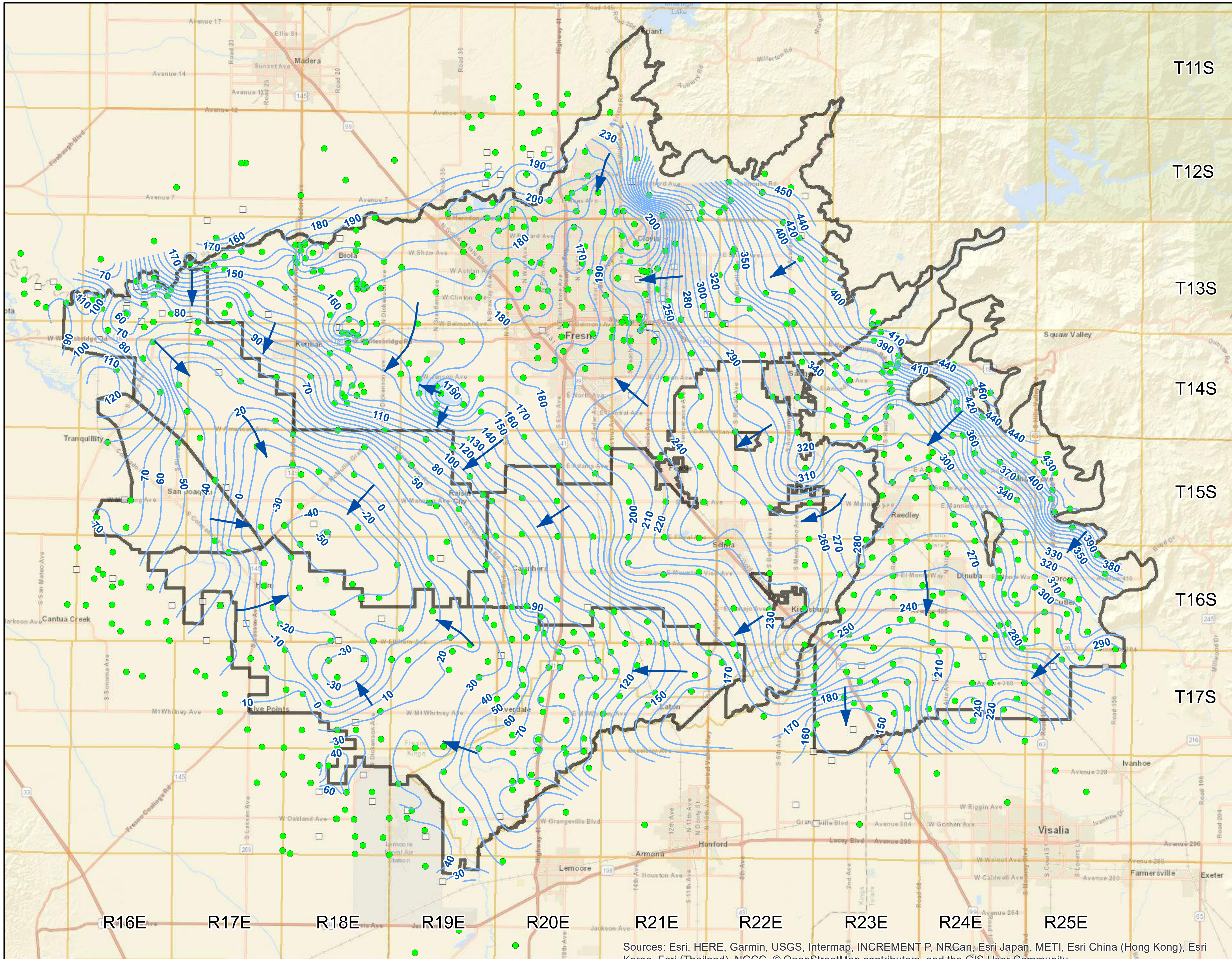
Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Fall 2017
Groundwater Elevation Contours

Figure 3-25



Legend

- 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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Figure 3-26 Kings Subbasin Changes to Groundwater Flow Patterns

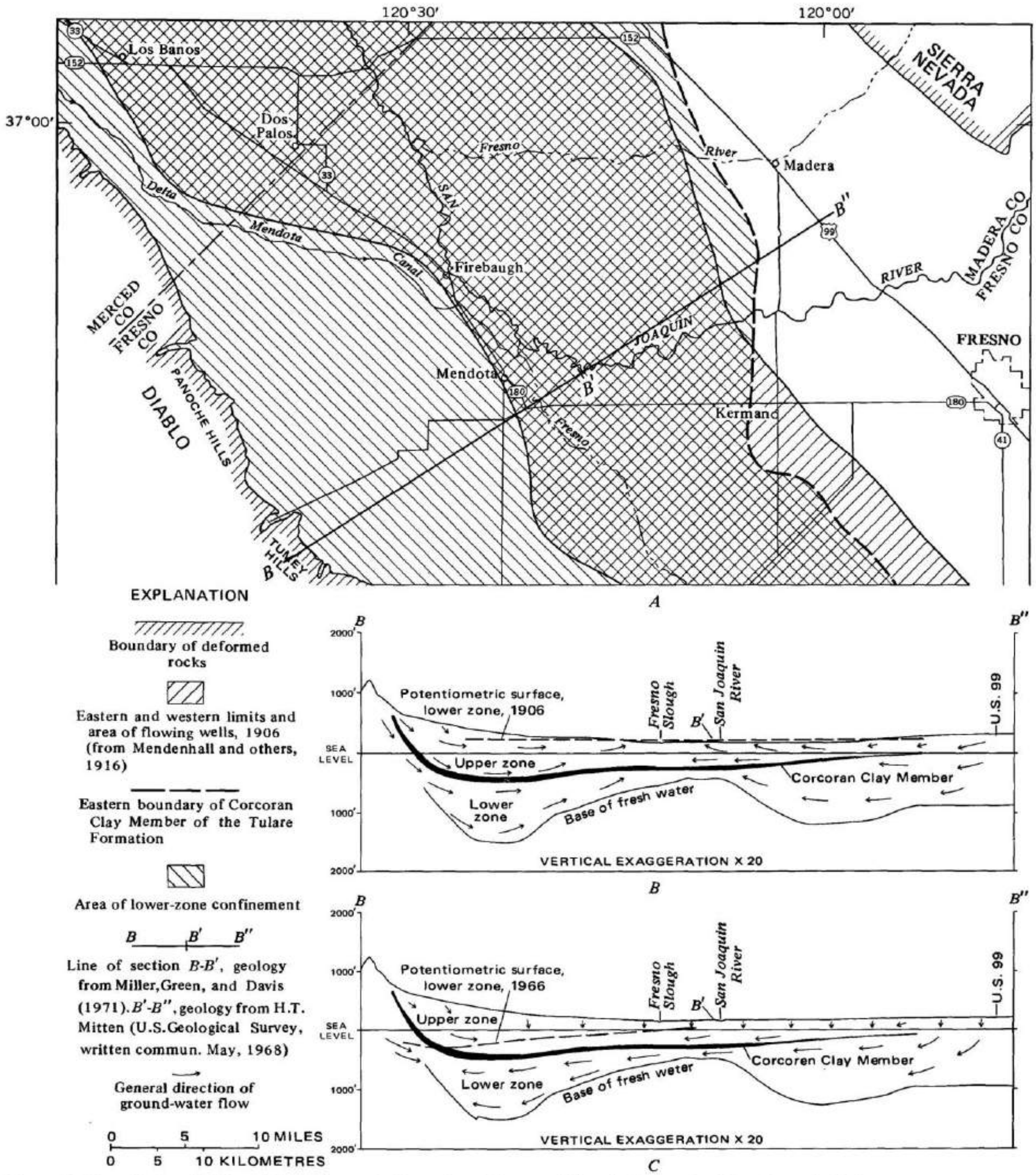
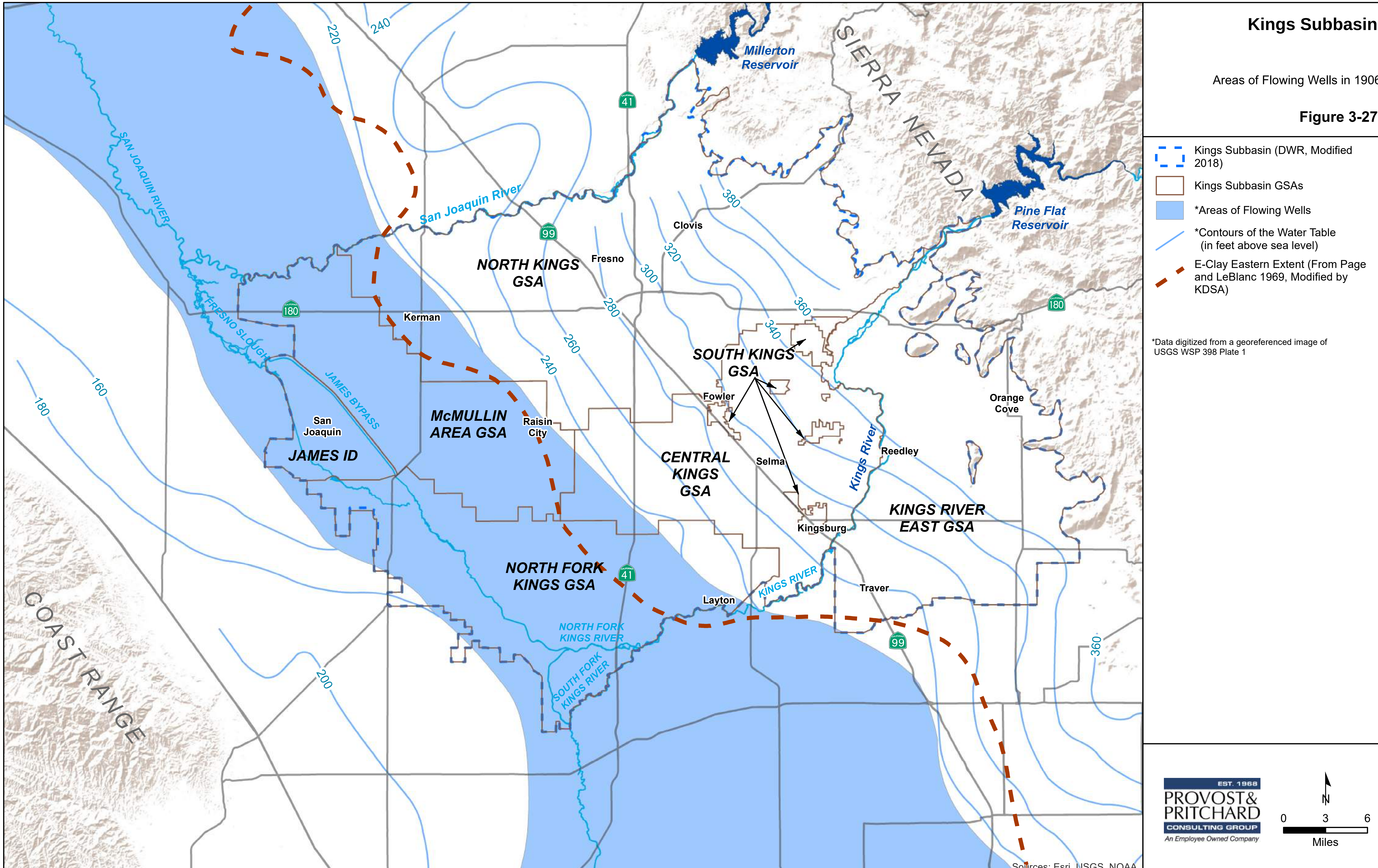


Figure 20 from Bull and Miller, 1975. Change in the natural-flow conditions in the central San Joaquin Valley.
A, Extent of lower-zone unconfined. B, Flow conditions in 1900 (pre-development). C, Flow conditions in 1906 (post-development).

Kings Subbasin

Areas of Flowing Wells in 1906

Figure 3-27



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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.

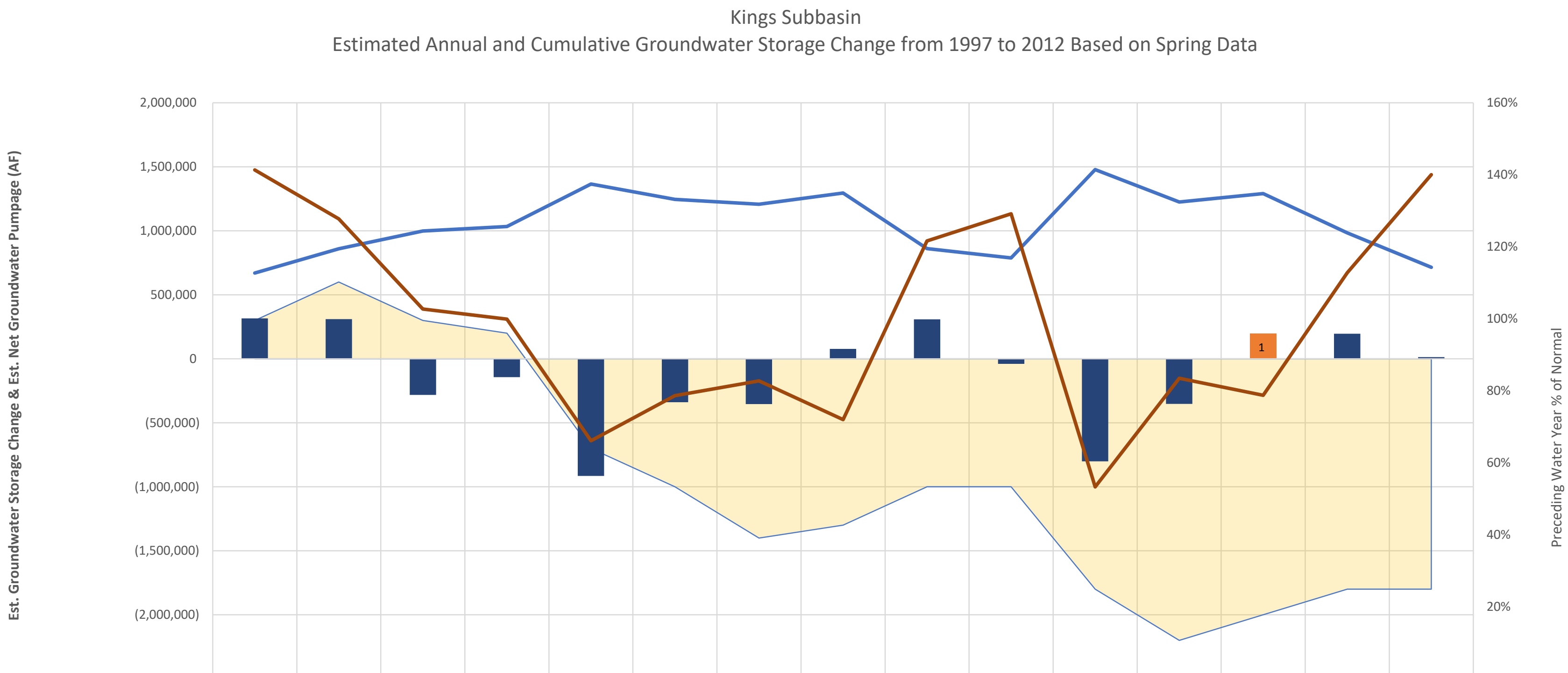
As part of the coordination of GSAs within the Kings Subbasin, a common method was utilized to estimate the change in groundwater storage for the entire subbasin and within each GSA. This method estimated storage within the upper, unconfined groundwater. Estimated storage change in the lower confined aquifer is not feasible due to limited data from confined wells throughout the NKGSA. Refer to Section 3.1 – Hydrogeologic Conceptual Model for more details on the different aquifers in the NKGSA.

Appendix 3-A includes Kings Groundwater Subbasin Technical Memorandum 2 that documents the basis for selecting specific yield values throughout the NKGSA. 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 NKGSA 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 NKGSA 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 subareas.
5. Then compare the storage from one year to the next, the difference equals the storage change.

A similar storage change calculation has been performed by the Fresno Area Regional Groundwater Management Group and Fresno Irrigation District for many years.

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 3-28**, for the Kings Subbasin. The methods for estimating storage change are detailed in Technical Memorandum 4 (**Appendix 3-A**). 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. 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.



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

Year

Notes:
1 - Storage change for 2010 is average between storage change from 2009 to 2011. Groundwater Elevation contours not prepared for Spring 2010 due to a lack of data in Central Kings GSA.
2 - Annual storage change is from spring of the preceding year to spring of year shown, for example storage change shown under 1 998 is storage change from spring 1997 to spring 1998.
3- Preceding WY ends Sept. 1 of the previous year, for example the 1996/1997 Water Year ends on Sept. 1, 1997 and is shown underthe 1998 column on this graph.

Figure 3-28

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.

As the NKGSA is approximately 100 miles from the Pacific Ocean, seawater intrusion is not feasible and is therefore not possible.

3.2.5 Groundwater Quality Issues

Regulation Requirements:

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

Groundwater quality in the NKGSA is generally suited for irrigation and domestic use, although a number of groundwater issues for drinking water exist in some areas within the NKGSA. The water purveyors within the NKGSA perform routine water quality monitoring as required by the State Water Resources Control Board, Division of Drinking Water. The requirements for testing are based on the public water system classification and size. The water is generally described as being a bicarbonate-type water, including calcium, magnesium, and sodium as the dominant cation. Specific water quality concerns include nitrate, arsenic, DBCP, 1,2,3-TCP, MTBE, landfill leachate, uranium, solvent-related constituents, such as trichloroethylene (TCE) and hexavalent chromium. While some of these constituents have point sources, others are naturally occurring.

Figure 2-7 in Chapter 2 - Plan Area is the most recently available map of major contaminant plumes in the Fresno Metropolitan area. **Figure 3-29** through **Figure 3-34** show relatively recent (July 2015 through October 2018) distribution of the chemicals of concern across the NKGSA outside of the Fresno Metropolitan area based on the enhanced Groundwater Ambient Monitoring and Assessment Program (GAMA) Groundwater Information System database utilized for the January 2019 Tulare Kern Funding Area DAC Preliminary Needs Assessment study (Provost & Pritchard, 2019). Additional discussion on the chemicals of concern in the NKGSA are below.

The following is a list of the water quality concerns in the area. Some of these are significant concerns while others are minor or geographically limited:

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

Nitrate is an important constituent of concern in the area. Concentrations exceeding the MCL of 10 mg/L have been detected in many shallow domestic wells. Data from the area shows that nitrate concentrations are higher in the unconfined groundwater and are much lower in the confined groundwater. Nitrate concentrations from monitored public water systems in the NKGSA range from not detected to greater than 90 mg/L with the predominance of results under the MCL of 10 mg/L. Elevated concentrations are generally in the southwest and southeast portion of the NKGSA. Pockets of larger numbers of septic systems can be found near Clovis and both northeast and southwest of Fresno, contributing to the nitrate loading.

In general, nitrate concentrations in the aquifers under Fresno have varied, increasing in some locations while decreasing in others. The City of Fresno has removed some wells from service with elevated nitrate concentrations and generally replaced them with deeper wells. The City's Nitrate Management Plan (Boyle Engineering, 2006) identified major sources of nitrate from the formerly unsewered Old Fig Garden and Mayfair areas, unsewered Sunnyside and Fort Washington areas, and the area along Clovis Avenue between Belmont and McKinley. Nitrate levels have been greatly reduced beneath and downgradient from the now sewered Mayfair and Old Fig Garden areas. Mayfair has seen the greatest reduction and is believed to be attributable to the nearby recharge activities at Leaky Acres. Continued elevated nitrate concentrations exist beneath and downgradient of the Sunnyside and Fort Washington areas, and both remain unsewered. These two areas and the Tarpey Village area along Clovis Avenue are continuing sources of nitrates. Higher nitrate in wells also remains a concern for some very small DAC and SDAC systems outside of the City of Fresno but within the NKGSA. A map depicting relatively recent nitrate concentrations around the NKGSA outside of the Fresno Metropolitan area is presented in **Figure 3-29.**

A 2006 Hydrologic Conditions in the Fresno Metro Area study by Kenneth D. Schmidt and Associates (KDSA) updated a 1992 evaluation of four groundwater quality constituents. Three large areas of recent high nitrate concentrations were identified near the Gallo Winery, the unsewered area in the Sunnyside area, and the irrigated area southwest of Fresno.

- Arsenic. Arsenic occurs in natural deposits. Arsenic in groundwater in the NKGSA is generally found at greater depths where reduced deposits are present. The MCL is 10 μg/L. A map depicting relatively recent arsenic concentrations around the NKGSA is presented in **Figure 3-30**

- Dibromo-Chloropropane (DBCP). DBCP was used as a fumigant to kill nematodes in soil before planting and was widely used in California until 1977. The MCL is 0.2 μg/L. DBCP was used in vineyards and deciduous orchards where sandy soils were present. The southeast and western portion of the NKGSA are the general areas where DBCP was detected. Higher DBCP levels are generally found in the shallow aquifer, above 200 feet. A 2006 assessment of DBCP trends indicated that the peak concentrations are significantly lower than in 1989-91. DBCP concentration levels and the extent of DBCP has decreased over time due to the degradation process and dilution due to recharge. DBCP in wells remains a concern for some small DAC and SDAC systems outside of the Fresno Metropolitan area but within the NKGSA. A map depicting relatively recent DBCP concentrations around the NKGSA outside of the Fresno Metropolitan area is presented in **Figure 3-31.** The City of Fresno has treatment on its well heads for DBCP, as does the City of Clovis. Both the Cities of Fresno and Clovis have petitioned DDW for removal of wellhead treatment by granular activated carbon (GAC) due to levels of DBCP being consistently less than half the MCL. DDW has a procedure for evaluating these requests and has granted permission to remove treatment for DBCP from several wells over the years. Many of these same wells are now impacted by 123-TCP.

  1,2,3-Trichloropropane (TCP). TCP is used industrially (paint and varnish remover as a cleaning and degreasing agent) and chemically (solvent and intermediate for pesticides).

There is no current federal MCL; however, California has adopted its own drinking water standard of 5 parts per trillion which went into effect on December 14, 2017. TCP has been detected in shallow groundwater in rural areas, along Highway 99, and in some public supply wells. Some municipal supply wells have existing GAC treatment that removes TCP, and the appropriate monitoring has been added at these locations. A map depicting relatively recent TCP concentrations in the NKGSA is presented in **Figure 3-32**.

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

- Landfill Leachate. Landfill leachate is formed when landfill waste degrades, and rain rinses the resulting products out. Leachate is a combination of many different chemicals. The black liquid contains organic and inorganic chemicals, heavy metals, as well as pathogens. Its composition varies both temporally and spatially since it depends on the composition of the originating waste. MCL's are dependent on the specific identifiable constituents in the leachate and not all constituents will have an MCL. Leachate is problematic in the NKGSA, but issues are isolated to areas around some existing or inactive landfills.

- Uranium. Uranium occurs naturally in groundwater in parts of the NKGSA. Uranium is derived from Sierra Nevada granitics and will preferentially adhere to clays. There is potential for radon gas, formed by the decay of uranium, to pool in unventilated basements. Uranium is used in nuclear technology, as a colorant in uranium glass, for tinting in early photography, in the leather and wood industries for stains and dyes, and in the silk and wood industries. The MCL is 30 µg/L or 20 picocuries/liter. Uranium has been found in municipal wells in the City of Kerman and in the area of Easton. A map depicting relatively recent uranium concentrations around the NKGSA outside of the Fresno Metropolitan area is presented in **Figure 3-33**.

- Solvents. Perchloroethylene (PCE) and Trichloroethylene (TCE) are both volatile organic compound solvents used as cleaning agents. Some dry cleaners and other businesses that used these chemicals were point source contributors. Used chemicals were often disposed into local wastewater conveyance systems. Leaks in the conveyance system and direct discharges may have contributed to point source contamination areas. PCE is listed as a potential cancer-causing agent. TCE is listed as both a potential cancer-causing agent and reproductive toxin causing developmental toxicity and male reproductive toxicity. The State MCL for both PCE and TCE is 5 µg/L. Some municipal wells within the City of Fresno and Pinedale County Water District have tested positive for PCE and TCE in concentrations above the MCL.

- Hexavalent Chromium. Hexavalent chromium [Cr(VI)] is one of the valence states (+6) of the element chromium. Although chromium is naturally occurring, Cr(VI) can be produced by industrial processes but sometimes is also naturally occurring. Inhalation and ingestion of

Cr(VI) is known to cause cancer. Workplace exposures occur mainly during welding and other types of "hot work" on stainless steel and other metals that contain chromium; use of pigments, spray paints and coatings; and operating chrome plating baths. In 1977, California established an MCL for total chromium as 50 μg/L under which Cr(VI) has been regulated. The US Environmental Protection Agency (EPA) adopted the same 50 μg/L standard for total chromium but in 1991 raised the federal MCL to 100 μg/L. California did not follow the US EPA's change and stayed with its 50 μg/L standard. Efforts to set a specific Cr(VI) MCL for drinking water in California resulted in an established MCL of 10 μg/L, effective July 1, 2014. On May 31, 2017, the MCL was invalidated by the Superior Court of Sacramento County stating that the State Water Resources Control Board (SWRCB) did not adequately document why the MCL was economically feasible. The court also ordered the SWRCB to adopt a new MCL for Cr(VI) which is currently in process. Hexavalent chromium has been found in Kerman, at some local groundwater banks and the City of Fresno based on the data available on the state's GAMA Geotracker database. A map depicting relatively recent hexavalent chromium concentrations in the NKGSA, based on GAMA Geotracker data, is presented in **Figure 3-34.** Hexavalent chromium concentrations shown on **Figure 3-34** are compared to the United States Geological Survey, Health Based Screening Level (USGS-HBSL) of 0.02 mg/l (20 μg/L). Note that hexavalent chromium water quality data for **Figure 3-34** includes date from 2014 to 2018.

Despite the water quality concerns documented above, the groundwater is generally good for irrigation and adequate for domestic consumption. Many of the groundwater quality concerns are found in the shallow water. Municipal wells are generally drilled deep enough to avoid these concerns. However, private domestic wells are typically shallow, and groundwater quality problems do exist in various rural communities. Composite wells perforated across from two or more aquifers are known to have been installed, at least occasionally, within the NKGSA. Such composite wells can be potential issues with regards to the migration of pollutants to deeper groundwater zones.

In 2015, the City of Clovis had 28 active wells that receive no treatment, with only six wells that receive treatment, and two wells that are on standby due to water quality issues. West Yost (2007) provides a summary of City of Fresno wells with water quality issues. In 2007, the City had approximately 250 production wells. Thirty-eight of the wells (15%) had wellhead treatment systems for the removal of various compounds. Most of the treatment systems used granular activated carbon (GAC). Approximately 6% of the wells were being blended or had blending plans. It was anticipated that more wells may require treatment in the future due to 1,2,3-TCP contamination. Several agencies have received settlements in a number of lawsuits related to certain contaminants, then used the settlement funds to construct wellhead treatment systems and implemented blending plans for several wells. Additionally, there may also be agencies in the process of pursuing litigation or have legal action pending decisions.

Several State of California online databases provide information and data on known groundwater contamination, planned and current corrective actions, investigations into groundwater contamination, and groundwater quality from select water supply and monitoring wells. These databases are listed below and discussed in section 2.4.3- Migration of contaminated groundwater:

- California Water Resources Control Board: http://geotracker.waterboards.ca.gov
- The Department of Toxic Substance Control: http://www.envirostor.dtsc.ca.gov

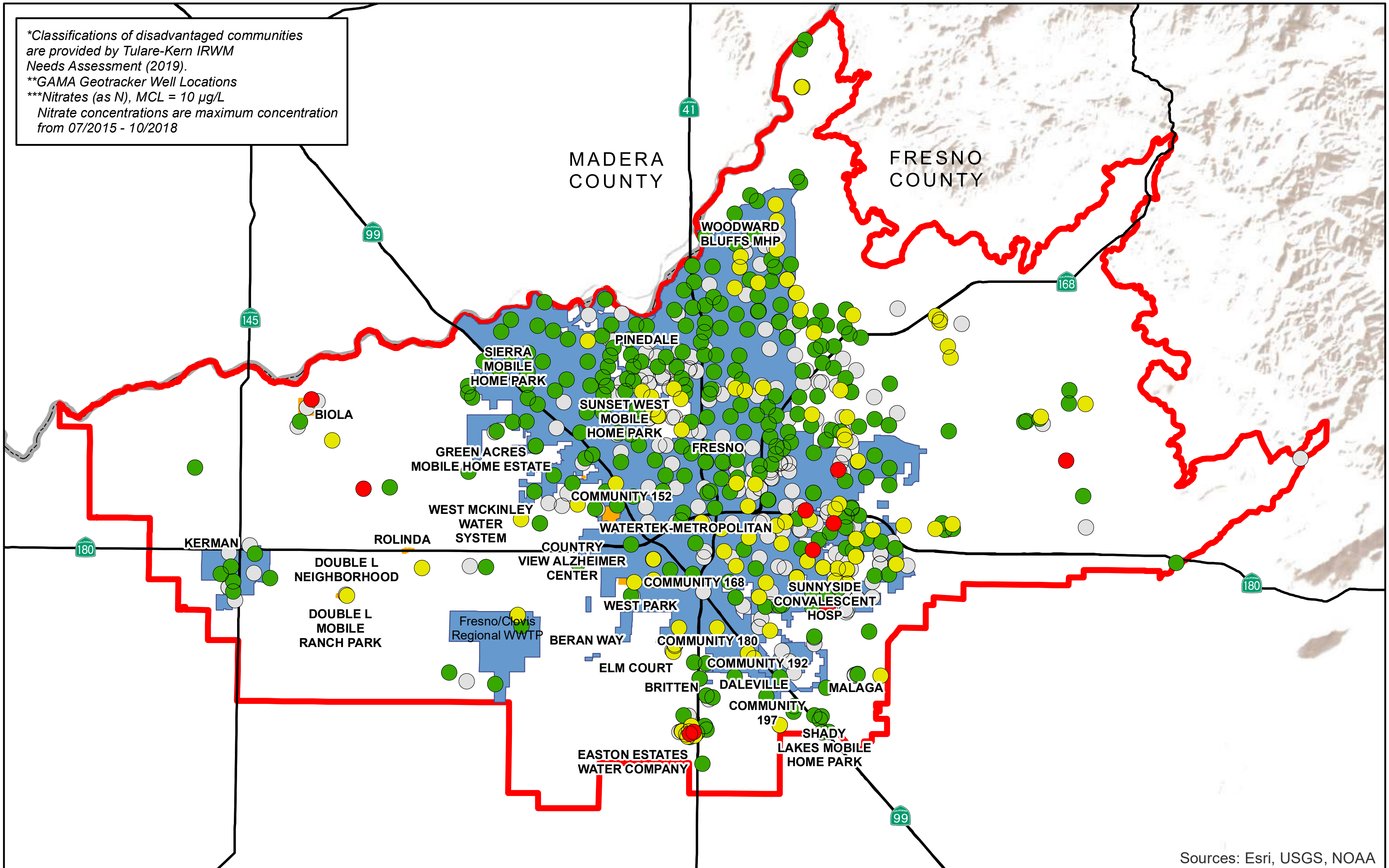
- Groundwater Ambient Monitoring and Assessment Program: http://geotracker.waterboards.ca.gov/gama/

Since the 1960s, testing for general chemical, trace mineral, and inorganic substances has been routinely performed on a large number of the community wells located in the Fresno/Clovis metropolitan area. The available water quality data is voluminous and, therefore, is not presented in this Plan.

In the Water Resources Management Plan for Fresno-Clovis Urban and Northeast Fresno County (1986), water quality was evaluated through research and assimilation of available data and the collection and analyses of water samples where additional data was needed. Documentary evidence of water quality held by the California Department of Health Services (DHS), Regional Water Quality Control Board (RWQCB), Department of Water Resources (DWR), Fresno County Health Departments Environmental Health System (EHS), and other agencies and municipalities were examined along with a historical review of pertinent literature. At that time, nitrate and DBCP were considered to be the most significant problem in terms of drinking water. In addition, data developed from water quality hydrographs was grouped and evaluated in the report. Since 1986, a vast quantity of additional water quality data has been collected by the aforementioned agencies and the Plan participants.

The groundwater quality beneath portions of the City of Fresno is compromised by several inorganic and organic chemical contaminants. The inorganic contaminants include chloride, nitrate, arsenic, manganese, and chromium. Organic contaminants include petroleum hydrocarbons and MTBE, volatile organic compounds (VOCs), DBCP and other pesticides, and TCP. The sources of these contaminants are primarily anthropogenic and include industrial facilities, fuel storage and dispensing sites, agricultural applications, septic systems, and food processing facilities. The responsible parties of many of the point source contaminants (i.e., hydrocarbons and VOCs) are working with state (RWQCB, Department of Toxic Substances Control) and the Fresno County Public Health Department (FCPHD) agencies to remediate the contaminants. Several area-wide contaminants, such as DBCP and TCP, are being addressed via wellhead treatment.

Page and LeBlanc (1969) noted that the Total Dissolved Solids (TDS) in groundwater in the Fresno area seldom exceeds 600 mg/L although at greater depths, 2,000 mg/L groundwater has been encountered. A typical range of groundwater salinity in the basin is 200 to 700 mg/L. 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. However, groundwater with naturally occurring elevated concentrations of salts exists at depth in the local aquifers. The base of freshwater, or the depth at which elevated specific conductance is encountered, has been characterized as the boundary where the concentration of specific conductance is over 3,000 µS/cm (Page, 1973). The base of freshwater varies throughout the NKGSA and is discussed in detail in Section 3.1 – Hydrogeologic Conceptual Model. As wells are drilled deeper, pumping can cause upwelling (i.e. upward vertical migration) of saline water thus increasing salinity in the freshwater aquifer.



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N

0 2 4 Miles

North Kings GSA
County

Disadvantaged Community*
DAC
SDAC

Potable Water System Wells**
Nitrate (as N)
Greater Than MCL
1/2 MCL to MCL
Less Than 1/2 MCL
No Sample Data

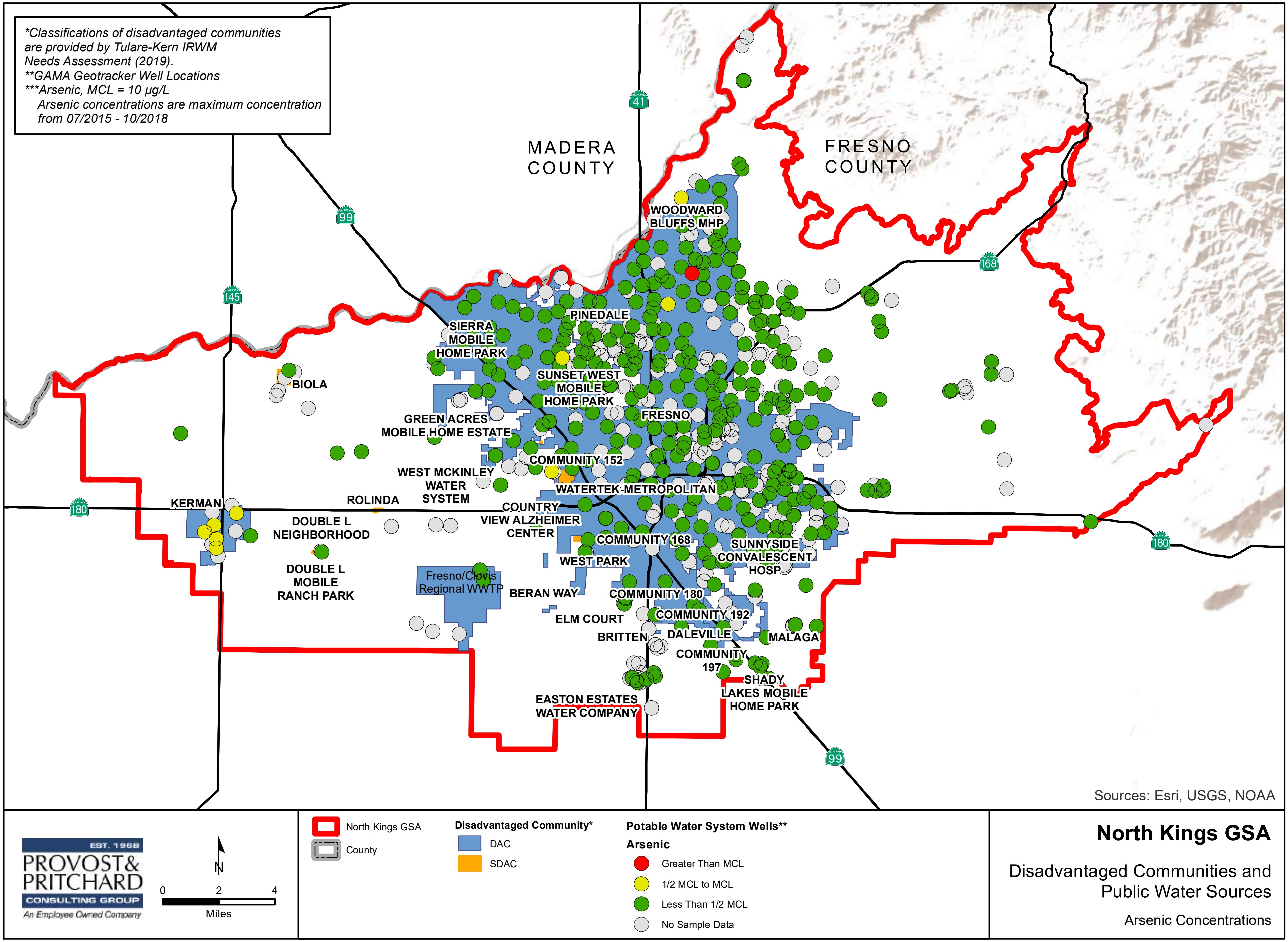
North Kings GSA

Disadvantaged Communities and Public Water Sources

Nitrate Concentrations

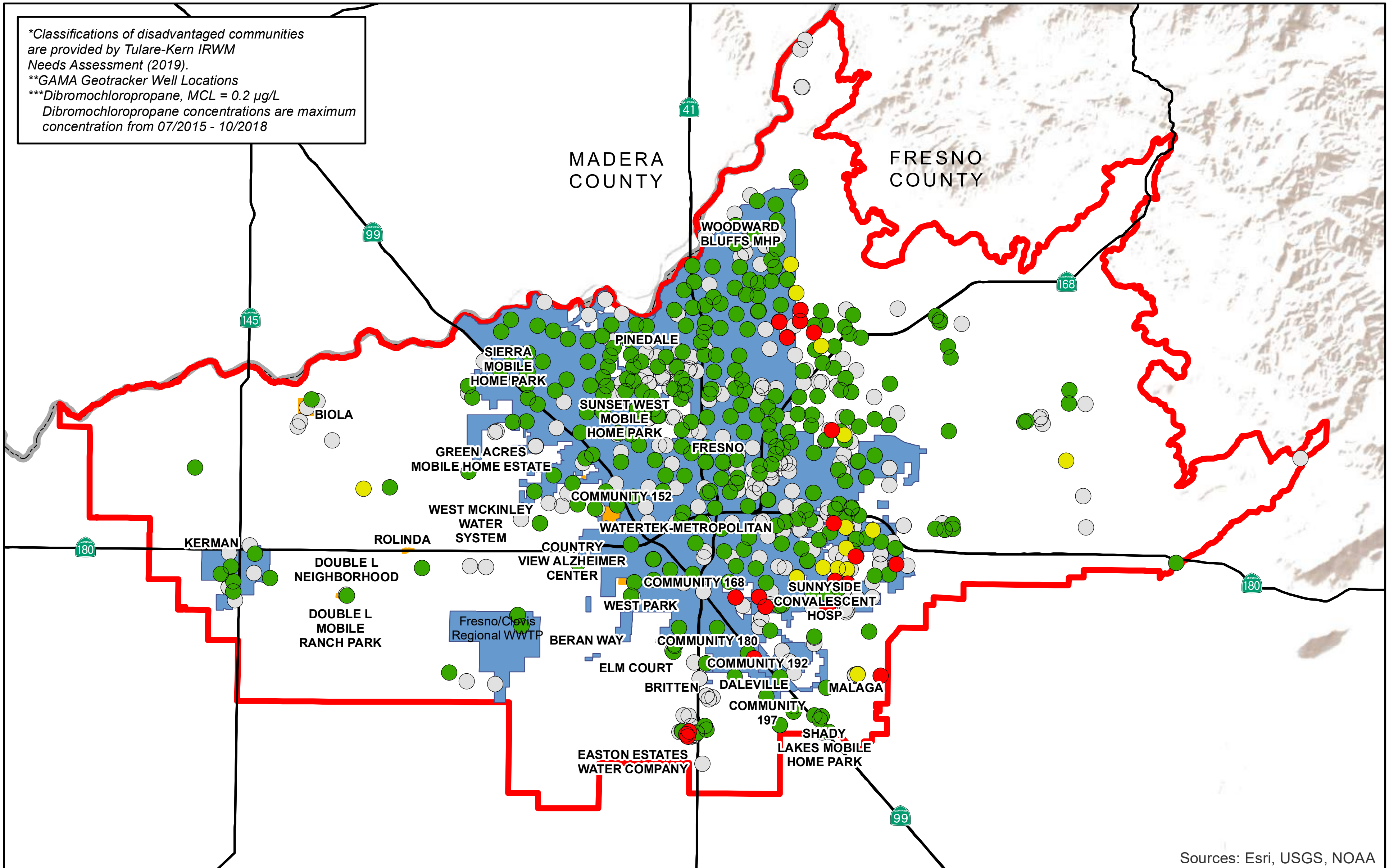
7/30/2019 : G:\North Kings GSA-2643\264317001-Groundwater Sustainability Plan\GIS\Map\WaterQuality\Constituents\w_FresnoClovis\WQ_DACs_PublicWells_Nitrate.mxd

Figure 3-29



7/30/2019 : G:\North Kings GSA-2643\264317001-Groundwater Sustainability Plan\GIS\Map\WaterQuality\Constituents\w_FresnoClovis\WQ_DACs_PublicWells_Arsenic.mxd

Figure 3-30



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N

0 2 4 Miles

North Kings GSA

County

Disadvantaged Community*

DAC

SDAC

Potable Water System Wells**

Dibromochloropropane

Greater Than MCL

1/2 MCL to MCL

Less Than 1/2 MCL

No Sample Data

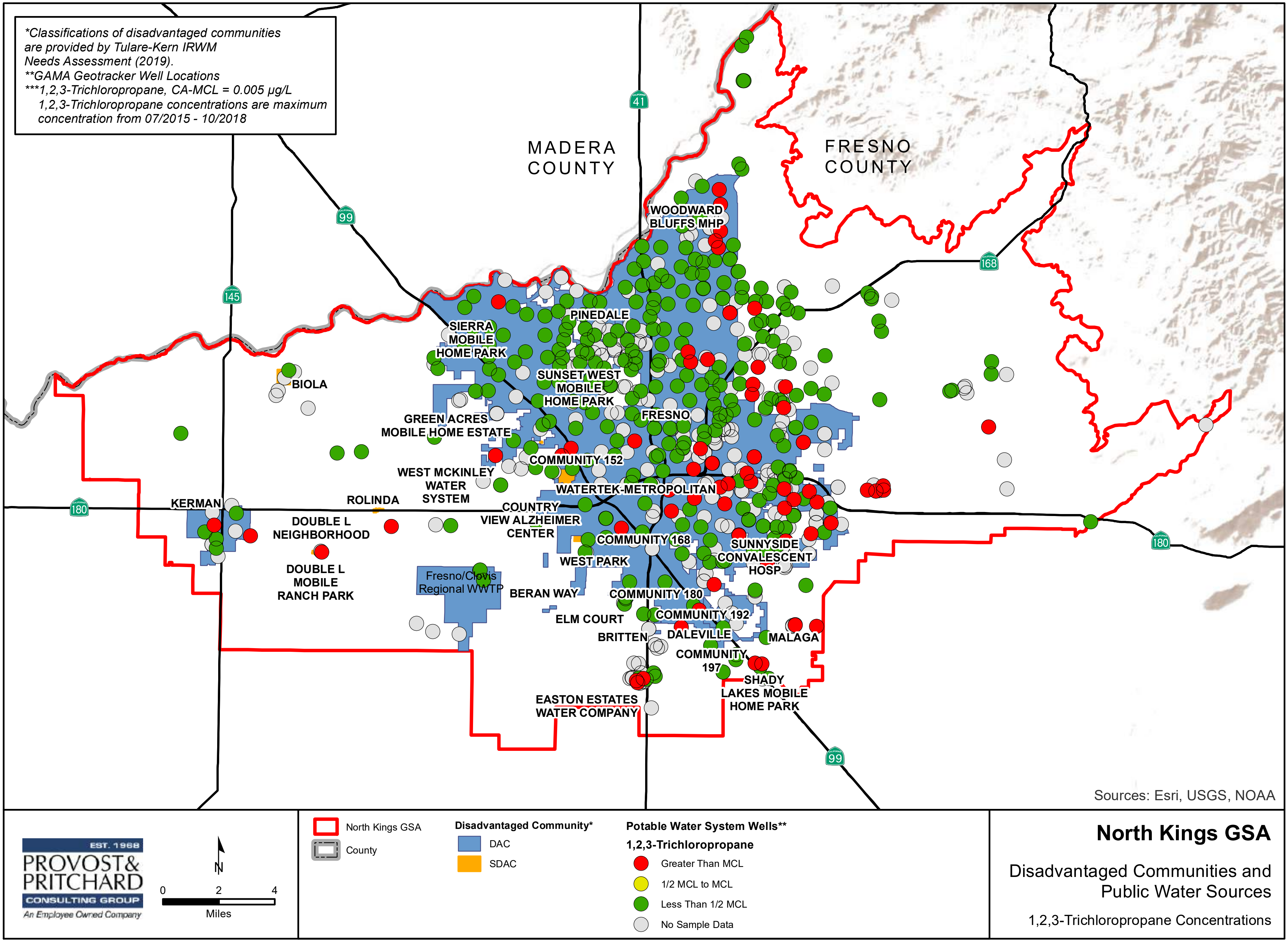
North Kings GSA

Disadvantaged Communities and Public Water Sources

Dibromochloropropane (DBCP) Concentrations

7/30/2019 : G:\North Kings GSA-2643\264317001-Groundwater Sustainability Plan\GIS\Map\WaterQuality\Constituents\w_FresnoClovis\WQ_DACs_PublicWells_dbcp.mxd

Figure 3-31



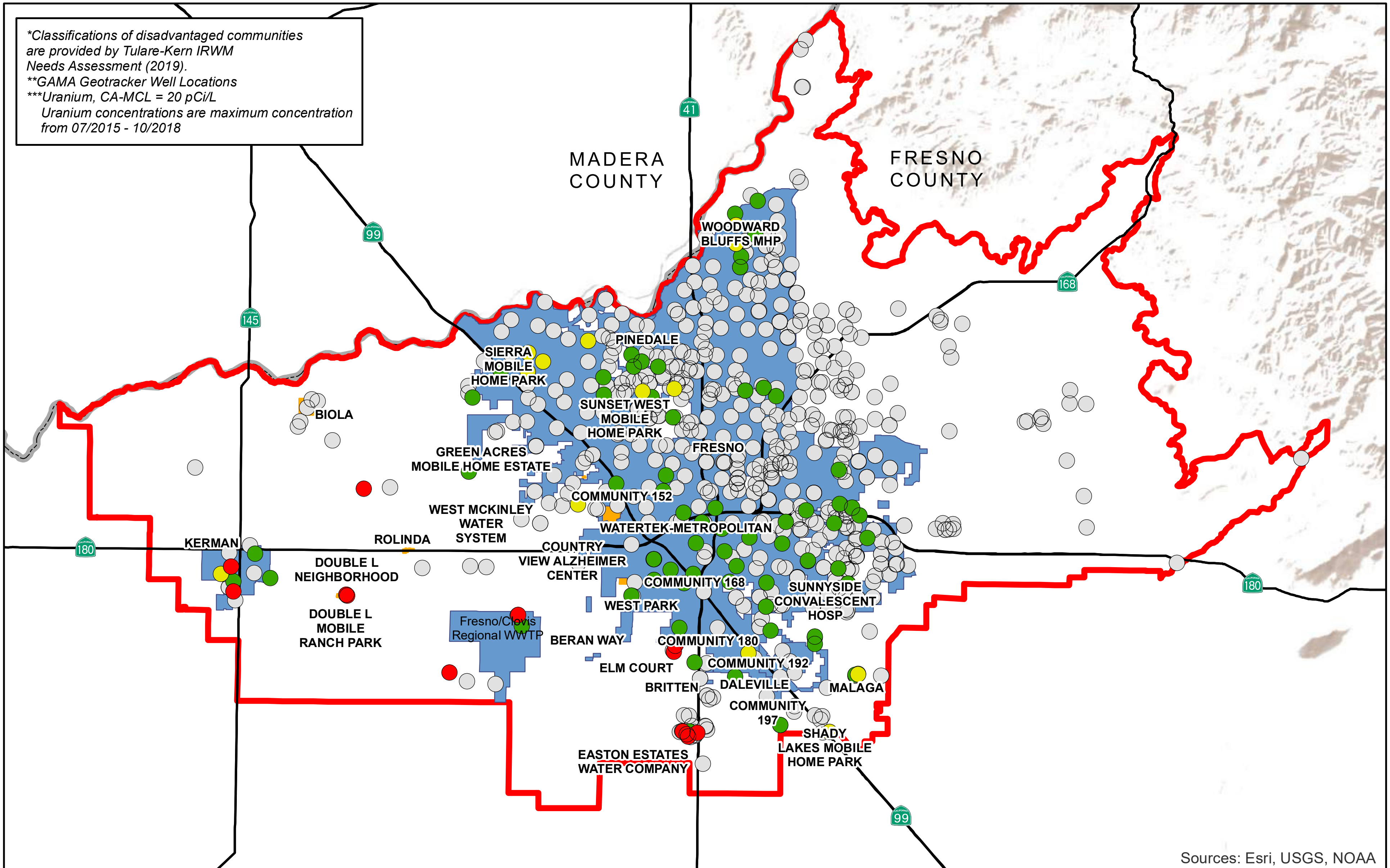
North Kings GSA

Disadvantaged Communities and Public Water Sources

1,2,3-Trichloropropane Concentrations

7/30/2019 : G:\North Kings GSA-2643\264317001-Groundwater Sustainability Plan\GIS\Map\WaterQuality\Constituents\w_FresnoClovis\WQ_DACs_PublicWells_123tcp.mxd

Figure 3-32



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N

0 2 4
Miles

North Kings GSA
County

Disadvantaged Community*
DAC
SDAC

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

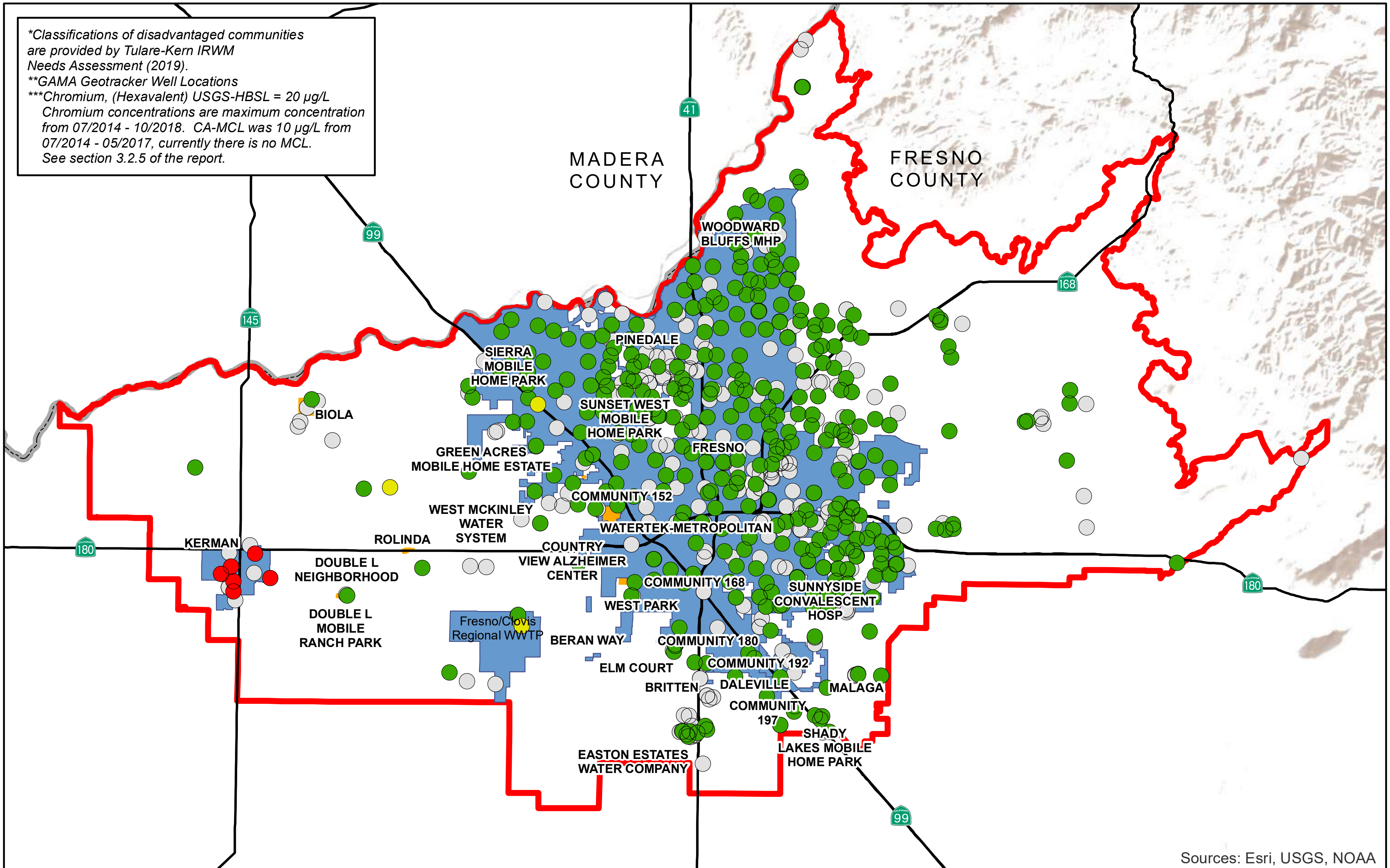
North Kings GSA

Disadvantaged Communities and Public Water Sources

Uranium Concentrations

8/12/2019 : G:\North Kings GSA-2643\264317001-Groundwater Sustainability Plan\GIS\Map\WaterQuality\Constituents\w_FresnoClovis\WQ_DACs_PublicWells_Uranium.mxd

Figure 3-31



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N

0 2 4

Miles

North Kings GSA

County

Disadvantaged Community*

DAC

SDAC

Potable Water System Wells**

Chromium, (Hexavalent)***

Greater Than USGS-HBSL

1/2 USGS-HBSL to USGS-HBSL

Less Than 1/2 USGS-HBSL

No Sample Data

North Kings GSA

Disadvantaged Communities and Public Water Sources

Chromium (Hexavalent) Concentrations

8/12/2019 : G:\North Kings GSA-2643\264317001-Groundwater Sustainability Plan\GIS\Map\WaterQuality\Constituents\w_FresnoClovis\WQ_DACs_PublicWells_Chromium.mxd

Figure 3-34

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 occurs when groundwater levels decline due to excessive withdrawals of groundwater. There are two types of subsidence: elastic and inelastic as shown in **Figure 3-35**. Elastic subsidence is recoverable if water levels later rise while inelastic subsidence is permanent. Elastic subsidence generally occurs in the unconfined portions of the aquifer where the materials compact. Elastic subsidence can rebound if groundwater levels are restored. Although there are several causes of inelastic land subsidence, the compression of clay 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 sediment grains. Once water is squeezed out of the compressible clay, the clay compacts, resulting in the lowering of the overlying land surface. The compressed clays, in which the clay particles have been re-arranged, can no longer re-absorb water, thus the subsidence in these areas cannot be reversed. This process is known as aquifer system compaction. The Corcoran Clay Member 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 historically been correlated to overdraft in the confined aquifer below the Corcoran Clay. However, with increased reliance on groundwater to meet demands, land subsidence is currently occurring in areas outside of the Corcoran clay. Even though subsidence is now occurring in areas outside of the Corcoran clay, the relative amount is less than the historical subsidence in areas underlain by the Corcoran Clay.

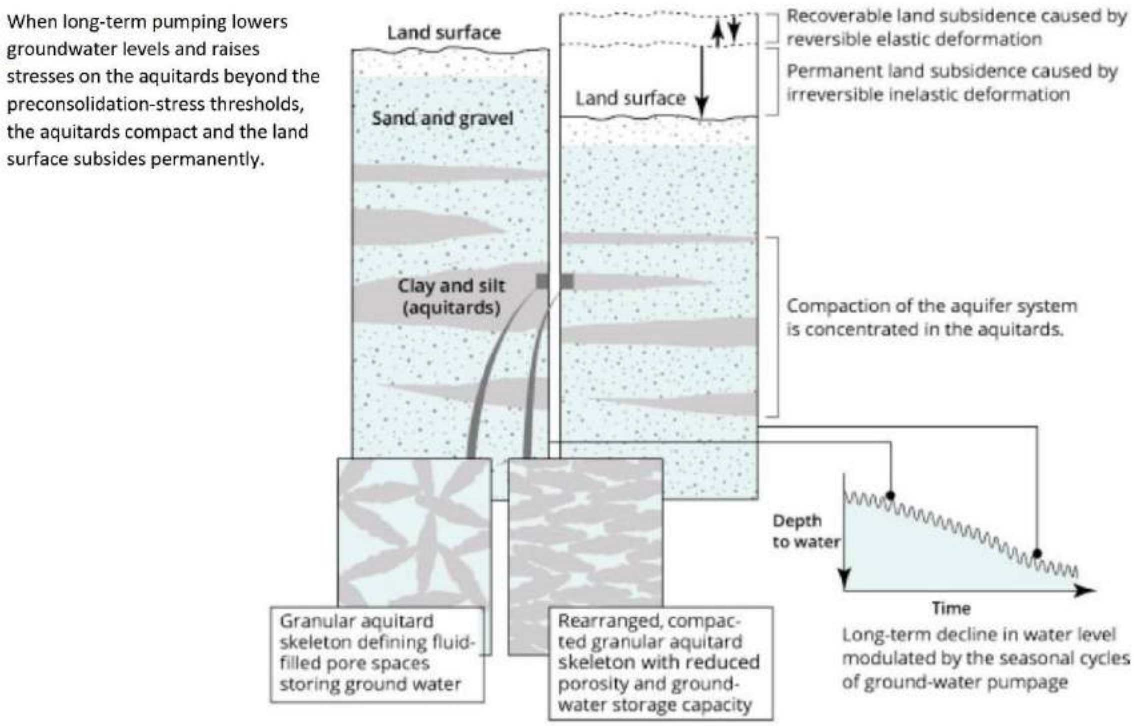


Figure 3-35 Aquifer compaction due to groundwater pumping as identified by USGS
(https://ca.water.usgs.gov/land_subsidence/california-subsidence-cause-effect.htm)

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

3.2.6.1 Review of Existing Data

Available land subsidence data was reviewed to assist in determining what information is available and in establishing a monitoring network. The effort included a review of the Hydrogeologic Conceptual Model (HCM), recorded subsidence, historic groundwater levels, historic infrastructure impacts, remote sensing data, and Continuous Global Positioning System stations. A summary of existing data is provided below. Refer to Section 5.1.3 – Description of Monitoring Network for detailed discussions on the technologies available for monitoring subsidence and the existing monitoring programs in the region.

Review of the HCM and understanding of grain-sized distributions and potential for subsidence to occur. Review of any known regional or correlative geologic conditions where subsidence has been observed.

Most subsidence in the San Joaquin Valley has occurred on the west side over the axial trough of the valley although some subsidence has been documented in the western portion of the NKGSA. Areas prone to subsidence and the attendant dominant soil textures, clay mineralogy and other geologic and geochemical properties were intensely studied by the USGS in a series of Professional Papers in the 1960s, 1970s and 1980s. The areas prone to subsidence were underlain by deposits where the clayey deposits were dominated by the clay mineral montmorillonite (USGS 497-C, Meade 1967). Meade in written communication with R. J. Janda reports that kaolinite and halloysite are the predominant clay mineral constituents of the soils and alluvium of the upper San Joaquin basin in the Sierra. This indicates that, while there is confined groundwater and fine-grained deposits over most of the NKGSA, the clay mineral assemblage in the fine-grained deposits for the most part do not appear to contain enough montmorillonite to be as susceptible to subsidence as those areas westerly of the NKGSA.

As mentioned above, historically and currently, areas with the most significant land subsidence from groundwater pumping are underlain by the Corcoran Clay member of the Tulare Formation. As shown on **Figure 3-15**, the Corcoran Clay only extends into the western portion of the NKGSA by a few miles. In addition to the clay mineralogy, aquifer compaction and the resultant land subsidence are also dependent on over-extraction of groundwater from a confined aquifer. **Figure 3-15** shows the base of unconfined groundwater beneath which confined groundwater extends to the base of the basin. This indicates that while confined groundwater is being extracted over the majority of the NKGSA, land subsidence appears to be minimal. It is likely that the reason for this is the differing clay mineralogy west of the NKGSA.

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 levels have been declining leading to the potential for land subsidence.

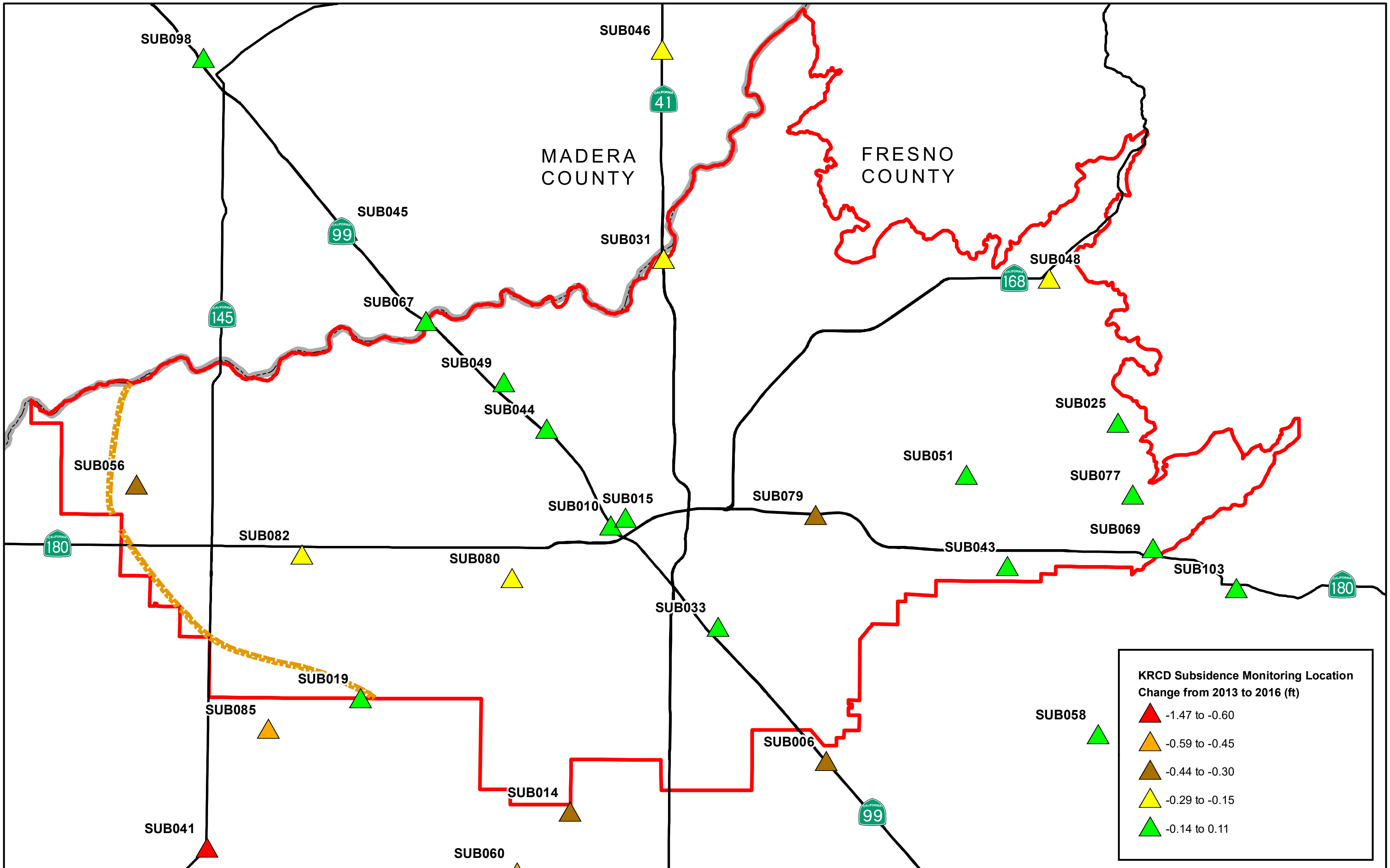
Review of historic records of infrastructure impacts, including, but not limited to, damage to pipelines, canals, roadways, or bridges, or well collapse potentially associated with land surface elevation changes.
There are no known infrastructure impacts in the NKGSA area.

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

Review of existing CGPS surveys. Continuous Global Positioning Systems (CGPS) stations can be used to monitor land subsidence. No CGPS stations are located in the NKGSA. Some nearby CGPS stations, outside of the NKGSA, are located in Mendota, Madera, and Coarsegold.

3.2.6.2 Subsidence Monitoring Results

Historically, land subsidence has occurred on the west side of the San Joaquin Valley. Land subsidence was first monitored from the 1920s to 1970s when there was less access to surface water. During this timeframe, subsidence rates varied but were as high as 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. This figure also shows subsidence in the Fresno area was less than one foot from 1926 to 1970, and the western edge of the NKGSA had about one foot of subsidence. Subsidence monitoring decreased after the 1970s when there was



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N

0 2 4
Miles

Legend

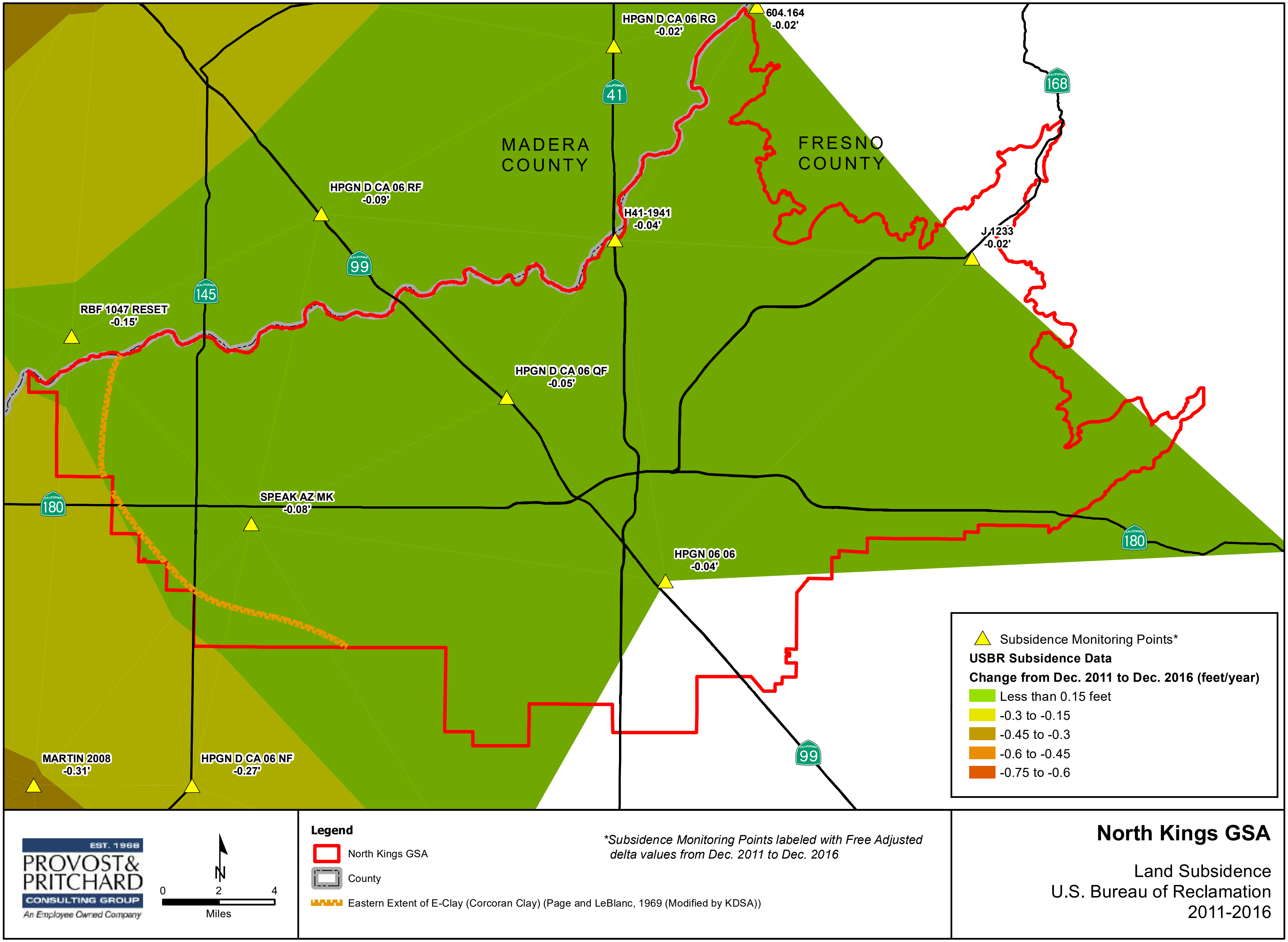
- North Kings GSA
- County
- Eastern Extent of E-Clay (Corcoran Clay) (Page and LeBlanc, 1969 (Modified by KDSA))

North Kings GSA

Land Subsidence
Kings River Conservation District
2013-2016

6/28/2019 : G:\North Kings GSA-2643\264317001-Groundwater Sustainability Plan\GIS\Map\Presentation\subsidence_krcd.mxd

Figure 3-37



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North Kings GSA

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

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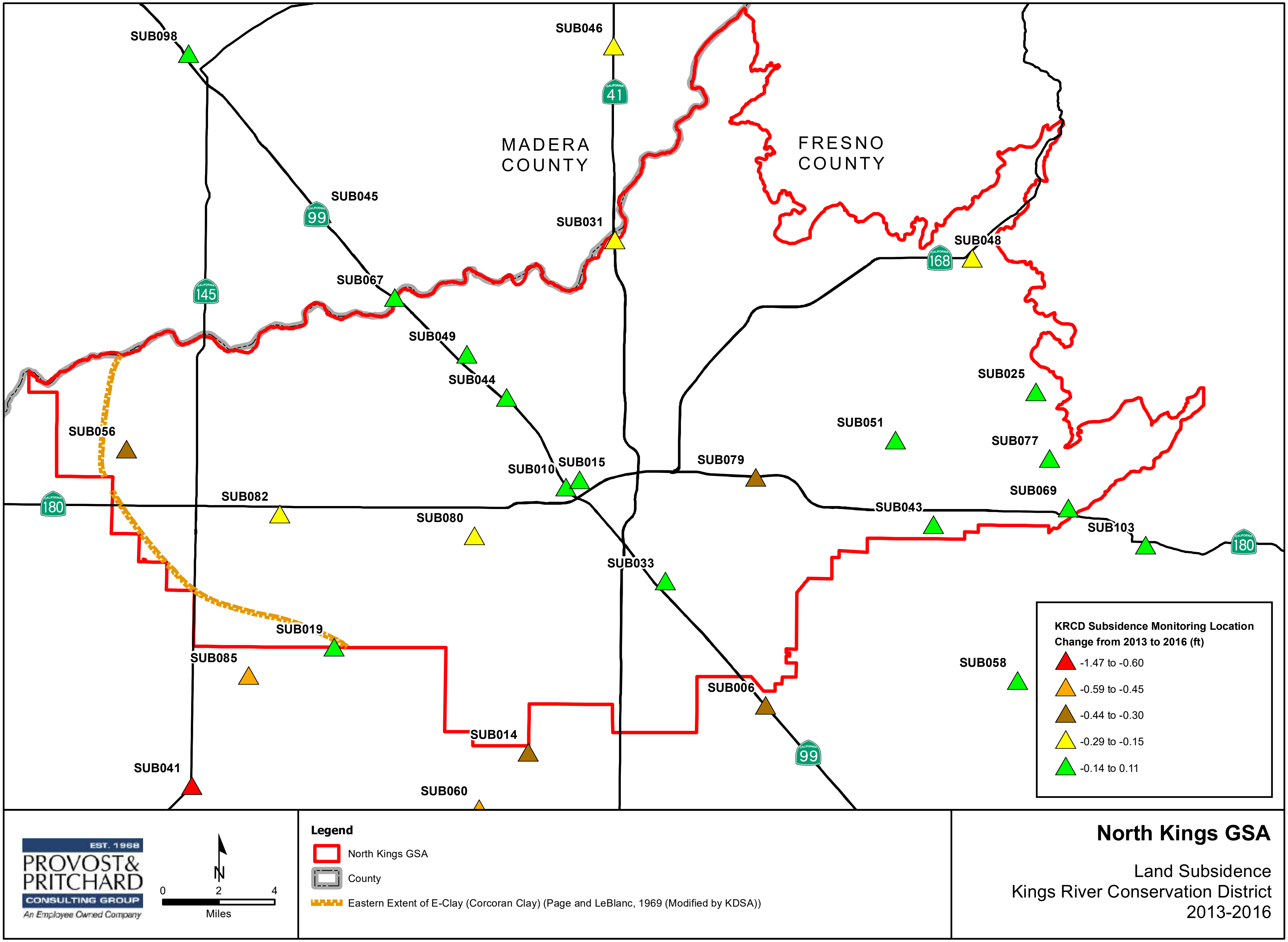
Figure 3-36

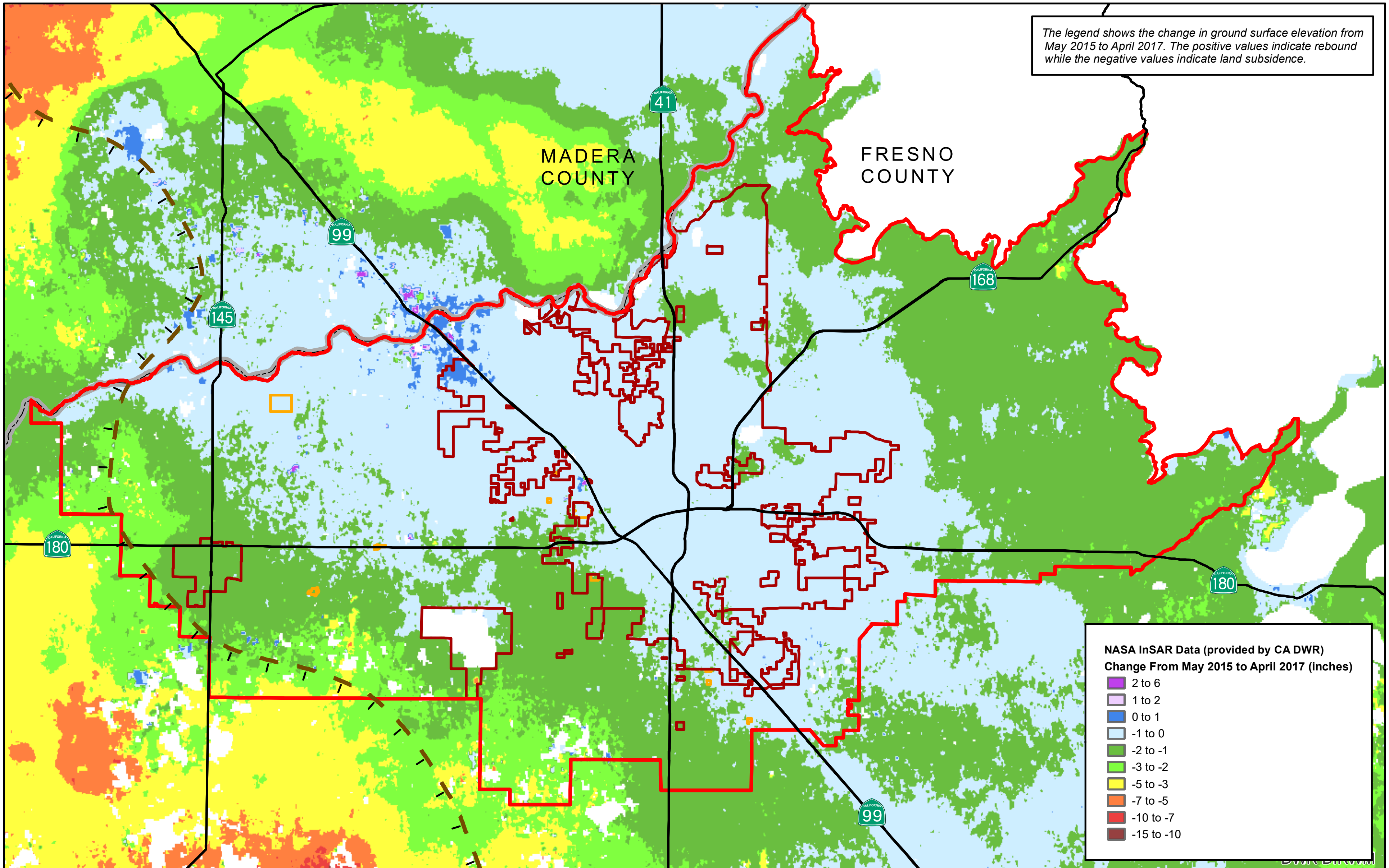


North Kings GSA

Land Subsidence
Kings River Conservation District
2013-2016

6/28/2019 : G:\North Kings GSA-2643\264317001-Groundwater Sustainability Plan\GIS\Map\Presentation\subsidence_krcd.mxd

Figure 3-37



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N

0 2 4 Miles

Legend

North Kings GSA

County

E Clay Eastern Extent (Page and LeBlanc1969, modified by KDSA)

Disadvantaged Community*

DAC

SDAC

**Classifications of disadvantaged communities are provided by Tulare-Kern IRWM*

North Kings GSA

Land Subsidence

NASA (via CA Dept. Water Resources)

2015-2017

Figure 3-38

8/11/2019 : G:\North Kings GSA-2643\264317001-Groundwater Sustainability Plan\GIS\Map\Presentation\subsidence_nasa 052015_042017.mxd

3.2.7 Surface Water and Groundwater Interconnections

Regulation Requirements:

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

SGMA Regulations require the GSA to quantify the volume or rate of surface water depletion caused by groundwater pumping in basins where surface water and groundwater are interconnected. Interconnected surface water systems are defined as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted (Modeling Best Management Practices, DWR, 2016). The purpose of this section is to identify any known areas within the NKGSA where groundwater pumping has caused surface water depletion. At this time there is no evidence that active wells along the river are causing increased seepage loss or impacts to downstream beneficial uses.

Present Day Conditions

A limited number of studies have evaluated groundwater and surface water interaction within the NKGSA. Present day regional groundwater elevations are significantly lower than the San Joaquin River channel and tributary channel elevations. The head differential between stream water elevations and the underlying groundwater elevations induces seepage losses from the stream reaches (losing stream). Historically (pre-Friant Dam), most reaches of the San Joaquin River were gaining reaches. The significant decrease in groundwater elevations has now led to most reaches of the San Joaquin River being losing reaches. The SJRRP maintains flows in the river according to the restoration program flow requirements. After the enactment of the SJRRP, there has been no known conflicts with downstream beneficial users, i.e. riparian right holders, associated with upstream groundwater pumping leading to decreases in flows in the river.

3.2.7.1 Interconnected Surface Water Systems

Information to evaluate the presence of interconnected surface water systems in the NKGSA in a few locations along the San Joaquin River is available through the USBR's SJRRP, a US. Geological Survey groundwater flow model documentation report (USGS SIR 2014-5148, 2014), and Friant Water Users Authority and Natural Resources Defense Council (FWUA and NRDC, 2002). Additional information, of a regional nature, is available from the USGS's Central Valley Hydrologic Model (USGS PP 1766, 2009) and USGS Open File Report 85-401 as part of the Regional Aquifer System Analysis (USGS, 1985). The model reports and regional studies indicate a lack of continuous connection between surface water and groundwater in the NKGSA.

The location specific data from the SJRRP indicate that there may be connection at some locations. Limited data is available from the DWR from shallow wells on interconnected surface water systems along the Kings River where it borders the NKGSA boundary.

Regional Reports

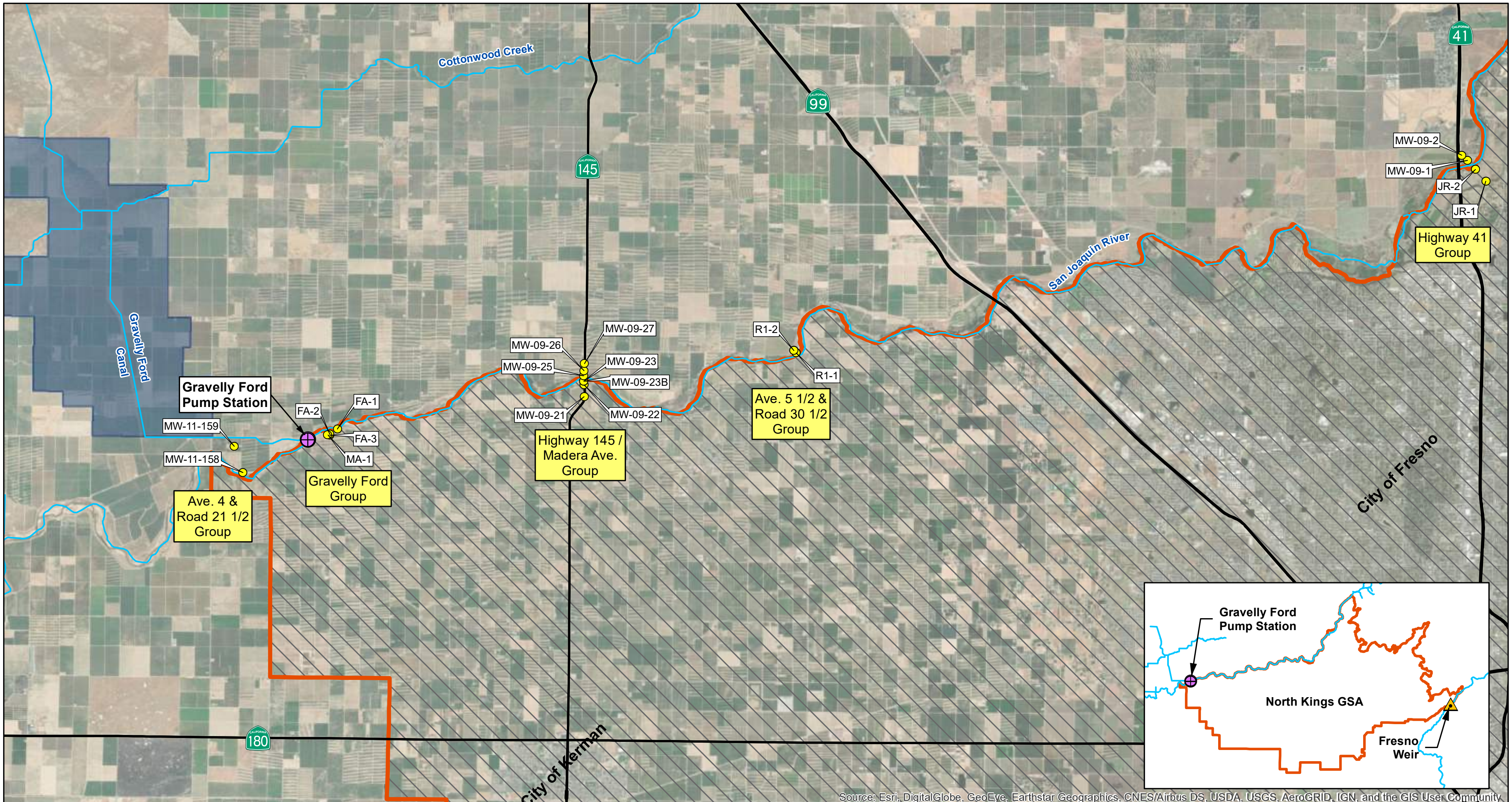
As mentioned, the regional reports (CVHM, 2009 and USGS OFR 85-401, 1985) appear to show that groundwater and surface water are not interconnected along the San Joaquin River in the NKGSA. However, these reports do not explicitly discuss interconnected surface water systems. Instead these reports provide maps that show areas of gaining or losing streams. Along the San Joaquin River, the regional maps provided show that as of 2009, the San Joaquin River in the

NKGSA is clearly a losing stream, i.e., surface water seeps into groundwater. Also, the USGS 1985 report (shown as Figure A22.A in the CVHM) indicates that the San Joaquin River was a losing stream in the NKGSA based on average conditions from 1961 to 1977.

San Joaquin River Studies
FWUA and the NRDC (2002) compared the 1998 thalweg (lowest portion of a continuous riverbed) elevation of the San Joaquin River (developed from topographic data gathered by the Corps of Engineers Comprehensive Study) to the 1996 groundwater elevations. Reaches where the 1996 shallow groundwater elevations were greater than the 1998 thalweg elevation of the stream were considered to be potentially gaining reaches. Within the NKGSA area, the reach between river mile (RM) 243 (Herndon) and RM 234 (SR 145) was identified as a potentially gaining reach. The Spring 2017 groundwater elevation contours, **Figure 3-24**, when compared to estimated river bed elevations where SJRRP data is available generally indicate a lack of connection along the river in the NKGSA. However, these contours are regional in nature, based primarily on agricultural or domestic wells that are likely perforated deeper than the SJRRP monitoring wells, discussed below, and represent regional groundwater conditions after several dry years.

USGS Scientific Investigations Report 2014-5148 (2014) is a groundwater flow model for the SJRRP prepared in cooperation with the USBR (USGS 2014). This model is an integrated hydrologic model that simulates the surface-water hydrologic system, the groundwater aquifer system, and land surface processes within 5 miles of the San Joaquin River and adjacent bypasses from Friant Dam to the confluence with the Merced River. The model indicates that under normal to dry hydrologic periods the San Joaquin River is not connected to the regional aquifer system, south (downstream) of the Copper Avenue alignment. During wet periods groundwater levels appear to approach within about 5 feet of the channel bottom in the reach between Highway 145 and downstream of Gravelly Ford (the western most part of the NKGSA along the river). Overall, this report agrees with the location specific data in that when the river has high flows, groundwater levels near it rise, and when the river has low flows, groundwater levels fall. As well, it appears to show that during periods of high flows the river may be connected in the reach between Highway 145 and downstream of Gravelly Ford.

San Joaquin River Restoration Program, Location Specific Data
Groundwater elevation data from piezometers installed to monitor shallow groundwater near the river as part of the SJRRP provide location specific data to evaluate interconnected surface water systems. Unfortunately for this evaluation, the majority of SJRRP groundwater elevation monitoring is being conducted downstream of the NKGSA. However, information from several sets of piezometers are available along with channel bed elevations near the locations in the NKGSA from the draft San Joaquin River and Bypass System HEC-RAS Model Documentation (Tetra Tech, Inc, 2013). The monitoring well clusters are located at HWY 41, HWY 145 (Skaggs Bridge), near Gravelly Ford, and near the western border of the NKGSA about 2 miles downstream of Gravelly Ford. Groundwater elevation data is available from the monitor wells from Fall 2009 to July 2017 (see **Appendix 3-C**). A map of the monitor well locations along with supporting documentation used to estimate the channel bed elevations at the monitor well locations is included in **Figure 3-39**. Flow data is available from the SJRRP below Friant and at Gravelly Ford a few miles upstream of the western most shared border between the river and the NKGSA. Flows at Gravelly Ford are linked to the amount of flow being released at Friant Dam. During prolonged periods of low flow releases at Friant, flows at Gravelly Ford are periodically reported as zero.



N
0 0.5 1
Miles

North Kings GSA
Gravelly Ford W.D.
Reach 1A and Reach 1B Wells (Near or in NKGSA)
Waterway

United States Bureau of Reclamation
San Joaquin River Restoration Program
Monitor Well Locations

Figure 3-39

North Kings GSA

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SJR at HWY 41

Groundwater elevation data is available at this location from two monitor wells: MW-09-1 (600 feet north of SJR) and MW-09-2 (1,000 feet north of SJR). The channel bed elevation is estimated to be approximately 259 feet. Groundwater elevations in both monitor wells increase when flows in the river increase and decrease when flows drop. When river discharge is high, groundwater elevations in both wells are higher than the channel bed elevation indicating interconnected groundwater-surface water during these times. When the river is flowing at low flow or base flow, the groundwater elevation is below the estimated channel elevation, indicating a lack of interconnection. However, these wells are not close enough to the river channel to provide adequate understanding of shallow groundwater in close proximity to the river.

SJR at HWY 145 (Skaggs Bridge)

Groundwater elevation data is available at this location from six monitor wells: MW-09-21 (1,500 feet south of SJR), MW-09-22 (500 feet south of SJR), MW-09-23 &23B (250 feet south of SJR), MW-09-25 (250 feet north of SJR), MW-09-26 (700 feet north of SJR), and MW-09-27 (1,300 feet north of SJR). The channel bed elevation is estimated to be approximately 199 feet. Groundwater elevations in the monitor wells increase when flows in the river increase and decrease when flows drop. Groundwater elevations in monitor well MW-09-23 &23B are higher than the estimated channel bed elevation during periods of low and high river discharge indicating that shallow groundwater is connected south of the river. However, groundwater elevations in MW-09-25 and MW-09-26, the two closest wells in this location north of the river, are below the estimated channel bed elevation except during periods of high flow, which indicates that the river is connected to the north only during periods of high flows. During periods when river discharge is high, groundwater elevations in monitor wells MW-09-21, MW-09-22, MW-09-25, and MW-09-26 are higher than the estimated channel bed elevation indicating interconnected groundwater-surface water during these times.

SJR at Gravelly Ford

Groundwater elevation data is available at this location from four monitor wells: FA-1 (200 feet south of SJR), FA-2 (500 feet south of SJR), FA-3 (550 feet south of SJR), and MA-1 (500 feet south of SJR). The estimated channel bed elevation is approximately 187 feet. Groundwater elevations in the monitor wells increase when flows in the river increase and decrease when flows drop. When river discharge is high, groundwater elevation in the wells are higher than the channel bed elevation indicating interconnected groundwater-surface water during these times. At times when the river is flowing at low flow or base flow, the groundwater elevation in the wells is near the estimated channel elevation potentially indicating a lack of interconnection. It should be noted that FA-1 is the closet of this set of wells to the river, and with few exceptions, available groundwater elevations in it are higher than the estimated channel bed elevation. During prolonged periods of low flow at Gravelly Ford, for example from about October 2014 to July 2015, groundwater levels appear to be below the bottom of the perforated section of the well, so it is not known if groundwater levels in this well were lower than the channel bed. However, groundwater elevations from MA-1 (500 feet from the river) during and after this period remain within a foot or so lower than the channel bed elevation during low flows. This indicates that groundwater near the river in this location may potentially be connected to the river. Unfortunately, groundwater elevations in FA-1, which the exception of a few data points that appear to be anomalous in mid-2015, are not available starting in September 2014. Therefore, a more complete evaluation based on data from the well nearest to the river is not feasible.

SJR at NKGSA Western Boundary

Groundwater elevation data is available at this location from two monitor wells: MW-11-58 (400 feet north of SJR) and MW-11-159 (1,600 feet north of SJR). The channel bed elevation is approximately 184 feet. Groundwater elevations in both monitor wells increase when flows in the river increase and decrease when flows drop. When river discharge is high, groundwater elevation in the wells trend higher than the channel bed elevation indicating interconnected groundwater-surface water during these times. When the river is flowing at low flow or base flow, the groundwater elevation is below the estimated channel elevation indicating a lack of interconnection. However, these wells are not located close enough to the river to ascertain with certainty a lack of connection. Based on the data available from other sets of monitor wells in this evaluation, monitor wells closer to the river have higher groundwater elevations. Groundwater elevations from MW-11-158 at 400 feet from the river are usually at or within a foot or two of the channel beds. A monitor well closer to the river would likely have higher groundwater elevation which could potentially indicate that the river is connected to shallow groundwater in this location.

The shallow groundwater elevation data presented here appears to indicate that the San Joaquin River in NKGSA is connected to shallow groundwater, especially the data from monitor wells in close proximity to the river. This finding is in part supported by channel bed elevation changes over relatively short distances where pools are deeper (e.g., at lower elevations) than riffle crests (where the riverbed elevation is higher than in pools). Pools, being deeper, are more likely to have channel bed elevations that show connectivity to shallow groundwater. Also east of Highway 99, the abundance of historical gravel mining pits probably enhanced connection of surface water and groundwater.

3.2.7.2 Kings River

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

3.2.8 Groundwater Dependent Ecosystems

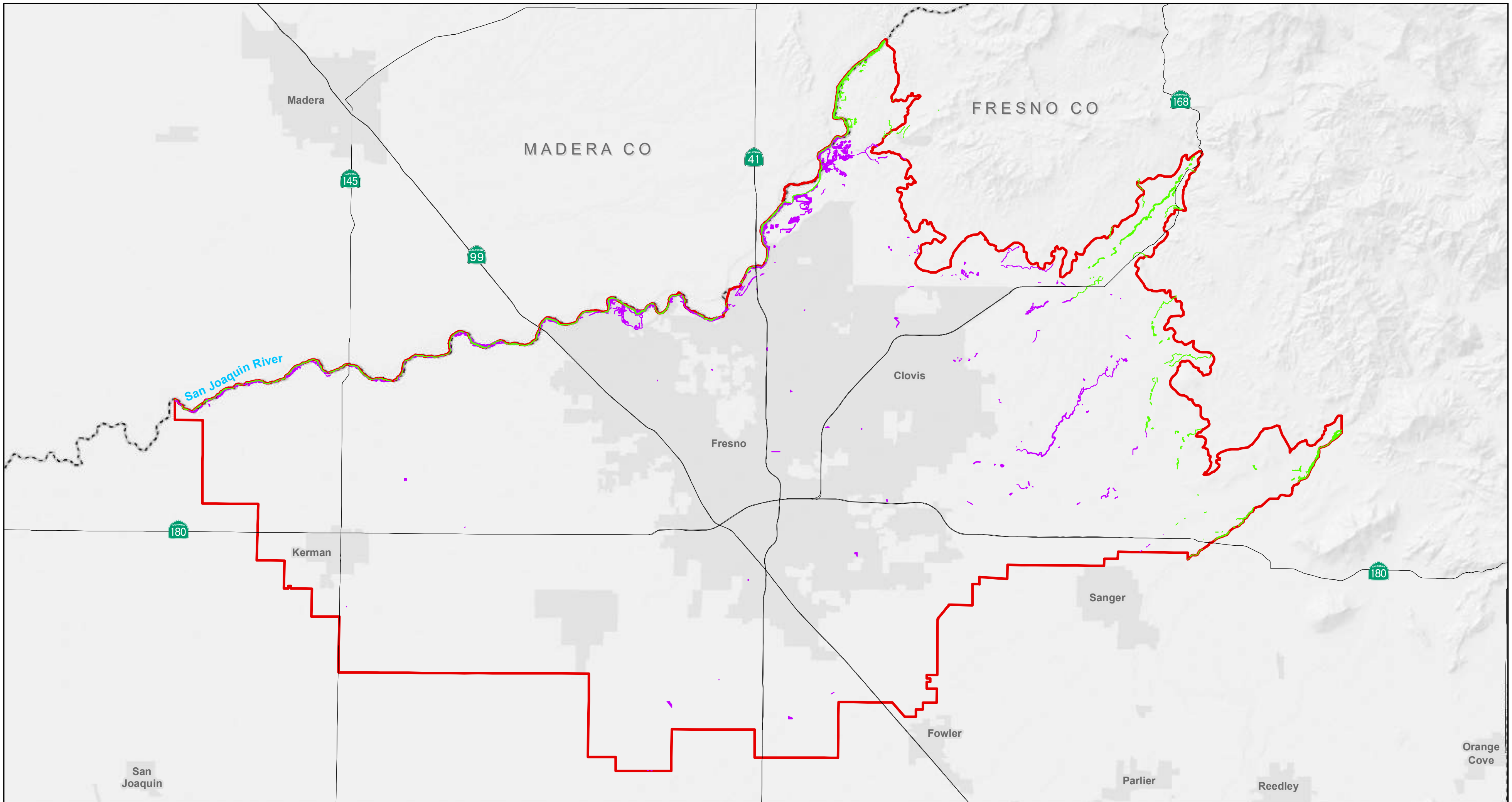
Regulation Requirements:

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

Groundwater Dependent Ecosystems (GDEs) are defined under SGMA as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)). While GDEs are not one of the six groundwater conditions that can lead to undesirable results, they can be related to sustainable management criteria identified in Chapter 4. The Nature Conservancy's Natural Communities Dataset Viewer (NC Dataset Viewer) Vegetative GDE and Wetland GDE map with basin-wide marked revisions is provided below as **Figure 3-40**. Recognizing that much of the Kings Subbasin has a depth to groundwater greater than the deepest vegetative GDE rooting depth of thirty feet, many of the GDEs identified in the NC Dataset Viewer were mischaracterized.

Spring 2017 depth to groundwater contours and NC Dataset Viewer GDEs were overlaid to identify GDEs in areas with depth to groundwater greater than 30 feet. GDEs meeting this criterion were categorized as "Rejected GDE" and depicted in purple in **Figure 3-40**. Areas closer to the foothills require more depth to groundwater data to sufficiently validate the presence of GDEs; therefore, they are categorized as "Possible GDEs" for the 2020 GSP. The Kings Subbasin also categorized GDEs within 100-ft of the Kings River and the San Joaquin River as "Possible GDEs." This 100-ft buffer is based on a California Department of Transportation typical wetland setback (CDOT, 2019).

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



Legend

- North Kings GSA
- Possible GDE
- Rejected GDE - Depth to Water > 30 ft
- City
- County Boundary
- Highway

Spring 2016 Depth to Water Used for Analysis

EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company

N

0 1.5 3
Miles

North Kings GSA

Groundwater Dependent Ecosystems

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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 any resulting water storage change; it also 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 North Kings GSA. A schematic diagram of a water budget indicating the primary inflows and outflows and impacts on the groundwater system is shown in **Figure 3-41** below:

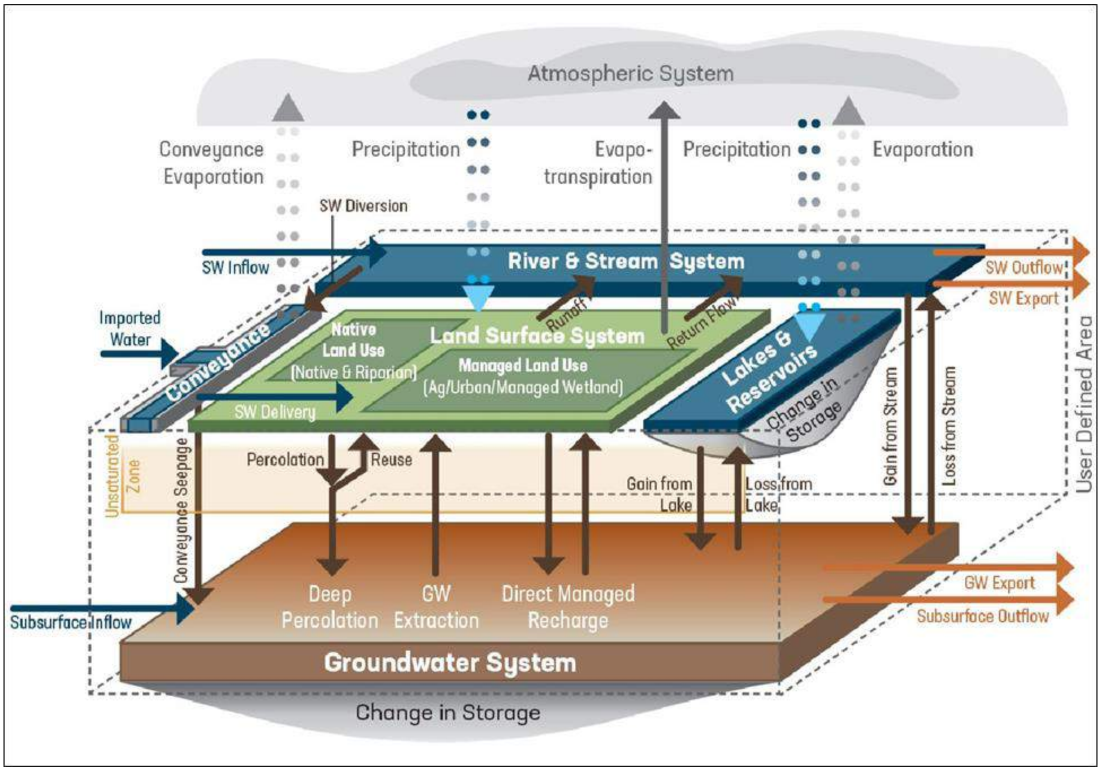


Figure 3-41 Water Budget Schematic

Purpose of Water Budget

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

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

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 Subbasin (using DWR IWFM model), 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:

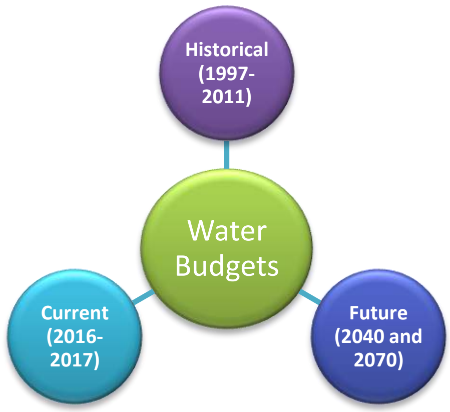


Figure 3-42 Water Budgets Evaluated

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

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

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

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

Table 3-3 includes a summary of the water budgets prepared, and their location in this section.

Table 3-3 Water Budgets

Description	Kings Basin	North Kings GSA		
		Dry	Normal	Wet
Historical (1997-2011)	Table 3-7	Table 3-4	Table 3-4	Table 3-4
Current (2016-2017)	-	Table 3-9	Table 3-9	Table 3-9
Future (2040)	-	Table 3-11	Table 3-11	Table 3-11
Future (2070)	-	-	Table 3-12	-

3.3.2 Best Available Information

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

3.3.3 Description of Water Budget

Regulation Requirements:

§354.18

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

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

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 for changes in demands, climate change impacts, etc.

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 since it is a relatively long period during which "…*water supply conditions approximate average conditions*" as specified in DWR Groundwater Regulations at §354.18 (b) (5). The analysis of average conditions was based on Kings River surface water diversion amounts being approximately the same as the long-term average. Kings River surface water diversions were used since they are the largest source of water supplies to the Kings Subbasin, constituting nearly 90% of surface water used and more than 60% of the total water supply. Surface water diversions were used to select the hydrologic base period rather than Kings River runoff because they are more representative of average groundwater pumping conditions, since runoff water can be regulated (carried over) 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, with increased groundwater recharge occurring in wet years. Average Kings River surface water diversions to the Kings Subbasin since the construction of Pine Flat Dam (1955-2018) were 1,088,932 AF. Average diversions during the selected 1997-2011 historical analysis period were 1,081,700 AF, 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 Year Types
Water budgets were developed for dry, normal and wet year water types. These water-year types were developed according to a water year classification based on water supply diversion information in the Kings Subbasin. The water year on the Kings River is October through September. The water year types were developed due to the absence of DWR-developed water year types for the Kings River watershed and other watersheds in the Tulare Basin, and to account for actual surface water diversions rather than runoff.

The water year types were defined based on percentage of average Kings River diversions to the Kings Subbasin for a 50-year hydrologic period from 1968-2017. Year types were selected for Dry, Normal and Wet conditions based on the historical diversions. A summary of the water year types is shown in **Table 3-4** below:

Table 3-4 Water Year Types

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

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

The Normal Year water budgets were based on average conditions over a period of record. The Wet and Dry water budgets used many of the same values as Normal Year water budgets, but with changes in precipitation, surface water supplies, deep percolation of precipitation, stormwater recharge and estimated private groundwater pumping. Some other variables could change in wet and dry years, however a simplified analysis was performed that included adjustments only to the most important variable. Since the wet and dry year water budgets were performed primarily to show the approximate range of bookends, this simplified analysis was deemed adequate.

Table 3-5 below presents historical Kings River water supplies from 1955 to 2018, including the volume, percent water year and water year type.

Table 3-5 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 water 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**.

Future climates may not be similar to past climates. This includes river hydrology and the frequency of wet and dry years, resulting in higher standard deviations for total water supplies. This could impact several variables in the water budget. While this is difficult to predict, the NKGSA will continue to monitor climate and river flows for long-term changes. Climate change is discussed in more detail in Section 3.3.10 – Projected Water Budget.

The following sections describe the variables used in the water budget, as well as assumptions and criteria used. **Table 3-6** below lists all of these variables. The same variables were used in all the water budgets throughout the Kings Basin

Table 3-6 Water Budget Variables

Surface Water Entering and Leaving (Section 3.3.3)	Flows to Groundwater System (Section 3.3.1)
○ Surface Water for Irrigation ○ Surface Water for M&I ○ Surface Water for Recharge ○ Precipitation ○ Spill Inflows	○ Groundwater Inflows ○ Deep Percolation of Irrigation Water ○ 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 3.3.2)	**Change in Groundwater Storage (Section 3.3.3)**
○ Groundwater Pumping for Irrigation ○ Groundwater Pumping for M&I ○ Evapotranspiration of Applied Water -Irrigation ○ Evapotranspiration of Applied Water – M&I ○ Evapotranspiration of Effective Precipitation ○ Evaporation of Conveyance Channels ○ Evaporation of Reservoirs and Recharge Basins ○ Evaporation and Runoff of Precipitation ○ Operational Spills ○ 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.

Surface Water for Irrigation

Surface water for irrigation comes from three sources: 1) contracted Kings River water; 2) contracted San Joaquin River water; and 3) Riparian diversions on the Kings and San Joaquin Rivers.

Kings River

About 87% of the surface water deliveries in NKGSA come from the Kings River. Kings River delivery data were acquired from Kings River Water Association Watermaster Reports for headgate diversions to each member unit.

San Joaquin River

About 13% of surface water comes from the San Joaquin River through the Friant Division of the Central Valley Project. This water is diverted directly through the Friant-Kern Canal

Riparian Diversions

About 2% of surface waters are estimated to come from riparian diversions along the Kings and San Joaquin Rivers. This includes Holding Contract lands along the San Joaquin River.

Kings River. It was assumed that identified pumps that abut the Kings River divert riparian water to meet crop demands for an assumed acreage when water was available in that reach of the river. Average annual demands were assumed to be 3 AF/acre and were divided into monthly values and apportioned to the appropriate GSA. Since portions of the Kings River are not a continuously operated stream, water was assumed to be pumped only in months when water was available in that reach of the river.

San Joaquin River. Holding Contracts, which operate under a special agreement with USBR regarding impacts from Friant Dam, are able to divert and use San Joaquin River water similar to riparian water diverters. It was assumed that these lands use 1.5 AF/acre. This is less than the 3 AF/acre assumed for Kings River Riparian Diversions, however, the Holding Contract lands include some areas that appear to be undeveloped, and even some that do not abut the River.

In reality, the acreage of riparian lands and quantity of diversions are unknown since the diversions are generally not reported, so these values may be modified in the future if additional information is gained. Since only total losses within reaches of the River are reported, which include seepage, evaporation and any riparian pumping, a change in riparian demand estimates will necessitate a similar change in estimated river seepage, and hence there would essentially be little to no change in the overall groundwater budget.

Surface Water for M&I

Urban surface-water delivery data were collected directly from the local agencies. In the North Kings GSA, surface water has been delivered to the City of Fresno, City of Clovis, Fresno County and Bakman Water Company for groundwater recharge or surface water treatment or both. This variable represents all surface water diverted for urban deliveries and recharge.

Surface Water for Recharge

Surface water use for intentional recharge is based on measured deliveries to recharge basins. When recharge basins were not metered, the deliveries were estimated by the local agency using their own criteria and assumptions. Intentional recharge programs are well developed by some agencies, with several agencies planning to develop new programs or expand existing programs in the future.

Precipitation

Precipitation data was gathered from the NOAA Regional Climate Center. Monthly precipitation was tabulated for stations throughout and adjacent to the Kings Subbasin boundary for the 1996 Water Year through the 2016 Water Year. Isohyetal contours were generated using the station coordinates and their respective average annual precipitation values. The average annual precipitation contour map was clipped to the individual GSAs to provide each GSA with a unique average for a 20-year hydrologic period. Monthly averages were calculated using California Climate Data Archive's COOP stations to estimate the percentage of precipitation that occurred per month within the Kings Subbasin. The annual average precipitation values per GSA were multiplied by the estimated monthly percentages to generate monthly precipitation values unique to each GSA.

The average precipitation in the North Kings GSA during the 1997-2011 historical period was 11.79 inches. The average for Wet Year Types was 16.85 inches, and the average for Dry Year Types was 8.18 inches.

Spill Inflows

This represents spills of surface water into an irrigation or water district, and therefore is a source of water. They are based on measured spills, or estimates provided by the district. No operational spills into the North Kings GSA were identified, and consequently they were set to zero.

3.3.5 Inflows 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.

Quantities of water entering groundwater in the Kings Subbasin from groundwater flow or recharge are described and quantified in this section using the procedures described below.

Groundwater Inflows

No groundwater inflow is believed to occur from the alluvial aquifers to the north, south or west of NKGSA. The eastern boundary of the Kings Subbasin is defined by the roughly 139-mile contact between alluvium and bedrock. A reasonably rigorous search was conducted to find information or previous work on estimating flow from fractured bedrock into alluvium. The literature search found no specific information on local groundwater flows. Existing literature consistently states that this hydrogeologic process is not well understood, and these types of groundwater flows are believed to be minor. The USGS Central Valley Hydrologic Model (USGS, 2009) assumes that the bedrock-alluvial boundary has no flow across the entire boundary of the Central Valley, which is consistent with conclusions from other studies. Since little information is available on the groundwater inflow, and it is believed to be minor, it was assumed to be zero. It is believed that water from the foothills enters the alluvial basin primarily through local streamflows, which are captured in other water budget variables.

Deep Percolation of Irrigation Water

Deep percolation of irrigation was calculated by assuming that the amount of water applied above and beyond the evapotranspiration rate (due to irrigation inefficiencies or over-irrigation) 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. The NKGSA-wide irrigation efficiency was estimated to be 82% based on the mix of annual and permanent crops. As a result, deep percolation of irrigation water is estimated at 100% – 82% = 18% of the applied water.

Deep Percolation of Precipitation

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 below).

Deep percolation of precipitation in the North Kings GSA averaged 48,900 AF/year during the base period, with considerably higher amounts, 119,100 AF/year, in wet years and 5,600 AF/year in dry years.

Deep Percolation of M&I Water

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

When sewer flows are known the volume percolated is equal to wastewater plant deliveries minus percolation pond evaporation. For rural populations, it is also assumed that 100 percent of indoor water use is percolated into the groundwater through septic systems and leach fields. Indoor consumptive water usage in rural areas is assumed to be 35% of water demands based on experience with other San Joaquin Valley communities.

It is assumed that 15% of outdoor water percolates to the groundwater with the remainder lost primarily to evapotranspiration of landscaping, and smaller amounts to evaporation of pool water and wash water.

Deep percolation of M&I water is a major component in the water budget and was estimated at about 96,000 AF/year during the historical period of 1997-2011.

Seepage of Channels and Pipelines

Pipeline seepage was based on data provided by local agencies, or standard values estimated using the AWWA Water Audit Loss Tool. When pipeline leakage rates were not known they were generally assumed to be 3% for gravity lines and 4% for pressurized lines.

Only Fresno Irrigation District (FID) has open channels that experience significant seepage in the NKGSA. A detailed analysis of canal seepage was not feasible due to limited data on soil types, existing canal soil compaction, canal widths, canal depths and percent of time canals are filled. FID has assumed for many years that their canal seepage rate is 18%. This is also documented in the FID 2013 Water Management Plan. While the exact origin of this number is unknown, FID has considered it a reasonable approximation for many years. This resulted in annual seepage of 80,400 AF/year during the historical period of 1997-2011. As a result, FID canal seepage is a major source of recharge in the NKGSA.

The Friant-Kern Canal, found on the eastern edge of the NKGSA, is estimated to leak about 4,400 AF/year with all of the water flowing into NKGSA.

Seepage of Reservoirs

Fresno Irrigation District is the only agency with surface reservoirs in the NKGSA. Their reservoirs are all operated as joint regulation reservoirs/recharge basins. Consequently, reservoir seepage is treated as intentional recharge, so reservoir seepage is recorded as zero.

Urban Stormwater – Recharge

Fresno Metropolitan Flood Control District (FMFCD) operates stormwater ponds that capture runoff from the Fresno/Clovis urban area in the North Kings GSA. FMFCD maintains detailed records of operations, and, based on local rainfall records over the Fresno-Clovis areas, it was estimated that about 20% of the local rainfall percolated through stormwater basins. It was assumed that deep percolation of precipitation in landscape and bare soils areas is negligible in urban areas. Urban stormwater recharge values were not available for any other cities in the Kings Basin. Therefore, lacking any better data, it is assumed that 20% of rainfall percolates to the groundwater in all urban areas in NKGSA.

Local Streams – Recharge

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

<u>Local Foothill Streams</u>
There are a number of local streams that drain small foothill watersheds into the North Kings GSA. These include Little Dry Creek, Big Dry Creek, Dry Creek, Redbank Creek, Fancher Creek, and Fish and Holland Creek. Note that the names of the creeks vary in different sources, but the flow estimates all cover the area draining into the NKGSA. Several studies provide approximate estimates of local flows. Using these results, it was estimated that local streamflow into NKGSA is 9,900 AF/year.

San Joaquin River

The northern portion of the NKGSA receives river seepage from the San Joaquin River. Direct seepage values were not available. Rather total losses were available for several years in records documented by USBR. River seepage was estimated as Total Losses – Assumed Riparian Diversions – Evaporation Losses. It was assumed that seepage is split evenly both north and south of the River. No detailed data was available to make a better assumption. It was also assumed that seepage was slightly larger in the downstream portion of the River than the upstream portion, since the upstream portion has high groundwater levels and shallow bedrock in some areas. Historical seepage from 1997-2011 was estimated at 36,600 AF/year.

Kings River

The Kings River is the main source of surface water that runs through the Kings Basin (see Section 3.3.3). Kings River seepage benefits each of the seven GSAs to a varying degree. KRWA Annual Watermaster Reports documents river losses along designated river reaches on a monthly basis. River seepage was estimated similarly to the San Joaquin River described above. Only a small area in the southeast corner of the NKGSA receives Kings River seepage, estimated at 3,100 AF/year.

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 primary outflow from the groundwater body is groundwater pumping, which was estimated for agricultural and M&I purposes as described below. Other outflows from the groundwater basin are also summarized.

Groundwater Pumping for Irrigation

Most irrigation groundwater pumping in the Kings Subbasin is not measured. Unmetered groundwater pumping has been estimated based on crop evapotranspiration and other water budget variables. In groundwater only areas, the groundwater pumping is simply the crop evapotranspiration demand less effective precipitation, divided by an average irrigation efficiency.

In conjunctive use areas with surface water and groundwater, the groundwater pumping must be back-calculated using numerous water budget variables if wells are not metered. In a simple situation, groundwater pumping = crop applied water demands – surface water deliveries.

However, in many areas, irrigation groundwater pumping must be estimated because surface water deliveries to growers differ from headgate surface water diversions due to system losses and deliveries made for intentional recharge. In these situations, irrigation groundwater pumping is estimated using the following formula:

Private Irrigation Pumping = Crop applied water demands – Surface water deliveries to growers

where:

Surface Water Deliveries to Growers = Headgate diversions – System losses – Intentional recharge

and

System Losses = Channel evaporation + Channel seepage + Reservoir evaporation + Reservoir seepage + Operational Spills

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

Private Irrigation Pumping = (Crop evapotranspiration less effective precipitation) / Irrigation efficiency – Headgate diversions + Channel evaporation + Channel seepage + Reservoir evaporation + Reservoir seepage + Operational spills + Intentional recharge

Almost all agricultural irrigation pumping in the North Kings GSA (with the exception of California State University Fresno) is performed by individual farmers and is estimated here using the formulas presented above. Agricultural groundwater pumping estimates during the 1997-2011 historical period averaged about 151,000 AF/year.

Groundwater Pumping for M&I

M&I groundwater pumping by urban water suppliers was collected directly from the local urban agencies.

Rural residential water demands include domestic well pumping at farmhouses and rural communities that are not served water from a City, County Service Area, Community Services District or other water utility. Rural residential water demands were estimated as the sum of indoor and outdoor water use. The water demands were estimated based on an assumed indoor per capita use, and assumed per acre use for outdoors. Population was estimated using 2010 US Census Block Groups. Census block groups did not always closely follow GSA boundaries. As a result, all block groups that were outside of designated urban areas, and had the majority of their area inside a GSA, were assumed to represent the local rural population.

Indoor use for rural areas was estimated by multiplying the rural population by 70 gallons/capita/day, based on the recent goal of 55 gallons per day from SB 606/AB 1668, which has likely been exceeded in the past. It was assumed that each parcel has 4 residents. Outdoor use was estimated by assuming that 0.65 AF/acre is used for landscape irrigation and other outdoor water uses. Estimates of aggregate outdoor water use were based on processing June 2016 multi-band satellite images to determine amount of irrigated vegetation in the North Kings GSA. Lacking data and a similar analysis elsewhere, the results were applied to all of the Kings Basin GSAs. The analysis determined that approximately 21 percent of the rural residential land area was vegetated, and 3 AF/acre water use was assumed to obtain 0.65 AF/acre aggregate water use over the NKGSA. The average parcel size was calculated as 2.5 acres using the satellite data. Using the indoor and outdoor water demands estimated above, rural residential demands were estimated to be 0.49 AF/capita/year. Total rural residential groundwater pumping was estimated to be about 17,000 AF/year during the historical period.

Evapotranspiration of Applied Water – Irrigation

This variable, also called crop water demands, represents crop evapotranspiration minus effective precipitation. For the historical period, this variable was estimated using DWR Land Use data and

DWR evapotranspiration estimates. Land use data from DWR was available by County for different years within the historical base period. DWR land use data was available for Fresno County for the years 1994, 2000, 2009 and 2014. The land use data for each GSA was interpolated each year during the water budget period using the DWR data. Annual crop evapotranspiration rates by Detailed Analysis Unit (DAU) were obtained from DWR (*https://water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Agricultural-Land-And-Water-Use-Estimates*). The DWR annual crop evapotranspiration rates were available on-line for 20 different crops for the years 1998 through 2010. 2011 annual crop evapotranspiration rates were obtained directly from DWR and 1997 was assumed to be equivalent to the average of the period 1998 through 2011.

The total crop evapotranspiration rates were generally computed as the product of the interpolated crop acreage for each crop times the annual crop evapotranspiration. The totals by crop were then aggregated to totals for each GSA. In addition to this normal computation, there was an adjustment for the acreage of newly planted orchards, which would not have the same ET rates as mature orchards. The adjustment for newly planted orchards assumes a four-year annual increase in evapotranspiration, increasing from 25% of the normal annual evapotranspiration rate in the first year to 100% of the normal rate in year four. In addition, there was also an assumption that orchard crops (primarily almonds) would be replanted on a twenty-year basis which resulted in an additional 6.25% reduction to crop evapotranspiration rates for ongoing orchard acreage. The cropping demands were adjusted within their estimated range of accuracy (+/- 15%) to help close the water budget.

Evapotranspiration of Applied Water – M&I

Evapotranspiration of M&I water primarily includes landscape irrigation demands, plus some additional evaporation from swimming pools and wash water. First, the quantity of M&I water used outdoors needs to be determined. When total water deliveries and sewer flows are known, then outdoor water use is simply the difference between the two values. When total pumping or sewer records are not available, then outdoor water use was assumed to be 65% of total water demands. This is based on general experience with other municipalities in the San Joaquin Valley. It was assumed that 85% of total water use is lost to evapotranspiration of landscape (75% of outdoor water supplies) and pools and other outdoor water uses (10% of outdoor water supplies).

Evapotranspiration of Effective Precipitation

Effective precipitation is the amount of rainfall beneficially used by crops, either directly as transpiration or through storage in the root zone and evapotranspiration in subsequent periods. Annual values of effective precipitation were obtained from DWR's Agricultural Land & Water Use Estimates website (*https://water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Agricultural-Land-And-Water-Use-Estimates*). As with annual crop evapotranspiration rates, annual estimates of effective precipitation were available for individual Detailed Analysis Units (DAUs) for the period 1998 through 2010. 2011 estimates were obtained directly from DWR and 1997 was estimated as the average for the period 1998-2011. The unit effective precipitation rates were multiplied by interpolated acreages for the 1997-2011 period as described earlier to develop estimates of overall effective precipitation in the NKGSA for the hydrologically average base period. Effective precipitation was assumed to be the same in normal, wet and dry periods, since a detailed analysis in a nearby GSA in the basin (the North Fork Kings GSA) found little difference in effective precipitation in different water year types.

Evaporation from Conveyance Channels

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

Evaporation from conveyance channels in the North Kings GSA was estimated to average 2,900 AF for the 1997-2011 historical period. Because it is such a small amount, no change to these average values was assumed for different water year types.

Evaporation from Reservoirs and Recharge Basins

Long-term evaporation rates were collected from seven California Irrigation Management Information System (CIMIS) stations in and around the Kings Basin. These included Stations No. 2 – Five Points, 15 – Stratford, 39 – Parlier, 80 – Fresno State, 105 – Westlands, 142 – Westlands, 142 – Orange Cove and 190 – Five Points South West. Reservoir, recharge basin, and effluent percolation pond evaporation estimates were based on actual evaporation rates during the study period for the closest CIMIS station, or a combination of CIMIS stations. When details were not available on the time of year or length of time waters were in storage, the evaporation rates were assumed to be 4 to 5% of total water supplies. Total reservoir and basin evaporative losses in the NKGSA were 7,800 AF/year during the historical period.

Evaporation and Runoff of Precipitation

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

> Evaporation and Runoff of Precipitation = Precipitation - Effective Precipitation - Deep Percolation of Precipitation

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

Operational Spills

This represent spills of surface water leaving the boundary of an irrigation or water district and is considered a non-recoverable loss to that district. They are based on measured spills, or estimates provided by the district. The only known spills in the NKGSA are from Fresno Irrigation District to McMullin Area GSA, and averaged 2,100 AF/year in the historical period.

Groundwater Exports

This represents the export of groundwater from one agency into another, based on metered well pumping. Groundwater exports can occur from water transfers, exchanges, banking agreements, or groundwater deeds. Groundwater exports by landowners that own adjacent properties on an agency boundary (one in the agency and one just outside) were neglected, since it is assumed they are minor and tend to balance each other out. There are no known groundwater exports from the NKGSA.

Groundwater Outflows

Unconfined groundwater outflows 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 for estimating estimate groundwater flows,
- The aquifer is relatively homogenous and isotropic

In the Kings Basin, unconfined groundwater flows were estimated at all of the NKGSA boundaries. The analysis divided the NKGSA borders into flow segments. Average flow direction and gradients for each segment were determined from groundwater contour maps developed for the Kings Subbasin (P&P Technical Memorandum #4)(P&P, 2018b). Transmissivities were estimated from available aquifer tests when available. In areas with sparse aquifer tests, specific capacities from USGS reports were used. A more complete description of the calculations is presented in P&P Technical Memorandum #5 (P&P, 2018c).

Confined groundwater outflows were not calculated due to a lack of confined groundwater level information in NKGSA. Confined groundwater flows were roughly estimated based on calculated confined groundwater flows in other parts of the Kings Basin.

In the North Kings GSA, subsurface outflows are estimated to be 122,000 AF/year, including 87,000 AF/year from the unconfined aquifer, and 35,000 AF/year from the confined aquifer.

Irrigation Efficiencies

Irrigation efficiencies were estimated based on the general crop types (USBR, July 2018). Field crops are assumed to use flood/furrow irrigation and have an efficiency of 70%. Trees and vines are assumed to use drip or micro-spray and have an irrigation efficiency of 85%. The NKGSA area-wide cropland irrigation efficiency was estimated to be 82%. Local landscape irrigation efficiencies are assumed to be 75% based on efficiencies in other areas of the San Joaquin Valley (Thomas Harder and Co., 2017 and Davids Engineering, 2018).

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.

Unconfined Groundwater Storage Change

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

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

Groundwater storage change for the range of years was computed using the procedure documented in P&P Technical Memorandum #4 (P&P, October 2018). The estimated change in unconfined groundwater storage in NKGSA was 24,000 AF/year during the historical period.

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

Groundwater Released from Aquifer Compaction

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

Available data indicates that land subsidence has been minimal in NKGSA. Therefore, there has been no measurable groundwater release from aquir compaction. Within the rest of the Kings

Groundwater Basin, other GSAs had an estimated reduction in storage of 12,000 AF/year due to aquifer compaction during the hydrologic base period.

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

<u>Kings Basin Water Budget</u>

Table 3-7 shows a water budget for the Kings Subbasin as a whole along with the equivalent individual water budgets for the seven GSAs within the Kings Subbasin. The water budget for Central Kings GSA and South Kings GSA were combined into a single water budget. The inflows and outflows to the groundwater basin are used to estimate the change in groundwater storage based on the water budget components (Method 1), and this estimated change in storage is compared to the calculated change in groundwater storage from the groundwater level data (Method 2).

Table 3-7 Kings Basin Historical 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

As shown in **Table 3-7**, the 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.

North Kings GSA Historical Water Budget

The detailed historical water budget for the North Kings GSA is shown in **Table 3-8. Figure 3-44** graphically illustrates the water budget variables and their values. Water Budgets were developed for normal, wet and dry year scenarios. The wet and dry year water budgets are similar to the normal year water budgets, with changes made for precipitation and surface water supplies. The normal year water budget reflects average conditions and is used for long-term planning. The wet and dry year water budgets essentially show bookend conditions, including significant overdraft in dry years and water surpluses in wet years.

An important component of the historical water budget is groundwater outflow to McMullin GSA. Through coordinated meetings with all of the GSAs, it was determined that groundwater pumping and lack of surface water in McMullin GSA (which is located directly west of North Kings GSA) has induced additional groundwater flow out of NKGSA. Recent flows were compared to historical flows from the 1920's before there was considerable development. The comparison determined that McMullin GSA is inducing 43,000 AF/year from NKGSA. McMullin GSA plans to mitigate these induced flows gradually from 2020 to 2040, with more progress expected in the latter years. This value is included in the historical water budget but is removed in the future water budget discussed later, since McMullin GSA is expected to mitigate these groundwater flows through water supply and demand reduction projects.

Table 3-8 NKGSA Historical Average Water Budget (1997-2011) (AF)

Description	Symbol	Volume (AF)			Source
	Irrigation Eff.	82%			
Supply		Normal Year	Dry Year	Wet Year	
1) Surface Water for Irrigation and Recharge	Qirr	434,700	321,870	559,400	Measured
2) Surface Water for M&I and Recharge	Qmi	72,300	72,300	72,300	Measured
3) Groundwater Pumping for Irrigation (Agency Wells)	Gwirra	1,600	1,600	1,600	Measured
4) Groundwater Pumping for Irrigation (Private Wells)	Gwirrp	145,800	258,200	21,100	Residual
5) Groundwater Pumping for M&I (Agency Wells)	Gwmia	180,900	180,900	180,900	Measured
6) Groundwater Pumping for M&I (Private Wells)	Gwmip	17,100	17,100	17,100	Calculated
7) Precipitation	P	304,900	211,600	435,700	Measured
8) Spill Inflows	Si	0	0	0	Calculated
9) Other Supply: Local River/Stream Seepage	Os	9,900	9,900	9,900	Caluclated
Total Supply		**1,167,200**	**1,073,470**	**1,298,000**	
Demand					
Consumptive Use					
10) Evapotranspiration met by Applied Irrigation Water	ETc	381,800	381,800	381,800	Calculated
11) Evapotranspiration met by Effective Precipitation	ETp	64,100	64,100	64,100	Calculated
12) Evapotranspiration of M&I	ETmi	98,600	98,600	98,600	Calculated
13) Other Consumptive Use:	Od	0	0	0	Calculated
Consumptive Subtotal		**544,500**	**544,500**	**544,500**	
Groundwater Recharge					
14) Groundwater Inflow	GWi	0	0	0	Calculated
15) Deep Percolation of Irrigation Water	PRCirr	86,300	86,300	86,300	Calculated
16) Deep Percolation of Precipitation (rural areas)	PRCp	31,000	4,300	79,800	Calculated
17) Deep Percolation of M&I Water	PRCmi	96,200	96,200	96,200	Calculated
18) Seepage of Channels & Pipelines	Sch	96,200	96,200	96,200	Calculated
19) Seepage - Reservoirs	Sr	0	0	0	Calculated
20) Urban Stormwater - Recharge	Rus	19,600	13,600	28,000	Calculated
21) Local Streams/Rivers - Recharge	Rst	49,600	49,600	49,600	Calculated
22) Groundwater - Intentional Recharge	Rint	82,000	82,000	82,000	Measured
23) Other Recharge:	Or	0	0	0	
GW Recharge Subtotal		**460,900**	**428,200**	**518,100**	
Nonrecoverable Losses					
24) Groundwater - Outflow	GWo	122,000	122,000	122,000	Calculated
25) Evaporation - Channels	Ech	2,900	2,900	2,900	Calculated
26) Evaporation - Reservoirs & Recharge Basins	Er	7,800	7,800	7,800	Calculated
27) Precipitation - Evaporation and Runoff	Ep	190,200	190,200	190,200	Residual
28) Operational Spills	S	2,100	2,100	2,100	Measured
29) Groundwater - Export	GE	0	0	0	Measured
30) Other Losses:	Ol	0	0	0	
Nonrecoverable Subtotal		**325,000**	**325,000**	**325,000**	
Method 1					
Estimated Annual Change in Groundwater Storage		**(6,500)**	**(151,600)**	**175,400**	Calculated
GW Recharge - #14 thru #23	460,900		428,200	518,100	
GW Pumping - #3 thru #6	(345,400)		(457,800)	(220,700)	
GW Outflow - #24 and #29	(122,000)		(122,000)	(122,000)	
Projects and Management Actions (see Section 6 of GSP)	0		0	0	
Method 2					
Calculated Annual Change in Groundwater Storage		**(24,000)**			Measured
	Water balance closes within acceptable limit				

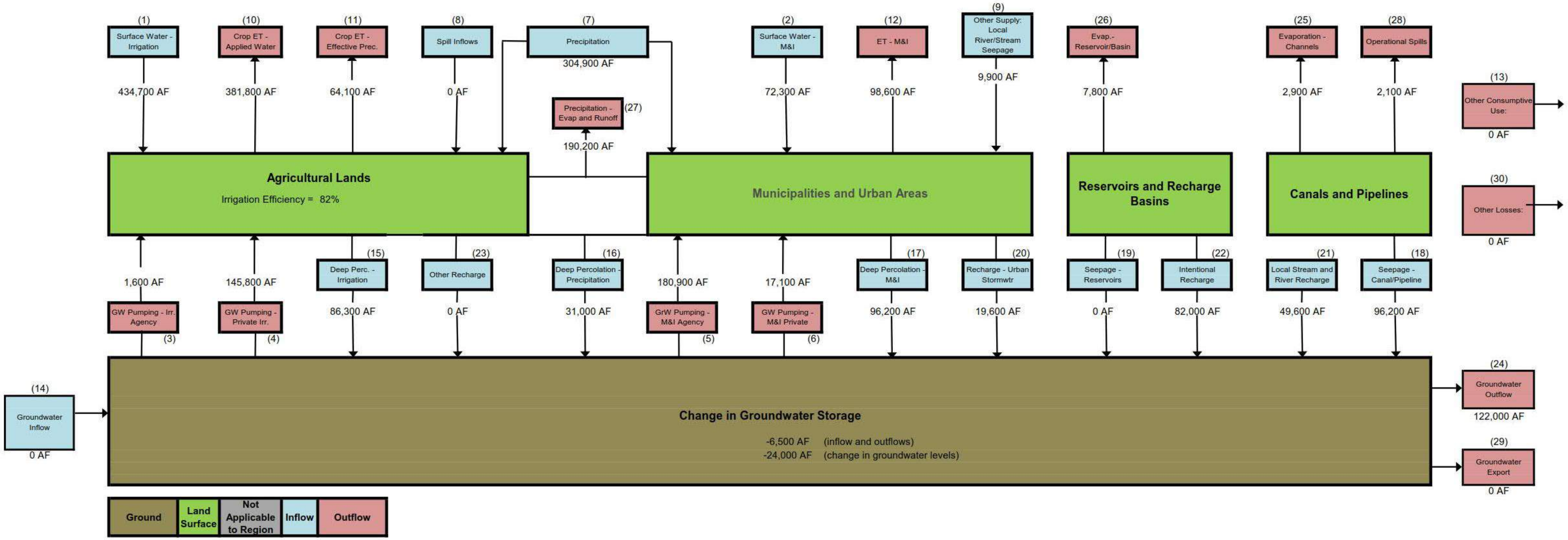


Figure 3-43 NKGSA Historical Water Budget Diagram (1997-2011)

<u>Uncertainty in Water Budgets</u>

There is considerable uncertainty in many of the water budget parameters. The parameters with the least uncertainty, estimated as plus or minus 5%, are limited to surface water diversions which are directly measured. Most other water budget parameters are indirectly estimated. For example, precipitation is estimated based on a limited number of sparsely distributed precipitation stations. Water budget parameters using precipitation (such as effective precipitation) start with the uncertainty of the precipitation value itself, which is increased by the need to estimate crop evapotranspiration, soil moisture storage and movement through the soil surface to provide recharge. The largest single component of water use, evapotranspiration of applied water, is estimated to have an accuracy of plus or minus 15%, with uncertainty resulting from infrequent surveys of cropping patterns, indirect estimates of unit evapotranspiration rates for crop types, and variations in agricultural management practices that result in variations in unit crop water use. The uncertainty in evapotranspiration of applied water alone is estimated to be about 57,000 AF/year for the historical period.

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

3.3.9 Current Water Budget

Regulation Requirements:

§354.18

(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:
(1) Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, water demand, and land use information.

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

<u>Kings Basin Current Water Budget</u>

Table 3-9 shows a current water budget for the Kings Subbasin as a whole along with the equivalent individual water budgets for the seven GSAs within the Kings Subbasin.

Table 3-9: 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 change in groundwater storage 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.

NKGSA Current Water Budget

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

1. Urban water demands were based on the average demands for 2016 and 2017. These represent a dry year and wet year, respectively. This period was selected since it best represented both current and average conditions. No recent single year was considered a better representation of current hydrology than these two years.

2. Agricultural demands were based on 2014 DWR land use maps, which are the most recent comprehensive land use maps for the area.

3. Surface water supplies were based on the long-term average supplies from the historical water budget, and not the actual supplies delivered in 2016 and 2017.

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

The Current Water Budget is shown in **Table 3-10.** Wet and Dry Year water budgets, with variations in surface water supplies and precipitation based on the year type, are also shown in **Table 3-10**. Overall, the water budget shows improved conditions over the historical conditions, including a water supply surplus, for the following reasons:

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

The current water budget is a short snapshot of water conditions and not considered as accurate as a long-term average water budget. The water budget was not compared to changes in groundwater levels since it would be inaccurate due to time lags from various forms of recharge, and inaccuracies that tend to balance out over longer time periods. Nevertheless, this water budget is still the best representation of current water budget conditions available. This period also included some significant water conservation, especially in 2016, which was the tail end of a severe multi-year drought. This conservation mindset is expected to continue due to ongoing legislation and ordinances that further drive it. Further, water metering requirements by 2025 and new technologies (i.e.. better leak detection) will also continue to help reduce demands.

Table 3-10 NKGSA Current Average Water Budget (2016-2017) (AF)

	Irrigation Eff.	82%			
Description	**Symbol**	**Volume (AF)**			**Source**
Supply		Normal Year	Dry Year	Wet Year	
1) Surface Water for Irrigation and Recharge	Qirr	419,700	306,020	543,550	Measured
2) Surface Water for M&I and Recharge	Qmi	87,600	87,600	87,600	Measured
3) Groundwater Pumping for Irrigation (Agency Wells)	Gwirra	1,300	1,300	1,300	Measured
4) Groundwater Pumping for Irrigation (Private Wells)	Gwirrp	145,200	257,500	20,500	Residual
5) Groundwater Pumping for M&I (Agency Wells)	Gwmia	124,600	124,600	124,600	Measured
6) Groundwater Pumping for M&I (Private Wells)	Gwmip	17,100	17,100	17,100	Calculated
7) Precipitation	P	304,900	211,600	435,700	Measured
8) Spill Inflows	Si	0	0	0	Calculated
9) Other Supply: Local River/Stream Seepage	Os	9,900	9,900	9,900	Caluclated
Total Supply		**1,110,300**	**1,015,620**	**1,240,250**	
Demand					
Consumptive Use					
10) Evapotranspiration met by Applied Irrigation Water	ETc	368,900	368,900	368,900	Calculated
11) Evapotranspiration met by Effective Precipitation	ETp	58,600	58,600	58,600	Calculated
12) Evapotranspiration of M&I	ETmi	66,100	66,100	66,100	Calculated
13) Other Consumptive Use:	Od	0	0	0	Calculated
Consumptive Subtotal		**493,600**	**493,600**	**493,600**	
Groundwater Recharge					
14) Groundwater Inflow	GWi	0	0	0	Calculated
15) Deep Percolation of Irrigation Water	PRCirr	83,400	83,400	83,400	Calculated
16) Deep Percolation of Precipitation (rural areas)	PRCp	31,000	4,300	79,800	Calculated
17) Deep Percolation of M&I Water	PRCmi	88,100	88,100	88,100	Calculated
18) Seepage of Channels & Pipelines	Sch	93,200	93,200	93,200	Calculated
19) Seepage - Reservoirs	Sr	0	0	0	Calculated
20) Urban Stormwater - Recharge	Rus	19,600	13,600	28,000	Calculated
21) Local Streams/Rivers - Recharge	Rst	49,600	49,600	49,600	Calculated
22) Groundwater - Intentional Recharge	Rint	84,500	84,500	84,500	Measured
23) Other Recharge:	Or	0	0	0	
GW Recharge Subtotal		**449,400**	**416,700**	**506,600**	
Nonrecoverable Losses					
24) Groundwater - Outflow	GWo	122,000	122,000	122,000	Calculated
25) Evaporation - Channels	Ech	2,800	2,800	2,800	Calculated
26) Evaporation - Reservoirs & Recharge Basins	Er	7,800	7,800	7,800	Calculated
27) Precipitation - Evaporation and Runoff	Ep	195,700	195,700	195,700	Residual
28) Operational Spills	S	2,100	2,100	2,100	Measured
29) Groundwater - Export	GE	0	0	0	Measured
30) Other Losses:	Ol	0	0	0	
Nonrecoverable Subtotal		**330,400**	**330,400**	**330,400**	
Method 1					
Estimated Annual Change in Groundwater Storage		**39,200**	**(105,800)**	**221,100**	
GW Recharge - #14 thru #23	449,400		416,700	506,600	Calculated
GW Pumping - #3 thru #6	(288,200)		(400,500)	(163,500)	
GW Outflow - #24 and #29	(122,000)		(122,000)	(122,000)	
Projects and Management Actions (see Section 6 of GSP)	0		0	0	

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 2040 and 2070. The 2040 water budget is the focus of this analysis as it represents near term periods and requires less speculative estimates of projected future climate change impacts, population growth and land use change. The projected water budgets are shown without the yield or water conservation from future projects, so they show the net impact if no action is taken.

Projected water budgets are based initially on the Current water budget, with changes made to various variables, as shown in **Figure 3-44** below.

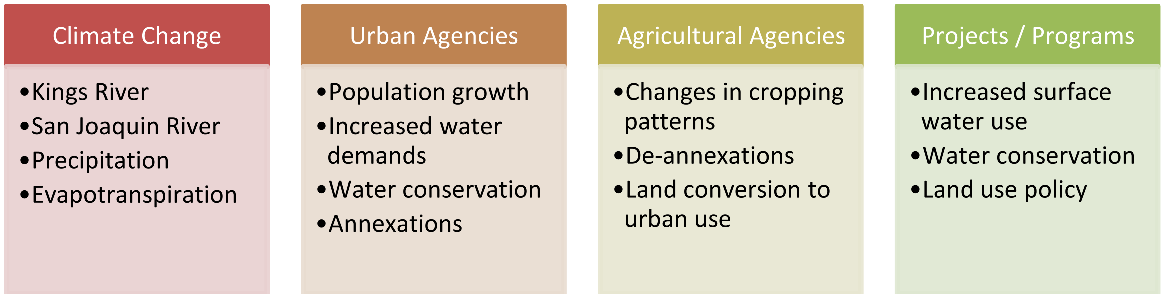


Figure 3-44 Variables Impacting Projected Water Budget

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 for 2030 and 2070. Since 2040 is the deadline for sustainability, and therefore the focus of the water budgets, impacts from 2040 were interpolated between the 2030 and 2070 results.

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

For the Kings Subbasin, three DWR datasets were used – projected Kings River inflows to Pine Flat Dam, projected precipitation in the Kings Subbasin and projected evapotranspiration. In addition, projections for Friant-Kern Canal water supplies (San Joaquin River) were developed by the Friant Water Authority (2018) and are also based on WISP projections.

Kings River Flows

Kings River inflows for future conditions were analyzed based on the WSIP water supply projections. It was concluded that climate change will have no significant impact on Kings River diversions. More detail is provided below.

The estimated Kings River flows (central tendency projections) for both 2040 and 2070 are shown in **Figure 3-45.** These have a slight increase in projected Kings River inflows, however there was a major shift in timing. 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 historically.

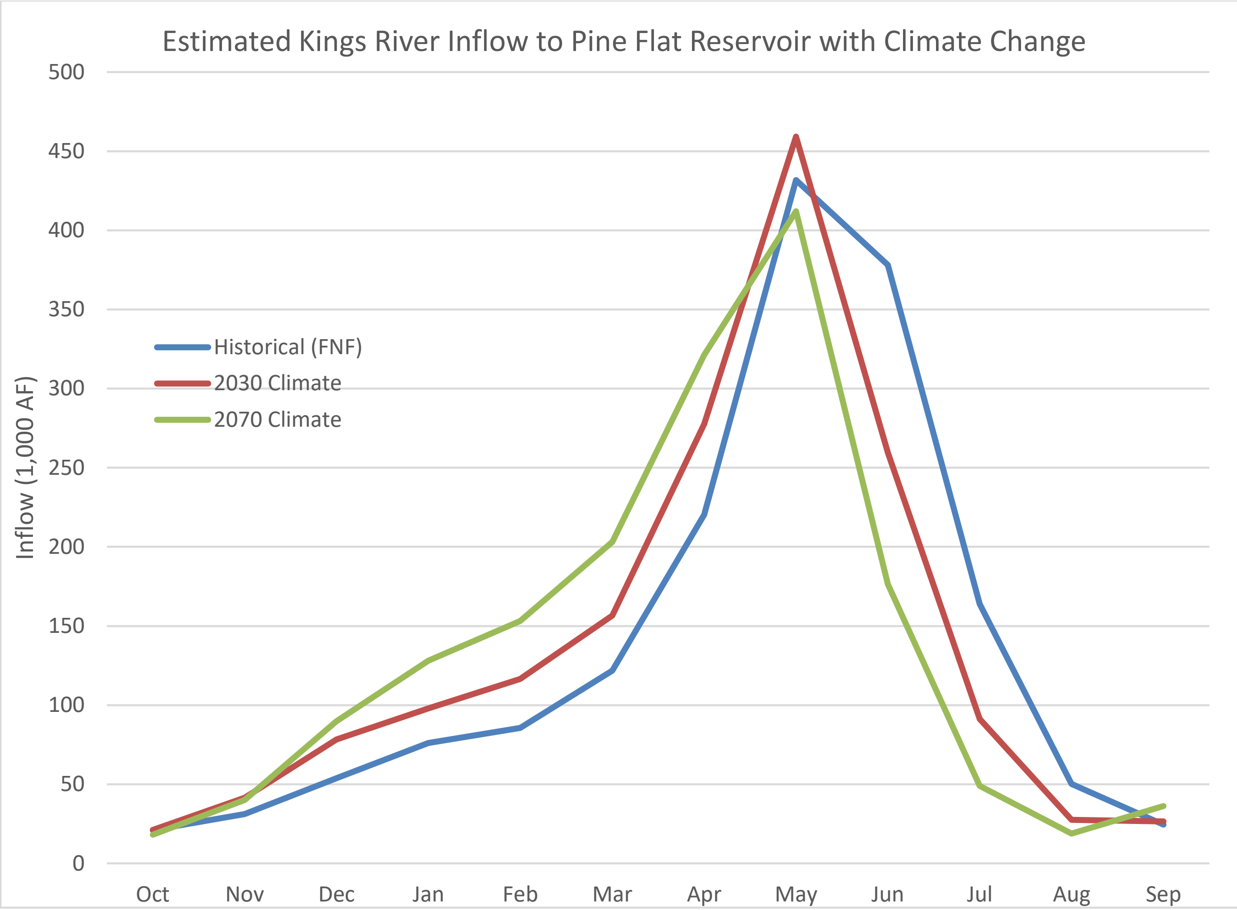


Figure 3-45 Estimated Climate Change impacts on Kings River Runoff

As noted earlier, the overall change in predicted annual Kings River inflows is a very slight increase. Inflows are expected to increase about 0.6% by 2040 and increase 0.3% by 2070 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. Future modeled flows indicate 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 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.

Quantifying 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 other factors 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 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 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 North Kings GSA, the historical water supply values described earlier will be used for both the 2040 and 2070.

<u>San Joaquin River</u>
Friant Water Authority (2018) estimated climate change impacts to San Joaquin River supplies (Friant Division of the Central Valley Project) based on the WISP datasets. These evaluate all of the water supplies available to Friant contractors, included Class I, Class II and floodwater supplies. In general, the data shows a slight reduction in future supplies. These results were used in the 2040 and 2070 scenarios.

<u>Precipitation</u>
The WSIP climate change datasets generally showed minimal changes to precipitation. More details are provided below in the figure below.

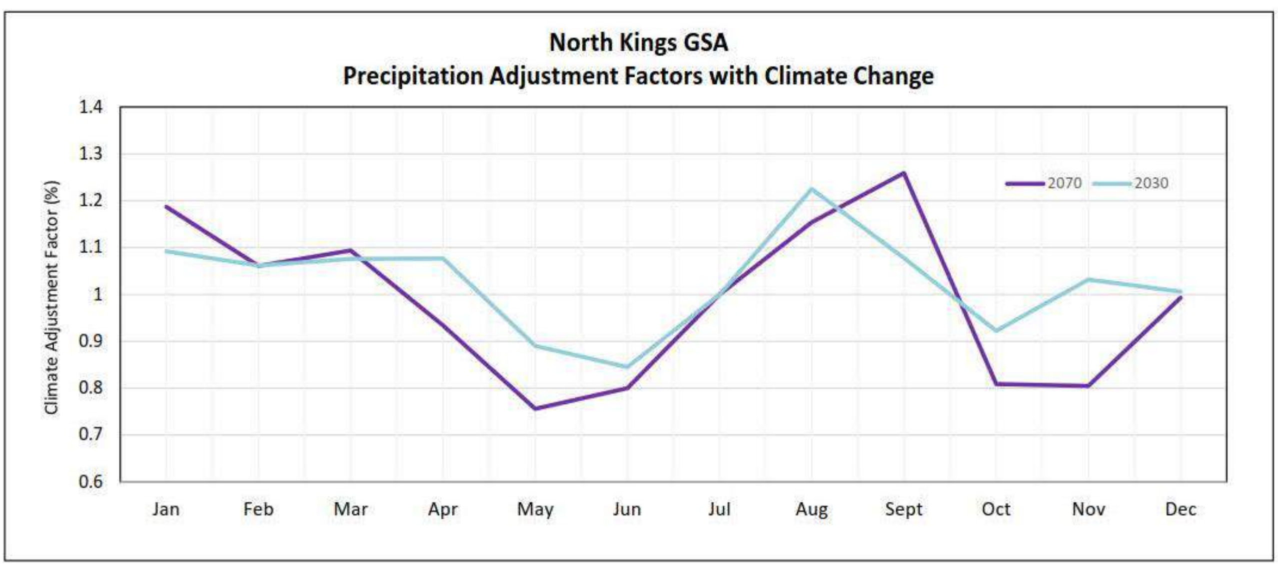


Figure 3-46 DWR Precipitation Adjustment Factors with Climate Change

Precipitation was evaluated by averaging the most recent 50-years of simulated changes to precipitation (1962-2011). The overall precipitation change factors were projected to increase by 3% for 2030 conditions and to decrease by 1% for 2070 conditions. When interpolated, this results in a 2% increase for 2040.

Moreover, the average monthly adjustment factors understate the effect on precipitation, as many of the months with projected decreases in precipitation (e.g., May, June and October) are low precipitation months while months with indicated increased precipitation tend to be wetter (e.g., January and February). Given the generally low amount of precipitation in the Kings Subbasin and the slight increase projected with climate change, a conservative assumption has been made that projected rainfall, and amounts available for water supply such as effective precipitation and recharge from precipitation, will remain the same for 2040 and 2070 projection as estimated for the historical period.

<u>Evapotranspiration</u>
WISP evapotranspiration estimates were similarly evaluated by taking the average of 50 years of simulated climate change impacts (1962-2011). The projections predicted higher evapotranspiration rates for 2030 (3%) and 2070 (8%). Using interpolation, the 2040 increase is about 4%. **Figure 3-47** shows the impact on a monthly basis for 2030 and 2070.

The projections show some variation by month, with higher rates in low evapotranspiration months (e.g., November, December and January) when irrigation is small, and relatively small increases during the irrigation season (April through September).

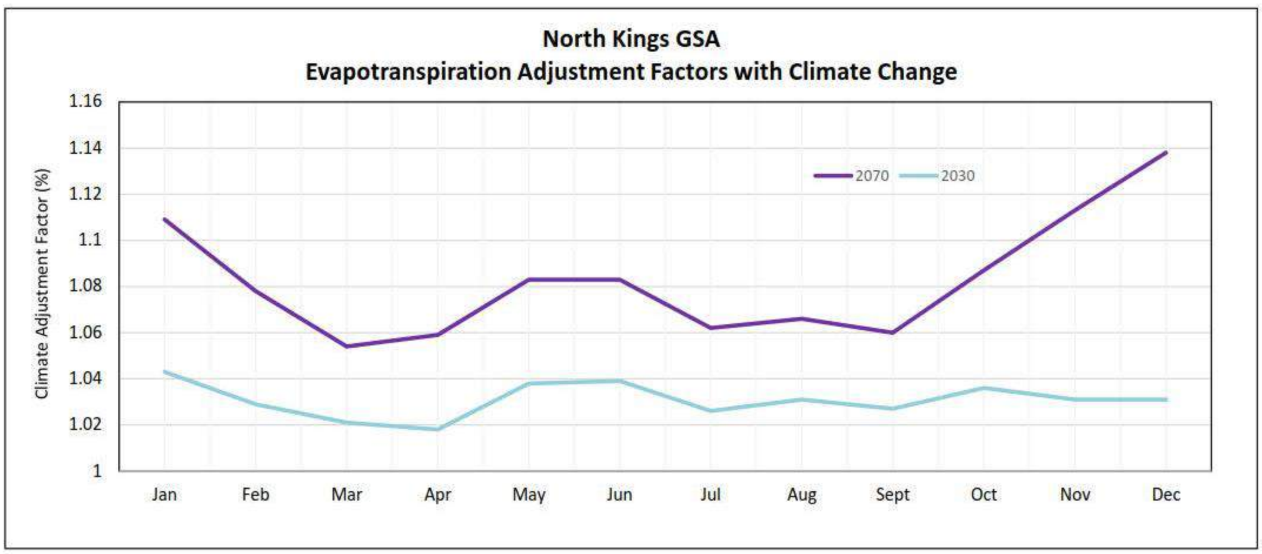


Figure 3-47 DWR ET Adjustment Factors with Climate Change

USBR (2015) predicted different impacts to annual crops versus perennial crops from climate change, as described below:

> "*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)*

As a result, in the Kings Subbasin, climate change impacts to crop evapotranspiration were applied to perennial crops, but not to annual crops.

Future water use for municipal areas has been updated based on projected population rates and per capita water use. Where available, Urban Water Management Plans have been used as the source of population projections and per capita water use rates. The ratios of indoor use, outdoor use and resulting recharge were left unchanged for the historical period. The higher anticipated ET is not expected to impact urban water use through higher landscaping demands, since urban agencies are seeking per capita consumption goals, which are lower in the future.

Urban and Agricultural Water Agencies

Urban and agricultural water agencies in NKGSA developed assumptions and estimates of future water demands through 2040. These are summarized in the table below.

Table 3-11 - Future Water Demand Assumptions by Organization

Organization	Future Water Demand Assumptions[1]
Bakman Water Company	Demands increase from 2,900 AF/year (2016/17) to 6,200 AF/year (2040)
Biola Community Services District	No anticipated increase in net demands. Water conservation expected to offset any new demands.
City of Clovis	Demands increase from 21,300 AF/year (2016/17) to 47,800 AF/year (2040)
City of Fresno	Demands increase from 116,100 AF/year (2016/17) to 195,800 AF/year (2040)
City of Kerman	Demands increase from 2,800 AF/year (2016/17) to 5,300 AF/year (2040)
California State University Fresno	Increase student population by 5,500 by 2040 resulting in 240 AF increase in domestic demands. No change in agricultural demands.
FID (not including agency overlaps)	No changes in cropping patterns. Reduction in demand due to conversion of 8,500 acres to urban use.
Fresno County	No increase in demand. Combination of annexations by Cities and new land use policies assumed to offset any future demands.
Garfield W.D.	No changes in cropping patterns. De-annexation of lands is no longer planned.
International WD	No changes in cropping patterns. Reduction in demand due to de-annexation of 325 acres by 2040.
Malaga County W.D.	Increase in demands from 1,600 AF/year (2016/2017) to 1,900 AF/year (2040)
Pinedale County W.D.	No changes in demands since area is largely built out. Any remaining in-fill will be balanced out by savings from future residential metering.

1 – Demands do not include water used for intentional recharge

Kings Basin Projected Water Budget

Table 3-12 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 3-12: 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

NKGSA Projected 2040 Water Budget

The projected NKGSA water budget for 2040 is shown in **Table 3-13.** The 2040 water budget includes the aforementioned impacts from climate change (crop evapotranspiration and San Joaquin River supplies), and estimated demand changes provided by the water agencies (**Table 3-14**). This water budget also assumed that groundwater outflow has been reduced by 43,000 AF/year, through mitigation measures by McMullin GSA. The projected water budget shows the anticipated yield from projects, resulting in a net groundwater storage change of zero in 2040.

Table 3-13 NKGSA 2040 Water Budget (AF)

Description	Irrigation Eff. Symbol	82% Normal Year	Volume (AF) Dry Year	Wet Year	Source
Supply					
1) Surface Water for Irrigation and Recharge	Qirr	422,756	306,310	422,756	Measured
2) Surface Water for M&I and Recharge	Qmi	87,600	87,600	87,600	Measured
3) Groundwater Pumping for Irrigation (Agency Wells)	Gwirra	1,100	1,100	1,100	Measured
4) Groundwater Pumping for Irrigation (Private Wells)	Gwirrp	157,600	274,000	38,000	Residual
5) Groundwater Pumping for M&I (Agency Wells)	Gwmia	236,400	236,400	236,400	Measured
6) Groundwater Pumping for M&I (Private Wells)	Gwmip	17,100	17,100	17,100	Calculated
7) Precipitation	P	305,900	212,500	437,300	Measured
8) Spill Inflows	Si	0	0	0	Calculated
9) Other Supply: Local River/Stream Seepage	Os	9,900	9,900	9,900	Calculated
Total Supply		**1,238,356**	**1,144,910**	**1,250,156**	
Demand					
Consumptive Use					
10) Evapotranspiration met by Applied Irrigation Water	ETc	380,700	380,700	380,700	Calculated
11) Evapotranspiration met by Effective Precipitation	ETp	55,800	55,800	55,800	Calculated
12) Evapotranspiration of M&I	ETmi	110,500	110,500	110,500	Calculated
13) Other Consumptive Use:	Od	0	0	0	Calculated
Consumptive Subtotal		**547,000**	**547,000**	**547,000**	
Groundwater Recharge					
14) Groundwater Inflow	GWi	0	0	0	Calculated
15) Deep Percolation of Irrigation Water	PRCirr	86,000	86,000	86,000	Calculated
16) Deep Percolation of Precipitation (rural areas)	PRCp	29,300	4,100	75,300	Calculated
17) Deep Percolation of M&I Water	PRCmi	146,400	146,400	146,400	Calculated
18) Seepage of Channels & Pipelines	Sch	100,400	100,400	100,400	Calculated
19) Seepage - Reservoirs	Sr	0	0	0	Calculated
20) Urban Stormwater - Recharge	Rus	22,200	15,400	31,700	Calculated
21) Local Streams/Rivers - Recharge	Rst	49,600	49,600	49,600	Calculated
22) Groundwater - Intentional Recharge	Rint	84,500	84,500	84,500	Measured
23) Other Recharge:	Or	0	0	0	
GW Recharge Subtotal		**518,400**	**486,400**	**573,900**	
Nonrecoverable Losses					
24) Groundwater - Outflow	GWo	122,000	122,000	122,000	Calculated
25) Evaporation - Channels	Ech	2,900	2,900	2,900	Calculated
26) Evaporation - Reservoirs & Recharge Basins	Er	10,500	10,500	10,500	Calculated
27) Precipitation - Evaporation and Runoff	Ep	198,600	198,600	198,600	Residual
28) Operational Spills	S	2,100	2,100	2,100	Measured
29) Groundwater - Export	GE	0	0	0	Measured
30) Other Losses:	Ol	0	0	0	
Nonrecoverable Subtotal		**336,100**	**336,100**	**336,100**	
Method 1					
Estimated Annual Change in Groundwater Storage		**0**	**(148,400)**	**175,100**	Calculated
GW Recharge - #14 thru #23	518,400		486,400	573,900	
GW Pumping - #3 thru #6	(412,200)		(528,600)	(292,600)	
GW Outflow - #24 and #29	(122,000)		(122,000)	(122,000)	
Projects for Water Supply Augmentation	**15,800**		**15,800**	**15,800**	
Demand Reduction from Project Development	**0**		**0**	**0**	
Management Actions for Demand Reduction	**0**		**0**	**0**	

As explained in Section 4 – Sustainable Management Criteria, a phased mitigation approach to achieving sustainability is proposed for the Kings Subbasin, including the following:

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

Note that these are minimum goals and progress may be faster than described. Projects and Management Actions are being developed to achieve sustainability within the NKGSA as explained in Section 6 – Projects and Management Actions. The initial focus will be on project development, with management actions implemented as needed to meet the identified Interim Milestones. The projects identified in Section 6 have an overall yield of well in excess of the estimated 2040 overdraft of approximately 17,000 AF.

Projected 2070 Water Budget

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

- Crop evapotranspiration rates increased by 8% over current levels. This results in an overall increase in demands of 16,200 AF above 2040 levels, all of which must be met with groundwater supplies.
- No changes were made to San Joaquin River supplies since Friant Water Authority (2018) determined that the impacts between 2040 and 2070 would be minor since it is not a major water supply in the NKGSA
- No changes were made to precipitation or Kings River supplies (similar to the 2040 water budget)
- No changes were made to urban water demands. The year 2070 is beyond a practical planning horizon for most urban water agencies and little data was available for estimated demands in 2070. Some agencies may even reach buildout before 2040. In the area, urban growth typically takes over irrigated farmland. While the two use different quantities of water, only the difference in water usage is relevant, so growth impacts may be moderate. These assumptions will be re-addressed in future GSP updates.

Table 3-14 summarizes the impacts to groundwater storage from climate change impacts in 2070. These values assume that McMullin Area GSA has already reduced groundwater outflow from NKGSA by 43,000 AF/year.

Table 3-14 NKGSA 2070 Groundwater Storage Change

Description	Volume (AF)
Groundwater Storage Change (2040)	-17,100
Climate Change Impacts (2040 to 2070)	-16,200
Groundwater Storage Change (2070)	-33,300

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

3.3.11 Quantification of Overdraft

Regulation Requirements:

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

DWR Bulletin 118 defines the Kings Subbasin as being subject to critical overdraft. The existence of overdraft in the Kings Subbasin is documented by historical decline in groundwater levels and is confirmed by the historical water budget presented previously. The historical water budget for the period of Water Year 1996-97 through 2010-11 represents an average hydrological period on the Kings River. The estimated annual decline in groundwater storage for the North Kings GSA during this period, as "directly" estimated based on groundwater levels, specific yields and measured groundwater subsidence, is 24,000 AF/year. This result was corroborated by the computed water budget, which identified an estimated annual groundwater storage decrease of 6,500 AF/year. As described earlier, the level of uncertainty for components of the water budget is such that the two estimated negative changes in groundwater storage (24,000 AF and 6,500 AF) are substantially similar when considering computational uncertainty. The value estimated based on groundwater contours is considered the more accurate values, since it was based primarily on measured data, whereas the water budget contains numerous assumptions and estimates. However, the two values are reasonably similar, thus helping to validate the estimate of 24,000 AF/year.

The current overdraft, based in the Current Water Budget for 2016/2017, shows an annual increase in groundwater storage of 39,200 AF/year. This is considered the best estimate of current conditions. It should be noted that while the NKGSA was in an overall surplus in 2016/2017, based on localized agency water budgets, several agencies are currently in overdraft and will be required to mitigate their condition. Also, the Current Water Budget is a short-term snapshot, and may not necessarily represent long-term average conditions.

NKGSA is currently estimating the overdraft responsibility for each of the twelve agencies in the NKGSA by estimating their Groundwater Impact, which is essentially their groundwater pumping minus natural and artificial forms of recharge.

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.

Water year types were identified for the Kings Subbasin based on Kings River diversions, since the Kings River is the largest source of water supply to the Subbasin. Water types were identified for Wet, Normal and Dry Years, with Wet Years occurring when diversions are more than 125% of normal and Dry Years occurring when diversions are less than 75% of normal. In the 15-year Historical period of WY 1997-2011, there were four wet years, three dry years and eight normal years. The water year type for each year from 1955 to 2018 is also shown in **Table 3-4**.

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 3-5**), the sustainable yield is estimated to be:

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

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

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

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

3.4 Water Supply Availability for Augmentation

A number of potential projects and management actions are described in Chapter 6 of this GSP as tools to achieve sustainability. The potential projects for supply augmentation each 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 NKGSA, it is located within the Place of Use for the USBR Central Valley Project (CVP) and the majority of the NKGSA 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 NKGSA 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 NKGSA 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. Fresno Irrigation District in NKGSA is one of the major KRWA member units with entitlement to the Kings River.

Like most Sierran 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 3-48** 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.

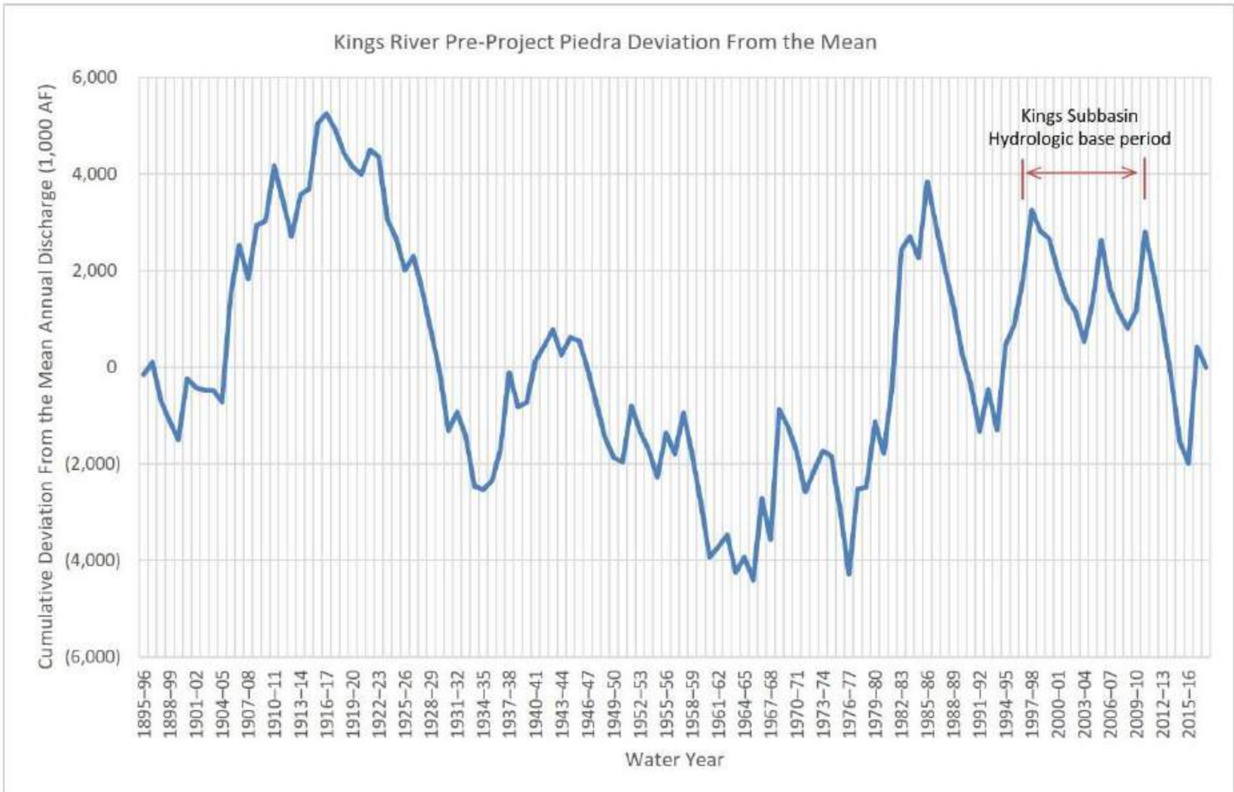


Figure 3-48 Kings River Cumulative Runoff Deviation from the Mean

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-line 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 amounts of entitlement received by a given member unit depending on what month it is and what the river runoff is. Fresno Irrigation District is an 'upper 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 3-15**, 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 3-15 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 3-13** would not be available today, even if the hydrology repeated itself, due to the reoperation of Pine Flat Reservoir by KRWA and its member water agencies, and as water demands have increased when high flow water is available, and as 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. 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 service area in the future, including during most flood release conditions.

As shown in **Figure 3-49** 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 3-49** 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 3-49** 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.

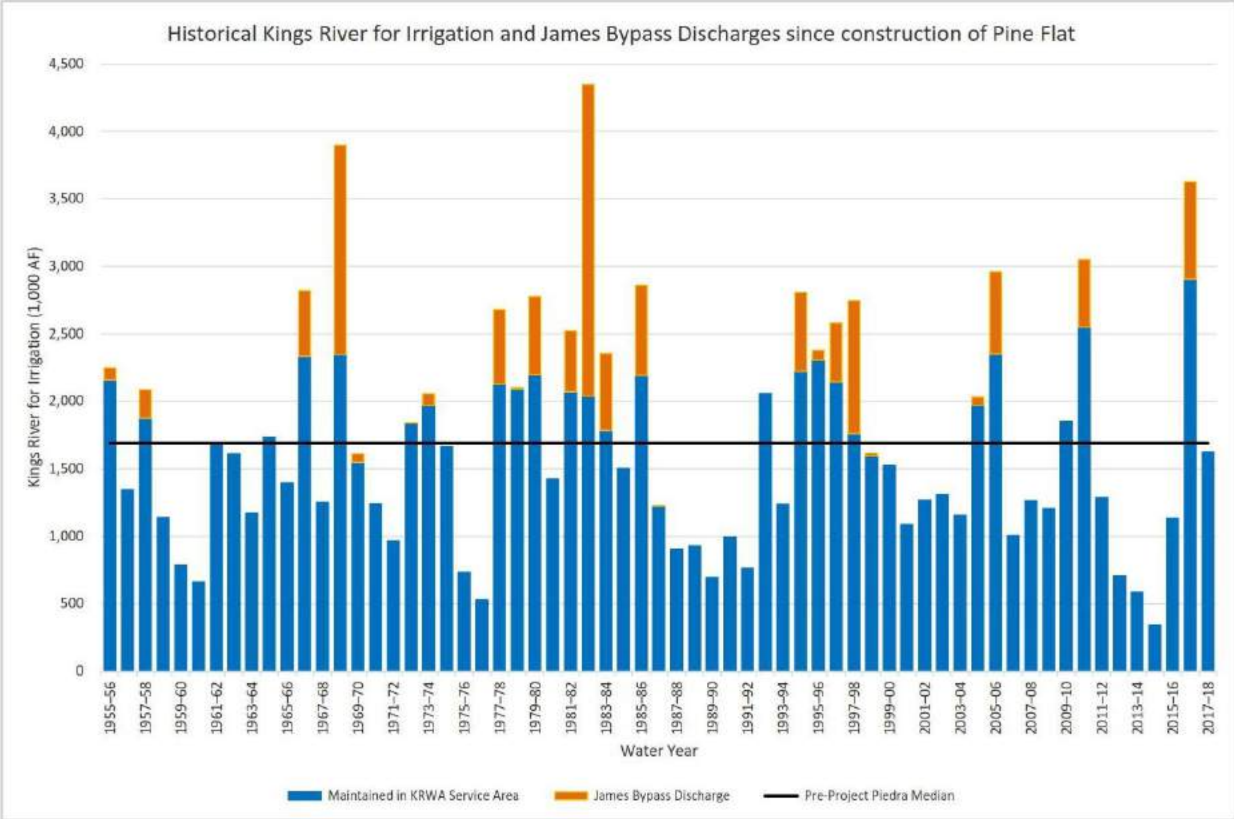


Figure 3-49 Historic Kings River for Irrigation and James Bypass Discharge (AF)

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 recharge capacities 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 NKGSA lies within the Kings River Service Area (Place of Use), a portion of the NKGSA 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 3-49** 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 Kings River high flow water when it is available.

3.4.3 Central Valley Project Supplies

Another potential source of water for supply augmentation projects would be the Central Valley Project (CVP). Friant Division CVP water could take several forms, including Section 215 water, contracted CVP Class 1, or Class 2 supplies, or uncontrolled season water that might be available for purchase. Several agencies in the NKGSA have a CVP contract including Fresno Irrigation District, Garfield Water District, International Water District and the City of Fresno.

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 federal designation for high flow 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, and 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 every 2 out of 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.

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 for 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.

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:

3.5.1 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.

3.5.2 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 NKGSA are discussed in Chapter 4.

3.5.3 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 NKGSA is discussed in Chapter 5.

3.5.4 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. **Figure 1-1** illustrates the seven GSAs in the Subbasin. 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.

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

Table 4-1 Sustainability Criteria Definitions

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

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

Figure 4-1 Sustainability Indicators

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

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 Sub-basin and this 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.

The conditions with the Kings subbasin 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 management activities prevent undesirable results to groundwater levels, groundwater storage, groundwater quality, land subsidence and interconnected surface water..

The seven GSAs within the Kings Sub-basin have been coordinating for several years on how to reach and maintain sustainability. As described in **Chapter 3** - Basin Setting, the Kings Sub-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 an agreement on initial quantities for each GSA to correct, identified in **Table 4-2**.

Table 4-2 Agreed Initial Responsibility Quantities

GSA	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

These quantities and each GSA's respective obligation will continue to be monitored and evaluated as additional information is gathered.

Each GSA in the Kings Subbasin is responsible for implementing projects and management actions required to reach sustainability and meet their initial mitigation requirements for overdraft. The measures to be implemented to ensure the basin will be operated within the sustainable yield are described in Section 6 – Projects and Management Actions to Achieve Sustainability. A similar list of measures has also been prepared in the six other GSPs developed for the Kings Sub-basin. Collectively, these projects and programs have been identified to ensure the basin reaches sustainability by 2040. The project and program descriptions include technical data and estimates of project benefit; the total yield of all the projects will allow the basin to reach sustainability. The basin has agreed to a phased approach of increasing mitigation to achieve sustainability. The proposed mitigation schedule is shown in the table below.

Table 4-3 Basin-Wide 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 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 when the water level has declined to a depth that water quality cannot be treated for beneficial use.

As defined by the subbasin, the undesirable result in much of the subbasin is actually below the elevation of the minimum threshold. The Kings Subbasin has a very large unconfined aquifer with existing water levels well above the base of the unconfined aquifer. As shown in Section 3 Basin Setting, 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 factor 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 historical 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 in **Section 4.2.3**.

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 in **Section 4.2.2**.

Much of the basin will have a significant aquifer of suitable quality below the levels set as the minimum threshold, meaning a productive well of suitable water quality could still be constructed if the water level drops below the minimum threshold. **Figure 4-2**, 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, and the basin will use the 5-year milestones and minimum threshold levels as trigger for operational change. Therefore, unless otherwise defined for a portion of a GSA, the basin will use the minimum threshold level as the point at which the effects of the groundwater decline become significant and unreasonable.

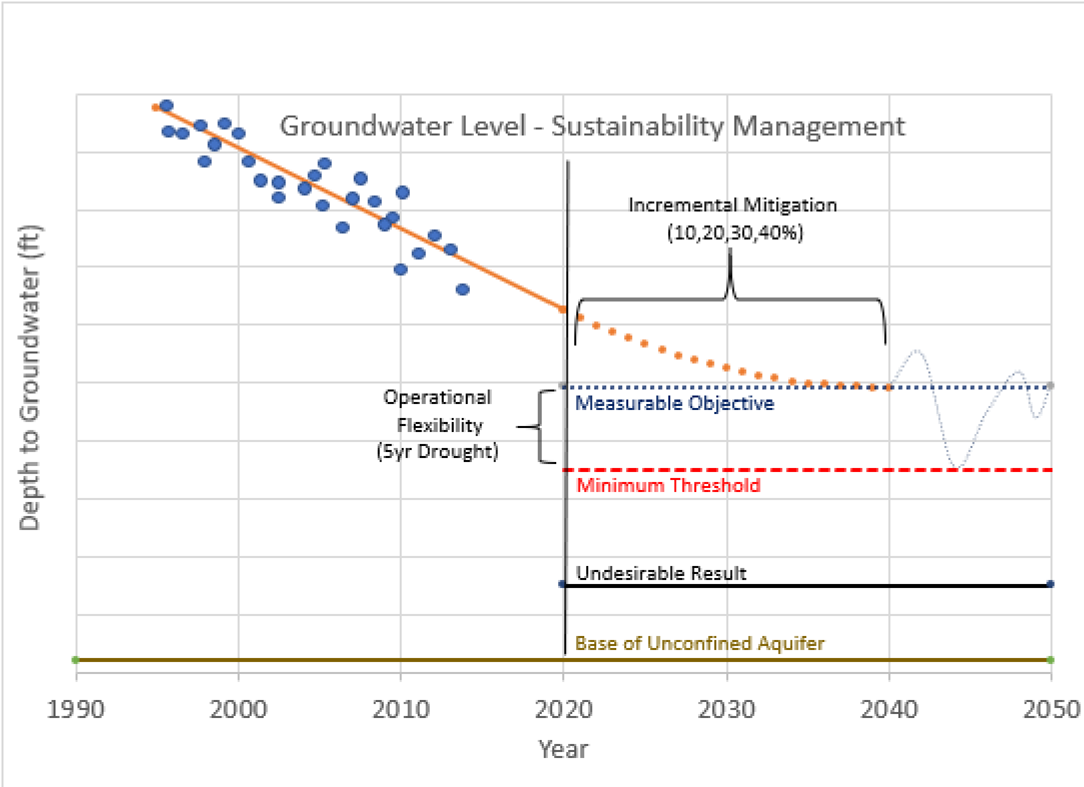


Figure 4-2 Groundwater Level - Sustainability Management

The GSAs in the basin recognize that water levels will continue to decline until the overdraft within the basin and the impact of pumping from neighboring basins has been corrected. The GSAs also recognize that during this time, the water level may decline below the depth of some wells within the basin. Well construction has varied over the years and wells have been constructed at varying depths. 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 NKGSA 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 historical average conditions.
- Extended or worse drought conditions than the historic 2012-16 drought.
- Neighboring GSAs and basins not correcting boundary flow losses to the Kings Basin and its GSAs.
- Increased demand and pumping beyond what are planned for in the water budget.

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

Regulation Requirements:

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

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

Regulation Requirements:

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

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

4.2.1.3 Evaluation of Multiple Minimum Thresholds

Regulation Requirements:

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

The NKGSA, in coordination with the other GSAs in the basin, will utilize multiple wells to monitor and manage the NKGSA 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 NKGSA'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 NKGSA, 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. 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 4-2** above, the minimum threshold is the elevation below the measurable objective that provides the operational flexibility to allow for periods of increased groundwater pumping during dry periods. As mentioned, the minimum threshold was set at an elevation to allow operational flexibility of the anticipated water level decline during a 5-year drought. The actual decline during the historic 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 some of the indicator wells, incomplete or inconsistent water level readings exist during the drought period. For those wells, the average rate of decline was multiplied by 15 (three times the standard rate of decline for 5 years) to determine the total depth of decline for operational flexibility.

The establishment of the minimum threshold was based on actual water level readings at each of the wells chosen to be indicator wells in the monitoring network. A hydrograph was generated for each well and the historic rate of decline identified for each well individually. The trendline was developed using the recent water level reading from the 1990s to the end of the basin base period (2012). This considers recent base period conditions for the basin which factors in recent land use changes, different water year types, and the water use within the basin. The amount of decline during the recent drought (2012-2016) was also determined. A table listing the minimum threshold for each indicator well is included as **Table 4-4** 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 4-4 Minimum Threshold for Representative Monitor Wells

WELL ID	Local Well ID	Ground Surface Elevation (GSE)	Measurable Objective Elevation	Measurable Objective Depth from GSE	Minimum Threshold Elevation	Minimum Threshold Depth from GSE	Difference Between Measurable Objective and Minimum Threshold (ft)	Interim Milestone 2025 Elevation	Interim Milestone 2030 Elevation	Interim Milestone 2035 Elevation
12S19E33P001MX	FC160	300.9	185.5	115.4	172.6	128.3	12.9	191.8	188.4	186.2
12S19E36J001MX	FC091	331.8	157.3	174.5	133.1	198.7	24.2	169.1	162.8	158.6
12S20E23D001MX	FC295	364.4	192.6	171.8	176.7	187.7	15.9	200.4	196.2	193.5
12S20E34K001MX	FC092	360.1	163.4	196.7	134.8	225.3	28.6	177.3	169.9	164.9
12S21E29K001M	FC29K1	379.0	284.8	94.2	263.2	115.8	21.6	295.3	289.7	286.0
12S21E34H001M	FC34H1	390.0	329.2	60.8	320.8	69.2	8.4	330.2	329.6	329.3
12S22E19N001M	FC19N1	438.0	384.0	54.0	361.6	76.4	22.4	390.2	386.9	384.7
12S22E26L001M	FC26L1	485.0	442.4	42.6	426.5	58.5	15.9	449.6	445.7	443.2
13S17E25C001MX	FD25C1	231.8	144.9	86.9	86.1	145.7	58.8	145.9	145.3	145.0
13S17E33M001MX	FD32H1	210.1	89.7	120.4	36.6	173.5	53.1	93.7	91.6	90.2
13S18E17A001MX	FD17A1	253.2	186.9	66.3	156.5	96.7	30.4	188.5	187.6	187.1
13S19E11L001MX	FC035	304.7	163.2	141.5	141.7	163.0	21.5	173.6	168.1	164.4
13S19E29A001MX	FD29A1	266.9	161.6	105.3	137.8	129.1	23.8	169.3	165.2	162.4
13S20E27C001MX	FC069	310.1	161.3	148.8	143.7	166.4	17.6	169.9	165.3	162.2
13S20E30B001MX	FC074	304.0	163.6	140.4	143.6	160.4	20.0	173.4	168.2	164.7
13S21E19E001MX	FC080	334.8	152.3	182.5	105.1	229.7	47.2	175.3	163.0	154.9
13S22E07R001MX	FD07R1	391.6	313.3	78.3	292.8	98.8	20.5	323.3	318.0	314.4
13S22E32A001MX	FD32A1	370.8	292.1	78.7	265.8	105.0	26.3	304.3	297.8	293.4
13S23E33B001MX	FD33B1	431.8	408.7	23.1	401.8	30.0	6.9	412.0	410.2	409.1
14S18E32D001MX	FD32D1	212.3	47.0	165.3	4.9	207.4	42.1	50.1	48.4	47.3
14S19E17C001MX	FD17C1	249.8	151.8	98.0	106.8	143.0	45.0	154.6	153.1	152.1
14S19E33D001MX	FD33D1	239.5	145.4	94.1	102.0	137.5	43.4	148.9	147.0	145.8
14S20E10M001MX	FC003	291.4	176.2	115.2	164.1	127.3	12.1	182.1	179.0	176.9
14S20E22J001MX	FC040	282.5	182.1	100.4	158.7	123.8	23.4	193.1	187.2	183.4
14S21E06Q001MX	FC077	309.6	176.5	133.1	151.7	157.9	24.8	188.6	182.2	177.9
14S21E22D001MX	FD22D1	317.8	228.0	89.8	200.4	117.4	27.6	231.8	229.8	228.4
15S19E02M001MX	FD03J1	242.9	119.4	123.5	79.2	163.7	40.2	126.4	122.7	120.2
15S19E14M001MX	FD14M1	241.3	92.2	149.1	56.9	184.4	35.3	97.9	94.9	92.9
15S20E07Q001MX	FD07P1	252.2	121.0	131.2	76.5	175.7	44.5	128.4	124.4	121.8
15S20E13E001MX	FD13E2	282.1	176.5	105.6	142.5	139.6	34.0	183.8	179.9	177.3
367113N1200785W001	14S17E14J001M	210.5	46.1	164.4	11.5	199.0	34.6	52.2	49.0	46.8
367556N1196666W001	13S21E34J002M	340.5	240.1	100.4	217.2	123.3	22.9	251.3	245.3	241.4
13S18E33M001MX	FD32J1	237.0	157.8	79.2	99.4	137.6	58.4	157.8	157.8	157.8
13S23E30B001MX	FD30B1	411.0	397.5	13.5	372.0	39.0	25.5	397.5	397.5	397.5
14S18E09H001MX	FD09H1	236.0	145.0	91.0	85.0	151.0	60.0	145.0	145.0	145.0

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 NKGSA determined that the minimum thresholds will avoid undesirable results for each indicator:

- **Groundwater Storage**. The minimum thresholds used for groundwater levels will set the overall groundwater storage volume desired to be maintained below the minimum threshold groundwater levels. As mentioned in much of the NKGSA and the basin, there will remain a very significant amount of groundwater below the minimum threshold elevations. In areas of shallow bedrock, the minimum thresholds were compared to elevations of the top of bedrock in effort to restrict decline of the water table below alluvial material. 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 contaminant concentrations positively and negatively. The minimum thresholds were compared with known contaminants of concern where data and quality information by elevation was available. Groundwater levels are not used as proxy for groundwater quality conditions. NKGSA 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 NKGSA has not experienced significant subsidence and has limited area with soil conditions for land subsidence. Water levels and primarily pumping from beneath clay layers can cause land subsidence. The majority of pumping in the NKGSA is from above or outside of clay layer areas encountering subsidence. The water level minimum thresholds have been established based on historical rates of decline that have not caused land subsidence of significance.
- **Interconnected Surface Water.** A very limited area of interconnected surface water occurs in the NKGSA. Minimum thresholds were set based on historical groundwater level declines which have not created undesirable results. Groundwater levels will continue to be monitored in the area of any interconnected surface water.

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 groundwater level decline starting immediately and reaching stabilization by 2040. This approach is believed to be conservative and correct the trend of existing groundwater decline. The NKGSA has significant surface water rights and has experienced minimal impacts compared to other basins. The Kings Basin is primarily negatively impacted by surrounding basin pumping as adjacent basins with limited surface water supplies have caused declining groundwater conditions that negatively impact the Kings Basin by increasing groundwater flows across basin boundaries. As described in Chapter 2, these flows have increased overtime. Groundwater pumping in the confined aquifer in adjacent basins has also impacted the Kings Basin as the confined aquifer is primarily fed by the groundwater upgradient in the Kings Basin.

As a basin, the various Kings GSAs have met with their neighboring GSAs outside of the Kings Basin to discuss how thresholds have been established and potential impacts. The NKGSA has met with the Madera Basin consultants and administrative staff to understand their estimations. 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 NKGSA 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. The NKGSA recognizes that some shallow wells will likely go dry prior to water levels reaching stabilization. Without SGMA and the proposed incremental mitigation by the NKGSA, 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 NKGSA and provide improved long-term certainty of groundwater levels within the NKGSA.

An analysis was performed to estimate the number of domestic wells that may go dry at the minimum threshold. Utilizing the minimum threshold depth at each of the water level monitoring well sites shown in **Table 4-3** (and included in **Appendix 4-A**, location shown in **Figure 5-2**), a groundwater level contour surface was generated for the entire GSA utilizing GIS software. From this surface, the estimated average depth to groundwater in each Section (one-square mile) was obtained which provides an estimate of the depth to groundwater at the minimum threshold. The depth to water at the minimum threshold in each section was compared to the well completion report records available from DWR. DWR's well completion reports are grouped by section, but locations within each section are not known. It is important to note the inaccuracies of the well record data, including inaccurate locations and construction information, no consideration of abandoned or inactive wells, and no consideration of well modifications. For this comparison, all domestic wells were selected from the DWR records. The perforation interval of the well was considered if included in the well completion report, otherwise the total depth of the well was considered. For every domestic well in each section in the GSA, the minimum threshold depth was compared to ten feet above the bottom of perforation interval (if known) or ten feet above the total depth of the well. Sections that are entirely contained within the boundaries of a community water system (City of Fresno, Clovis, etc.) were removed from the comparison, but if only a portion of the section was within the water system service area or within the GSA's exterior boundary, all of the wells in the section were included in the analysis since the exact location of the wells in a section is not included in the available data. This likely includes many wells that have been abandoned but was considered a conservative approach to this evaluation. The results of this analysis are shown in **Figure 4-3** showing the number of wells in each section that may be impacted.

Since the first comparison to minimum thresholds included all wells regardless of age, and many of those wells have likely been abandoned or failed, a second comparison was performed for wells constructed after 1990. 1990 was chosen as a comparison to provide a range of the estimated impact to wells that will be up to 50 years old in 2040. The results of this analysis are shown in **Figure 4-4**.

Since the minimum threshold is the lowest depth that is anticipated, a third comparison was made to the measurable objectives using all domestic wells in DWR records. Utilizing the measurable objective provides an estimate of the low end to the range of wells that may be impacted as the measurable objective is the groundwater level that will be sustained. A contour surface was generated using GIS software for the entire GSA utilizing the measurable objective depths from **Figure 4-3** (and identified in the hydrographs in **Appendix 4-A**). The results of this analysis using all wells in DWR records is shown in **Figure 4-5**.

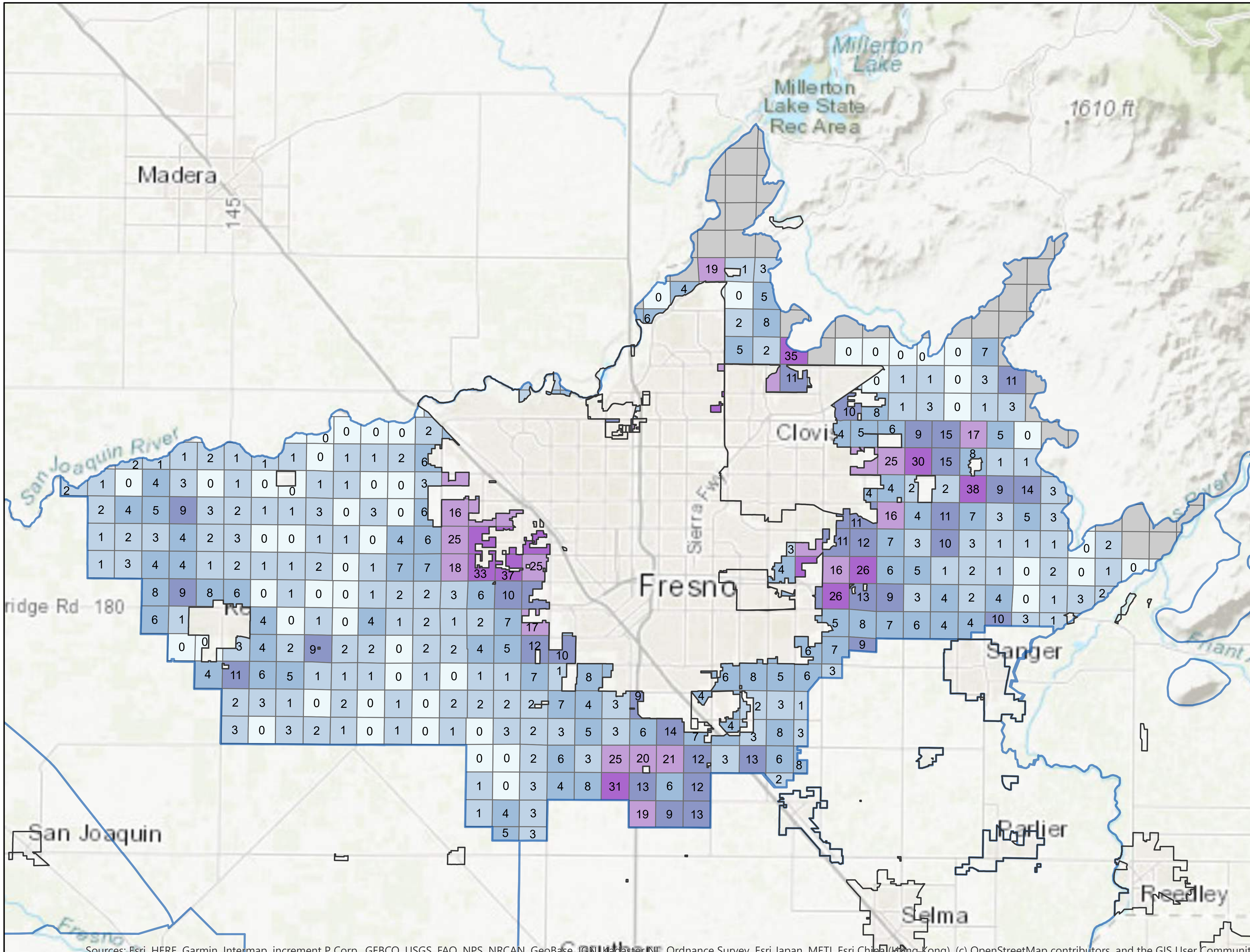
A fourth comparison was made using measurable objectives using the same process, but limiting to wells constructed after 1990. The results of this analysis are shown in **Figure 4-6**.

For each of the four comparisons, the number of domestic wells shallower than the minimum threshold or measurable objective were totaled and compared to the total number of domestic well records. As mentioned previously, the total number of domestic wells used in these calculations is based on DWR records, and may include abandoned, destroyed, or inactive wells. **Table 4-5** provides a summary of the results and an estimate of the percentage of wells impacted.

Table 4-5 Estimate of Percentage of Domestic Wells Shallower than Minimum Threshold or Measurable Objective

Wells Used	Shallower than Measurable Objective	Shallower than Minimum Threshold
All Wells	12%	32%
Post 1990 Wells	3%	13%

In summary, the analysis shows that the estimated percentage of domestic wells that may be affected at the measurable objective levels is between 3% and 12%, and between 13% and 32% at the minimum thresholds. The percentage of wells impacted is lower than shown when removing wells that are already shallower than current groundwater levels. Utilizing all well data and all wells in a section that is only partially outside a community water system is very conservative considering the data includes many wells that are no longer active or are nearing the end of their usable life. For these reasons, it is anticipated that the percentage of impacted wells is closer to the lower percentages listed. These percentages may be refined as the GSP is implemented.



Kings Subbasin Coordinated Effort

Per Section
Review of DWR WCR Data
Domestic Wells
All Years

North Kings Groundwater Sustainability Agency

Figure 4-3

Community Water Systems

Wells Where MT is Deeper than 10' Above the Total Depth or Bottom of Perforation

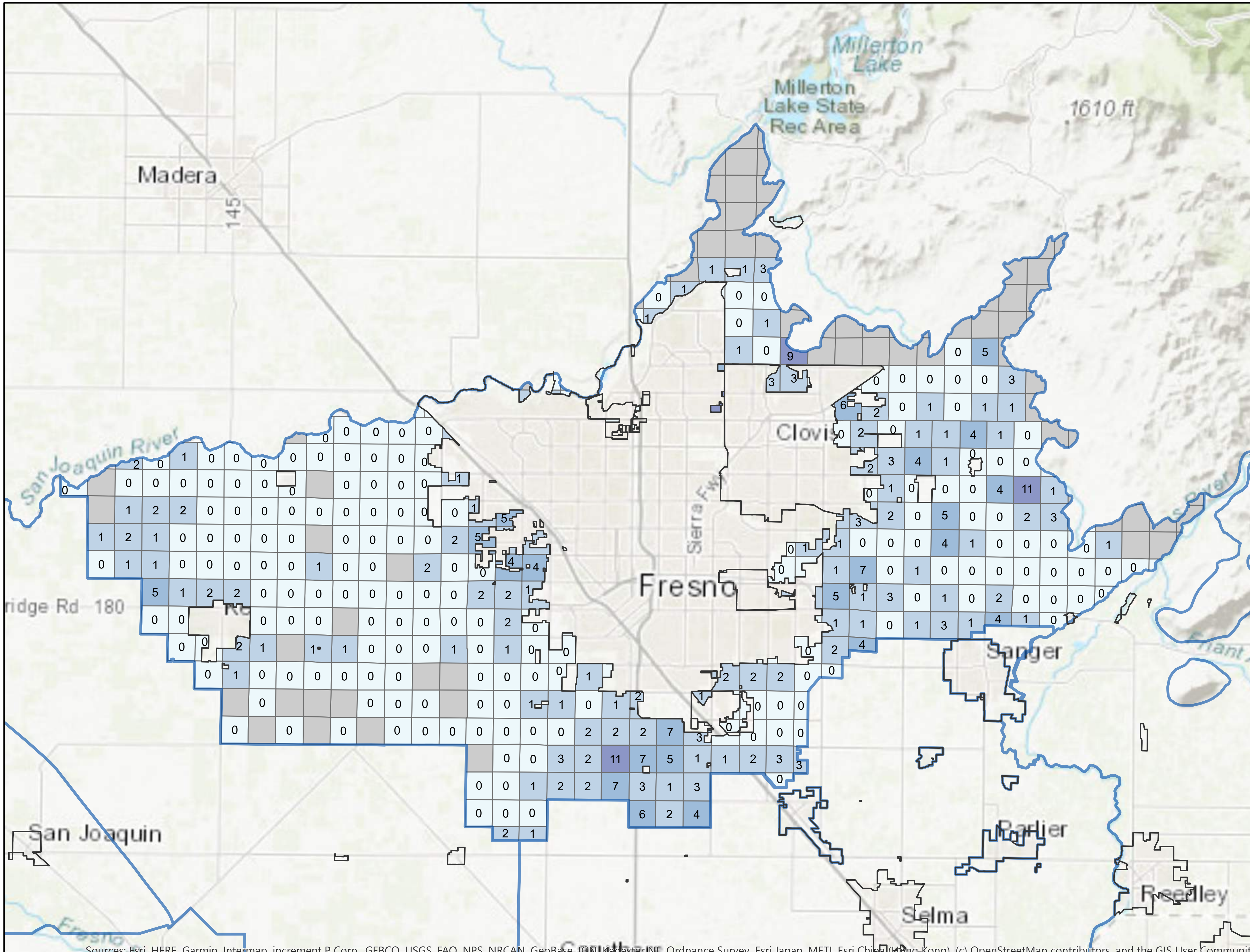
- 0
- 1-3
- 4-8
- 9-15
- 16-25
- >25
- No WCR Records

N

0 1 2
Miles

EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community



Kings Subbasin Coordinated Effort

Per Section
Review of DWR WCR Data
Domestic Wells
Post 1990

North Kings Groundwater Sustainability Agency

Figure 4-4

Community Water Systems

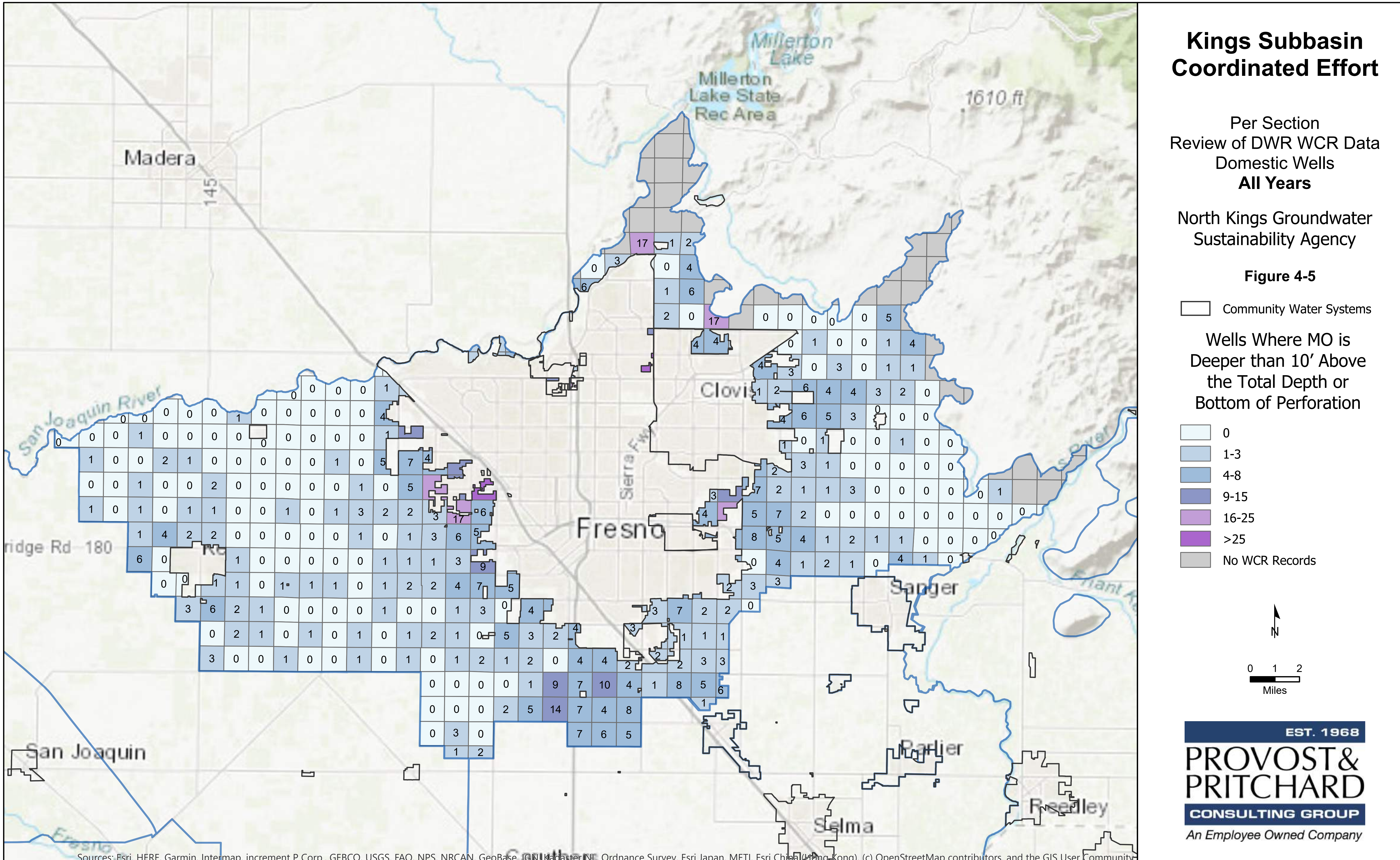
Wells Where MT is Deeper than 10' Above the Total Depth or Bottom of Perforation

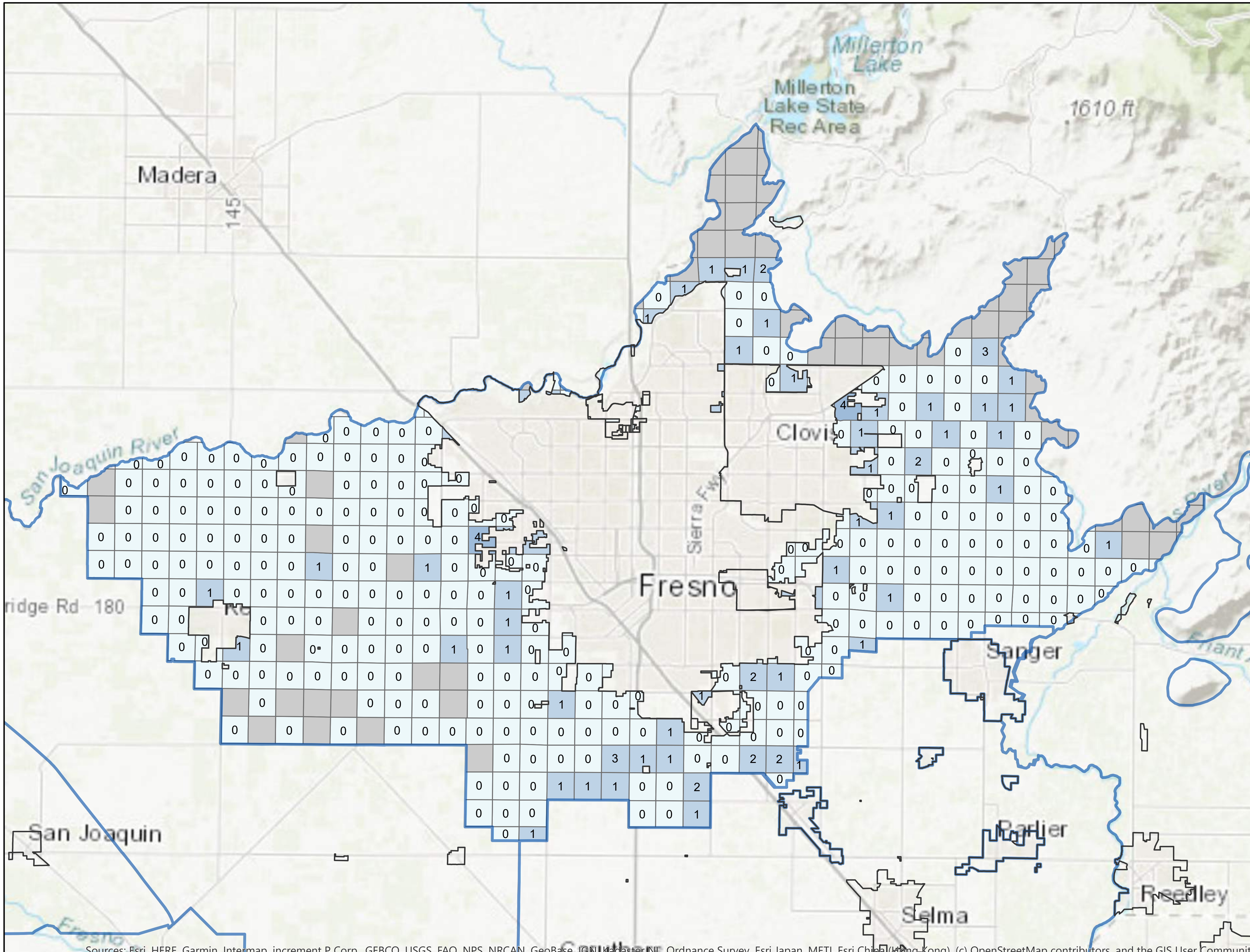
- 0
- 1-3
- 4-8
- 9-15
- 16-25
- >25
- No WCR Records Post 1990

N

0 1 2
Miles

EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company


Kings Subbasin Coordinated Effort
Per Section
Review of DWR WCR Data
Domestic Wells
All Years
North Kings Groundwater Sustainability Agency
Figure 4-5
Community Water Systems
Wells Where MO is Deeper than 10' Above the Total Depth or Bottom of Perforation
0
1-3
4-8
9-15
16-25
>25
No WCR Records
N
0 1 2
Miles
EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company
Millerton Lake
Millerton Lake State Rec Area
1610 ft
Madera
145
San Joaquin River
Clovis
Sierra Fwy
Fresno
ridge Rd 180
Sanger
San Joaquin
Parlier
Reedley
Selma
Caruthers
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community



Kings Subbasin Coordinated Effort

Per Section
Review of DWR WCR Data
Domestic Wells
Post 1990

North Kings Groundwater
Sustainability Agency

Figure 4-6

Community Water Systems

Wells Where MO is Deeper than 10' Above the Total Depth or Bottom of Perforation

- 0
- 1-3
- 4-8
- 9-15
- 16-25
- >25
- No WCR Records Post 1990

N

0 1 2
Miles

EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company

4.2.2.5 Current Standards Relevant to Sustainability Indicator

Regulation Requirements:

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

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

4.2.2.6 Measurement of Minimum Thresholds

Regulation Requirements:

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

Groundwater level readings will be made at indicator wells in accordance with water level measurement protocols described in Chapter 5 Monitoring Network of this GSP.

4.2.3 Measurable Objectives

4.2.3.1 Description of Measurable Objectives

Regulation Requirements:

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

The establishment of the measurable objective was based on actual water level readings at each of the wells chosen to be indicator wells in the monitoring network. The monitoring network is described in detail in Section 5 of this GSP. A hydrograph was generated for each well and the historical rate of decline identified for each well individually. The trendline was developed using the recent water level reading from the 1990s to the end of the recent average base period for the basin period (through 2012). Use of this historical data considers recent base period conditions for the basin which factors in recent land use changes, different water year types, and the water use within the basin. The rate of decline was projected through 2020 for each well. The basin-wide agreed incremental mitigation rate for correction (shown in **Table 4-3**) was applied to each well's hydrograph. The incremental correction provides the calculation of the anticipated water level at 2040. A table listing the minimum threshold for each indicator well is included as **Table 4-4** 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.

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

4.2.3.2 Operational Flexibility

Regulation Requirements:

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

As shown in **Figure 4-2**, the operational flexibility is the change in groundwater levels between the measurable objective and minimum threshold and represents the amount of allowable decline in groundwater levels below the measurable objective. The measurable objective was established using the basin base period which represents recent average hydrologic conditions and water uses with recent land uses and demands. As mentioned, the minimum threshold was set at an elevation to allow operational flexibility of the anticipated water level decline during a 5-year drought, and was based on the recent historic drought of 2012-2016.

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 NKGSA 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 NKGSA and the other GSAs in the basin will implement projects and programs to correct the declining groundwater levels and reach sustainability. The NKGSA projects and programs are described in Section 6 of this GSP and implementation discussed in Section 7 of the GSP. The interim milestones for water level correction are unique to each well and are shown on the hydrographs in **Appendix 4-A**. The measurable objective water levels have been used to determine the estimated volume of overdraft correction that is required within this NKGSA and the entire basin. The NKGSA has identified the schedule for implementation of each project as well as that project's anticipated benefit or yield. The combined benefit of each project at each milestone shows that the NKGSA has identified projects to correct the total overdraft by 2040. Future projects are included in the anticipated reduction in demand and overdraft.

4.3 Groundwater Storage

Groundwater storage is directly linked to groundwater levels, and the measurable objective and minimum threshold for groundwater levels dictate the amount of groundwater in storage for cyclic use once 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 changes 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 in which water level is fluctuating. The amount of groundwater storage change (or change over time) is estimated from these contoured surfaces from the beginning and end of the period in question. Once the subbasin reaches sustainability, the estimated volume of groundwater between the measurable objective and the minimum threshold levels provides the operational flexibility. The calculation of these volumes 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 operation flexibility..

Storage change in the confined aquifer was not estimated since actual changes are considered small to negligible as long as that portion of 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 layers 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 NKGSA and Subbasin were used to estimate the amount of groundwater in storage from the Minimum Thresholds to the Interim Milestones and 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 threshold and only periodically use the storage between the minimum threshold and measurable objective, the total amount of groundwater in storage 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 storage change 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 2012-16 drought.
- Neighboring GSAs and Basins not correcting boundary flow losses to the Kings Basin and its GSAs.
- Increased demand and pumping beyond what are planned for in the water budget

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

Regulation Requirements:

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

The criteria for undesirable results for water levels are also used for groundwater storage as they define the minimum threshold elevations below which an undesirable result would occur for 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 groundwater quality changes could potentially be significant enough to require additional treatment, but ongoing evaluation of groundwater quality data 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 NKGSA, in coordination with the other GSAs in the subbasin, utilized multiple wells to develop groundwater contours and estimate the change in groundwater storage. A water level surface was created from the minimum thresholds, interim milestone and measurable objective water level elevations at the monitor wells. The amount of groundwater in storage above the minimum thresholds to the measurable objective, as well as to each of the 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 the 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 between 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**.

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

The criteria for minimum thresholds for water levels are also used for groundwater storage as they define the elevations that are used to 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 **Section4.2.2.1**. The minimum threshold for groundwater storage is the minimum threshold water surface for water level at all the 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.

The minimum thresholds used for groundwater levels will set the overall groundwater storage volume desired to be maintained above the measurable objective and the interim milestones at five-year increments. 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 NKGSA 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 the 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 as the neighboring basins have likely taken different approaches to establishing minimum thresholds. Once the neighboring basins GSPs are completed, the NKGSA 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 rates of decline, the proposed mitigation rate and enough operational flexibility to maintain beneficial use in the Subbasin during a five-year 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 NKGSA and provide improved long-term certainty of groundwater levels within the NKGSA.

4.3.2.5 Current standards relevant to sustainability indicator

Regulation Requirements:

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

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

4.3.2.6 Measurement of Minimum Thresholds

Regulation Requirements:

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

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

4.3.3 Measurable Objectives

4.3.3.1 Description of Measurable Objectives

Regulation Requirements:

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

The groundwater storage measurable objective is based on the groundwater level measurable objective (described previously) as the basis for the calculation of groundwater in storage from the measurable objective to the minimum threshold. 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 water levels to the measurable objective and the interim milestones. The groundwater in storage between the ultimate measurable objectives and the minimum threshold 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 Subbasin reaches sustainability at measurable objective levels. As described in **Section 4.2**, the measurable objective for water levels at each five-year milestone (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 **Section 4.2**. Utilizing the process for groundwater storage change estimation described in **Section 3.2.3**, the groundwater in storage between the measurable objective and at each interim milestone, and the minimum threshold was estimated and shown in **Table 4-7**.

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 Kings	900,000	780,000	700,000
James ID	150,000	130,000	110,000
Kings River East	810,000	710,000	640,000
McMullin Area	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 groundwater level data, historic trendlines, measurable objective, interim milestones, 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 estimated 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 NKGSA 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 NKGSA and the other GSAs in the basin will implement projects and programs to correct the declining groundwater levels and reach sustainability. The GSA's projects and programs are described in Section 6 of this GSP and implementation discussed in Section 7 of the GSP. The groundwater storage interim milestones are calculated based on the basin wide agreed incremental mitigation rate to reach groundwater level measurable objectives. The NKGSA 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 NKGSA has identified projects to correct the total overdraft by 2040.

4.4 Seawater Intrusion

Regulation Requirements:

§354.26 (d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.
§354.28 (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 Coastal Range lies between the Central Valley and the Pacific Ocean. The Kings Subbasin and NKGSA are over 100 miles from the Sacramento-San Joaquin Delta, which would be the only means for seawater to enter the Central Valley. Due to the great distance and the current groundwater elevations, NKGSA and the Kings Subbasin do not need to account for seawater intrusion.

4.5 Groundwater Quality

As discussed in these previous chapters, groundwater quality in the NKGSA is generally well suited for irrigation and domestic use, although groundwater quality issues for drinking water exist in localized areas within the NKGSA. While some of these chemical concerns are caused by humans, several are natural occurring. Groundwater quality concerns within the NKGSA have been identified in this GSP's Groundwater Conditions Chapter (**Section 3.2**). Groundwater monitoring and reporting by community water systems and non-community public supply wells is a requirement of California Code of Regulations (CCR) Title 22. Community and other public supply wells within the NKGSA monitoring network area are already being routinely monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyors under Title 22. Groundwater pollution characterization and mitigation are typically enforced by local agencies and state level programs. The NKGSA will only have authority related to groundwater pumping policies, however the NKGSA will review and analyze publicly available routine groundwater monitoring data reported by the community and non-community public supply wells in order to monitor if groundwater pumping may be exacerbating groundwater quality concerns and where to enforce mitigation measures not already being addressed by appropriate State Agencies should it become necessary. The minimum thresholds will be set at the levels protective of human health as applicable for the respective chemicals of concern identified and discussed in this GSP's Groundwater Conditions Chapter (**Section 3.2**).

The following chemicals are groundwater quality concerns in the NKGSA. Some of these are significant concerns while others are minor or geographically limited. Additional discussion on groundwater quality is presented in Section 3.2.

Nitrates

Nitrate is commonly found in groundwater as a result of application of nitrogen fertilizers in irrigated agricultural and landscaped areas, seepage from feedlots/dairies, wastewater and food processing waste ponds, winery waste, sewage effluent, and leachate from septic system drain fields. The California drinking water Maximum Contaminant Level (MCL) for nitrate as nitrogen (NO3-N) is 10 mg/L. Elevated concentrations are generally in the southwest and southeast portion of the NKGSA. Pockets of larger numbers of septic systems can be found north and east of Clovis and both north and southwest of Fresno, contributing to the nitrate loading. Higher nitrate in wells also remains a concern for some very small DAC and SDAC systems outside of the City of Fresno but within the NKGSA.

Arsenic

Arsenic occurs in natural sedimentary deposits throughout the San Joaquin Valley. Arsenic in groundwater in the NKGSA is generally found at greater depths where reduced deposits are present. Concentrations of arsenic approaching the MCL concentration of 10 μg/L have been found in municipal wells in the City of Kerman.

Dibromo-Chloropropane (DBCP)

DBCP was used as a fumigant to kill nematodes in soil before planting and was widely used in California until 1977. The MCL is 0.2 μg/L. DBCP was used in vineyards and deciduous orchards where sandy soils were present. In general, within the NKGSA concentrations of DBCP above the MCL value have historically been detected northeast, east, south, and southeast of the City of Fresno. Lower concentrations, below the MCL value, have also been detected in the western portion of the NKGSA. Higher DBCP levels are generally found in the shallow aquifer, above 200 feet. A 2006 assessment of DBCP trends indicated that the peak concentrations are significantly lower than in 1989-91. DBCP concentration levels and the extent of DBCP has decreased over time due to the degradation process and dilution due to recharge. DBCP in wells remains a concern for some small DAC and SDAC systems outside of the Fresno Metropolitan area.

1,2,3-Trichloropropane (TCP)

TCP is used industrially (paint and varnish remover as a cleaning and degreasing agent) and chemically (solvent and intermediate for pesticides). There is no current federal MCL; however, California has adopted its own drinking water standard of 5 parts per trillion. TCP has been detected in shallow groundwater in rural areas, along Highway 99, and in City of Fresno and City of Clovis public supply wells.

Methyl Tert-Butyl Ether (MTBE)

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

Uranium

Uranium occurs naturally in groundwater in parts of the NKGSA. Uranium is derived from Sierra Nevada granitic formations and will preferentially adhere to clays. The MCL is 30 µg/L or 20 picocuries/liter. Uranium has been found in municipal wells in the City of Kerman and in the area of Easton.

Perchloroethylene (PCE) and Trichloroethylene (TCE)

Perchloroethylene (PCE) and Trichloroethylene (TCE) are both volatile organic compound solvents used as cleaning agents. PCE is listed as a potential cancer-causing agent. TCE is listed as both a potential cancer-causing agent and reproductive toxin causing developmental toxicity and male reproductive toxicity. The State MCL for both PCE and TCE is 5 µg/L. Some municipal wells within the City of Fresno and Pinedale County Water District have tested positive for PCE and TCE in concentrations above the MCL.

Hexavalent Chromium

Hexavalent chromium [Cr(VI)] is one of the valence states (+6) of the element chromium. Hexavalent chromium can be produced by industrial processes but sometimes is also naturally occurring. Inhalation and ingestion of Cr(VI) is known to cause cancer. Hexavalent chromium has been found in Kerman and at some local groundwater banks. The California Superior court invalidated the hexavalent chromium MCL in 2017 over concerns that the State Waterboard failed to properly consider the economic feasibility of complying with the MCL. At this time there is no MCL for this chemical and the State Waterboard is seeking to adopt a new MCL.

4.5.1 Undesirable Results

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 agricultural irrigation and domestic use. The NKGSA only has authority related to groundwater pumping policies, however the NKGSA 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. **Section 5** of this GSP describes the NKGSA monitoring well network.

4.5.1.1 Criteria to Define Undesirable Results

Regulation Requirements:

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

With the powers provided to GSAs by SGMA, a GSA can only regulate and manage groundwater pumping as part of its effort to change groundwater conditions. 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 Irrigated Lands Regulatory Program (ILRP), Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS), Fresno County Rural Domestic Well Program (Volunteer basis), Dairy General Order, Regional Water Quality Control Board (RWQCB), and Department of Toxic Substances Control (DTSC).

While there are several existing groundwater monitoring programs, they do not monitor all contaminants of concern within the NKGSA and may not provide depth-specific water quality data. For example, ILRP and CV-Salts are mostly focused on nitrate and salinity trends in groundwater. 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 upon to set sustainable management criteria at this time.

Groundwater monitoring and reporting by community water systems is a requirement of California Title 22 Code of Regulations. Monitoring and reporting schedule requirements can vary based on the service population size, geographic area and population type (i.e. transient vs. non-transient). Under California Domestic Water Quality and Monitoring Regulations, community water systems must distribute, to each customer, an annual water quality report on the water purveyed. This consumer confidence rule requires public water suppliers that serve the same customers throughout the year (community water systems) to provide consumer confidence reports to their customers. These reports are also known as annual water quality reports or drinking water quality reports. These reports are generally publicly available from the water suppliers or through an online data base such as the State Safe Drinking Water Information System (https://sdwis.waterboards.ca.gov/PDWW/) or the "My Water Quality" portal of the California Water Quality Monitoring Council (https://mywaterquality.ca.gov/index.html). 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 the NKGSA monitoring network will be reviewed annually and the analytical results for the chemicals of concern specific to the individual well locations will be compared against the respective MCL values for the chemicals of concern. The State MCL values for the chemicals of concern that have been identified in the **Section 3.2** will be relied upon heavily as the criteria for defining undesirable results. Chemical of concern within the NKGSA 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 have a recent history of being below MCLs; and 2) a statistically significant increase in groundwater degradation where concentrations of chemicals of concern have a recent history of being above MCLs. The occurrence of an undesirable result will be defined as 15% of the representative monitoring wells having reached either of these two criteria for two consecutive years 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)
Nitrate as N	10
Arsenic	0.010
Dibromo-Chloropropane (DBCP)	0.0002
1,2,3-Trichloropropane (TCP)	$5X10^{-6}$
Methyl Tert-Butyl Ether (MTBE)	0.013
Uranium	20 (pCi/L)
Tetrachloroethylene (PCE)	0.005
Trichloroethylene (TCE)	0.005
Hexavalent Chromium	0.02 mg/L**

* = As of June 2019, unless otherwise noted

** = California Superior Court invalidated the Hexavalent Chromium MCL of 0.01 mg/l in May 2017. The State Waterboard is in the process of adopting a new MCL. The USGS Health Based Screening Level (HBSL) of 0.02 mg/L or 20 ug/L is shown here

4.5.1.2 Causes of Groundwater Conditions That Could Lead to Undesirable Results

Regulation Requirements:

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

There are several potential causes of groundwater quality degradation that could lead to undesirable results. These include, 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;
- DBCP, EDB, and TCE are legacy contaminants and thus no future degradation from them is foreseen, rather efforts include managing current contamination plumes;

- One-time releases from sources of chemical contamination such as from fuel storage tanks or cleaning solvent tanks leading to petroleum hydrocarbon, MTBE, or solvent contaminant plumes;
- The accumulated effects of regulated and unregulated waste discharge streams from wastewater treatment facilities, septic systems, industry, food processors, feed lots, and dairies;
- Declining groundwater levels can cause pumped groundwater to have higher concentrations of some naturally occurring chemicals which may be either health concerns or aesthetic concerns, such as arsenic or uranium; and
- Groundwater pumping mobilizing groundwater contaminant plumes.

Regulation Requirements:

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

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

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 have a recent history of being below MCLs; and 2) a significant increase in groundwater degradation where concentrations of chemicals of concern have a recent history of being above MCLs. The occurrence of an undesirable result will be defined as 15% of the representative monitoring wells having reached either of these two criteria for two consecutive years.

Regulation Requirements:

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

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 sprouting difficult. Water quality within the NKGSA is generally such that groundwater degradation leading to impacts to crop is not considered a likely scenario.

Groundwater quality degradation has potential effects to urban area and rural residential drinking water quality. Within the NKGSA there are 10 urban agencies operating hundreds of community groundwater wells. Under California law, agencies that provide drinking water are required to routinely sample groundwater from their wells and compare the results to potable water standards (MCL), as appropriate for the individual chemicals. These results are reported by the water purveyors in Consumer Confidence Reports and are publicly available. Degraded groundwater quality can make drinking water treatment more difficult and expensive.

Residential structures not located within the service areas of the 10 NKGSA urban agencies will typically have private domestic groundwater wells. Such wells are not monitored routinely and groundwater quality from those wells is unknown unless the landowner has initiated testing and shared the data. Degraded water quality could potentially lead to rural residential use of groundwater not meeting potable water standards or the need for installation of new domestic wells drilled 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 NKGSA over consecutive years.

4.5.2 Minimum Thresholds

Regulation Requirements:

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

Groundwater quality in the NKGSA is generally suited for irrigation and domestic use, although groundwater issues for drinking water exist in some areas within the NKGSA. 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**.

To help evaluate changes in concentration levels at representative monitoring wells, information such as pumping rates and water level data may be obtained from the well owners.

Regulation Requirements:

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

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

4.5.2.1 Criteria to Define Minimum Thresholds

Regulation Requirements:

> **§354.28** (b) The description of minimum thresholds shall include the following:
> (1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.

> **§354.28** (c) Minimum thresholds for each sustainability indicator shall be defined as follows:
> (4) Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be used on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.

The criteria to define minimum thresholds will be based on the MCL values of the chemicals of concern discussed in the Groundwater Conditions chapter, **Section 3.2.5** 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 an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.

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

4.5.2.3 Minimum Thresholds in Relation to Adjacent Basins

Regulation Requirements:

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

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

4.5.2.4 Impact of Minimum Thresholds on Beneficial Uses and Users

Regulation Requirements:

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

The minimum thresholds for groundwater quality will be protective of water uses and users from degradation of groundwater quality by known chemicals of concern to concentrations detrimental to human health. The minimum thresholds for degraded water quality will maintain 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. With the powers provided to GSAs by SGMA, a GSA can only regulate and manage groundwater pumping as part of its effort to change groundwater conditions. 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 NKGSA area are already being monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyors under Title 22. The publicly available groundwater quality data from selected representative wells will be obtained annually and either compared against MCL values, if recent historical data has indicated chemicals of concern were initially below MCLs, or evaluated for groundwater quality trends with respect to the chemicals of concern utilizing appropriate statistical methods, such as the Mann-Kendall trend test. The Mann-Kendall trend test is a nonparametric test used to identify a trend in a series, even if there is a seasonal component to the series.

Selected public supply wells that will form the basis of the representative monitoring wells for groundwater quality are shown on **Table 4-9**. Available construction information for these wells is included in **Table 4-10.** The density of groundwater quality representative monitoring wells is approximately two wells per township. Locations were selected to be representative of large and small communities dependent on groundwater and to spatially cover the NKGSA (**Figure 5-4**). The chemicals of concern that the individual wells are routinely monitored for are summarized in **Table 4-8**.

As transient non-community wells within the representative groundwater quality monitoring network are only required to be analyzed for nitrates, the NKGSA will coordinate with the owners of the transient non-community wells to analyze groundwater samples for the remaining chemicals of concern every three years, consistent with the community public supply wells. Additionally, for chemical of concern uranium, monitoring is only triggered when gross alpha (GA) analysis is greater than 5.0 pCi/L. If gross alpha is always less than 5.0 pCi/L, there will be no uranium analytical results. It should be noted that the monitoring frequency for GA for wells in areas where uranium impacted groundwater has historically not been an issue can be up to one sample per nine years. As a result, limited uranium data will be available for most of the representative monitoring wells.

If for some reason a representative monitoring well is not available to be monitored, a well in the same general location and of similar construction will be used. The NKGSA will work with the agencies to establish backup locations. The representative groundwater quality monitoring network will be evaluated and revised if needed in subsequent GSP 5-year revisions.

Table 4-9 Selected Representative Groundwater Quality Wells and Most Recent Reported Concentrations

Public System No.	Township	Chemicals of Concern and Most Recent Reported Concentrations								
		Arsenic (µg/L)	1,2,3-Trichloropropane (TCP) (µg/L)	Hexavalent Chromium (µg/L)	Dibromo-Chloropropane (DBCP) (µg/L)	Methyl Tert-Butyl Ether (MTBE) (mg/L)	Nitrate as N (mg/L)	GA/Uranium (pCi/L)	Tetrachloroethylene (PCE) (µg/L)	Trichloroethylene (TCE) (µg/L)
1000514-003	T13S/R23E	ND	ND	--	ND	ND	4.1	ND	ND	ND
1000104-001	T14S/R23E	ND	ND	ND	ND	ND	1.4	ND	ND	ND
1000217-001	T13S/R18E	2.7	ND	17	ND	ND	1.6	1.3	ND	ND
1010049-003	T13S/R18E	2.94	ND	4.44	ND	ND	2.71	1.0	ND	ND
1000201-001	T13S/R17E	ND	ND	9.6	ND	ND	3.9	1.4	ND	ND
1010018-015	T14S/R17E	8.5	ND	27	ND	ND	1.6	4.6/1.4	ND	ND
1010018-014	T14S/R17E	7.2	ND	29	ND	ND	1.8	ND	ND	ND
1010018-017	T14S/R18E	4.5	ND	17	ND	ND	1.6	ND	ND	ND
1000279-003	T14S/R19E	ND	0.007	1.3	0.083	ND	2.2	--	--	--
1010057-003	T14S/R19E	ND	ND	8.9	ND	ND	3.8	26.6/22.1	ND	ND
1000362-003	T14S/R19E	4.8	ND	8.2	ND	ND	1.7	3.28/4.57	ND	ND
1000018-001	T15S/R20E	2.8	ND	1.9	0.063	ND	2.5	1.8	ND	ND
1000552-001	T15S/R20E	--	--	--	--	--	1.8	--	--	--
1000578-001	T15S/R21E	1.9	ND	ND	ND	ND	0.54	1.2	ND	ND
1000467-001	T15S/R21E	4.2	ND	0.33	0.015	ND	ND	1.4	ND	ND
1000039-002	T13S/R22E	2.3	ND	1.3	ND	ND	4.0	1.4	ND	ND
1000492-001	T13S/R22E	--	--	--	--	--	1.9	--	--	--
1000259-002	T13S/R19E	5.7	ND	ND	ND	ND	ND	1.62	ND	ND
1000366-001	T14S/R21E	1.4	ND	3.6	ND	ND	3.3	1.85	ND	ND
1010007-274	T14S/R21E	ND	ND	ND	ND	ND	1.8	ND	ND	ND
1010007-328	T14S/R20E	ND	ND	7.1	ND	ND	4.0	6.29/3.7	ND	ND
1010007-147	T14S/R20E	ND	ND	4.2	ND	ND	3.6	ND	ND	ND
1000208-001	T13S/R19E	2.4	ND	6.6	ND	ND	2.2	3.7	ND	ND
1010007-178	T13S/R19E	ND	ND	3.1	ND	ND	2.5	14.9/15	ND	ND
1010007-019	T13S/R20E	ND	ND	3.6	ND	ND	3.1	4.36/2.7	ND	ND
1010007-099	T13S/R20E	ND	ND	4.1	ND	ND	2.2	13.1/9.6	ND	ND
1000447-067	T13S/R21E	2.4	ND	1.6	ND	ND	2.2	0.44	ND	ND
1000023-013	T14S/R21E	2.8	0.033	1.0	ND	ND	3.1	3.8	ND	ND
1000554-002	T13S/R21E	1.8	ND	2.6	ND	ND	7.1	4.3	ND	ND
1010007-272	T12S/R19E	ND	ND	ND	ND	ND	0.8	ND	ND	ND
1000632-001	T12S/R20E	7.2	ND	ND	--	ND	1.7	3.6	ND	ND
1010007-230	T12S/R20E	2.4	ND	2.1	ND	ND	1.2	ND	ND	ND
1000078-004	T12S/R21E	2.4	ND	1.2	ND	ND	8.6	3.5	ND	ND
1010003-050	T12S/R21E	ND	ND	ND	ND	ND	5.6	3.27	ND	ND
1000555-002	T11S/R21E	2.3	ND	3.6	--	ND	5.1	3.6	ND	ND
California Primary MCL *		10	0.005	20 **	0.2	0.013	10	20	0.005	0.005

Notes:

* = As of June 2019, unless otherwise noted

** California Superior Court invalidated the Hexavalent Chromium MCL of 0.01 mg/L in May 2017. The State Waterboard is in the process of adopting a new MCL. The USGS Health Based Screening Level (HBSL) of 0.02 mg/L or 20 ug/L is hown here.

GA= Gross alpha determination. If gross alpha is greater than 5 pCi/L, uranium analysis is performed. Monitoring frequency for GA in areas where uranium impacted groundwater has historically not been an issue can be up to nine years. As a result, limited uranium data will be available for most of the representative monitoring wells.

ND = Not detected

-- = Not analyzed

Table 4-10 Selected Representative Groundwater Quality Wells Construction Information

Public System No.	Water System Name	Well Name	Well Completion Report Available	Drilling Method	Casing Size (inches)	Well Diameter	Completed Depth (feet)	Casing Depth (feet)	Date Drilled	Open Bottom (OB) or Gravel Pack (GP)	Perforation Interval Depth (feet)	Sanitary Seal Depth (feet)
1000514-003	Kings River Packing	Well No. 02 - Raw	YES	Casing Hammer	12	17	105	84	9/7/2018	OB	55-105	50
1000104-001	Centerville School	Well 01	--	--	--	--	--	--	--	--	--	--
1000217-001	Central High School West	Well 01 - Primary - Raw	YES	Cable Tool	12	16	474	474	7/15/1990	OB	410-474	100
1010049-003	Biola CSD	Well 3 - Raw	YES	Reverse Rotary	16	30	535	--	3/11/1993	--	--	--
1000201-001	Sun Empire School	Well 01	YES	Cable Tool	10	--	417	--	7/10/1989	--	--	100
1010018-015	City of Kerman	Well 15 - Raw	YES	Reverse Rotary	16	30	750	730	4/4/2004	GP	630-670; 710-730	580
1010018-014	City of Kerman	Well 09A - Raw	YES	--	16	30	800	800	7/3/1999	GP	640-780	610
1010018-017	City of Kerman	Well 17 - Raw	YES	Reverse Rotary	16	28	670	650	--	GP	510-540; 630-650	470
1000279-002	U.C. Kearney Field Station	Well 03	--	--	--	--	--	--	--	--	--	--
1010057-003	COF WWTF	Well 3A - Raw	YES	Reverse Rotary	16	28	614	614	5/6/1993	GP	464-474; 488-498; 516-526; 574-604	410
1000362-003	Golden State Vintners	Well 03	YES	Reverse Rotary	16	28	820	820	7/15/2009	GP	630-800	607
1000018-001	Easton Estates Water Company	Well 02	--	--	--	--	--	--	--	--	--	--
1000552-001	Fresno South Jehovah Witnesses	Well 01	--	--	--	--	--	--	--	--	--	--
1000578-001	West Tech Industrial	Well 01	YES	Reverse Rotary	10	UNK	265	265	3/15/2006	GP	120-265	50
1000467-001	USA Waste of California	Well 01 - Raw	YES	Reverse Rotary	12	24	420	420	1/25/1991	GP	210-420	175
1000039-002	FCA #10 Cumorah Knolls	Well 02	YES	Cable Tool	14	UNK	130	120	5/2/1962	UNK	68-106	NONE
1000492-001			--	--	--	--	--	--	--	--	--	--
1000259-002	New Horizons Mobile	Well 02	YES	Direct Rotary	8	14	400	400	4/18/2013	GP	320-400	106
1000366-001	Sunnyside Convalescent Home	Well 01	YES	Cable Tool	8	12	405	392.5	10/30/1992	UNK	UNK	50
1010007-274	City of Fresno	Well 147 - RAW	YES	Reverse Rotary	12	22	320	320	2/3/1992	GP	315-610	300
1010007-328	City of Fresno	Well 170 - RAW	YES	Reverse Rotary	16	26	650	650	3/5/1994	GP	320-640	290
1010007-147	City of Fresno	Well 21A - RAW	YES	--	18	20	307	300	7/24/1958	GP	210-290	NONE
1000208-001	Well 01 - Raw		--	--	--	--	--	--	--	--	--	--
1010007-178	City of Fresno	Well 44A - RAW	YES	Reverse Rotary	14	24	530	530	1/29/1969	GP	130-530	50
1010007-019	City of Fresno	Well 211 - RAW	YES	Cable Tool	12	16	268	260	7/1/1963	GP	180-260	NONE
1010007-099	City of Fresno	Well 283 - INF	YES	Reverse Rotary	16	28	312	312	12/1/1971	GP	162-312	50
1000447-067	E&J Gallo	Well 08 Raw	YES	Reverse Rotary	16	28	660	660	5/22/2010	GP	360-640	323
1000023-013	FCA#14 - Belmont Manor	Well 02	YES	--	--	--	--	--	--	--	--	--
1000554-002	FCA#10A - Mansionette Estates	Well 02	--	--	--	--	--	--	--	--	--	--
1010007-272	City of Fresno	Well 160 - RAW	YES	Reverse Rotary	18	28	790	770	5/15/1992	GP	190-760	180
1000632-001	Vulcan Materials	Well 01	--	--	--	--	--	--	--	--	--	--
1010007-230	City of Fresno	Well 096 - RAW	YES	Reverse Rotary	16	24	500	500	4/2/1980	GP	235-290	60
1000078-004	FCWWD#42 - Alluvial and Fancher	Well 05	YES	Cable Tool	10	UNK	202	188	3/23/1976	UNK	100-171	50
1010003-050	City of Clovis	Well 30 - Raw	YES	Reverse Rotary	18	30	270	270	11/25/1998	GP	200-260	180
1000555-002	FCA#44C Riverview Estates	Well 02	YES	Casing Hammer	6	10	210	75	4/20/1993	OB	75-210	50

Notes:
UNK = Unknown
-- = Information currently unkown
GP= Gravel pack well
OB= Open bottom well

4.5.3 Measurable Objectives

4.5.3.1 Description of Measurable Objectives

Regulation Requirements:

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

Groundwater within the NKGSA is generally used beneficially for municipal/domestic consumption or agriculture. Groundwater quality standards for municipal/domestic consumption 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 have a recent history of being 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 a recent history of being 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 have a recent history of being 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 a recent history of concentrations above MCLs for contaminants of concern.

4.5.3.3 Representative Monitoring

Regulation Requirements:

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

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

4.5.3.4 Path to Achieve Measurable Objectives

Regulation Requirements:

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

Groundwater pollution characterization and remediation are enforced by local agencies and state level programs. The NKGSA will only have authority related to groundwater pumping policies, however the NKGSA will review and analyze publicly available routine groundwater monitoring data reported by the community and non-community public supply wells in order to understand how and if groundwater pumping is exacerbating groundwater quality concerns and when and where to enforce pumping restrictions or other mitigation measures should it become necessary. Management of groundwater pumping will occur over the lifetime of the planning and implementation horizon. No interim milestones have been set for the water quality indicator.

Consistent with current practices by groundwater pumping agencies, and in an effort to proactively monitor conditions before MCLS are exceeded, data will be reviewed for increased constituent of concern levels approaching the MCL, and when appropriate, the NKGSA will contact the well owner to discuss concerns of levels approaching the MCL. Actions may be conducted as adverse water quality changes are observed to prevent an undesirable result. These 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.

NKGSA 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 in the NKGSA area is deep subsidence from declining groundwater levels. Current and historical information on land subsidence is discussed in Section 3.2.6 and the land subsidence monitoring network is discussed in section 5.6. Section 4.5 will discuss the undesirable result, minimum threshold, and measurable objective set for land subsidence. A summary of the Minimum Threshold and Measurable Objective for land subsidence can be seen in **Table 4-11** and **Table 4-12** respectively. More details and the methodology to set the criteria can be found later in Section 4.5.

Table 4-11 Minimum Threshold for Land Subsidence

Minimum Threshold Parameter	Minimum Threshold Quantity
Annual Land Subsidence Rate	5 inches/year over an area of 36 square miles
Maximum Cumulative Land Subsidence	2 feet over 20 years

Table 4-12 Measurable Objective for Land Subsidence

Measurable Objective Parameter	Measurable Objective Quantity
Annual Land Subsidence Rate	2.5 inches/year over an area of 36 square miles
Maximum Cumulative Land Subsidence	0.5 foot over 20 years

4.6.1 Undesirable Results

The NKGSA has minimal to no land subsidence as described in detail in Section 3.2.6, and there have been no known significant impacts from land subsidence within the NKGSA.

An undesirable result for land subsidence would be the significant and unreasonable loss of functionality of structures, infrastructure, and major damage to roads within the Kings Basin due to land subsidence. This could include, for example, , water distribution systems, and canal banks failing or taking critical damage. There are five major highways located within the NKGSA: State Route 41, State Route 99, State Route 145, State Route 168, and State Route 180. Existing surface water conveyance infrastructure includes FID canals and structures and the Friant Kern Canal. It would be undesirable if subsidence caused the canals to lose significant conveyance capacity.

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 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 NKGSA. Since there have been no known issues with historic land subsidence in NKGSA, it is reasonably assumed that historic subsidence rate, and resulting cumulative subsidence would not lead to undesirable results. 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.

As described in 3.2.6, there are five types of subsidence in California; only deep subsidence from declining groundwater levels is found in NKGSA.

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.

SGMA only applies to land subsidence from groundwater pumping. There are two general types of subsidence: elastic and inelastic. Elastic subsidence is recoverable if water levels later rise while inelastic subsidence is permanent. Elastic subsidence generally occurs in the coarse- grained portions of the aquifer where the materials compact. Although there are several causes of inelastic land subsidence, the compression of clay 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 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 more compactly, can no longer re-absorb water, thus the subsidence in these areas cannot be reversed. This process is known as aquifer system compaction.

In the Central Valley, aquifer system compaction primarily occurs within the Corcoran Clay layer and less so in the overlying “A” and “C” clays. The Corcoran Clay layer within the Kings basin is shown in **Figure 4-7**. Since the Corcoran Clay is a confining layer, land subsidence would occur when water is pumped from the confined aquifer below the Corcoran Clay. 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). Most of the permanent subsidence in the San Joaquin Valley has historically been correlated to overdraft in the confined aquifer below the Corcoran Clay. However, with increased reliance on groundwater to meet demands, land subsidence is currently occurring in areas outside of the Corcoran clay. In these areas subsidence is typically less than the historical subsidence in areas underlain by the Corcoran Clay.

The Corcoran Clay starts along the very western edge of the NKGSA as shown in **Figure 4-7**, and extends west, so the potential for this type of land subsidence within the NKGSA is limited to a relatively small area within a few miles east of the edge of the Corcoran Clay.

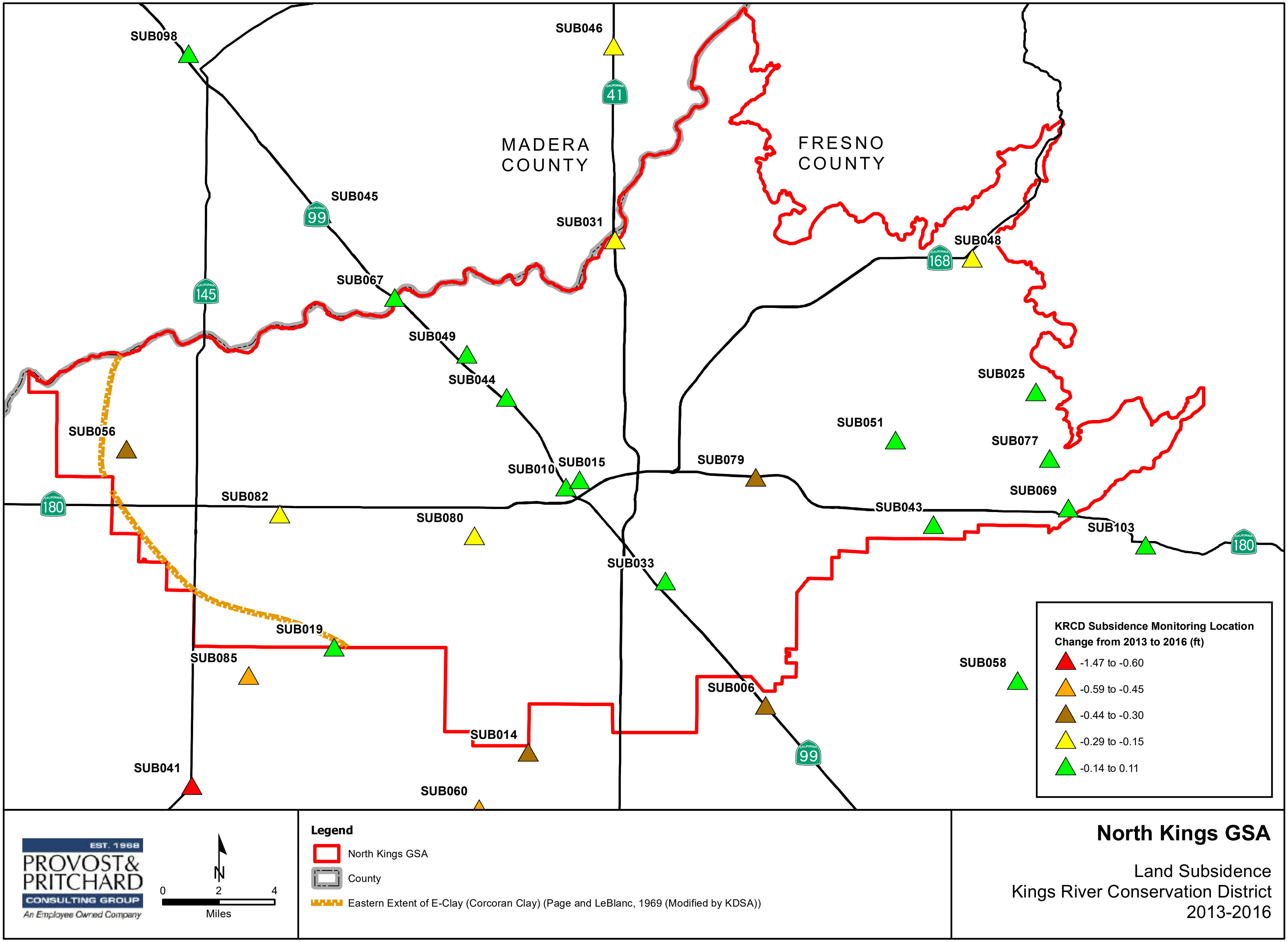


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Figure 4-7

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 to define the Undesirable Result related to land subsidence is the significant loss of functionality of a structure or facility to the point that the feature cannot be operated as designed, requiring either retrofitting or replacement.

This includes review of subsidence data in NKGSA to monitor the rate and cumulative subsidence to verify those variables have not exceeded the minimum threshold identified in section 4.5.2.1. A description of the criteria used to set the minimum threshold is described in Section 4.5.2.1.

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 potential effects of land subsidence include those on manmade structures and those on natural features. In the San Joaquin Valley, the main problems related to land subsidence are the impacts to gravity driven water conveyance structures, where even minor changes in gradients can cause reductions in the designed capacity of the feature. Other facilities sensitive to subsidence include roads, railways, bridges, pipelines, buildings, levees, and wells.

While more focus has been placed on the highly visible infrastructure damage from subsidence, which generally can be repaired, compaction of the aquifer system may permanently decrease its capacity to store water. Most compaction that occurs as a result of historically low groundwater levels is irreversible.

4.6.1.3 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.

Monitoring for land subsidence will be done by evaluating data released from KRCD and NASA InSAR (see Monitoring Network Section 5.6), 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.

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.

NKGSA is not currently experiencing any known significant subsidence related issues along major highways or infrastructure. While there are no known issues because of land subsidence, as described in 3.6.2, there has been some minimal land subsidence in small portions of the NKGSA. The amount of historic subsidence is nominal and not believed to cause a continued concern, however the NKGSA has set a minimum threshold as a precaution. The minimum threshold has been set based on historic subsidence trends. This historical subsidence was minimal, and caused no discernable damage, so it is assumed that a continuation of this rate until groundwater levels are stabilized in 2040 will be acceptable.

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. Land subsidence occurs in areas that are underlain by clayey deposits dominated by the clay mineral montmorillonite. In the Central Valley, this is usually the Corcoran Clay layer including the confined aquifer below. The Corcoran Clay layer barely extends into the western edge of NKGSA. 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 limited wells within NKGSA that are drilled below the Corcoran Clay with reliable well construction information, and those that do are primarily composite wells constructed across multiple aquifers. Since the Corcoran clay layer covers a relatively small area within NKGSA, groundwater levels will not be used as a proxy for land subsidence. This may be re-evaluated in the future by NKGSA.

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.

The Minimum Thresholds for land subsidence are shown in **Table 4-13** below as an annual land subsidence rate and a maximum cumulative land subsidence amount.

Table 4-13 Minimum Threshold for Land Subsidence

Minimum Threshold Parameter	Minimum Threshold Quantity
Annual Land Subsidence Rate	5 inches/year over an area of 36 square miles
Maximum Cumulative Land Subsidence	2 feet over 20 years

Most subsidence in the San Joaquin Valley is occurring west of the NKGSA area over the axial trough of the Valley, in an area west and south of the Kings Basin. 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 dominated by the clay mineral montmorillonite (USGS 497-C, Meade 1967). The historic subsidence map, **Figure 4-9**, and the recent subsidence map, **Figure 4-8**, both show that generally subsidence increases westerly and southwesterly of NKGSA, indicating that deeper 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 4-14** shows the summary of total land subsidence in NKGSA as estimated by different agencies over various time frames and **Table 4-15** 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 NKGSA.

The Minimum Threshold for land subsidence has been established as 5-inches/year over an area of at least 36 square miles (area of one township/range), with a maximum cumulative land subsidence of 2 ft over 20 years. The maximum historical land subsidence rate in NKGSA was about 2.5 in/year as measured by NASA from 2015-2017, **Figure 4-8**. With this historical rate, local stakeholders, landowners and water agencies have not observed any negative impacts from the subsidence. The historical rate of 2.5 inches/year is used for the Measurable Objective in NKGSA. The minimum threshold is twice this number to allow for operational flexibility during periods of drought. Since there have been no undesirable results with the historical rate of subsidence, it is anticipated that the minimum threshold will not cause undesirable results. The maximum cumulative amount of land subsidence was determined by reviewing a 1949-2005 map of land subsidence by DWR, **Figure 4-9**. This shows the maximum subsidence in NKGSA over a period of 56 years was around 5 feet in very localized areas. The 5 ft of land subsidence over 56 years has an annual rate of

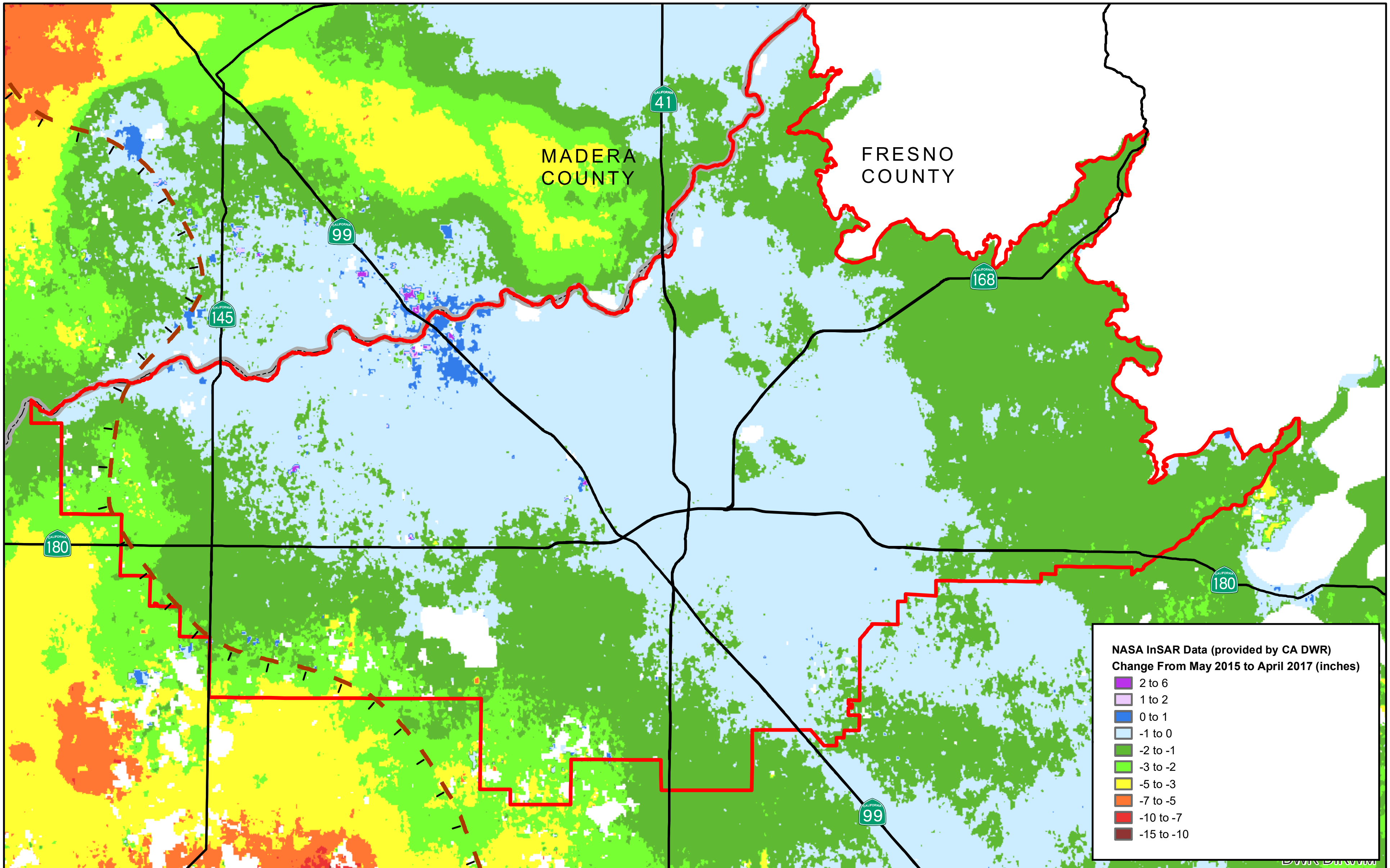
1.07 inches/year. The annual rate of 1.07 inches/year was used to estimate the potential subsidence over the next 20 years, which is 20 years times 1.07 inches/year to estimates 2 feet of subsidence.

Table 4-14 Historical Total Land Subsidence in NKGSA

Total Subsidence in NKGSA				
Monitoring Agency	Date Range			
	Start	End	Min (in)	Max (in)
USGS	1926	1970	0	-12
DWR	1949	2005	0	-60
USBR	2011	2016	-1.2	-4.8
KRCD	2013	2016	1.3	-5.3
NASA	2015	2017	2	-5

Table 4-15 Historical Land Subsidence Rate in NKGSA

Subsidence Rate in NKGSA				
Monitoring Agency	Date Range			
	Start	End	Min (in/yr)	Max (in/yr)
USGS	1926	1970	0.00	-0.27
DWR	1949	2005	0.00	-1.07
USBR	2011	2016	-0.24	-0.96
KRCD	2013	2016	0.44	-1.76
NASA	2015	2017	1.00	-2.50



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Legend

- North Kings GSA
- County
- E Clay Eastern Extent (Page and LeBlanc1969, modified by KDSA)

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.

North Kings GSA

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

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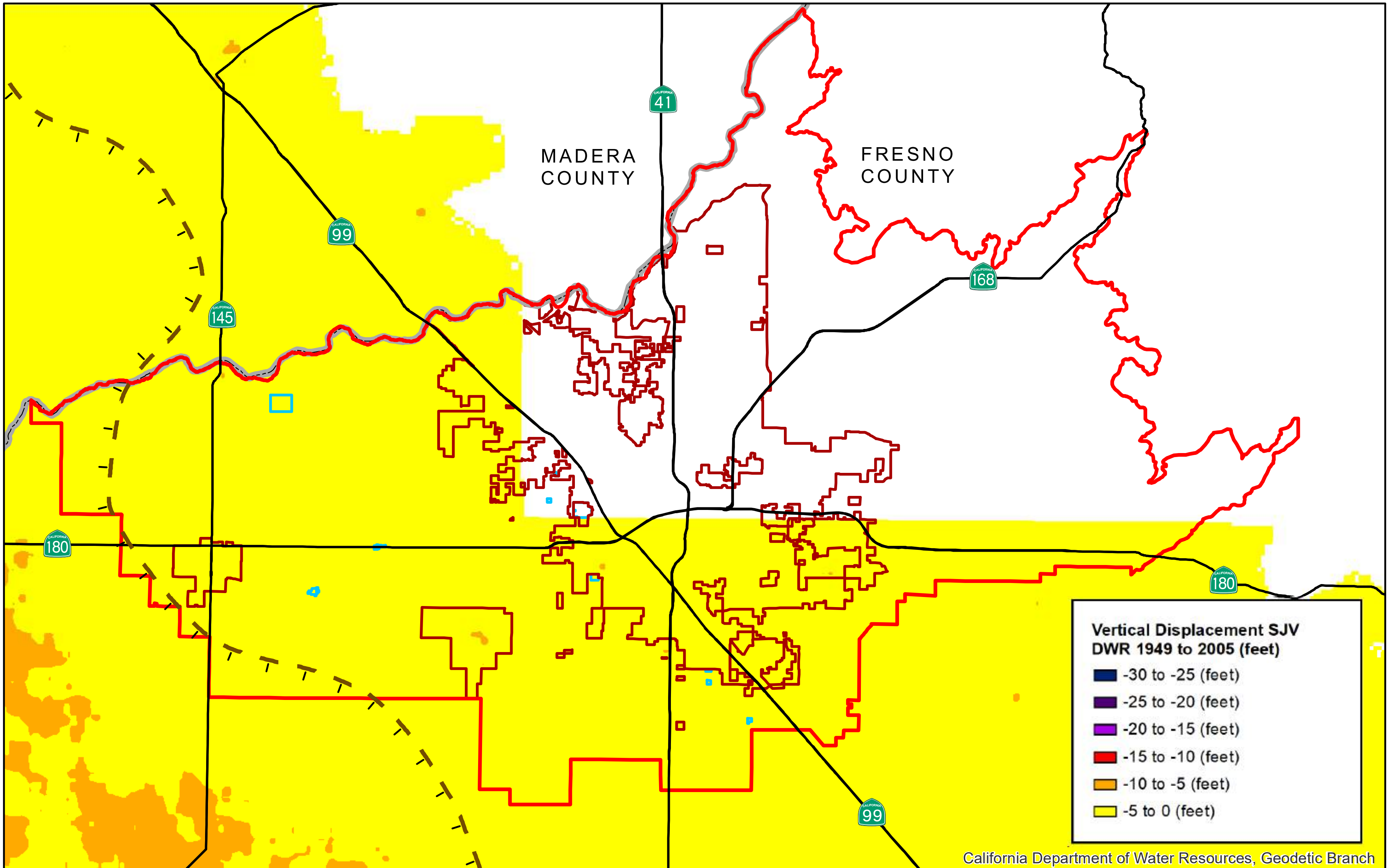
Figure 4-8



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North Kings GSA

County

E Clay Eastern Extent (Page and LeBlanc1969, modified by KDSA)

Disadvantaged Community*

DAC

SDAC

Classifications of disadvantaged communities are provided by Tulare-Kern IRWM

North Kings GSA

Land Subsidence

Department of Water Resources

1949-2005

Figure 4-9

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4.6.2.2 Relationship for each sustainability indicator

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 NKGSA and since the historical subsidence was small, the cumulative impacts is still not expected to cause problems if the rate of subsidence and maximum cumulative subsidence remains less than the minimum threshold. **Table 4-16** lists the relationship to land subsidence for each sustainability indicator.

Table 4-16- Relationship for Each Sustainability Indicator

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 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.

The minimum thresholds have been selected to avoid causing undesirable results in adjacent basins. The minimum thresholds do not exceed historical subsidence observed in the Kings Basin. It is anticipated that as water levels stabilize in NKGSA, so will land subsidence. Furthermore, historical subsidence in NKGSA has been lower than in adjacent areas, especially to the west, so it is reasonably assumed that NKGSA will not cause detrimental land subsidence in adjacent areas.

The majority of NKGSA has minimal subsidence and undesirable results have not been identified. **Figure 4-8** from NASA InSAR data shows that areas of greater subsidence are located outside of NKGSA to the west where the Corcoran clay layer exists. NKGSA will continue to monitor the subsidence within the NKGSA as well as along the borders to see if subsidence is spreading into the NKGSA where the subsidence is caused from confined aquifer pumping outside of the NKGSA. When subsidence that originates from confined aquifer pumping outside the NKGSA and extends into the NKGSA, NKGSA will coordinate with its neighboring GSAs to address the subsidence issue.

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 water uses and water users should be minimal. The NKGSA will monitor land subsidence as well as actual impacts from land subsidence. If the land subsidence monitoring shows subsidence in the area, NKGSA may assess the land subsidence in the area and address accordingly. Most beneficial users in NKGSA have mentioned they are not aware of subsidence within the NKGSA or that any minimal subsidence has not caused issues of concern. Since there have been no issues with subsidence historically, it is not anticipated that land subsidence will cause issues with the minimum threshold criteria, particularly as groundwater levels are sustained.

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.

Land subsidence is currently measured by the KRCD (survey) and NASA (remote sensing). The monitoring density is considered of adequate density and frequency to determine subsidence annually. For more information on the monitoring network, refer to Section 5.1.3.5.

4.6.3 Measurable Objectives

4.6.3.1 Description of measurable objectives

Regulation Requirements:

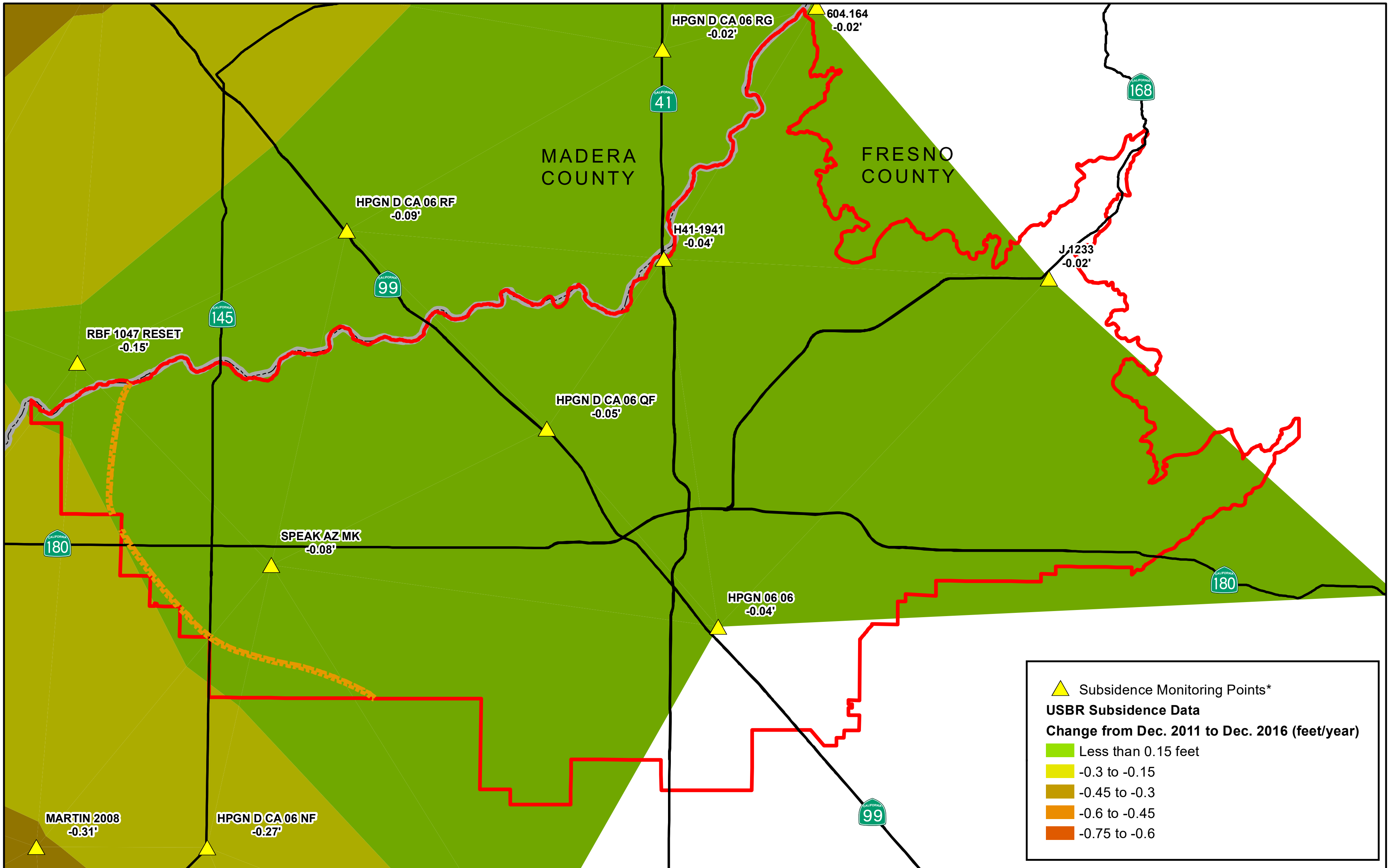
§354.30 (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin with 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation 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.

The Measurable Objectives for land subsidence are shown in **Table 4-17** below as an annual land subsidence rate and a maximum cumulative land subsidence amount.

Table 4-17 Measurable Objective for Land Subsidence

Measurable Objective Parameter	Measurable Objective Quantity
Annual Land Subsidence Rate	2.5 inches/year over an area of 36 square miles
Maximum Cumulative Land Subsidence	0.5 foot over 20 years

Measurable objectives for land subsidence were set based on historical rates. The Measurable Objective for land subsidence will be no more than 2.5-inches/year over an area of at least 36 square miles, with a cumulative amount of land subsidence of 0.5 ft over 20 years. The measurable objective land subsidence rate matches the maximum historical land subsidence rate in NKGSA of about 2.5 in/year as measured by NASA from 2015-2017, **Figure 4-8,** which has not yielded any significant and undesirable results in the NKGSA. The cumulative amount of land subsidence was determined by reviewing the 2011-2016 USBR map, **Figure 4-10**. This shows the minimum subsidence in NKGSA over a period of 5 years was around 1.2 inches, or 0.24 inches/year. The annual rate of 0.24 inches/year was used to estimate the amount of subsidence that would occur over 20 years. The estimate of land subsidence over 20 years is 0.5 feet. It is assumed that land subsidence would stabilize as the water levels stabilize as part of the water level measurable objectives.



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North Kings GSA

County

Eastern Extent of E-Clay (Corcoran Clay) (Page and LeBlanc, 1969 (Modified by KDSA))

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

North Kings GSA

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

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Figure 4-10

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 NKGSA, the operational flexibility is 5.0 in – 2.5 in = 2.5 in/year or 2.0 feet – 0.5 feet = 1.5 feet of cumulative subsidence. NKGSA 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. Land subsidence occurs in areas that are underlain by clayey deposits dominated by the clay mineral montmorillonite. In the Central Valley, this is usually the Corcoran Clay layer, including the confined aquifer below. The Corcoran Clay layer barely extends into the western edge of NKGSA. 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 limited wells within NKGSA that are drilled below the Corcoran Clay with well construction information that are not composite wells. Since the area covered by the Corcoran clay layer is relatively small within NKGSA, groundwater levels will not be used as a proxy for land subsidence. However, the NKGSA may reevaluate this in the future.

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 4-18 and **Figure 4-11** presents 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 -0.5 feet. If

land subsidence exceeds the 2.5 in/year annual rate or exceeds the interim milestones, then there will be outreach and education to make the affected areas aware of the land subsidence. There will also be increased monitoring and observing the impacts on facilities. If the land subsidence exceeds the Minimum Threshold and causes an undesirable result, then NKGSA will implement projects and management actions, see chapter 6 for more information.

Table 4-18 Land Subsidence Interim milestones

	Cumulative Subsidence (feet)	
Year	Measurable Objective	Minimum Threshold
2020	0.00	0.00
2025	-0.13	-0.50
2030	-0.25	-1.00
2035	-0.38	-1.50
2040	-0.50	-2.00
2045	-0.50	-2.00

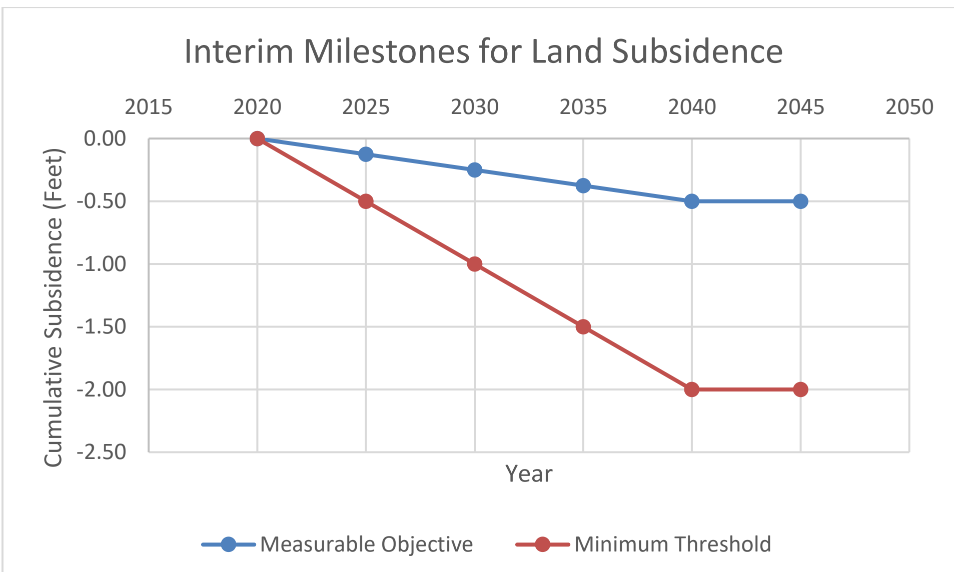


Figure 4-11 Interim Milestones for Cumulative Land Subsidence

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.

NKGSA 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

Interconnected surface water has been defined in the California Code of Regulations Title 23, Division 2, Chapter 1.5, Subchapter 2 as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. Within the NKGSA, interconnected surface water is a potential concern in the areas adjacent to the Kings River. These locations are shown on **Figure 4-12**. For the purposes of this GSP, a gaining stream can be defined as one in which the channel bed is lower in elevation than the surrounding groundwater table. In general terms, overall the San Joaquin River stretch along the NKGSA boundary is a not a gaining stream while the Kings River stretch along the NKGSA boundary is believed to be a gaining stream.

There are some complexities in seepage, and it is challenging to disentangle groundwater pumping impacts from other causes as increases in seepage could occur without increases in pumping and likewise increases in pumping would not necessarily increase seepage. There are several considerations in relating seepage to groundwater pumping such as volume of flows, timing of flows, climate, water quality, drought, antecedent moisture content, groundwater levels, etc. Increased seepage could be caused by many reasons other than increased groundwater pumping, including increased riparian pumping from rivers, change in operation, saturation, etc. At this time there is no evidence that active wells along the either river are causing increased seepage loss or impacts to downstream beneficial uses.

<u>San Joaquin River</u>
While they do not explicitly discuss interconnected surface water systems, regional reports (CVHM, 2009 and USGS OFR 85-401, 1985) appear to show that surface water is not interconnected along the San Joaquin River in the NKGSA.

The Spring 2016 groundwater elevation contours, as shown in **Figure 4-13** when compared to estimated riverbed elevations where SJRRP data is available generally indicate a lack of connection along the San Joaquin river in the NKGSA. This is also illustrated on **Figure 4-14** where Spring 2016 groundwater depth contours show groundwater depths in the area of the San Joaquin River range from approximately 60 to 150 feet below ground.

Additional discussion of interconnected surface water is discussed in **Section 3.2** (Current and Historical Groundwater Conditions).

<u>Kings River</u>
Based on the information reviewed, the Kings River appears to be interconnected with groundwater in the NKGSA. The draft Hydrogeological Conceptual Model (HCM) and Groundwater Conditions for the East Kings Sub-basin GSP (KDSA, 2017) contains descriptions of interconnected groundwater along the Kings River between Highway 180 and Reedley. The Kenneth D. Schmidt and Associates draft report findings were based on groundwater elevation data from shallow monitor wells at existing or proposed gravel processing facilities and the waste-water facilities for Sanger and Reedley. The results of the monitoring indicate that shallow groundwater flows in the same direction as the river and is interconnected with stream flow in the reach between Highway 180 and Reedley. This area is downstream from where the NKGSA borders the Kings River.

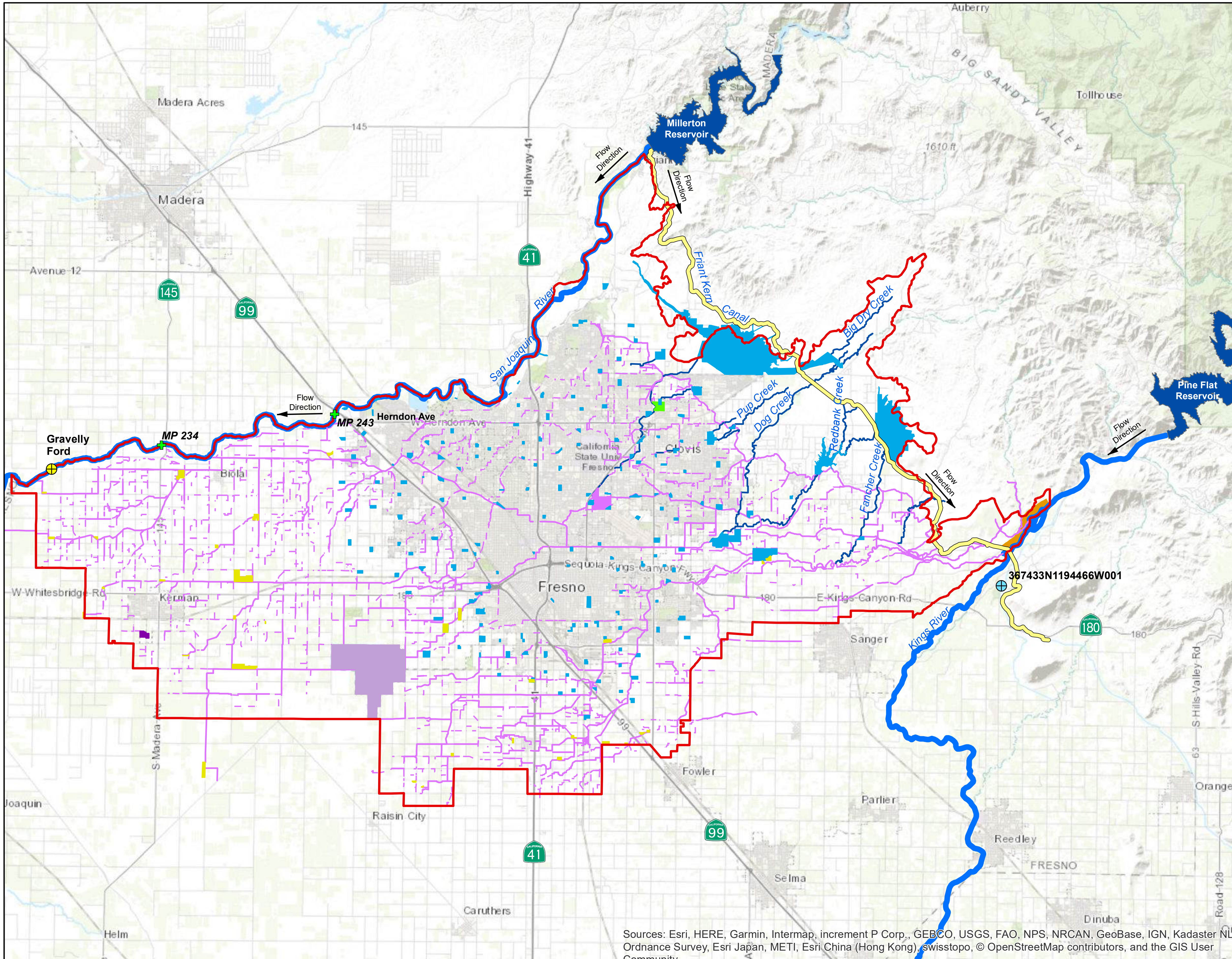
KDSA further indicates that along the reach of the Kings River upstream of the Reedley narrows, the groundwater is indicated to be in direct hydraulic communication with streamflow in the Kings River. This finding is supported by several hydrographs from wells monitored by DWR in the area downstream of where the Friant-Kern Canal crosses the Kings River. In this area the Kings River is a multiple channel system and numerous canals have their headworks there. Overall, depths to water reported from the DWR monitored wells varies from about 6 to 10 feet. Well 367433N1194466W001 (**Figure 4-12**), which is next to one of the river channels, had several reported depths to water of less than 10 feet. A hydrograph for Well 367433N1194466W001 is shown in **Figure 4-15.**

Without having surveyed channel bed elevations, it is difficult to know for sure but the shallow depths to water appear to indicate that the surface water system in this area is connected to groundwater. This information supports the draft findings from KDSA 2017. Based on the reviewed information, portions of the Kings River downstream of the NKGSA have been identified as interconnected, therefor it is likely that portions of the Kings River where it borders the NKGSA are also interconnected.

North Kings GSA

Areas of Potential Interconnected Surface Water

Figure 4-12



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- Well
- SJRRP Mile Post
- Gravelly Ford
- North Kings GSA
- Fresno Clovis Regional WRF
- City of Fresno Leaky Acres
- City of Kerman WWTF
- FID Basin
- FMFCD Basin
- City of Clovis Basin
- Areas of Potential Interconnected Surface Water Concern

Facility Type

- Canal
- Pipeline
- Creek
- River
- Friant Kern Canal

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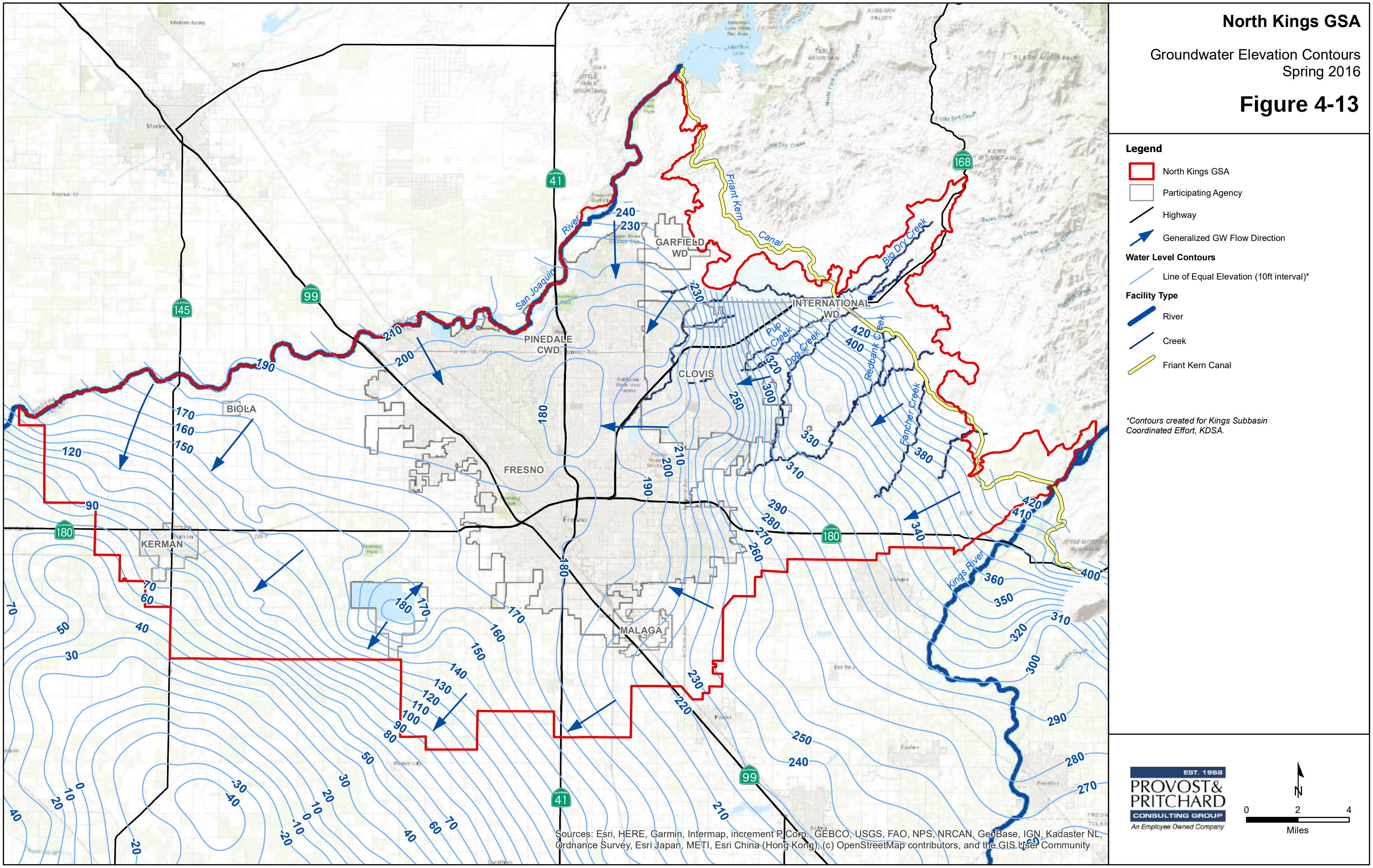

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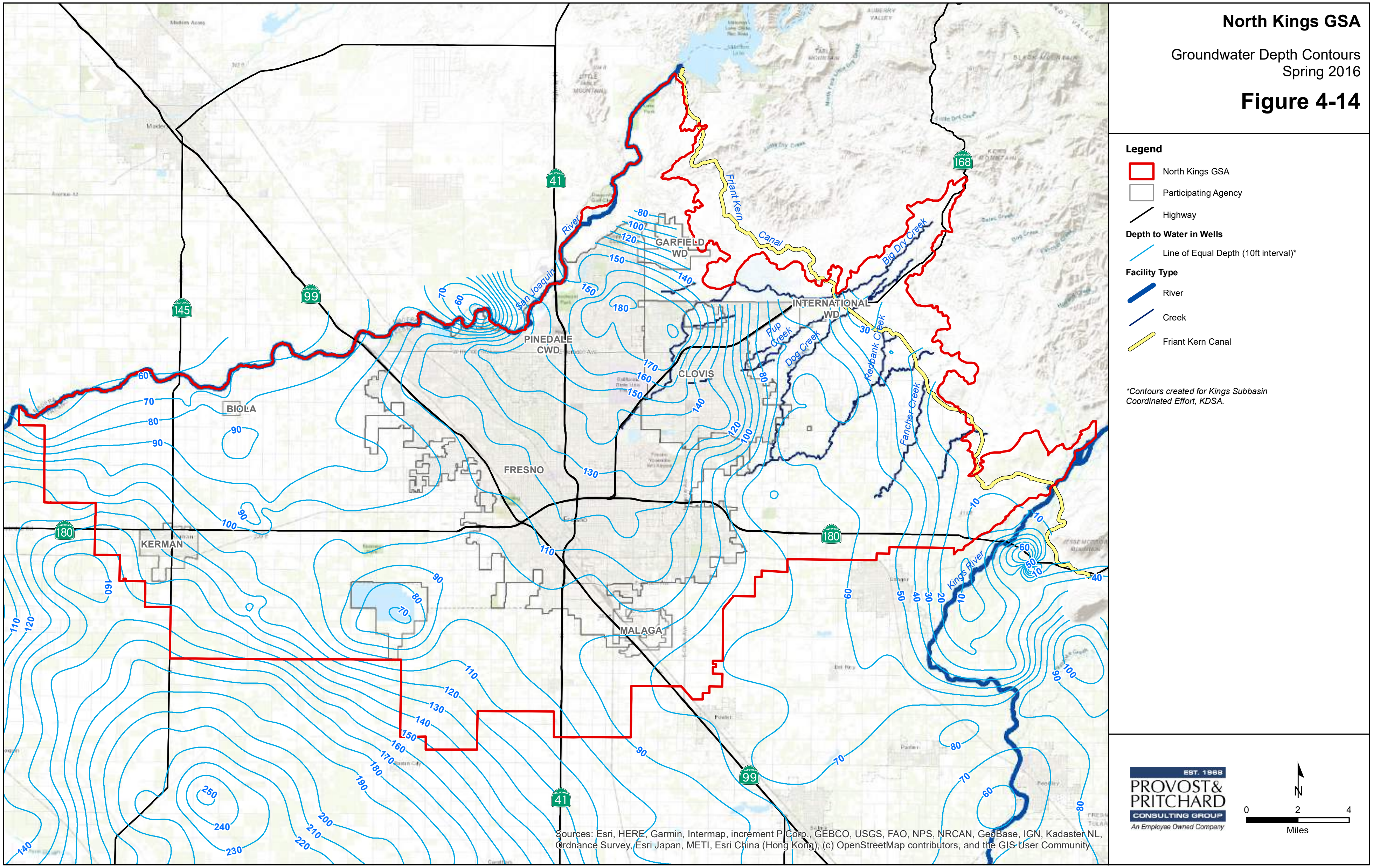

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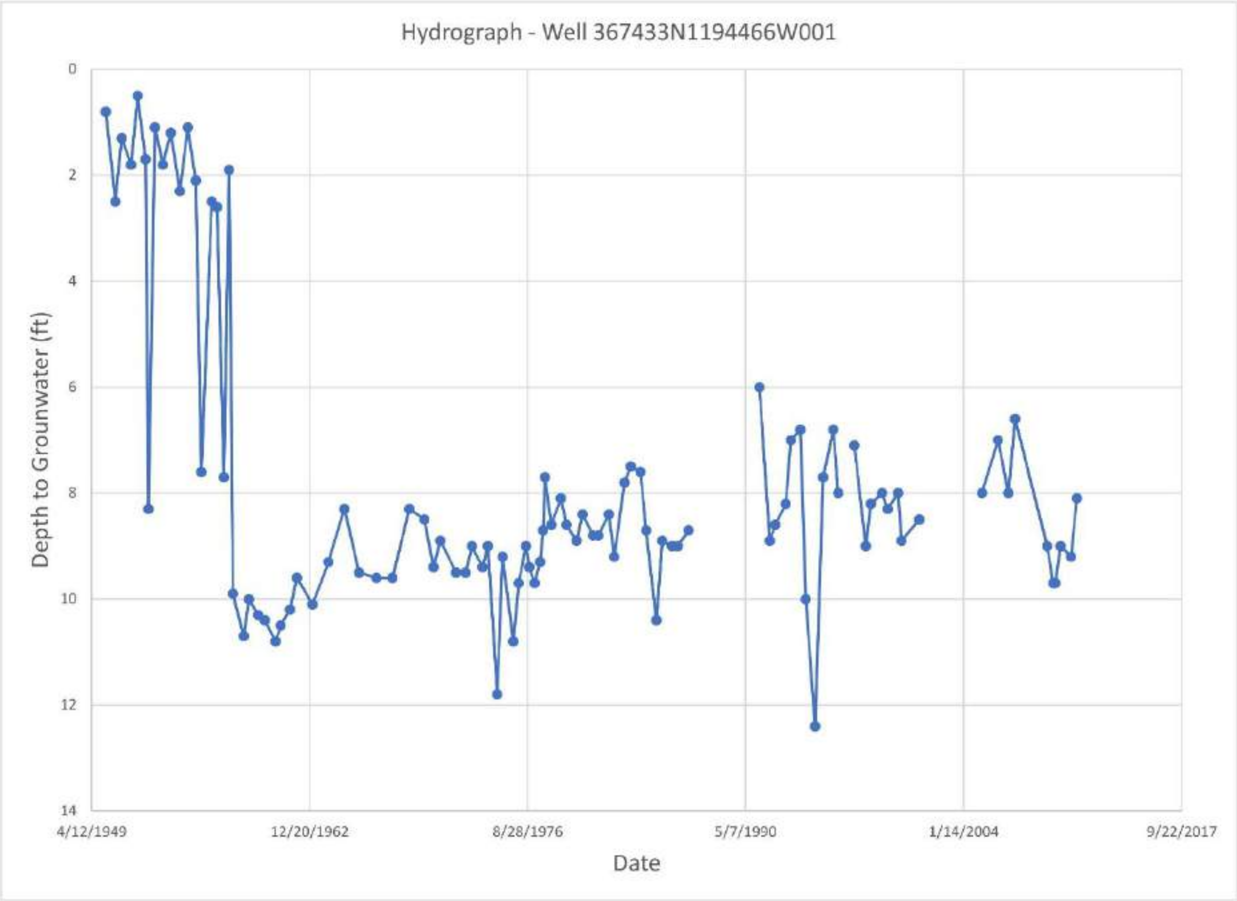


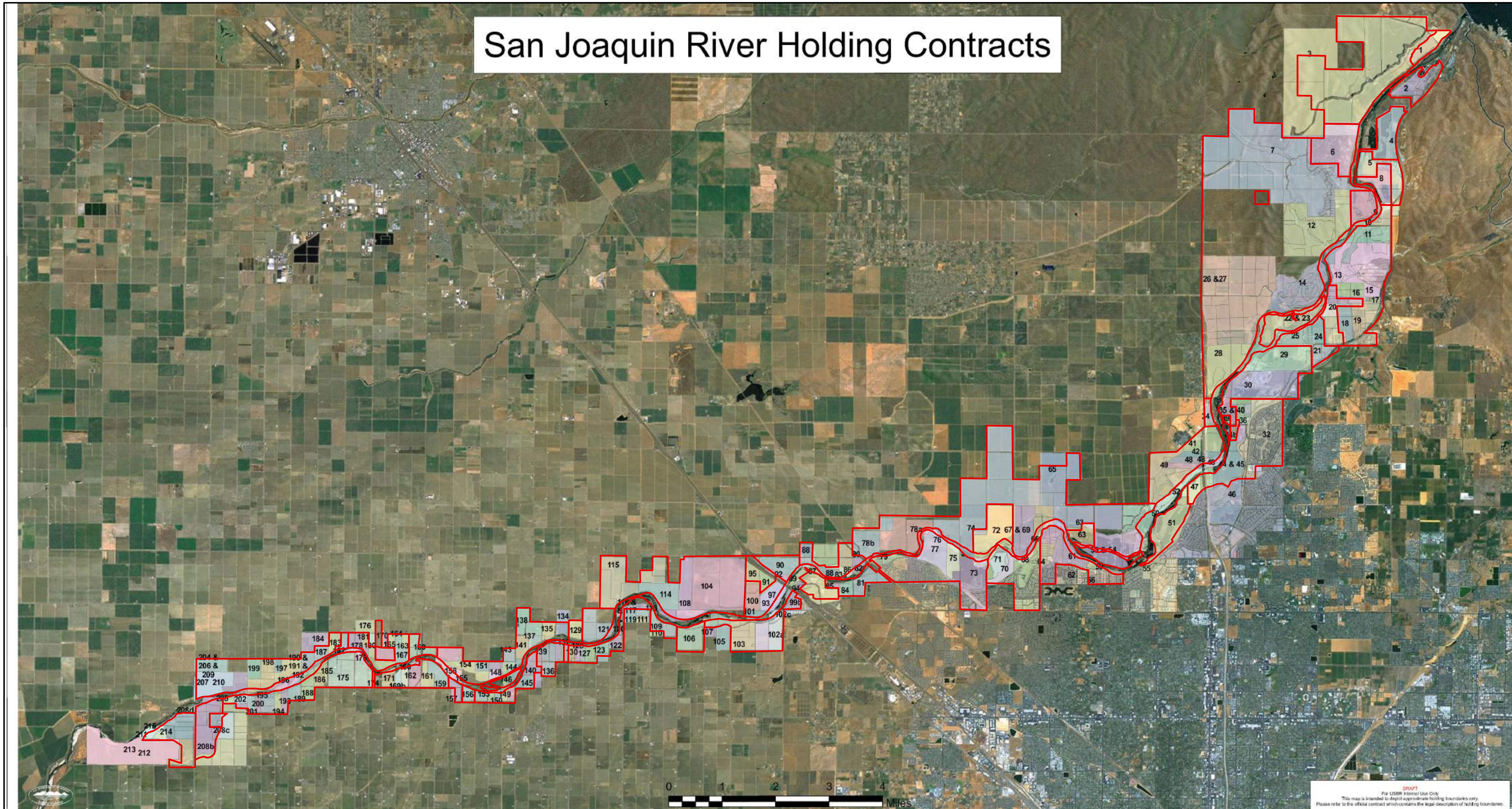
Figure 4-15 Well 367433N1194466W001 Hydrograph

River Management Programs

Along the San Joaquin River (SJR), the US Bureau of Reclamation (USBR) entered into contracts in the 1950s with landowners along both sides of the river from Friant Dam to Gravely Ford as settlements to landowner claims for impacts caused by the construction of Friant Dam and Millerton Lake to surface and groundwater supplies and their associated water rights along the SJR. These settlement agreements are generally described as the Holding Contracts, which apply to specific lands. The contracts are roughly estimated to cover areas about 1 mile from the SJR and extend to specific land areas and not always to just lands deemed riparian land (i.e., parcels that physically touch the river). These Holding Contracts do not establish a right to the water, as water rights are regulated by the State of California but provide for specific releases of water into the San Joaquin River for these Holding Contract properties for irrigation and drinking water. A USBR Holding Contract provisional map produced in 2018 (**Figure 4-16**) indicates that the Holding Contracts cover a total of approximately 10,000 acres north and south of the San Joaquin River. From the map it appears that the riparian area is a smaller area than the Holding Contracts lands within the NKGSA at about 7,000 acres.

The language in the Holding Contracts requires the US to maintain a live stream, the water to be used on defined land for reasonable irrigation/domestic purposes; the landowner cannot sell the right or convey the water to other property; and the US is defined as the agent to protect the right. The agreements are for a defined piece of land that water could potentially be diverted to. The USBR places water in the San Joaquin River for use of those with a "Holding Contract," as a settlement of any claims of impacts the contract holder may have as a result of the construction of Friant Dam and Millerton Lake to their surface water or groundwater supplies under the influence of the San Joaquin River.

Prior to the San Joaquin River Restoration Program (SJRRP), under the Holding Contracts, minimum flows of 5 cfs were maintained to Gravelly Ford (i.e., the western extent of the Holding Contract settlements along the San Joaquin River adjacent to the NKGSA). Under the SJRRP restoration flow guidelines (SJRRP, 2017) a flexible flow schedule is implemented with minimum flows of 125 CFS to occur in the summer months to Gravelly Ford during wet or dry years. During critically dry years, the SJRRP schedule reverts back to the minimum flows of 5 CFS to Gravelly Ford year-round. Depletion of interconnected surface water, even if it were present, is not likely to occur due to the river management programs.



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Digitized Holding Contracts 1952 Map

North Kings GSA

USBR 2018 Holding Contracts Map

Figure 4-16

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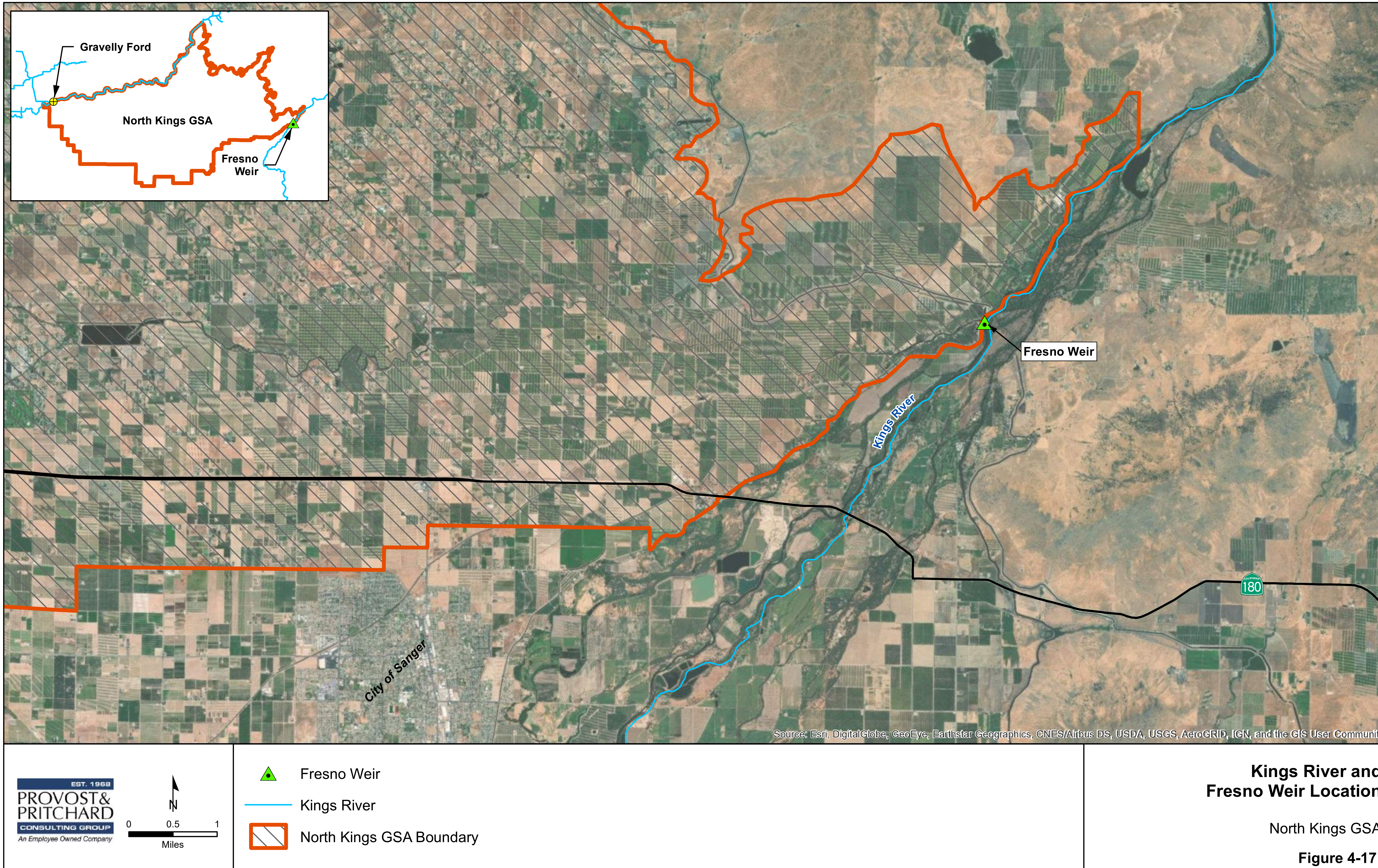
Since 1999, the Kings River Conservation District (the "District"), the Kings River Water Association (the "Association"), and the California Department of Fish and Wildlife (the "Department") has operated a comprehensive program referred to as the *Kings River Fisheries Management Program* to further enhance the broad range of fish and wildlife resources associated with the Kings River and Pine Flat Reservoir. The Kings River Water Association employs adaptive management of river flows to balance fishery needs with other beneficial water uses while adjusting to changing conditions, opportunities and constraints. Among other improvements since its inception the program has:

- Made beneficial changes in the operation of Pine Flat Dam and related facilities;
- Established a temperature control pool in the reservoir;
- Enhanced releases for fisheries purposes from Pine Flat Dam;
- Installed new facilities for fish and wildlife purposes at Pine Flat Dam and the Kings River;
- Enhanced program of law enforcement, fish stocking and monitoring; and
- Made other physical and non-flow related improvements for the benefit of aquatic habitat quality.

As part of the original agreement between the District, the Association, and the Department, a minimum flow of 95 cubic feet per second (CFS) is to be maintained at Fresno Weir to support the fisheries program. The Kings River follows the NKGSA border until it reaches the approximate location of the Fresno Weir, where the Kings River flows southwesterly, and away from the NKGSA. This means the stretch of the Kings River through the NKGSA does not go dry and depletion of interconnected surface water cannot occur due to the river management program. A map depicting the Fresno Weir location is included as **Figure 4-17**. Additional information on the King River Fisheries Management Program can be found on its website (http://krfmp.org). The 1999 Kings River Fisheries Management Program Framework Agreement between the District, the Association, and the Department can be found online at: http://krfmp.org/_pdf_fmp/FMP_FrameworkAgreement1999.pdf. The 2009 amendment to the program agreement is at http://krfmp.org/_pdf_fmp/Signed%20Extension.pdf.



Kings River and Fresno Weir Location

North Kings GSA

Figure 4-17

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4.7.1.1 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.

§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.

<u>San Joaquin River</u>
As discussed in **Section 4.6.1**, the San Joaquin River does not appear to be hydraulically connected to groundwater in the reaches of the NKGSA and therefore under regulation §354.26 (d) setting sustainable management criteria for surface water is not required. Additionally, the existing San Joaquin River Restoration program will continue to ensure certain flow rates in the river along the NKGSA and release water to accommodate all river losses (evaporation, seepage, riparian diversions and groundwater pumping induced seepage). Undesirable results to surface water related to groundwater pumping are not likely to occur.

<u>Kings River</u>
As discussed in **Section 4.6.1, t**he existing river management program will continue to be utilized to guide the fisheries and management of the Kings Rivers. SGMA based sustainable management criteria does not appear to be applicable with regards to the Kings River as the various river programs guarantee certain flow rates in the rivers and release water to accommodate all river losses (evaporation, seepage, riparian diversions and groundwater pumping induced seepage). Undesirable results to surface water related to groundwater pumping are not likely to occur.

4.7.1.2 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.

A substantial increase in near-river groundwater pumping could lead to additional induced groundwater seepage requiring excess surface water to be sent down the rivers for the operators to fulfill downstream obligations. There are several considerations in relating seepage to groundwater pumping such as volume of flows, timing of flows, climate, water quality, drought, antecedent moisture content, groundwater levels, etc. Increased seepage could be caused by many reasons other than increased groundwater pumping, including increased riparian pumping from rivers, change in operation, saturation, etc. Connected surface water sustainable management criteria do not apply to the San Joaquin River or the Kings River, however the significance of the San Joaquin River and the Kings River to riparian water rights holders and other stakeholders is understood.

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 NKGSA has established a groundwater monitoring network with monitoring points near both the San Joaquin River and the Kings River. Monitoring network locations are discussed in **Section 5 Monitoring Network** of this GSP. NKGSA will continue to review the near-river groundwater monitoring data collected by the San Joaquin River Restoration Program and will utilize the near-river monitoring well(s) in its own monitoring well network to verify that groundwater near-river gradients do no increase significantly. Updates will be included in subsequent GSP revisions as necessary.

Currently there is no evidence that active wells along the river are causing increased seepage loss or impacts to downstream beneficial uses and there are no known complaints of increased water required as a result of groundwater pumping.

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.

Potential impacted parties could include:

- Groundwater pumpers downstream of the NKGSA or in an adjacent basin;
- Environmental flow proponents, or
- The USBR, CVP Friant water contractors or the San Joaquin River Exchange contractors who could complain of the need for greater surface water releases to satisfy losses.

4.7.1.3 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.

While there have been no known third-party complaints of increased river water releases required as a result of NKGSA groundwater pumping, the possibility exists that such complaints could be received in the future. As a safeguard even though undesirable results are unlikely, NKGSA plans to monitor and investigate received complaints to verify legitimacy. The obligation to prove complaints would be the responsibility of the third party.

If a complaint is received, the validity of the complaint would be evaluated through review of data and information provided by the claimed affected party. An assessment/inventory of groundwater wells in the area would be performed by NKGSA. After NKGSA review of the complainant supplied documentation, and the assessment/inventory of groundwater wells in the area, a determination on the complaint would be made. Determinations could include that the complaint is either valid, invalid, or inconclusive based on the information supplied by the complainant.

Mitigation of conditions leading to a valid complaint could be dependent on specific circumstances and a one-size-fits-all approach to mitigation may not be appropriate. Should NKGSA review determine a complaint to be valid, a cascading set of actions such as the following may be taken to alleviate conditions leading to the complaint:

- Encourage or incentivize NKGSA near-river groundwater pumpers to prioritize the use of surface water from FID canals or use Holding Contract water where appropriate and available;
- Limit construction of new or replacement shallow near-river production wells;
- Restrict pumping of shallow near-river production wells; and
- Install recharge facilities in the vicinity to create a hydraulic barrier.

Monitoring and data evaluation would be performed during the implementation of each action to establish the need for the next cascading action.

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.

The San Joaquin River does not appear to be hydraulically connected to groundwater in the reaches of the NKGSA and therefore under regulation §354.26 (d) setting sustainable management criteria for surface water is not required. Additionally, the existing San Joaquin River Restoration Program and Kings River management programs will continue to ensure certain flow rates in the rivers along the NKGSA and release water to accommodate river losses (evaporation, seepage, riparian diversions and groundwater pumping induced seepage). Undesirable results to surface water related to groundwater pumping are not likely to occur and criteria has therefore not been set.

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.

Undesirable results to surface water related to groundwater pumping are not likely to occur and criteria, including minimum thresholds, has therefore not been set under regulation §354.26 (d).

4.7.2.1 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:
(6) Depletions of Interconnected Surface Water. The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following:
(A) The location, quantity, and timing of depletions of interconnected surface water.
(B) A description of the groundwater and surface model used to quantify surface water depletion. If a numerical groundwater and surface water model is not used to quantify surface water depletion, the Plan shall identify and describe an equally effective method, tool, or analytical model to accomplish the requirements of this Paragraph.

Undesirable results to surface water related to groundwater pumping are not likely to occur and criteria has therefore not been set under regulation §354.26 (d).

4.7.2.2 Relationship for Each Sustainability Indicator

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.

Depletions of interconnected surface water would generally have no relationship to seawater intrusion or land subsidence in the NKGSA due to the distance from the coast. Seepage from river waters supplies shallow groundwater of good quality. Depletions of interconnected surface water would generally be tied to shallow groundwater levels in the area of the surface water body and therefore groundwater storage also. However undesirable results to surface water related to groundwater pumping are not likely to occur and criteria has therefore not been set under regulation §354.26 (d).

4.7.2.3 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.

Undesirable results to surface water related to groundwater pumping are not likely to occur and criteria has therefore not been set under regulation §354.26 (d). As described in **Sections 4.6.1.2 and 4.6.1.3** the NKGSA does plan to monitor and investigate any received complaints from potential impacted parties, including those from adjacent basins.

4.7.2.4 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.

Undesirable results to surface water related to groundwater pumping are not likely to occur and criteria has therefore not been set under regulation §354.26 (d). As described in **Sections 4.6.1.2 and 4.6.1.3** the NKGSA does plan to monitor and investigate any received complaints from potential impacted parties.

4.7.2.5 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 interconnected surface water. If state, federal, or local agencies implement an interconnected surface water standard, then it will be reviewed and may be incorporated into the GSP.

Undesirable results to surface water related to groundwater pumping are not likely to occur and criteria has therefore not been set under regulation §354.26 (d).

4.7.2.6 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.

Undesirable results to surface water related to groundwater pumping are not likely to occur and criteria has therefore not been set under regulation §354.26 (d). Nonetheless and as described in **Section 4.6.1.2**, the NKGSA has established a groundwater monitoring network with monitoring points near both the San Joaquin River and the Kings River. Additionally, the NKGSA will continue to review the near-river groundwater monitoring data collected by the San Joaquin River Restoration Program and will utilize the near-river monitoring well(s) in its own monitoring well network to verify that groundwater near-river gradients do not increase significantly. Groundwater level measuring protocols are discussed in **Section 5** "Monitoring Network" of this GSP.

4.7.3 Measurable Objectives

4.7.3.1 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.

Undesirable results to surface water related to groundwater pumping are not likely to occur and criteria, including measurable objectives has therefore not been set under regulation §354.26 (d).

4.7.3.2 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.

Undesirable results to surface water related to groundwater pumping are not likely to occur and criteria, including operational flexibility, has therefore not been set under regulation §354.26 (d).

4.7.3.3 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.

Undesirable results to surface water related to groundwater pumping are not likely to occur and criteria, including operational flexibility, has therefore not been set under regulation §354.26 (d). However, the NKGSA has established a groundwater monitoring network with monitoring points near both the San Joaquin River and the Kings River. Monitoring network location are discussed in **Section 5** "Monitoring Network" of this GSP. NKGSA will continue to review the near-river groundwater monitoring data collected by the San Joaquin River Restoration Program and will utilize the near-river monitoring well(s) in its own monitoring well network to verify that groundwater near-river gradients do not increase significantly. Updates will be included in subsequent GSP revisions as necessary.

4.7.3.4 Path to Achieve Measurable Objective

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.

Undesirable results to surface water related to groundwater pumping are not likely to occur and criteria, including measurable objectives has therefore not been set under regulation §354.26 (d).

4.7.3.5 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.

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

5 Monitoring Network

5.1 Introduction

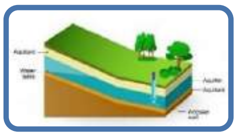
Regulation Requirements:

§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 identifies the monitoring network being developed by the NKGSA . The purpose of the monitoring network is to collect sufficient data to determine short-term, seasonal, and long-term trends in groundwater and related surface conditions and document information necessary to support the implementation of this Plan, evaluate the effectiveness of this Plan, and support decision making. The monitoring network includes six components, as shown below.

Groundwater Levels

- Monitoring of static groundwater levels each Spring and Fall

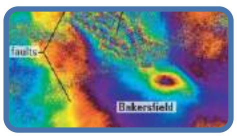


Groundwater Storage

- Measurement of the annual change in groundwater storage

Water Quality

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

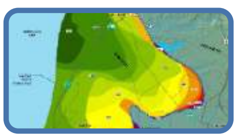


Land Subsidence

- 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 North Kings GSA

This chapter describes current and future monitoring programs. The results of historical monitoring efforts can be found in Section 3.2 – Current and Historical Groundwater Conditions.

5.1.1 Monitoring network objectives

Regulation Requirements:

§354.34(b) Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:

1) Demonstrate progress toward achieving measurable objectives described in the Plan.
2) Monitor impacts to the beneficial uses or users of groundwater
3) Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.
4) Quantify annual changes in water budget components.

The objectives of the various monitoring programs include the following:

1. Establish a baseline for future monitoring.
2. Provide warning of potential future problems.
3. Use data gathered to generate information for water resources evaluation.
4. Help to quantify annual changes in water budget components.
5. Develop meaningful long-term trends in groundwater characteristics.
6. Provide data comparable from place to place in the Plan Area.
7. Demonstrate progress toward achieving measurable objectives described in the Plan.
8. Monitor changes in groundwater conditions relative to minimum thresholds.
9. Monitor impacts to the beneficial uses or users of groundwater.

5.1.2 Network Development Process

§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.

Groundwater monitoring has been performed in the NKGSA area for many decades by the Fresno Irrigation District (FID) and the communities that pump and supply domestic water. More recently, most of the NKGSA member agencies performed groundwater monitoring as part of the Fresno Area Regional Groundwater Management Plan. These programs will continue and be expanded to comply with SGMA monitoring requirements. Past monitoring has been performed on a local agency level, with data sharing between neighboring agencies to better understand groundwater boundary conditions such as depth to water and flow. These partnerships will also be maintained and enhanced to provide useful agency and region-wide information.

New monitoring networks will be developed, 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 and Identification of Data Gaps (2016a) and Best Management Practices for Monitoring Protocols, Standards and Sites (2016b). The DQO process includes the following:

1. State the problem.
2. Identify the goal.
3. Identify the inputs.
4. Define the boundaries of the area/issue being studied.
5. Develop an analytical approach.
6. Specify performance or acceptance criteria.
7. Develop a plan for obtaining data.

The DQO process helps to ensure a robust approach and that data is collected with a specific goal in mind.

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:

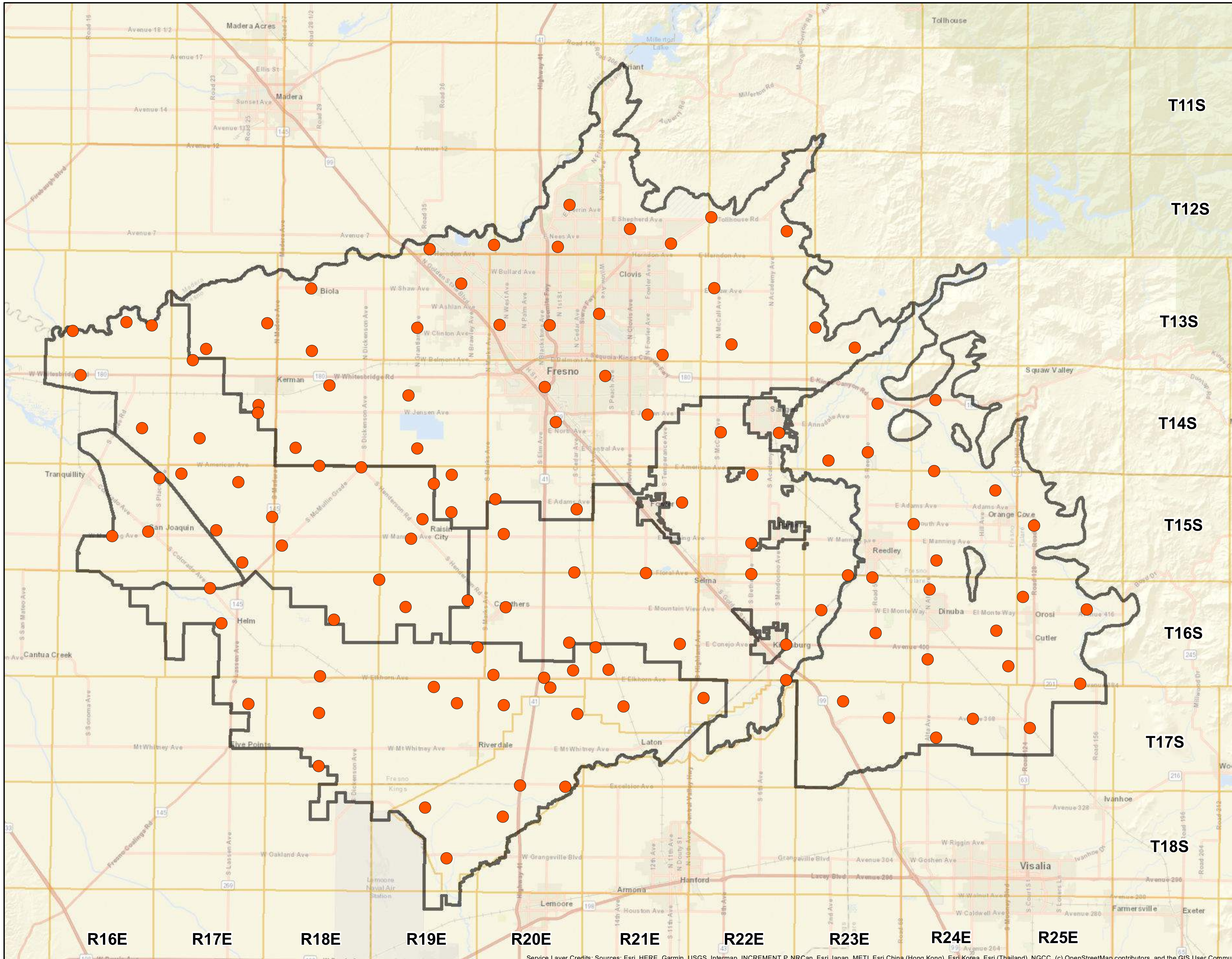
A) A sufficient density of monitor wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.

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, City, and District monitoring wells. The groundwater level monitoring network for each GSA is shown in **Figure 5-1.** 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, respectively.

Groundwater levels have been monitored in most of the NKGSA area since the 1920s. In 2005, the Fresno Regional Groundwater Management Group was formed and began collaborating on groundwater level monitoring and reporting for a region similar in geographic extent to the NKGSA. This group shared groundwater level data and has prepared an annual groundwater report since 2006. The geographic area covered by this effort will be slightly expanded to include the entire NKGSA area. Each agency will continue to manage its groundwater level monitoring network, and the NKGSA may assist with data collection and monitoring. The data will be compiled into a single database to assist with regional evaluations, groundwater contour maps, groundwater flow determination, and annual reporting (see **Section 7.4** – Data Management System). Data will also be shared with each of the six other GSAs in the Kings Basin to prepare regional groundwater contour maps and annual reports.

Most of the NKGSA members have measured groundwater levels on a regular basis. However, some have only performed it annually or on a sporadic basis, and the timing of fall and spring measurements has not been consistent. Each agency will monitor groundwater levels every March and October to provide consistency in the measurements.



Kings Subbasin Coordinated Effort

Water Level Monitoring Network

Figure 5-1

Legend

- Indicator Well
- Groundwater Sustainable Agency
- Township/Range

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Groundwater levels are measured in various types of wells including:

- **Municipal wells**: Most municipal wells are available for monitoring.
- **Dedicated Monitor Wells**: Dedicated monitor wells are in the NKGSA, such as next to productions wells and at groundwater banks and wastewater treatment plants. These are the most useful monitoring points. A select group of monitor wells has been added to the network and will be monitored semi-ly.
- **Groundwater Bank Recovery Wells**: FID owns and operates groundwater recovery wells at its banking facilities.
- **Private Wells**: Areas outside of the municipal agencies have limited coverage from public owned wells. As a result, FID has consent from numerous landowners, primarily irrigators, to monitor water levels in their wells. Access agreements are needed to monitor these wells. Sometimes these wells cannot be monitored if the pump is running or there are access issues, such as locked gates.
- **Wells in Adjacent GSAs**: Groundwater level data from adjoining areas, including other agencies to the north, south, and west of the North Kings GSA, will also be collected to help provide better interpretation of GSA boundary flow conditions. (*Note: long term agreements still need to be prepared to collect/share data with other GSAs.)* Groundwater levels to the east of the NKGSA would not be useful since the alluvial groundwater basin ends on the eastern border of the NKGSA with the adjacent Sierra Nevada.

Within the NKGSA there is an unconfined aquifer, covering the entire NKGSA, and a confined aquifer, covering a smaller portion of the western edge of the NKGSA beneath the Corcoran Clay. As indicated in **Section 3.1**- Hydrologic Conceptual Model, there is an enhanced concept of confined groundwater conditions over most of the NKGSA (outside of the area underlain by the Corcoran Clay). Groundwater level data from wells in the NKGSA will continue to be collected and evaluated to gain a better understanding of whether the confined groundwater conditions east of the Corcoran Clay are present. The NKGSA will develop a program to obtain additional construction information on wells in the monitoring network. This information will be used to evaluate shallow groundwater conditions, and as wells are identified that tap the deeper confined to semi-confined water, the data will be used to help refine the concept of confined groundwater conditions in the NKGSA. In time, as more well construction information becomes available, separate groundwater-level monitoring programs may be needed to monitor the two aquifers.

5.2.2 Adequacy of Monitoring Network

Regulation Requirements**:**

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.
§354.34(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

The Kings Basin is not establishing management areas, rather the Basin is split into seven GSAs that will each have their own GSP. Each GSA has a minimum monitoring density of two 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.

Groundwater Levels

The existing groundwater-level monitoring network has performed adequately for several decades in preparing groundwater contour maps and identifying groundwater level trends. The urban areas have dense well networks, and Well Completion Reports are readily available for most municipal wells. In 2005, FID strengthened their network by adding more private wells, matching Well Completion Reports to some wells, surveying well locations using a common datum, photographing each well, and collecting well attribute information. The current density of the monitoring network is adequate throughout the entire NKGSA (see Section 5.1.5). However, data on the depth and perforated interval is required according to SGMA guidelines but is not known for many wells.

5.2.3 Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements**:**

§354.34(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:

1) Amount of current and projected groundwater use.
2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.
3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.
4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

Groundwater Levels

Groundwater levels in the NKGSA area have been monitored since at least the 1920s. Many wells have been continuously monitored for much of that time. This data has enhanced understanding of long-term trends and the ability of the aquifer to respond to droughts and wet periods.

The groundwater levels will be monitored in the spring (March) and fall (October) of each year. This differs slightly from historical measurements, but the NKGSA participants have agreed to this schedule to provide consistency in the data. Spring measurements are designed to capture the recovery of the groundwater basin after an extended period of minimal agricultural and landscape irrigation demand, assuming a normal rainfall. The fall measurement would capture a period after peak irrigation and summertime urban demands have ceased, thereby showing the cumulative impacts on the groundwater basin before any natural recovery has taken place.

Hopkins and Anderson (2016) provide recommendations for groundwater-level monitor well densities. The densities range from 1 well per 150 square miles to 1 well per 25 square miles based on the quantity of groundwater pumped. A minimum density of 1 well/25 square miles is recommended for areas using over 100,000 AF of groundwater per year. Groundwater use in the NKGSA 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 1 well/18 square miles. This is a bare minimum density, and the NKGSA will strive to maintain a denser network when economically feasible and practical.

Figure 5-3 shows the monitoring wells' density by Township for the NKGSA area and the area just outside the NKGSA boundary. The density ranges from 3 wells to 61 wells per township within the NKGSA boundary and 1 well to 81 wells per township outside the NKGSA boundary.

The minimum density of 2 wells/Township shall apply to *High Quality Monitoring Points*, which are defined as wells with reliable access each spring and fall, information on the well depth and perforated interval, and sufficient depth to accommodate seasonal fluctuations. Wells that do not meet these guidelines will be maintained in the network, as they can still provide useful information. Well construction information on these wells may be obtained in the future, and it is desired to keep wells that have a long period of record. During development of groundwater contours, those wells with and without well construction information will be labeled to assist with the analysis.

The monitoring network also includes areas outside of the NKGSA, so the following criteria were established:

- Townships wholly within the NKGSA. In these Townships, there shall be at least two high quality monitoring points.
- Township partially within the NKGSA. In these Townships, there shall be at least two high quality monitoring points, but the monitoring points only need to be within the Township and not necessarily within the NKGSA boundary.
- Townships wholly outside of the NKGSA. These areas are monitored to provide better information on boundary conditions. No minimum well density is specified for these areas partially because they include wells owned and monitored by other agencies. Data collection will be outside of the NKGSA's control. However, there is a desire to obtain at least 2 wells per Township if feasible.

5.2.4 Monitoring Network Information

The following sections describe the monitoring network, including scientific rationale for the selection; consistency with data and reporting standards; corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone; and the locations of the monitoring sites.

5.2.4.1 Scientific 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.

Groundwater Levels

The scientific rationale for the groundwater level monitoring network includes the following:

- The network meets the minimum density goal of 1 well/18 square miles.
- The network has performed adequately for several decades in providing information for annual reporting, groundwater contour maps, and estimation of storage change.
- Many existing wells have a significant period of record (i.e. greater than 20 years) and are useful for long-term evaluations.

The following scientific rational will be used to add new wells:

- Add wells whenever necessary to maintain minimum monitor well density (1 well/18 square miles).
- Avoid wells located near water bodies such as canals, reservoirs, etc.
- Avoid wells perforated across multiple aquifers.
- Select dedicated monitor wells over production wells where feasible.
- Select wells with available construction information (i.e., depth, perforated interval).
- Avoid domestic wells since they are rarely idle.

5.2.4.2 Consistency with Data and Reporting Standards

Regulation Requirements**:**

> §354.34(g) 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 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 (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.)

5.2.4.3 Quantitative Values

Regulation Requirements**:**

> §354.34(g)(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.

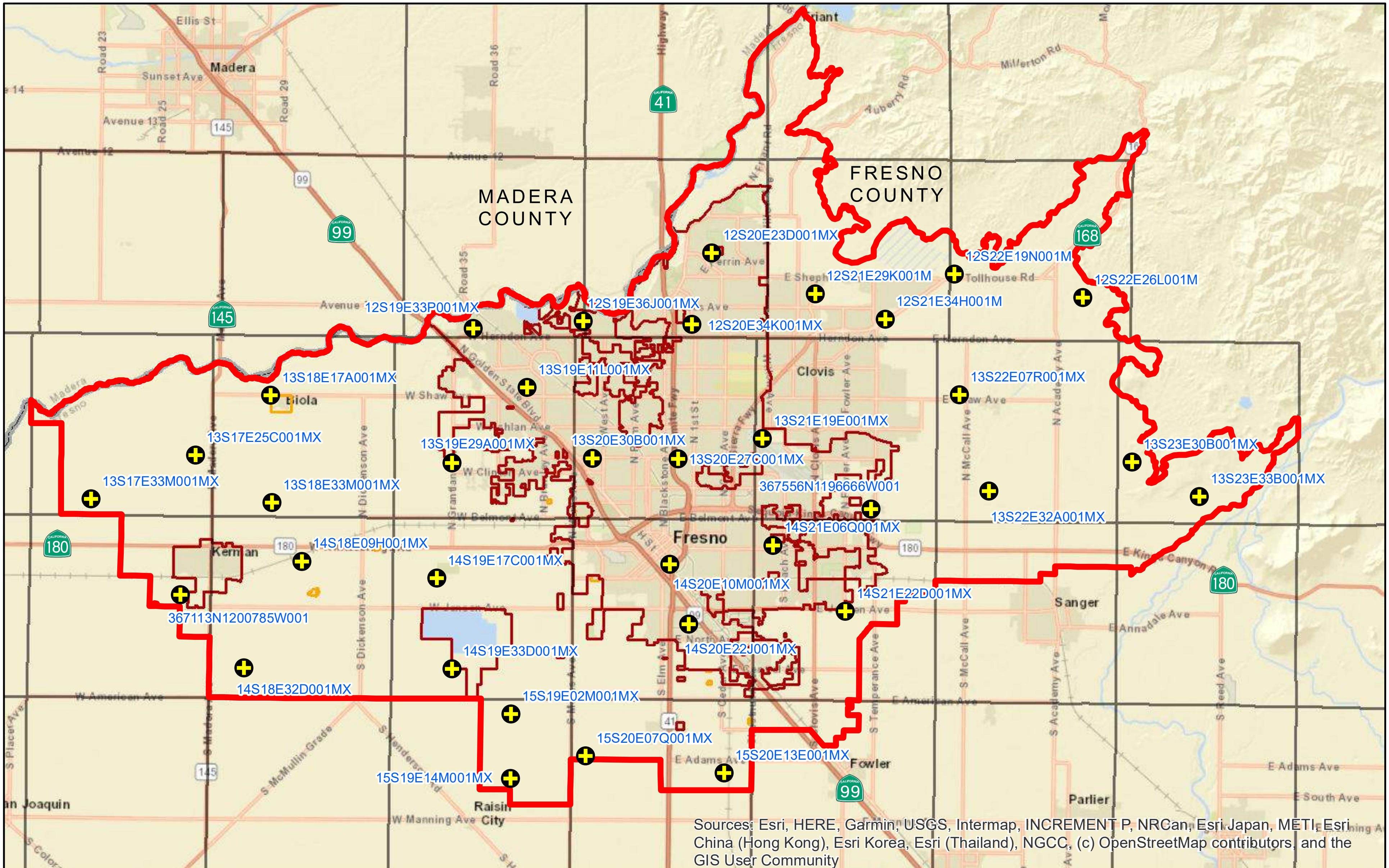
The quantitative values for minimum threshold, measurable objective, and interim milestones will be set for each well in the monitoring network. Refer to section 4.2.2.1 Criteria to Define Minimum Thresholds in the Sustainable Management Criteria chapter for the table with the criteria set for each well.

5.2.5 Monitoring Locations

Regulation Requirements**:**

§354.34(h) The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.

Figure 5-1 shows the groundwater level indicator wells for the Kings Basin. Seasonal monitoring will be compared to interim milestones, measurable objectives, and minimum thresholds established for these indicator wells. **Figure 5-2** shows the monitoring site locations for the NKGSA. Available well construction information for the indicator wells is included in **Table 5-1.** Monitoring is also performed in areas outside of the NKGSA to help document more accurate boundary conditions. Groundwater is monitored in wells outside the NKGSA boundary by agencies that have agreed to share data with NKGSA.



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- North Kings GSA
- County
- Well - Proposed Long Term Monitoring

Disadvantaged Community*

- DAC
- SDAC

**Classifications of disadvantaged communities are provided by Tulare-Kern IRWM*

North Kings GSA

Groundwater Level Monitor Wells

Figure 5-2

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Table 5-1 Representative Monitor Wells Construction Information

WELL ID	Local Well ID	Well Completion Report Available	Drilling Method	Casing Size (inches)	Well Diameter (inches)	Completed Depth (feet)	Casing Depth (feet)	Date Drilled	Open Bottom (OB) or Gravel Pack (GP)	Perforation Interval Depth (feet)	Sanitary Seal Depth (feet)
12S19E33P001MX	FC160	YES	Reverse Rotary	18	28	790	770	5/15/1992	GP	190-760	180
12S19E36J001MX	FC091	YES	Reverse Rotary	20	34	420	420	2/28/1977	GP	150-420	50
12S20E23D001MX	FC295	YES	Casing Hammer	16	16	305	221	5/26/1967	OB	150-164; 188-192	NONE
12S20E34K001MX	FC092	YES	Reverse Rotary	20	34	520	510	3/15/1978	GP	150-510	60
12S21E29K001M	FC29K1	--	--	--	--	--	--	--	--	--	--
12S21E34H001M	FC34H1	YES	--	--	--	--	--	--	--	--	--
12S22E19N001M	FC19N1	--	--	--	--	--	--	--	--	--	--
12S22E26L001M	FC26L1	--	--	--	--	--	--	--	--	--	--
13S17E25C001MX	FD25C1	YES	--	--	--	--	--	--	--	--	--
13S17E33M001MX	FD32H1	--	--	--	--	--	--	--	--	--	--
13S18E17A001MX	FD17A1	--	--	--	--	--	--	--	--	--	--
13S19E11L001MX	FC035	YES	Reverse Rotary	20	34	640	640	9/21/1980	GP	200-640	50
13S19E29A001MX	FD29A1	YES	--	--	--	--	--	--	--	--	--
13S20E27C001MX	FC069	YES	Reverse Rotary	18	30	455	455	4/1/2003	GP	170-455	140
13S20E30B001MX	FC074	YES	Rotary	20	34	410	410	5/5/1967	GP	160-410	60
13S21E19E001MX	FC080	YES	Rotary	20	34	500	428	9/23/1970	GP	265-428	80
13S22E07R001MX	FD07R1	--	--	--	--	--	--	--	--	--	--
13S22E32A001MX	FD32A1	YES	--	--	--	--	--	--	--	--	--
13S23E33B001MX	FD33B1	YES	--	--	--	--	--	--	--	--	--
14S18E32D001MX	FD32D1	--	--	--	--	--	--	--	--	--	--
14S19E17C001MX	FD17C1	--	--	--	--	--	--	--	--	--	--
14S19E33D001MX	FD33D1	--	--	--	--	--	--	--	--	--	--
14S20E10M001MX	FC003	YES	Reverse Rotary	18	30	530	530	7/19/1998	GP	210-520	180
14S20E22J001MX	FC040	YES	Rotary	15.5	34	450	450	10/29/1974	GP	150-450	50
14S21E06Q001MX	FC077	YES	Rotary	20	34	420	420	7/2/1970	GP	140-420	50
14S21E22D001MX	FD22D1	--	--	--	--	--	--	--	--	--	--
15S19E02M001MX	FD03J1	--	--	--	--	--	--	--	--	--	--
15S19E14M001MX	FD14M1	--	--	--	--	--	--	--	--	--	--
15S20E07Q001MX	FD07P1	--	--	--	--	--	--	--	--	--	--
15S20E13E001MX	FD13E2	--	--	--	--	--	--	--	--	--	--
367113N1200785W001	14S17E14J001M	--	--	--	--	--	--	--	--	--	--
367556N1196666W001	13S21E34J002M	YES	--	--	--	--	--	--	--	--	--
13S18E33M001MX	FD32J1	--	--	--	--	--	--	--	--	--	--
13S23E30B001MX	FD30B1	--	--	--	--	--	--	--	--	--	--
14S18E09H001MX	FD09H1	--	--	--	--	--	--	--	--	--	--

Notes:
-- = Information currently unkown
GP= Gravel pack well
OB= Open bottom

5.2.6 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, groundwater quality, and land subsidence monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites Best Management Practices* (DWR, December 2016b). The NKGSA 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; however, this is not practical for many measurement methods. In addition, this level of accuracy would have little value since groundwater contours maps typically have 10 or 20-foot intervals, and storage calculations are based on groundwater levels rounded to the nearest foot. The accuracy of groundwater level measurements will vary based on the well type and condition. For instance, if significant oil is found in an agricultural well, then readings to the nearest foot are the best one can achieve.
2. If used in a well suspected of contamination or if there are obvious signs of contamination (such as oil), well sounding equipment will be decontaminated after use.
3. Wells will be surveyed to a horizontal accuracy of 0.5 foot and the elevation of the Reference Point (RP) of each well will be surveyed to an accuracy of 0.1 foot.
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 NKGSA and a 4-week period will be granted for semi-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.

5.2.7 Representative Monitoring

Regulation Requirements**:**

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

5.2.7.1 Description of Representative Sites

Regulation Requirements**:**

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

DWR has referred to representative monitoring as utilizing one well to represent an entire GSA or Management Area. Use of one representative well in the NKGSA is not practical to cover such a large area with varying conditions. Not all wells within the NKGSA are monitored, so a subset of wells is used as representative of conditions in the NKGSA. Groundwater conditions can vary substantially across the NKGSA. The NKGSA area has a history of using multiple wells to monitor groundwater and will continue to use available water level and water quality data from multiple wells to assess groundwater conditions.

5.2.7.2 Use of Groundwater Elevations as Proxy for Other Sustainability Indicators

Regulation Requirements**:**

§354.36(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following: 1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy. 2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

The NKGSA does not plan to use groundwater elevations as a proxy for monitoring other sustainability indicators. As noted, groundwater elevations will be used as a critical component of groundwater storage estimation, but the elevation monitoring will not replace the storage change estimation.

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.

The NKGSA is not using one representative well for the NKGSA. See description above regarding monitoring well site selection.

5.2.8 Assessment and Improvement of Monitoring Network

5.2.8.1 Review and Evaluation of Monitoring Network

Regulation Requirements:

§354.38(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

This chapter includes a description of the different types of data gaps, a summary of existing data gaps in each monitoring network, and a future plan to fill the data gaps.

5.2.8.2 Identification of Data Gaps

Regulation Requirements:

§354.38(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency..

There are three general types of data gaps to consider for monitoring networks:

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 often poor, making it difficult or impossible to match wells with their well logs.

<u>Groundwater Levels</u>

Temporal Data Gaps: There are currently no temporal data gaps in the network. If some wells (i.e., private wells) are not accessible in both the spring and the fall, then there could be a temporal gap. However, the existing network currently has enough redundancy so that temporal gaps are not an issue.

Spatial Data Gaps: There are currently no spatial gaps in the network. **Figure 5-3** shows that monitoring well density far exceeds the minimum goal of 2 wells/Township in most of the NKGSA. The lowest monitoring well densities are found in the northern portion of the NKGSA toward Friant and the eastern portion of the NKGSA along Highway 168. However, these areas have shallow bedrock, thin alluvial deposits, and lower groundwater use.

Insufficient Quality of Data: Currently, most of the wells monitored in unincorporated areas are privately owned. Specific well construction information, including depth and perforated interval, are not known for many of the wells. While these wells do not provide ideal data points, they will continue to be used until well attribute data can be collected. Collecting well attribute information is especially important in the far western portion of the District (and areas west of the NKGSA) where there is a confined aquifer. The NKGSA has applied for grant funding to video log wells where construction information is currently unknown. Additionally, dedicated monitoring wells may be installed in the future which will have known construction information.

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.

Groundwater Levels

The groundwater-level network has a data quality gap, as well as missing construction information for many wells (confined, unconfined, and domestic), primarily in rural areas. The goal is to have at least 2 wells in each township with accurate well construction information. Separate monitoring systems may be needed for the confined and unconfined aquifers. Based on a review of the well driller's reports, well construction information will be needed for several of the wells in the network. 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 DWR; however, several challenges exist. First, landowners may not have the report or may not be willing to provide them. The NKGSA 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. A map of monitoring well density within the NKGSA is provided in **Figure 5-3**. 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 NKGSA will either collect information on these wells or identify other wells to be used instead of by or before 2025.

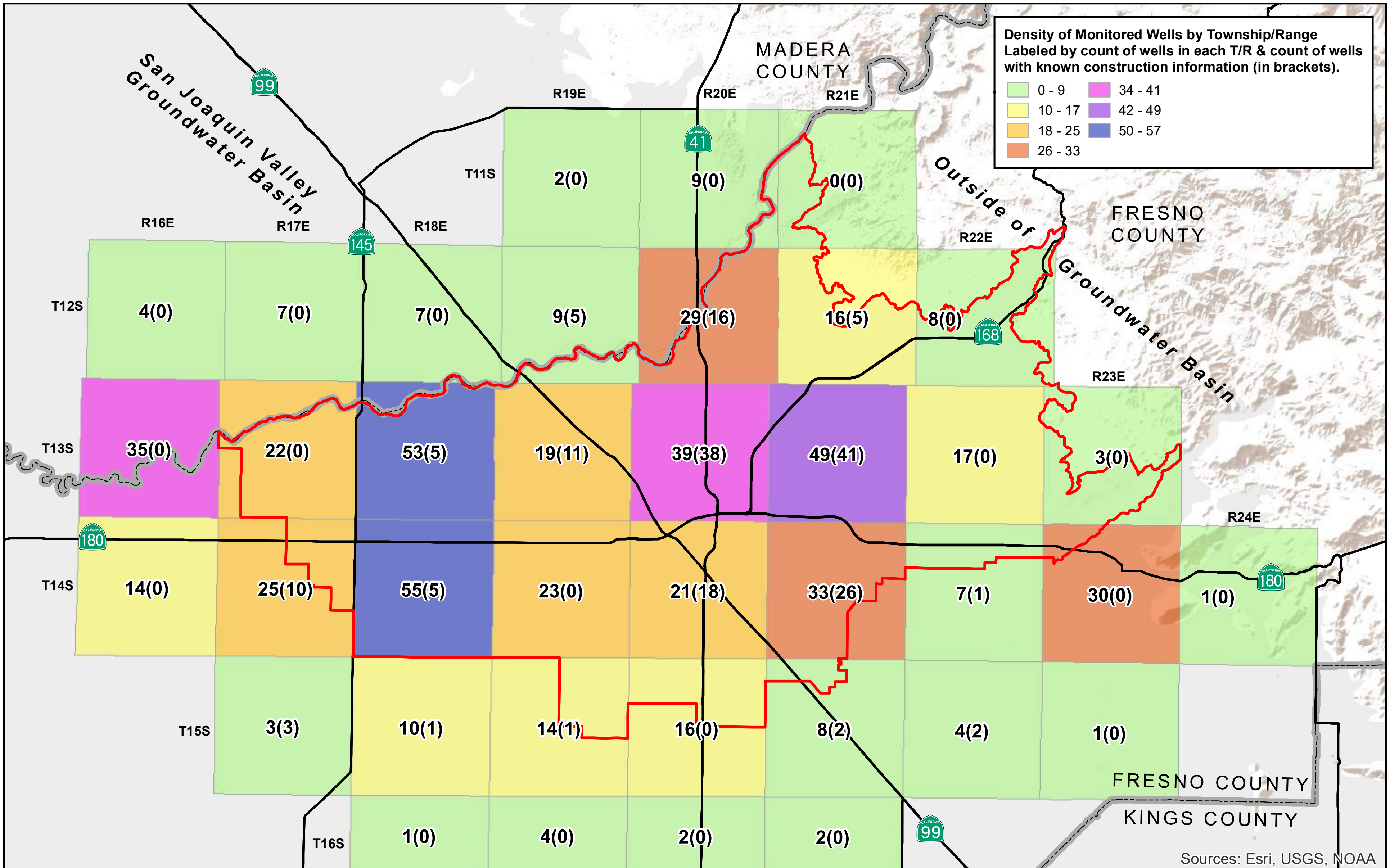
5.2.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements**:**

§354.38(e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:

1) Minimum threshold exceedances.
2) Highly variable spatial or temporal conditions
3) Adverse impacts to beneficial uses and users of groundwater.
4) The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.

The frequency and density of the proposed monitoring programs are discussed in previous sections. The criteria are considered adequate to provide sufficient monitoring data and to satisfy SGMA requirements. Beginning in 2020, when groundwater conditions are compared to sustainability goals, the monitoring network may be modified or enhanced if deemed necessary.



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Groundwater Basin

North Kings GSA

Monitoring Well Density By Township/Range

Figure 5-3

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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 measured groundwater levels.

The Fresno Area Regional Groundwater Management Group has estimated groundwater storage change in their annual reports since 2006. Prior to 2006, FID performed groundwater storage change estimates for many years. The general methodology used in those efforts will continue to be used by the NKGSA.

Groundwater storage change will be estimated by multiplying local specific yield values by the change in groundwater levels. As part of the Kings Basin Coordination effort and GSP development, specific yield values originally identify by FID were reviewed and refined through an extensive literature search and prioritization of several data sources (see map in Section 3.1.8.1 – Aquifer Characteristics and Properties). Specific yield values were estimated for each designated area, usually by 36 square mile Townships, for depths of 10-50 feet, 50-100 feet, and 100-200 feet below the ground surface. In some areas, specific yield data is limited to one value from 10-300 feet.

The process for calculating storage capacity includes the following steps:

1. Calculate average depth to groundwater for each specific yield area based on spring groundwater levels.
2. Multiply the height of water within each depth zone by the specific yield for that depth zone and by the area of that specific yield area within the Plan area.
3. Sum the total storage capacity for all areas.
4. Compare storage capacity from one year to the next.

A multi-year average will be evaluated and compared to long-term trends to understand the impact of the implementation of the Plan.

Please refer to the subsection on Aquifer Characteristics in Chapter 3: Hydrologic Conceptual Model for more information on specific yield values.

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

<u>Groundwater Storage</u>
Groundwater storage capacity has been calculated for many years using local groundwater levels and specific yield values. This methodology has proved adequate in estimating annual change in groundwater storage. The program has been enhanced with a more robust groundwater level network with an adequate density and refined specific yield values. Groundwater storage calculations are largely dependent on the groundwater level network. Collection of more well attribute information in the future 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.

<u>Groundwater Storage</u>
Groundwater storage change will be estimated annually, based on spring groundwater levels. Groundwater storage changes will generally be reported for each 36-square mile Township, which is based largely on the geographic availability of specific yield data (see **Figure 3-17** in Section 3.1-Hydrogeologic Conceptual Model). 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 rationale 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.

<u>Groundwater Storage</u>
Change in groundwater storage is based on a simple calculation involving the specific yield and change in groundwater levels. The groundwater level monitoring sites are discussed above. Specific yield values were acquired from several publications (see Section 3.1.8.1) and are based on textural analysis of numerous Well Completion Reports. The specific yield values generally cover 36-square mile Townships. 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 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 (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 well in the monitoring network. Refer to section 4.2.2.1 Criteria to Define Minimum Thresholds in the Sustainable Management Criteria chapter for the table with the criteria set for each well.

5.3.5 Monitoring Locations

Regulation Requirements**:**

§354.34(h) The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.

Figure 5-1 shows the groundwater level monitoring site locations for the Kings Basin. Groundwater Storage monitoring utilizes the groundwater level monitoring network.

Figure 5-2 shows the monitoring site locations for the NKGSA. Monitoring is also performed in areas outside of the NKGSA to help document more accurate boundary conditions. Groundwater is monitored in wells outside the NKGSA boundary by agencies that have agreed to share data with NKGSA.

Monitoring is also performed in areas outside of the NKGSA to help document more accurate boundary conditions. Groundwater is monitored in wells outside the NKGSA boundary by agencies that have agreed to share data with NKGSA.

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, groundwater quality, and land subsidence monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites Best Management Practices* (DWR, December 2016b). The NKGSA 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; however, this is not practical for many measurement methods. In addition, this level of accuracy would have little value since groundwater contours maps typically have 10 or 20-foot intervals, and storage calculations are based on groundwater levels rounded to the nearest foot. The accuracy of groundwater level measurements will vary based on the well type and condition. For instance, if significant oil is found in an agricultural well, then readings to the nearest foot are the best one can achieve.
2. If used in a well suspected of contamination or if there are obvious signs of contamination (such as oil), well sounding equipment will be decontaminated after use.
3. Wells will be surveyed to a horizontal accuracy of 0.5 foot, and the elevation of the Reference Point (RP) of each well will be surveyed within 0.1 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 NKGSA and a 4-week period will be granted for semi-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.

DWR has referred to representative monitoring as utilizing one well to represent an entire GSA or Management Area. Use of one representative well in the NKGSA is not practical to cover such a large area with varying conditions. Not all wells within the NKGSA are monitored, so a subset of wells is used as representative of conditions in the NKGSA. Groundwater conditions can vary substantially across the NKGSA. The NKGSA area has a history of using multiple wells to monitor groundwater and will continue to use available water level and water quality data from multiple wells to assess groundwater conditions.

5.3.7.2 Use of Groundwater Elevations as Proxy for other Sustainability Indicators

Regulation Requirements:

§354.36(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following: 1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy. 2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

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.

As discussed in Section 4.3, groundwater elevations are directly related to groundwater storage and will be used as a proxy for the groundwater storage sustainability indicator.

5.3.8 Assessment and Improvement of Monitoring Network

5.3.8.1 Review and Evaluation of Monitoring Network

Regulation Requirements:

§354.38(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

This section includes a description of the different types of data gaps, a summary of existing data gaps in each monitoring network, and a future plan 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 often poor, making it difficult or impossible to match wells with their well logs.

Groundwater storage change is dependent on groundwater level readings. Data gaps related to the groundwater level monitoring network are described in **Section 5.2**.

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 are no identified data gaps in the groundwater storage monitoring networks, other than groundwater levels which are discussed under the groundwater level monitoring program.

5.3.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

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

The frequency and density of the proposed monitoring programs are discussed in previous sections. The criteria are considered adequate to provide sufficient monitoring data and to satisfy SGMA requirements. Beginning in 2020, when groundwater conditions are compared to sustainability goals, the monitoring network may be modified or enhanced if deemed necessary.

5.4 Seawater Intrusion

Regulation Requirements:

§354.34(c)(3) Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.

The NKGSA is approximately 100 miles from the Pacific Ocean, and, therefore, seawater intrusion is not feasible. In addition, there are no saline water lakes in or near the NKGSA. As a result, seawater intrusion is not discussed hereafter in this chapter. Saline water intrusion from up-coning of deep saline groundwater is a potential problem and will be monitored as part of general water quality monitoring (see following section).

5.5 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 NKGSA is generally well suited for irrigation and domestic use, although groundwater issues for drinking water exist in localized areas within the NKGSA. While some of these chemical concerns are caused by humans, several are natural occurring. Groundwater pollution characterization and mitigation are typically enforced by local agencies and state level programs. The NKGSA will only have authority related to groundwater pumping policies. The NKGSA will review and analyze publicly available routine groundwater-monitoring data reported by the community and non-community public supply wells to: 1) understand how and if groundwater pumping is exacerbating groundwater quality concerns; and 2) understand where to enforce pumping restrictions or other mitigation measures should it become necessary. Contaminant plum migration concerns are discussed in **Sections 2.2.2 and 3.2.5**.

Groundwater quality concerns within the NKGSA have been identified in this GSP's Groundwater Conditions Chapter (**Section 3.2**). Groundwater monitoring and reporting by community water systems and non-community public supply wells is a requirement of California Code of Regulations (CCR) Title 22. Community and other public supply wells within the NKGSA monitoring network area already being routinely monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyors under Title 22. The publicly available groundwater quality data from selected representative wells will be obtained annually and evaluated against sustainable management criteria.

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

5.5.2 Adequacy of Monitoring Network

Regulation Requirements**:**

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.
§354.34(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

<u>Groundwater Quality</u>
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 NKGSA are already being routinely monitored for a wide range of contaminants, including the chemicals of concern, by the water purveyors under Title 22. Selected public supply wells will form the basis of the representative monitoring wells for groundwater quality. Locations were selected to be representative of large and small communities dependent on groundwater and to adequately spatially cover the NKGSA.

5.5.3 Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements**:**

§354.34(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors: 1) Amount of current and projected groundwater use. 2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow. 3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal. 4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

Groundwater Quality

The density of groundwater quality representative monitoring wells is approximately two wells per township wholly within the NKGSA. Locations were selected to be representative of large and small communities dependent on groundwater, and to spatially cover the adequately represent the NKGSA. This is an initial density, and the NKGSA will may maintain a denser network when necessary and practical.

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 density of groundwater-quality representative monitoring wells is approximately two per township wholly within the NKGSA. Locations were selected to be representative of large and small communities dependent on groundwater and to spatially cover the adequately represent the NKGSA. The scientific rationale for the existing water quality monitoring sites is based primarily on State monitoring requirements and specific monitoring programs established by regulatory agencies. These sites were particularly selected due to their accurate representation of groundwater quality throughout the NKGSA. The selected network will present ongoing data from public water supply wells and GAMA data to assist in providing ongoing assessment as to known constituent levels in the NKGSA and preventing new concerns. The NKGSA Board may further study, develop, or expand the monitoring well network for the NKGSA, if deemed necessary in the future.

The following scientific rationale will be used to add new wells, should it become necessary:

- Add wells whenever necessary to maintain minimum groundwater quality monitor well density (approximately 2 wells per township wholly within the NKGSA).
- Avoid wells perforated across multiple aquifers.
- Preferentially select public wells routinely monitored by water purveyors under Title 22.
- Select wells with available construction information (i.e., depth, perforated interval).

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 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 (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.)

5.5.4.3 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.

As previously described in the *Chapter 4 Sustainable Management Criteria* ***Section 4.4****,* wells within the existing monitoring network will be annually evaluated in accordance with values set in order to protect human health and intended for both the beneficial use and users of groundwater resources (i.e. CCR Title 22). In the case that there are known constituent levels in exceedance of MCL or State secondary maximum contaminant (SMCL) values (esthetics such as taste and odor) over recent historical recordings, the objective will be for the wells to maintain stable or improving groundwater quality trends. In the case that a constituent is known to be present within the NKGSA and appears to have no recent historical pattern or exceedances above the MCL or SMCL, the objective will be to maintain water quality standards below the MCL or SMCL threshold.

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.

A map of the proposed monitoring sites for water quality is included as **Figure 5-4**.

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.

The NKGSA will not be sampling wells at this time. Publicly available groundwater quality monitoring data collected by others will be reviewed and evaluated by the NKGSA. As such, groundwater quality monitoring protocols are not included in this GSP. The groundwater quality data will be analyzed as it becomes available. The NKGSA will coordinate with the Division of Drinking Water and the public water systems on any results that do not appear to be accurate to investigate possible causes for unexpected results.

As transient non-community wells within the representative groundwater quality monitoring network are only required to be analyzed for nitrates, the NKGSA will coordinate with the owners of the transient non-community wells to analyze groundwater samples for the remaining chemicals of concern every three years, consistent with the community public supply wells. Additionally, for chemical of concern uranium, monitoring is only triggered when gross alpha (GA) analysis is greater than 5.0 pCi/L. If gross alpha is always less than 5.0 pCi/L, there will be no uranium analytical results. It should be noted that the monitoring frequency for GA for wells in areas where uranium impacted groundwater has historically not been an issue can be up to nine years. As a result, limited uranium data will be available for most of the representative monitoring wells.

If for some reason a representative monitoring well is not available to be monitored, a well in the same general location and of similar construction will be used. The NKGSA will work with the agencies to establish backup locations. To help evaluate changes in concentration levels at representative monitoring wells, information such as pumping rates and water level data may be obtained from the well owners.

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:

Representative monitoring as it pertains to the NKGSA are described in **Section 5.5.7.1**.

5.5.7.1 Description of Representative Sites

Regulation Requirements**:**

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

DWR has referred to representative monitoring as utilizing one well to represent an entire GSA or Management Area. Use of one representative well in the NKGSA is not practical to cover such a large area with varying conditions. Not all wells within the NKGSA are monitored, so a subset of wells is used as representative of conditions in the NKGSA. Groundwater conditions can vary substantially across the NKGSA. The NKGSA area has a history of using multiple wells to monitor groundwater and will continue to use available water level and water quality data from multiple wells to assess groundwater conditions.

5.5.7.2 Use of Groundwater Elevations as Proxy for other Sustainability Indicators

Regulation Requirements**:**

§354.36(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following: 1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy. 2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

Water level is not being used as a proxy by the NKGSA.

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.

The NKGSA is not using a representative well for the NKGSA. A description of the selection method for wells is described previously.

5.5.8 Assessment and Improvement of Monitoring Network

5.5.8.1 Review and Evaluation of Monitoring Network

Regulation Requirements:

§354.38(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

This chapter includes a description of the different types of data gaps, a summary of existing data gaps in each monitoring network, and a future plan to fill the data gaps.

5.5.8.2 Identification of Data Gaps

Regulation Requirements:

> §354.38(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.
> .

There are three general types of data gaps 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 often poor, making it difficult or impossible to match wells with their well logs.

<u>Groundwater Quality</u>
As discussed in Section 5.1.4, the Groundwater Quality Monitoring Network is considered adequate and has no data gaps. The existing network provides sufficient monitoring in areas of urban and rural domestic use groundwater and agricultural areas.

5.5.8.3 Plans to Fill Data Gaps

Regulation Requirements**:**

> §354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:
> 1) The location and reason for data gaps in the monitoring network.
> 2) Local issues and circumstances that limit or prevent monitoring .
> §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.

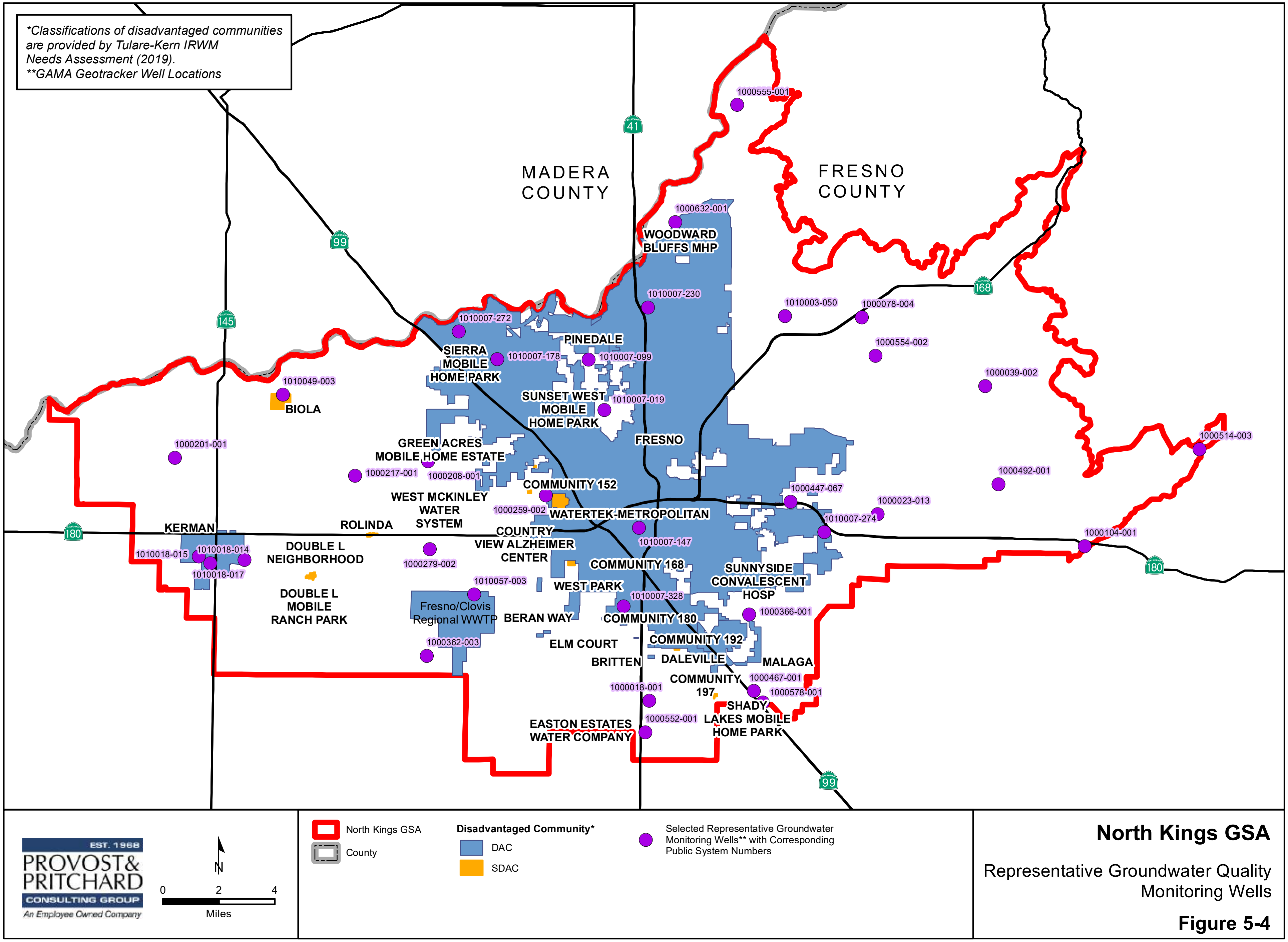
There are no identified data gaps in the groundwater quality monitoring network.

5.5.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements**:**

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

The frequency and density of the proposed monitoring programs are discussed in previous sections. The criteria are considered adequate to provide sufficient monitoring data and to satisfy SGMA requirements. Beginning in 2020, when groundwater conditions are compared to sustainability goals, the monitoring network may be modified or enhanced if deemed necessary.



*Classifications of disadvantaged communities are provided by Tulare-Kern IRWM Needs Assessment (2019).
**GAMA Geotracker Well Locations
MADERA COUNTY
FRESNO COUNTY
41
99
145
168
180
1000555-001
1000632-001
WOODWARD BLUFFS MHP
1010007-230
1010003-050
1000078-004
1000554-002
1000039-002
1010007-272
PINEDALE
SIERRA MOBILE HOME PARK
1010007-178
1010007-099
1010049-003
BIOLA
SUNSET WEST MOBILE HOME PARK
1010007-019
FRESNO
1000514-003
1000201-001
GREEN ACRES MOBILE HOME ESTATE
1000217-001
1000208-001
COMMUNITY 152
1000492-001
1000447-067
1000023-013
WEST MCKINLEY WATER SYSTEM
1000259-002
WATERTEK-METROPOLITAN
1010007-274
KERMAN
ROLINDA
COUNTRY VIEW ALZHEIMER CENTER
1000104-001
1010018-015
1010018-014
1010018-017
DOUBLE L NEIGHBORHOOD
1000279-002
1010007-147
COMMUNITY 168
SUNNYSIDE CONVALESCENT HOSP
1010057-003
WEST PARK
DOUBLE L MOBILE RANCH PARK
Fresno/Clovis Regional WWTP
BERAN WAY
1010007-328
COMMUNITY 180
1000366-001
1000362-003
ELM COURT
COMMUNITY 192
BRITTEN
DALEVILLE
MALAGA
COMMUNITY 197
1000467-001
1000578-001
1000018-001
SHADY LAKES MOBILE HOME PARK
1000552-001
EASTON ESTATES WATER COMPANY
North Kings GSA
County
Disadvantaged Community*
DAC
SDAC
Selected Representative Groundwater Monitoring Wells** with Corresponding Public System Numbers
EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company
N
0
2
4
Miles
North Kings GSA
Representative Groundwater Quality Monitoring Wells
Figure 5-4

5.6 Land Subsidence

5.6.1 Description of Monitoring Network

Regulation Requirements:

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

Land subsidence within the NKGSA is minimal. Most of the subsidence in the San Joaquin Valley has happened and is happening west of the NKGSA over the axial trough of the valley, although minor subsidence has been documented in the extreme western portion of the NKGSA. Most significant subsidence is underlain by the Corcoran Clay member of the Tulare Formation. As shown on **Figure 3-38**, the Corcoran Clay only extends into the western portion of the NKGSA by a few miles.

While some local agencies in the San Joaquin Valley monitor for land subsidence, the majority rely on monitoring performed by regional water agencies or the State and Federal government. Measurement and monitoring for land subsidence are performed by a variety of agencies including USGS, DWR, USBR, USACE, University NAVSTAR (Navigation Satellite Timing and Ranging) Consortium (UNAVCO), and various private contractors. Interagency efforts between the USGS, USBR, the U.S. Coast and Geodetic Survey (now the National Geodetic Survey) and DWR resulted in an intensive series of investigations that identified and characterized subsidence in the San Joaquin Valley. NASA also measures subsidence in the Central Valley and has maps on its websites that show the subsidence for a defined period. These programs are described in more detail later in this section.

As discussed in Section 3.2.6 – Land Subsidence Conditions, the clay mineralogy outside of the Corcoran Clay area is not conducive for land subsidence, which may explain why subsidence has not been observed in most of the NKGSA even as groundwater levels approached historical lows in 2015.

A summary of subsidence monitoring technologies and local/regional subsidence monitoring programs is provided below. From these, the monitoring network will utilize data collected by KRCD and use the NASA InSAR data to verify the areas of subsidence. KRCD has an approximately 7-mile grid that monitors new and existing benchmarks for land subsidence. **Figure 4-7** shows the locations of the benchmarks in their monitoring system. NASA obtains subsidence data by comparing satellite images of Earth's surface over time. For the last few years, InSAR observations from satellite and aircrafts have been used to produce the subsidence maps. More information can be found on their website: https://www.nasa.gov/jpl/nasa-california-drought-causing-valley-land-to-sink

KRCD and NASA subsidence maps are provided in Section 3.2.6 – Land Subsidence Conditions and show the land subsidence for the NKGSA area. Following is background information on subsidence monitoring technologies and local/regional monitoring programs.

Subsidence Monitoring Methods and Technology

Several methods are available for measuring subsidence and are discussed below.

Surveying. In the past, subsidence measurement relied upon conventional land 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.

Extensometers. An extensometer is an instrument for measuring the deformation of materials. For measuring land subsidence, they are placed inside a borehole. In the 1950s and 1960s, the USGS, DWR and USBR installed several borehole extensometers which allow for continuous measurement of subsidence. Extensometers are costly to install and require frequent maintenance and calibration. There are presently no known extensometers within the NKGSA area. The closest known extensometers are near Mendota and along the California Aqueduct southwest of Five Points. Extensometers have a relative accuracy of approximately 1/100th of a foot.

Continuous Global Positioning System. Subsidence can also 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.

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. InSAR has a relative accuracy of approximately +/- fractions of an inch.

LiDAR. DWR and USBR utilize LiDAR coupled with land elevation surveys to monitor subsidence. LiDAR utilizes a laser device that is flown from an airplane.

Subsidence Monitoring Programs

Continuous Global Positioning System Stations. Three CGPS Stations are located in the vicinity of NKGSA area. The CGPS stations provide daily horizontal and vertical data at these locations, with records starting as early as 2004. The CGPS stations also show subsidence or lack thereof at locations near the NKGSA area. 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. CGPS are located in Mendota, Madera, and Coarsegold with no stations located within the NKGSA Boundary. Information on CGPS stations can be found at the following website: http://pbo.unavco.org/network/soh_map

DWR Monitoring Network. DWR, along with other agencies, has monitored land subsidence in California for decades. DWR has been working with NASA to acquire and process InSAR data to measure land subsidence in portions of the Central Valley and other locations in California since 2007.

Kings River Conservation District. KRCD has a 7-mile grid that monitors new and existing benchmarks for land subsidence. Sixteen benchmarks are monitored for subsidence in the NKGSA area.

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. 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 publish maps of the results in December and July as part of the San Joaquin River Restoration Program (SJRRP). The subsidence areas shown in these maps cover the majority of the NKGSA area. 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. This subsidence monitoring network in the San Joaquin Valley was installed in the 1950s and consisted of 31 extensometers to quantify the subsidence occurring in the Valley. By the 1980's, 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, continuous Global Positioning System (CGPS) stations, and Interferometric Synthetic Aperture Radar (InSAR). More information can be found on their website: https://ca.water.usgs.gov/land_subsidence/

5.6.2 Adequacy of Monitoring Network

Regulation Requirements**:**

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.
§354.34(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

Land Subsidence

Land subsidence will be primarily monitored with KRCD's land subsidence surveying program. The monitoring network includes benchmark surveying at least every 7 miles with records dating back to 2010. This is considered adequate, especially since there is minimal subsidence in the NKGSA. An expanded network may be considered if subsidence becomes problematic in the future. The NKGSA will also track land subsidence points just outside of the NKGSA area to see if it is encroaching into the area. NASA INSAR remote sensing data will be used to verify any observed subsidence and fill in gaps between the surveyed benchmarks.

5.6.3 Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements**:**

§354.34(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors: 1) Amount of current and projected groundwater use. 2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow. 3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal. 4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

Land Subsidence
The subsidence monitoring network has adequate density to determine land subsidence in the NKGSA area. Within the NKGSA, the KRCD land subsidence monitoring program has 16 sites for 487 square miles or around 1 site per 32 square miles. INSAR data will also be used to monitor land subsidence in the NKGSA area. INSAR provides complete coverage of the NKGSA area and may be used to fill in the gaps in the KRCD monitoring network.

5.6.4 Monitoring Network Information

The following sections describe the monitoring network, including scientific rationale for the selection; consistency with data and reporting standards; corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone; and the locations of the monitoring sites.

5.6.4.1 Scientific 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.

Land Subsidence
The KRCD land subsidence monitoring program data was established using National Geodetic Survey (NGS) control points. KRCD chose these points due to the details, history, and stability rankings of the monuments. The control points were the foundation for monitoring subsidence. From the control points, KRCD decided to use a 7-mile grid to monitor subsidence in the Kings basin. This is considered the best method to monitor subsidence since it involves direct measurements, as opposed to remote sensing which relies on indirect or inferred measurements.

If additional monitoring locations are added, the following scientific rationale will be used:

- Add sites to areas of higher subsidence in the NKGSA area.
- Add sites that can be easily surveyed and tied back to a nearby monument.
- Add sites where the ground surface is unlikely to be modified by future construction and will remain undisturbed.
- Add sites in areas where the geology and soil types present the greatest potential for subsidence.

5.6.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

§354.34(g) 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 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 (e.g., elevations shall be reported in feet relative to established datum)
- Monitoring site information (e.g., Site identification number, description of site location, etc.)
- Map standards (e.g., Data layers, shapefiles, geodatabases shall be submitted in accordance with the procedures described in Article 4, etc.)

5.6.4.3 Quantitative Values

Regulation Requirements:

§354.34(g)(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.

The quantitative values for minimum threshold, measurable objective, and interim milestones will be set for the NKGSA. Refer to section 4.5.3.4 Path to Achieve Measurable Objectives in the Sustainable Management Criteria chapter for the table with the criteria set for the NKGSA.

5.6.5 Monitoring Locations

Regulation Requirements:

§354.34(h) The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.

Figure 4-7 shows land subsidence monitoring locations for the NKGSA. Monitoring is also performed in areas outside of the NKGSA to help document more accurate boundary conditions. Land subsidence is also monitored up to five miles outside of the border to track possible encroachment of subsidence into the NKGSA.

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.

Groundwater level and land subsidence monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites Best Management Practices* (DWR, December 2016b). Land subsidence is monitored by the various agencies using established methodologies and technologies as listed above in section 5.6.1. Therefore, the NKGSA will not be actively engaged in monitoring for subsidence but will rather collect and evaluate land subsidence data from the existing agency programs. The NKGSA may develop standard monitoring forms or include additional data categories pertinent to land subsidence data collection in the future if deemed necessary.

5.6.7 Representative Monitoring

Regulation Requirements**:**

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

5.6.7.1 Description of Representative Sites

Regulation Requirements**:**

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

DWR has referred to representative monitoring as utilizing one well to represent an entire GSA or Management Area. Use of one representative well in the NKGSA is not practical to cover such a large area with varying conditions. Not all wells within the NKGSA are monitored, so a subset of wells is used as representative of conditions in the NKGSA. Groundwater conditions can vary substantially across the NKGSA. The NKGSA area has a history of using multiple wells to monitor groundwater and will continue to use available water level and water quality data from multiple wells to assess groundwater conditions.

5.6.7.2 Use of Groundwater Elevations as Proxy for other Sustainability Indicators

Regulation Requirements**:**

> §354.36(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:
> 1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.
> 2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

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.

Due to a lack of clear correlation, groundwater elevations will not be used as a proxy for monitoring land subsidence.

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 a future plan to fill the data gaps.

5.6.8.2 Identification of Data Gaps

Regulation Requirements:

> §354.38(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.
> .

There are three general types of data gaps 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 often poor, making it difficult or impossible to match wells with their well logs.

Land Subsidence

No data gaps were identified in the subsidence monitoring network.

5.6.8.3 Plans to Fill Data Gaps

Regulation Requirements:

> §354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:
> 1) The location and reason for data gaps in the monitoring network.
> 2) Local issues and circumstances that limit or prevent monitoring .
>
> §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 are no identified data gaps in the land subsidence monitoring network.

5.6.8.4 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

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

The frequency and density of the proposed monitoring programs are discussed in previous sections. The criteria are considered adequate to provide sufficient monitoring data and to satisfy SGMA requirements. Beginning in 2020, when groundwater conditions are compared to sustainability goals, the monitoring network may be modified or enhanced if deemed necessary.

5.7 Depletion of Interconnected Surface Water

5.7.1 Description of Monitoring Network

Regulation Requirements:

> **§354.34(c)(6)** Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:
> A. Flow conditions including surface water discharge, surface water head, and baseflow contribution.
> B. Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.
> C. Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.
> D. Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.

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.

Interconnected surface water has been defined in the California Code of Regulations Title 23, Division 2, Chapter 1.5, Subchapter 2 as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. Within the NKGSA, interconnected surface water is a potential concern in the areas adjacent to the Kings River. Regional reports (USGS 2009 and USGS 1985) appear to show that surface water is not interconnected along the San Joaquin River in the NKGSA. Existing river management programs maintain minimum flows in both rivers year-round in the NKGSA, so depletion of interconnected surface waters, if present, is not likely to occur in the Kings River or San Joaquin River. Additional discussion on the status of interconnected surface water is discussed in **Section 3.2** (Current and Historical Groundwater Conditions) and **Section 4.6** (Sustainable Management Criteria - Interconnected Surface Water and Groundwater).

Regardless of the determined interconnected status of the Kings River and the San Joaquin River, the significance of the San Joaquin River and the Kings River to riparian water rights holders and other stakeholders is understood. The rivers, and nearby groundwater levels, will continue to be monitored so the status of any interconnection is better understood. The NKGSA has established a groundwater level monitoring network (**Figure 5-1)** with monitoring points near both the San Joaquin River and the Kings River. NKGSA will continue to review data from San Joaquin River Restoration Program near-river groundwater monitoring wells (**Figure 5-2**) and publicly available flow data for both rivers.

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.

<u>Depletion of Interconnected Surface Water</u>

As discussed above in this Section, under Groundwater Levels, the NKGSA has established a groundwater level monitoring network with an adequate density throughout the NKGSA, including near the rivers, and will be collecting data on the depth and perforated interval of wells where it is unknown, as is required according to SGMA guidelines. Additionally, the NKGSA will continue to review data from San Joaquin River Restoration Program near-river groundwater monitoring wells as it becomes available.

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.

Depletion of Interconnected Surface Water

Groundwater level data adjacent to rivers can help to show whether the surface and groundwater are hydraulically connected, and whether the flow between the two is increasing or decreasing. As discussed above in this Section, under Groundwater Levels, the NKGSA has established a groundwater level monitoring network with an adequate density throughout the NKGSA, including near the rivers, and will be collecting data on the depth and perforated interval of wells where it is unknown, as is required according to SGMA guidelines. The groundwater levels in these wells will be monitored in the spring (March) and fall (October) of each year. Additionally, the NKGSA will continue to review data from San Joaquin River Restoration Program near-river groundwater monitoring wells as it becomes available. The San Joaquin River Restoration Program near-river groundwater monitoring wells have historically been sampled multiple times per year.

5.7.4 Monitoring Network Information

Regulation Requirements:

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

5.7.4.1 Scientific Rationale for Site Selection

Regulation Requirements:

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

Depletion of Interconnected Surface Water

Interconnected surface water is a potential concern in the areas adjacent to the Kings River. Surface water is not interconnected along the San Joaquin River in the NKGSA. River management programs maintain minimum flows in the rivers year-round in the NKGSA so depletion of interconnected surface waters, if present, is not likely to occur in the Kings River or San Joaquin River. Regardless of the determined interconnected status of these Rivers, the significance of the San Joaquin River and the Kings River to riparian water rights holders and other stakeholders is understood. The NKGSA has established a groundwater level monitoring network discussed in this Section with monitoring points near both the San Joaquin River and the Kings River. Additionally, the NKGSA will continue to review data from San Joaquin River Restoration Program near-river groundwater monitoring wells.

The scientific rationale discussed above in this Section for Groundwater Levels will be used to add new wells, should it become necessary.

5.7.4.2 Consistency with Data and Reporting Standards

Regulation Requirements:

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

The data gathered through the monitoring networks is consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans. The main topics of Section 352.4 are outlined below, and the full section is included as **Appendix 5-A.**

- 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.)
- Groundwater and surface water models (e.g., the model shall include publicly available supporting documentation, etc.)

5.7.4.3 Quantitative Values

Regulation Requirements:

§354.34(g)(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.

These USBR monitoring wells and the groundwater elevation data that is collected on an annual basis as discussed in, *Chapter 3 Basin Settings 3.2.7* and *Chapter 4 Sustainable Management Criteria* of the GSP will continue to be reviewed and evaluated by the NKGSA. The NKGSA has established a groundwater level monitoring network (**Figure 5-1)** with monitoring points near both the San Joaquin River and the Kings River. The rivers, and nearby groundwater levels, will continue to be monitored so the status of any interconnection is better understood.

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.

The NKGSA has established a groundwater level monitoring network (**Figure 5-1)** with monitoring points near both the San Joaquin River and the Kings River. NKGSA will continue to review data from San Joaquin River Restoration Program near-river groundwater monitoring wells (**Figure 5-2**) and publicly available flow data for both rivers.

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, groundwater quality, and land subsidence monitoring will generally follow the protocols identified in the *Monitoring Protocols, Standards, and Sites Best Management Practices* (DWR, December 2016b). The NKGSA 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; however, this is not practical for many measurement methods. In addition, this level of accuracy would have little value since groundwater contours maps typically have 10 or 20-foot intervals, and storage calculations are based on groundwater levels rounded to the nearest foot. The accuracy of groundwater level measurements will vary based on the well type and condition. For instance, if significant oil is found in an agricultural well, then readings to the nearest foot are the best one can achieve.
2. If used in a well suspected of contamination or if there are obvious signs of contamination (such as oil), well sounding equipment will be decontaminated after use.
3. Wells will be surveyed to a horizontal accuracy of 0.5 foot.
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 NKGSA and a 4-week period will be granted for semi-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.
8. For water quality monitoring, field parameters for pH, electrical conductivity, and temperature will be collected only when required for the particular parameter being monitored. Determining if a well has been purged adequately may be ascertained by calculating a run time before sampling.

5.7.7 Representative Monitoring

Regulation Requirements:

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

5.7.7.1 Description of Representative Sites

Regulation Requirements:

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

DWR has referred to representative monitoring as utilizing one well to represent an entire GSA or Management Area. Use of one representative well in the NKGSA is not practical to cover such a large area with varying conditions. Not all wells within the NKGSA are monitored, so a subset of wells is used as representative of conditions in the NKGSA. Groundwater conditions can vary substantially across the NKGSA. The NKGSA area has a history of using multiple wells to monitor groundwater and will continue to use available water level and water quality data from multiple wells to assess groundwater conditions.

5.7.7.2 Use of Groundwater Elevations as Proxy for Other Sustainability Indicators

Regulation Requirements:

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

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

NKGSA does not plan to use groundwater elevations as a proxy for monitoring other sustainability indicators. As noted, groundwater elevations will be used as a critical component of groundwater storage estimation, but the elevation monitoring will not replace the storage change estimation.

5.7.8 Assessment and Improvement of Monitoring Network

5.7.8.1 Review and evaluation of monitoring network

Regulation Requirements:

§354.38(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

This chapter includes a description of the different types of data gaps, a summary of existing data gaps in each monitoring network, and a future plan to fill the data gaps.

5.7.8.2 Identification of data gaps

Regulation Requirements:

§354.38(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.

There are three general types of data gaps to consider for monitoring networks:

4. **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.
5. **Spatial**: Insufficient number or density of monitoring sites in a specific area.
6. **Insufficient quality of data**: Data may be available but be of poor or questionable accuracy. Poor data may at times be worse than no data since it could lead to incorrect assumptions or biases. The data may not appear consistent with other data in the area or with past readings at the monitoring site. The monitoring site may not meet all the desired criteria to provide reliable data, such as having information on perforation depth, etc. Past experiences have shown that well location information on Well Construction Reports is often poor, making it difficult or impossible to match wells with their well logs.

Depletion of Interconnected Surface Water

the NKGSA has established a groundwater level monitoring network with an adequate density throughout the NKGSA, including near the rivers. Additionally, the NKGSA will continue to review data from San Joaquin River Restoration Program near-river groundwater monitoring wells as it becomes available. The data gap discussions presented under Groundwater Levels also applies to Depletion of Interconnected Surface Water.

5.7.8.3 Plans to fill data gaps

Regulation Requirements:

§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:

1) The location and reason for data gaps in the monitoring network.
2) Local issues and circumstances that limit or prevent monitoring.

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

There are no identified data gaps in the depletion of interconnected surface water monitoring network.

5.7.9 Adjustment to Density of Monitoring Sites and Frequency of Measurements

Regulation Requirements:

§354.38(e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:

1) Minimum threshold exceedances.
2) Highly variable spatial or temporal conditions.
3) Adverse impacts to beneficial uses and users of groundwater.
4) The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.

The frequency and density of the proposed monitoring programs are discussed in previous sections. The criteria are considered adequate to provide sufficient monitoring data and to satisfy SGMA requirements. Beginning in 2020, when groundwater conditions are compared to sustainability goals, the monitoring network may be modified or enhanced if deemed necessary.

5.8 Reporting Monitoring Data to the Department

Regulation Requirements:

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

Monitoring programs are coordinated within the Kings Subbasin. Well location, construction, and level data are shared amongst the different GSAs. In addition, the monitoring programs described in this 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 Sections 7.4 and Section 7.5.

6 Projects and Management Actions to Achieve Sustainability

Regulation 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 Introduction

The NKGSA member agencies and entities have agreed to have each groundwater pumping entity mitigate for the estimated net impact of their pumping. As discussed in the water budget section, groundwater pumping outside one of the municipal systems but within the boundary of FID, International Water District or Garfield Water District will be the responsibility of FID, International Water District or Garfield to ensure sustainability. Groundwater pumping outside of all other agencies will be the responsibility of the County of Fresno to mitigate. The agencies within the NKGSA have chosen this responsibility method in order to provide an equitable method of mitigation that is based on impact of actions by each agency, and to allow each agency to control its own methods of mitigation and implementation. The NKGSA will provide the ongoing monitoring of impacts by agency, and oversee each agency to ensure mitigation requirements are met. The NKGSA will also be an active participant and reviewer of proposed project impacts through the project development and CEQA process.

The NKGSA is developing an initial policy for estimating groundwater impact caused by pumping. . The groundwater impact will be based on a combination of native safe yield from precipitation and river/stream seepage, groundwater pumping and groundwater recharge. This estimate will continue to be evaluated and may be modified as more information is collected. Each agency is responsible for identifying projects and programs to mitigate for their estimated impact. The agencies have a variety of tools that can be used to achieve sustainable groundwater management that fall into two primary categories: 1) Project development for water supply augmentation; and 2) management actions for demand reduction. As municipal systems expand their service area, the new areas will be added to the responsibility of these agencies.

The first priority of each agency is to develop projects that augment the water supply through the use of surface water to meet demands, or provide groundwater recharge within the area of extraction. If project development is not able to achieve the interim sustainability milestones or if minimum thresholds are exceeded, then management actions or programs will be needed. The agency's projects described herein primarily focus on using available surface water supplies within the NKGSA to reduce the impacts of groundwater pumping. Alternatively, management actions have been identified that primarily focus on reducing water demand, along with increased data collection and associated actions including education and outreach, regulatory policies, incentive-based programs, and enforcement actions.

6.2 Projects

Each agency within the NKGSA has identified projects to meet the initial estimate of impact on groundwater.

Each agency developed and submitted a project information form to the NKGSA for review and incorporation into the GSP. Each project was reviewed by a subgroup of the Technical Subcommittee for consistency and justification. The current projects are summarized in **Table 6-1**, sorted by milestone year implementation.

The table includes a listing of each of the required elements for a project under the regulations. A more detailed description of each project is included in the Project Information Forms, included in **Appendix 6-A**.

The projects are in various stages of development, ranging from conceptual level to projects that are ready for construction. Thus, a different level of investigation has been completed for each project, ranging from preliminary conceptual projects with limited information, to projects with a feasibility level design completed, to projects that are "shovel ready", which is defined as having complete environmental documentation and complete design plans and specifications. Projects discussed in this Plan will remain a part of the potential projects that the NKGSA's agencies may choose to implement; however, as additional information is gathered other projects may be identified and considered in the future that have a higher yield or lower cost than the currently envisioned projects. This list will continue to be updated and modified by each of the agencies and the updates provided to the NKGSA on an annual basis. All management actions will be supported by the best available information and the best available science.

The projects currently considered would yield an estimated average annual volume of approximately 200,000 AF/year if fully implemented as envisioned. However, it is important to note that a significant amount of the project yield identified in the project list will utilize surface water previously delivered to growers, now delivered to City of Fresno (through a cooperative agreement between the City and FID) that has historically had limited surface water use capability.

Table 6-1 NKGSA Currently Identified Projects

			354.44(a)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(4)	354.44(b)(4)	354.44(b)(4)	354.44(b)(8)
#	**Agency to Implement**	**Project or Management Action Title**	**Description**	**Description of how benefit was determined**	**Quantified Project Benefit**	**Project Benefit Units**	**Start Date**	**Completion Date**	**Completion by Milestone Year**	**Cost Estimate**
10	City of Fresno	Residential Water Meter Retrofit Project	In 2004, California passed State Assembly Bill 514, which requires "urban water suppliers" who receive water from the federal CVP through existing USBR water service contracts, install water meters on all residential service connections on or before January 1, 2013. The City maintains a contract for 60,000 acre feet of surface water every year from the CVP through the USBR. To comply with this bill and to take acts to reduce water consumption all residential services will be equipped with meters.	Residential meter installation contracts commenced in 2010 and run through the end of 2012. Per capita water consumption from 2007 through 2011 averaged 277 gpcd. Per capita consumption after meters were installed, excluding the drought period of 2012-2016, averages 201 gpcd (2017 & 2018). The population at the end of 2011 was 513,358. Applying the per capita water consumption values from before and after meter installation yields a 43,600 AF reduction for the base 2011 population.	43,600	AF/yr	2010	2012	2015	$ 76,829,600
11	City of Fresno	T-3 Surface Water Treatment Facility	This project is for the construction of a 3 million gallon water storage tank and 4-MDG surface water treatment facility (with possible future expansion to 8-MGD). The project will include, engineering & design, construction of tank, booster pumps, operations and treatment buildings, and associated site improvements. As development continues in the southeast region of Fresno, the need for supplemental water system infrastructure and production is required to meet peak summertime demands. The project goal is to utilize surface water supplies to meet these new demands rather than groundwater.	Production yield is based on the treatment plant running 180-days per year at a rate of 4-MGD. Actual production may vary depending on supply availability and other factors.	2,210	AF/yr	2011	2013	2015	$ 21,819,800
9	City of Fresno	Southwest Reclamation Facility and Distribution System	As part of the City's long-term goal to utilize resources sustainably the development of a recycled water program will be key. This project includes the design and construction of an initial 5-MGD tertiary treatment facility and transmission and distribution system. The reclaimed water produced and distributed in the southwest region will provide a direct potable water offset, thus reducing the reliance on and use of groundwater supplies.	Production yield is based on the tertiary treatment facility operating 335-days per year at a rate of 5-MGD.	5,140	AF/yr	2014	2019	2020	$ 114,600,000

			354.44(a)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(4)	354.44(b)(4)	354.44(b)(4)	354.44(b)(8)
#	**Agency to Implement**	**Project or Management Action Title**	**Description**	**Description of how benefit was determined**	**Quantified Project Benefit**	**Project Benefit Units**	**Start Date**	**Completion Date**	**Completion by Milestone Year**	**Cost Estimate**
12	City of Fresno	Nielsen Recharge Facility	This project is to expand the City's groundwater recharge program and includes land acquisition, development of new recharge basins, structures and conveyance systems such as pipelines, canal turnouts, metering systems, and interties. The project goal is to optimize groundwater recharge efforts so as to balance groundwater extractions as laid out in the City's 2014 Metropolitan Water Resources Plan.	The provided value is the measured flow that was delivered to the facility last year for groundwater recharge purposes.	3,500	AF/yr	2015	2016	2020	$ 3,657,000
13	City of Fresno	Southeast Surface Water Treatment Facility	Design, construction, start-up, and commissioning of the new Southeast Surface Water Treatment Facility (SESWTF) and associated large diameter transmission mains. New facility is required to treat surface water diverted from the Kings River through canal and raw water pipeline system. Historically, the City has largely relied on groundwater to meet municipal water demands. The SESWTF will utilize surface water supplies and permit the balanced use of both groundwater and surface water, thus greatly reducing groundwater extractions.	Production yield is based on the plant running 335-days per year at a rate of 80-MGD. Actual production may vary depending on supply availability and other factors.	82,240	AF/yr	2014	2019	2020	$ 314,600,000
1	Bakman	Water Meter Project	Bakman Water Company is installing water meters on all of its approximately 2,450 service connections in its service area. The project will provide an estimated 20% reduction in usage which is approximately 870 acre-feet per year of benefit. Bakman has initiated meter installation, however is including in the GSP because the benefits of the project are just starting to be observed.	The estimate of 20% conservation is based on recent studies and local case studies from the City of Fresno, Clovis and Kerman that have observed 20-26% reduction in usage from leakage reduction and conservation measures.	870	AF/yr	2015	2025	2025	$ 2,907,000
2	Biola Community Services District	Biola Groundwater Recharge Project	Construct a canal turnout and pipeline to deliver surface water from FID Herndon Canal to an existing storm drain basin that will be enlarged to hold 30 acre-feet of water.	The basin will be capable of percolating 2.5 a-f/day based on percolation tests. Assuming 60 days per year for percolation time, the total amount is 150 a-f /yr.	150	AF/yr	2020	2021	2025	$ 705,000
3	City of Clovis	Marion Recharge Basin Improvements	Improve recharge at the Marion Recharge Basins through a variety of measures to increase percolation including routine maintenance and capital projects.	Quantity is estimated. The City is entertaining the use of a proprietary product and/or installing dry wells to increase groundwater percolation.	2,500	AF/yr	2020	2021	2025	TBD

			354.44(a)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(4)	354.44(b)(4)	354.44(b)(4)	354.44(b)(8)
#	**Agency to Implement**	**Project or Management Action Title**	**Description**	**Description of how benefit was determined**	**Quantified Project Benefit**	**Project Benefit Units**	**Start Date**	**Completion Date**	**Completion by Milestone Year**	**Cost Estimate**
6	City of Clovis	Clovis SWTP Pretreatment	This project will construct effective pretreatment for the existing 22.5 MGD surface water treatment plant (SWTP) so that the plant can continuously run during times of high turbidity in the raw water source.	On average, the SWTP produces approximately 60% of the City's total water demand during the winter and spring months. It is estimated that the plant would be able to produce an average of an additional 125 MG per month over a 5 month (Jan - May) period which equates to 2,000 AF per year.	2,000	AF/yr	2020	2021	2025	$ 1,025,000
8	City of Fresno	Northeast Surface Water Treatment Facility Expansion	The NE-SWTF Expansion Project is part of the City's near-term program to attain and maintain the sustainable use of water resources. This project is for the 30-MDG expansion of the existing surface water treatment facility for a total capability of 60-MGD. To enable water from the expansion to reach further into the City large diameter transmission mains will also be constructed. This project will meet future growth demands and ensure groundwater utilization attains and remains at safe-yield levels.	Production yield is based on the plant expansion running 335-days per year at a rate of 30-MDG (this is only for the expansion). Actual production may vary on supply availability and other factors.	30,840	AF/yr	2021	2025	2025	$ 161,500,000
14	City of Kerman	Lions Park Groundwater Recharge project	The City's Lion's Park Stormwater Basin serves the majority of the west side of the City. The stormwater collection system for the Basin currently includes an intertie with FID's Siskiyou Lateral No. 146 pipeline at a structure on the west side of Siskiyou Avenue, north of Kearney Boulevard. Currently, the intertie only allows for occasional overflows via overtopping of a weir into the City's stormwater collection system. The proposed project would install the valving, piping, and metering equipment necessary to allow for regular distribution of FID surface water into the City's stormwater collection system, to be conveyed to the Lion's Park Stormwater Basin for groundwater recharge purposes	The estimated recharge volume was calculated based on the basin size, percolation/recharge rate, and number of days water would be available for recharge. The Basin is anticipated to be maintained approximately half full, resulting in a wetted area of 5.79 acres. The percolation/recharge rate used, 0.25 feet per day, is from master-planning and permitting done for the City's WWTP, which has similar soil characteristics. The City assumed 135 days per year of available surface water from FID.	195	AF/yr	2021	2021	2025	$ 41,000

			354.44(a)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(4)	354.44(b)(4)	354.44(b)(4)	354.44(b)(8)
#	**Agency to Implement**	**Project or Management Action Title**	**Description**	**Description of how benefit was determined**	**Quantified Project Benefit**	**Project Benefit Units**	**Start Date**	**Completion Date**	**Completion by Milestone Year**	**Cost Estimate**
15	FID	Central Basin Recharge Project	The Fresno Irrigation District's Central Basin Project is approximately 90-acres of groundwater banking and recharge facilities at three locations that will yield a usable surface water supply as well as recharge the aquifer. The project includes approximately 90-acres of recharge basins at three locations and multiple monitoring wells. The project will expand the available water supply to the region. Kings River flood water and local flood water conveyed through FID's canals will be delivered to the basin sites for recharge. This project component is a continuation of the collaboration between FMFCD and FID to provide flood protection and better manage the region's water resources. The project will address several current needs facing the region, including improving regional water self-reliance and providing additional surface and groundwater storage to adapt to climate change. The project will also contribute to water security, create a conjunctive use facility, increase water supply reliability, provide needed groundwater recharge to slow/prevent groundwater contaminant plume migration, decrease risk of flooding, facilitate the Kings River Fisheries Management program and create increased wetted area.	Consistent with the expected benefits stated in the project's Proposition 1 grant application, an estimation of the recharge potential of the project was originally calculated based on the available surface supply, basin volume (360AF, 90 wetted acres at 4 feet deep), diversion capacity (100cfs) and assumed infiltration rate of 0.25ft/day. Figure 8 shows the total potential recharge for the basin using these assumptions for the years data was available. (Of note, Fancher Creek data after 2000 was not available at the time of this application). A 50-year estimation was then prepared and is included as Figure 9 in the attached report. The recharge potential using only the Kings and Fancher water supplies was estimated to be 2,592 AF/yr. It is important to understand that the 2,592AF/yr is an average number. In dry years, the amount recharged using these surface water supplies may be zero, however in wet years, the amount of water recharged will exceed 6,000AF. This is clearly indicated in both Figures 8 and 9 of the attached report. After the original expected annual benefit was calculated for the Proposition 1 grant application, the project was later reduced in size from 100 acres to 90 acres. However, using a still conservative recharge estimate of 0.3 ft/day infiltration rate, the project at three sites is estimated to recharge 2,717 AF/yr, which exceeds the originally planned estimate of 2,592 AF/yr. The 2,592 AF/yr will still be used as a conservative estimate.	2,592	AF/yr	2018	2020	2025	$ 6,500,000

			354.44(a)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(4)	354.44(b)(4)	354.44(b)(4)	354.44(b)(8)
#	**Agency to Implement**	**Project or Management Action Title**	**Description**	**Description of how benefit was determined**	**Quantified Project Benefit**	**Project Benefit Units**	**Start Date**	**Completion Date**	**Completion by Milestone Year**	**Cost Estimate**
16	FID	Wagner Recharge Basin	The project is a 60-acre groundwater recharge basin, including earthwork and structures. The project will provide approximately 200 AF of flood water surface storage and recharge approximately 2,300 AF/year annual average. Floodwater and other available surface waters will be delivered to the new basin and recharged into the aquifer. The primary purpose of this project is to halt, and ultimately reverse, the current groundwater overdraft in the area by utilizing unused regional flood water supplies available to FID and provide for sustainable management of surface and groundwater.	The project would allow FID to increase its use of Kings River surface water supplies through the project. The project will capture, store, and recharge surface water normally lost from the Kings River, allowing for sustained management. Recharging the water that is diverted into the project during wet years will help replenish the groundwater and can be stored to be used during dry years. The project will recharge water at the project site, putting 2,300 AF/year of water into the aquifer. The project will capture and recharge flood water lost to the region, and the recharged water will be available for pumping by nearby or new wells. The expected annual benefit was calculated using the actual recharge rates for FID's groundwater banking facilities (Waldron, Lambrecht, Empire, and Boswell). Attached is the project's Proposition 1 grant funding pre-application for more details.	2,300	AF/yr	2019	2021	2025	$ 4,276,780
17	FID	Savory Pond Expansion	FID will expand the expanding Savory Pond to an approximately 30-acre recharge basin near the corner of Lincoln & Chestnut Avenues. The project will provide an estimated 1,200AF per year of groundwater recharge to the aquifer. The project will include construction of basin levees, new turnout and measurement into the basin, fencing and other basin improvements.	The 0.4 feet per day is considered conservative based on recharge rates at the existing site and other nearby basins. 100 days of delivery of water to the recharge basin is an average annual amount that is also conservative based on available FID surface water supplies.	1,200	AF/yr	2020	2022	2025	$ 2,000,000
18	FID	On-Farm Recharge Program	FID will establish a program to offer and encourage growers to perform on-farm recharge during wet years when would otherwise be lost to the region.	The program is in the conceptual phase and will be dependent on grower's willing to take surface water during wet periods. Floodwater is typically available every 3-4 years. A conservative estimate of 40,000AF of supply could be available for this program, netting an average annual benefit of 10,000af/yr.	10,000	AF/yr	2025	2025	2025	$ 100,000

			354.44(a)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(4)	354.44(b)(4)	354.44(b)(4)	354.44(b)(8)
#	**Agency to Implement**	**Project or Management Action Title**	**Description**	**Description of how benefit was determined**	**Quantified Project Benefit**	**Project Benefit Units**	**Start Date**	**Completion Date**	**Completion by Milestone Year**	**Cost Estimate**
19	Garfield Water District	Ricchiuti Recharge Basin Project	The Garfield Water District, as a part of its current reorganization, proposes to annex into the District the remaining portion of APN 580-040-01. Said parcel contains an existing five (5) acre basin, which is owned by Frances M. and Partick V Ricchiuti. Following annexation, the District proposes to construct a delivery connection from its distribution system to the existing basin to allow for the delivery of surface water for recharge into the basin. Basin improvements include the installation of a metered turnout facility and a conveyance pipeline.	The estimate of recharge benefit is based on the basin size, multiplied by the anticipated recharge rate, multiplied by the number of days water is available for recharge. The five (5) acre site is anticipated to have an infiltration/percolation rate of .625 feet per day with water being available an average of 240 days per year.	150	AF/yr	2020	2020	2025	$ 175,000
20	Malaga County Water District	Basin CF - Stormwater Recharge and Flood Protection Project	This project will construct an intertie (connection) between FMFCD's existing Basin "CF" with FID's Washington Colony Canal No. 15 to allow for the delivery of surface water for recharge into the basin. Basin improvements include a basin pump station, telemetry system, internal basin pipeline, basin relief pipeline, canal intertie structure and appurtenant facilities. The basin is used for local urban stormwater capture to prevent localized flooding. Currently, there is no pipeline to convey water from the nearby canal to the basin. The project will construct the intertie and is estimated to provide approximately 1,000 acre-feet per year.	The estimate of recharge benefit is based on the basin size, multiplied by the anticipated recharge rate, multiplied by the number of days water is available for recharge. The 20 acre site will have an approximately 18 acre wetted basin area and is anticipated to have an infiltration/percolation rate of 0.45 feet per day based on actual infiltration rates observed at other nearby FMFCD basins. For estimating purposes, it has been assumed that water will be available an average of 120 days per year.	970	AF/yr	2021	2021	2025	$ 1,072,036

			354.44(a)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(4)	354.44(b)(4)	354.44(b)(4)	354.44(b)(8)
#	**Agency to Implement**	**Project or Management Action Title**	**Description**	**Description of how benefit was determined**	**Quantified Project Benefit**	**Project Benefit Units**	**Start Date**	**Completion Date**	**Completion by Milestone Year**	**Cost Estimate**
21	Pinedale County Water District	PCWD residential meter installation	The District has initiated efforts to secure funding for plans to install residential water meters (including multi-unit customers) and switch from a fixed flat-rate to a volumetric rate based on consumption. The project also includes replacing 8,050 feet of old main lines. The project will be bolstered by outdoor water restrictions and conservation efforts.	Studies show a range of 15% - 20% reduction in water usage when water utilities switch to volumetric charging for consumptive use. Fresno reduced its per capita water use by 17% when it started charging a volumetric rate in 2013. To be conservative, we will expect a 10% reduction in use. In addition to letting us be able to charge for use, the meters have leak detection technology that will enable us to notify customers of on-site leaks.	210	AF/yr	2022	2022	2025	$ 7,000,000
7	City of Fresno	Southeast Reclamation Facility and Distribution System	As part of the City's long-term goal to utilize resources sustainably the development of a recycled water program will be key. This project includes design and construction of an initial 8-MGD tertiary treatment facility with transmission and distribution mains. The reclaimed water produced and distributed in the southeast region will provide a direct potable water offset, thus reducing the reliance on and use of groundwater supplies.	Production yield is based on the tertiary treatment facility operating 335-days per year at a rate of 8-MGD.	8,227	AF/yr	2021	2025	2030	$ 155,000,000
22	County of Fresno	County of Fresno NKGSA Recharge Program	This project will implement priority projects identified in the Northeast Fresno-Clovis Area Potential and Groundwater Investigation (April 2015), to provide groundwater recharge in the County of Fresno area east of FID within the NKGSA. The report identified 19 potential recharge within Big Dry Creek, Dog Creek, as well as dedicated recharge basin sites. The County of Fresno will further evaluate the project list and identify priority projects for implementation.	The expected annual project benefits have not been identified in detail as the County still needs to evaluate the priority projects in detail. The estimated project benefit is subject to a negotiated water supply. Recharge within Big Dry Creek and Dog Creek will likely provide significant volume of recharge if water supply allows for recharge during the summer months.	2,000	AF/yr	2025	2030	2030	$8,000,000

			354.44(a)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(2)&(5)	354.44(b)(4)	354.44(b)(4)	354.44(b)(4)	354.44(b)(8)
#	**Agency to Implement**	**Project or Management Action Title**	**Description**	**Description of how benefit was determined**	**Quantified Project Benefit**	**Project Benefit Units**	**Start Date**	**Completion Date**	**Completion by Milestone Year**	**Cost Estimate**
5	City of Clovis	Clovis SWTP Expansion	Expand the existing SWTP 22.5 MGD to a total of 45 MGD.	Production yield is based on the facility operating 335-days per year the 22.5-MGD increased rate	23,100	AF/yr	2030	2031	2035	$ 30,000,000
4	City of Clovis	ST-WRF Expansion	Expand the existing 2.8 MGD Clovis Sewage Treatment/Water Reuse Facility (ST-WRF) to 5.6 MGD and then to 8.4 MGD	2.8 MGD equates to 3,100 AFY (Current) 5.6 MGD equates to 6,300 AFY (2030) 8.4 MGD equates to 9,400 AFY (2042)	9,400	AF/yr	2030	2042	2045	$ 40,200,000

6.3 Management Actions

The NKGSA and its member agencies believe sustainability will be reached with the projects identified in Section 6.2, however a listing of management actions is included should interim milestones not be reached or minimum thresholds exceeded. Domestic water supply agencies are already obligated to consider demand reduction/conservation efforts during dry periods. These domestic supply agencies have identified their demand management actions in their Urban Water Management Plans. These management actions, as well as others are listed in this section as possible actions that may be required if conditions in the NKGSA worsen. Some management actions, such as education and outreach, will be initiated by the NKGSA as a whole, while most listed here will only be implemented if necessary, by the individual agencies within the NKGSA responsible to meet their mitigation requirements to remain sustainable.

This Section discusses a suite of possible management actions the member and participating agencies may consider if the projects are not proving to reach sustainability. Not all management actions apply to each agency. The menu of management actions discussed below may not be implemented in a strictly linear fashion as numbered below as some management actions must be implemented before others can be achieved, and specific actions may not be implemented at all if sustainability is achieved through other actions. It is expected the NKGSA and its agencies will further develop management actions in response to stakeholder input on parallel timelines and adapt to the estimated schedules according to the best available information and best available science at any given time.

The legal authority and basis for the management actions described in this GSP are outlined in the SGMA and related provisions. The management actions that may be considered by the NKGSA or its member agencies are shown in **Table 6-2** and are discussed below.

Table 6-2 List of Management Actions

No.	Category	Action
EO-1	Education and Outreach	Regular Communication
EO-2	Education and Outreach	Non-Routine Responses to Minimum Threshold Exceedances
WH-1	Wellhead Requirements	Registration of Extraction Facilities
WH-2	Wellhead Requirements	Installation of Wellhead Meters, Sounding Tubes and Water Quality Sample Ports
WH-3	Wellhead Requirements	Self-Reporting of Groundwater Extraction, Level, and Water Quality
GA-1	Groundwater Allocation	Groundwater Quantification Methods
GA-2	Groundwater Allocation	Development of Groundwater Allocation Per Acre
GA-3	Groundwater Allocation	Groundwater Allocation “Ramp-Down” Gradual Decrease
GA-4	Groundwater Allocation	Groundwater Allocation “Adaptive Management” Approach
GP-1	Groundwater Pumping Restrictions	Regulate Groundwater Exports
GP-2	Groundwater Pumping Restrictions	Require New Developments to Prove Sustainable Water Supply

No.	Category	Action
GP-3	Groundwater Pumping Restrictions	Pumping Restrictions During Droughts

6.3.1 Education and Outreach Management Actions

EO-1 Regular Communication

The NKGSA and its member agencies and entities will continue to promote education and outreach to all beneficial users within the NKGSA as detailed in Section 2.5.

EO-2 Non-Routine Responses to Minimum Threshold Exceedances

In addition to regular correspondence, the NKGSA may also immediately notify member agencies of a Minimum Threshold (MT) exceedance as defined in Section 4.3. In an effort to provide communication and outreach, the notification may contain the following information:

- Description and location of the MT exceedance.
- Notice of increased frequency of water level and/or water quality monitoring.
- Non routine notices and responses when the water levels are between MO and MT.
- The potential effects to the member agency.
- The planned NKGSA response (i.e. trigger of specific projects and managements actions).
- A written reminder of the NKGSA powers and authorities granted in SGMA, as well as, State intervention when Undesirable Results occur.

The regular correspondence and notice of MT exceedance may or may not generate a quantifiable groundwater demand reduction.

Table 6-3 Summary of Management Actions EO1 and EO2

Management Action No.:	**EO1 and EO2**
Measurable Objective(s) Addressed - 354.44(b)(1)	
The measurable objectives would be the number of annual correspondence letters and MT exceedance notices that are mailed each year	
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)	
The education and outreach management action may be developed and implemented shortly after the adoption of the GSP. The policy would remain indefinitely and be reevaluated every 5 years. A trigger for the end of this management action may be that another GSA management action or program provides comparable annual education letters and outreach notices.	
Process for Public Notification - 354.44(b)(1)(B)	
The process for public notification will be addressed by the consistent communication and outreach between the NKGSA and the groundwater extractor. The NKGSA will develop a system to initiate communication on a regular basis and will additionally respond to overdraft or non-compliance with minimum thresholds with escalating correspondence as deemed	

Management Action No.:	EO1 and EO2
necessary. The cost associated with NKGSA correspondence will be assessed on an annual basis.	
Permitting and Regulatory Requirements - 354.44(b)(3)	
No permits or regulatory requirements are anticipated for this Action.	
Status and Schedule - 354.44(b)(4) Anticipated Start & Completion, Timeframe to accrue benefits	
The education and outreach program with annual education letter and notice of MT exceedance has not been drafted. It is expected to commence shortly after the adoption of the GSP and be completed within 1 year. The initial focus will be the annual correspondence letter since the notices of MT exceedance may not occur for many years.	
Evaluation of Benefits - 354.44(b)(5)	
The NKGSA will use education and outreach opportunities to encourage active engagement, open lines of communication with interested and affected stakeholders, let them know the future opportunities for input, establish communication channels, and receive feedback on the GSP implementation process. The expected benefits may mitigate overdraft by educating the public about the current use and quality of groundwater supplies. Without levying penalties, the NKGSA intends for all correspondence and mailed notices to educate extractors about the NKGSA's monitoring practices, procedures, and enforcement capabilities. Other program benefits include the transparent and expeditious communication of NKGSA groundwater overdraft conditions, implementation of specific projects and managements actions, funding opportunities, and potential for State intervention if undesirable results occur.	
How will the management action be accomplished? - 354.44(b)(6)	
The annual correspondence and escalation letters will be accomplished by utilizing the in-house mailing database that the NKGSA will develop and maintain. All correspondence will be drafted by NKGSA staff and will be in accordance with the actions of the Board of Directors. Further detail regarding communication can be found in **Section 2.5.**	
Estimated Costs - 354.44(b)(8)	
The costs related to the education and outreach management action include one-time expenses and reoccurring annual expenses. The NKGSA has included an annual budget for ongoing communication and outreach. Individual member and participating agency expenses for outreach and communication will be the responsibility of those agencies.	

6.3.2 Well Head Requirements Management Actions

Additional well requirements may be required to more effectively manage and understand the dynamic groundwater conditions. The Fresno County Public Health Department (FCPHD) permits well construction and the remaining member agencies manage new well construction within their respective city boundaries and do not allow new, private wells, to be constructed. Obtaining a well permit through FCPHD is currently a ministerial process, not requiring discretionary action or CEQA. The intent of this management action is to have the NKGSA work cooperatively with the FCPHD to modify well requirements without disrupting the current ministerial permit process. Additionally, the NKGSA would promote constant communication with the FCPHD and would seek to implement more monitoring responsibility. The NKGSA may request the County to augment the current well requirements set by the FCPHD and establish new permit criteria, enforce NKGSA policies, and require NKGSA approval of all permit paperwork before FCPHD permit issuance. The policy would affect permits to construct, deepen, destroy, recondition, or repair a well. In order to increase data collection, reporting, and ongoing groundwater management efforts, the additional well requirements policy may contain the following information:

- Registration of extraction facilities within the NKGSA.
- Require the installation of wellhead meters, sounding tubes, and water quality sample ports.
- Require the well owner to self-report groundwater extraction volumes, static water levels, and water quality data.

The NKGSA may consider separating the additional well requirements management action into multiple policies or be silent on various bulleted components until the NKGSA deems them necessary. For example, the requirement of installing sounding tubes and water quality sample ports may be enacted before the requirement of a well flow meter. Further explanation and detail of the potential additional well requirements are continued below. The desired outcome of additional well permitting requirements is the ability to monitor groundwater extractions, water levels, and water quality in a thorough, accurate, and efficient manner across the NKGSA. The measurable objectives differ amongst the bulleted considerations. The NKGSA may also consider in the future a policy to curtail or prohibit the construction of new wells, in coordination with other local agency policies. This policy is not anticipated to be needed, but the NKGSA reserves the right to enact this policy if sustainability is not being reached or a certain area of the NKGSA is not adequately implementing measures to protect and sustain the aquifer.

WH-1 Registration of Extraction Facilities

As stated in SGMA 10725.6, "a GSA may require the registration of a groundwater extraction facility within the management area of the GSA." The NKGSA has greatly benefited from the current exchange of well information and use of the online DWR Well Completion Report Map Application tool found here:
https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37.

However, through research of the proposed well monitoring network, the NKGSA understands many existing wells do not have well completion reports or have not been entered into the DWR database and may be absent from the existing records. The intent of registration of groundwater extraction facilities would be to complement existing well recordkeeping and ensure that the NKGSA can fully understand and quantify the potential impacts of groundwater decline. Coupled with the registration of extraction facilities, the NKGSA may invest in a complete well canvass study to verify the number of wells and presence of a flow meter.

WH-2 Installation of Wellhead Meters, Sounding Tubes and Water Quality Sample Ports

The NKGSA may require the installation of a flow meter on groundwater extraction facilities to provide more accurate quantities of groundwater extraction and serve as the nexus to other management actions. The policy would describe the acceptable types of flow measurement devices, installation standards and requirements, operation and maintenance requirements, and penalties for tampering, neglect, or misconduct. The NKGSA may also require the installation of a well sounding tube, airline, electric depth gauge, and/or other water level sensor for the purpose of measuring water levels throughout the NKGSA. The accurate and widespread collection of water level data will provide the NKGSA with the necessary information to monitor the success/failure of the GSP against the established Sustainable Management Criteria in Chapter 4. The policy would describe the acceptable types of water measuring devices and sample ports, installation requirements, and penalties for tampering, neglect, or misconduct. The installation must provide or allow for the accurate measurement of static groundwater level in feet below the ground surface. If applicable, the water measurement device must be routinely maintained by the well owner. Once the well construction, deepening, or destruction work was completed, the contractor would be required to provide a Notice of Completion, also known as a Well Driller's Report or Well Log, within thirty (30) days of completion. The report would document that the work was completed in accordance with the County's Well Standards Ordinance and NKGSA additional well requirements policy.

WH-3 Self-Reporting of Groundwater Extraction, Level, and Water Quality

The NKGSA may require the well owner to self-report to the NKGSA the groundwater extraction volumes, static water levels, and water quality data twice per year, generally in March and October. The policy would describe the frequency of reporting, various methods of reporting, due dates, and specific instructions for data collection. If there is limited compliance with self-reporting, the NKGSA may elect to gather the appropriate data with their own staff. The policy would describe that the frequency of the reporting may be temporarily increased if minimum thresholds are exceeded.

Management Action No.: WH1 through WH3
Measurable Objective(s) Addressed - 354.44(b)(1)
WH1: The measurable objective would be the number of documented extraction facilities. The method of evaluation may be comparing the number of registered wells to the FCPHD and DWR well records. WH2: The measurable objective would be the number of installed meters, sounding tubes and water quality sample ports. The method of evaluation would be reviewing the number of well permits and confirming whether meters, sounding tubes, and sample ports were installed. WH3: The measurable objective would be number of received reports for each mailing cycle. The method of evaluation would be reviewing the number of responses from groundwater users analyzing data validity/accuracy, and filling data gaps.
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)
The current situation of critical groundwater overdraft leading to the unsustainable management of groundwater resources justifies the implementation of additional well requirements. This policy requires the support and coordination of the member agencies for successful implementation. For existing wells, there may be extenuating circumstances where the installation of flow meter, sounding tube, and/or water quality sample port are not practical or financially advisable. The policy would remain indefinitely or until another GSA program serves the same purpose.
Process for Public Notification - 354.44(b)(1)(B)

Management Action No.: WH1 through WH3

Educational correspondence regarding self-reporting of groundwater extractions would be accomplished through direct communication between the well owner and the NKGSA. This will take place in the form of self-reporting and the monitoring of water level and water quality which is then compiled and distributed through each mailing cycle of correspondence mailings. Should the Board of Directors choose to adopt policy addressing WH-1-WH-3 the public will be notified through established NKGSA correspondence methods as explained in Section 2.5.

Permitting and Regulatory Requirements - 354.44(b)(3)

The regulatory process would require member agency coordination and support to ensure new well permits issued within the NKGSA adhere to the NKGSA policy. No other environmental or regulatory permits would be required.

Status and Schedule - 354.44(b)(4)

The additional well requirements policy has not been drafted. The draft policy and NKGSA discussions may commence sometime after the adoption of the GSP if required.

Evaluation of Benefits - 354.44(b)(5)

The expected benefits would include a complete geo-database of groundwater extraction locations. Requiring new well permits to provide accurate information on location, depth, perforated zone, and measured water use and level would allow for more accurate data analysis of groundwater extraction, storage change, and water table fluctuations. The expected benefits of water quality sample ports and analytical testing would fill data gaps and provide extractors with useful information. The benefits of self-reporting include the avoidance of NKGSA staff or consultant time to individually collect data. The benefits of prohibiting composite wells include the avoidance of potential migration of pollutants.

How will the management action be accomplished? - 354.44(b)(6)

WH1: Validating all documented extraction facilities and the NKGSA may authorize a complete well canvass study to verify the number of wells and presence of a flow meter.

WH2 & WH3: Additional review will take place in order to confirm the number of reported well permits and to verify the installation of meters, sounding tubes and sample ports.

Estimated Costs - 354.44(b)(8)

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

The costs related to the additional well requirements management action include one-time expenses and ongoing monthly expenses. The one-time expenses include the labor costs of the NKGSA, NKGSA's counsel and NKGSA's consultant to prepare the formal program description and adopt the management action policies. Through a NKGSA Board resolution, the program would be incorporated into the NKGSA's policy manual for transparency. The database of extraction facilities would be created and include individual fields for owner, location, well construction information, NKGSA additional requirements (i.e. meter, sounding tube, sample port, etc.), and future measurement data. The costs of these actions are not estimated at this time and would require further consideration before estimating.

Management Action No.: WH1 through WH3

The adoption of this policy would have other resulting costs for the groundwater extractor including:

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

6.3.3 Groundwater Allocation Management Actions

6.3.3.1 Groundwater Allocations

The NKGSA does not anticipate needing to set a groundwater allocation at this time but has chosen to include it as a possible management action in the GSP should conditions worsen and the path to sustainability not be achieved.

GA-1 Groundwater Quantification Methods

The NKGSA may adopt a policy to specify the approved method or methods to quantify the individual and aggregate groundwater extractions for the required SGMA annual reporting and to track groundwater allocation use. If adoption of the additional well requirements policy is considered, specifically the installation of flow meters, it will be years before measurement at locations would be completed, so the NKGSA may consider a variety or combination of quantification methods to estimate groundwater extraction. The report *Groundwater Trading as a Tool for Implementing California's Sustainable Groundwater Management Act (Environmental Defense Fund et. al, 2017)* identifies several possible methods of quantifying groundwater use in-lieu of flowmeters.

GA-2 Development of Groundwater Allocation Per Acre

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

Table 6-4 Comparison of Groundwater Quantification Methods

Comparison of groundwater quantification methods

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

Table 6-5 Example of Methods for Establishing Groundwater Pumping Allocations

(Table excerpt from 2018 EDF Report)

Method	Description	Advantages and Disadvantages
Pro Rata Allocation per Overlying Acre	This approach divides the available groundwater between overlying landowners proportionate to property size. This system treats all landowners equally, irrespective of whether the landowner has developed groundwater resources.	Approach Advantages ▪ Recognizes the underlying correlative right of each overlying acre to share in the reasonable use of the water within the subbasin. ▪ Is simple in approach and calculation. Approach Disadvantages ▪ Does not recognize some of the legal limitations and nuances that affect groundwater rights in a subbasin such as prescription, public use, imported water to the subbasin (see Box 3), and others (or make adjustments to the allocations based upon such limitations and nuances). ▪ It allocates a portion of the sustainable yield to overlying lands that may have not yet exercised the right to use groundwater. This raises significant questions about how you provide water for such lands, if at all, and how allocations will be adjusted when, and if, such lands exercise the right to a share of the sustainable yield. ▪ It creates inequities between those who have invested nothing to develop the right and those who have invested heavily to utilize the right.
Pro Rata Allocation per Irrigated Overlying Acre[10]	This approach certifies all existing overlying groundwater use (e.g. irrigated acres) and develops an allocation proportionate to land use. In this approach, each irrigated acre would be given a specific quantity of groundwater (e.g. inches/acre per year) that can be applied to the land. This approach grandfathers in existing groundwater users but does not give differential allocations based on historic use. Further, any reductions in the allocations to reduce overdraft would be felt proportionately across all historic users.	Approach Advantages ▪ Acknowledges existing pumping by overlying landowners. ▪ Is reasonably simple in approach and calculations. Approach Disadvantages ▪ Does not address the unexercised pumping rights on some overlying lands (to the extent such rights have not been lost to prescription or subordination). ▪ Does not consider historic quantities of groundwater pumped, which could disproportionately impact users of high water demand crops grown on overlying acreage. ▪ Does not recognize some of the legal limitations to and nuances that affect groundwater rights in a subbasin such as prescription, public use, imported water to the subbasin and others (or make adjustments to the allocations based upon such limitations and nuances).

Method	Description	Advantages and Disadvantages
continued		
Allocation Based Upon a Fraction of Historic Pumping[14]	This approach establishes allocations based off historic groundwater use, grandfathering in existing users and excluding those who have not yet developed groundwater resources. This method does not make necessary determinations as to whether historic pumping is supported by claims of overlying users.	Approach Advantages ▪ Can reduce conflict among existing pumpers. Approach Disadvantages ▪ Does not apply the law of correlative rights. ▪ Does not identify appropriative or prescriptive rights. ▪ Does not recognize potentially disproportionate impacts by pumpers on groundwater overdraft. ▪ Does not account for those who have surface water supplies and rely on groundwater only as a supplemental or dry-year supply. ▪ Treats all pumping, regardless of amount, the same and may be perceived as unfair by grandfathering in higher per-acre allocations. ▪ Requires baseline information about individuals' historic groundwater use, which may not exist.
Comprehensive Allocation Method (Recommended Method)	This approach establishes allocations based on a comprehensive consideration of California groundwater law to the extent practical. This approach preserves the relative priority of overlying, prescriptive, and appropriative users and can address the unexercised rights of overlyers. See Figure 1 for a decision tree graphic description of how this approach might be applied.	Approach Advantages ▪ This method would apply California groundwater law to the conditions existing in the subbasin and make allocations accordingly. ▪ If an allocation methodology is developed in this manner, it has a reasonable probability of surviving judicial scrutiny in the context of adjudication, especially if the majority of rightholders in the subbasin find the methodology acceptable. Approach Disadvantages ▪ The law is in many cases vague and ambiguous, and also requires the exercise of interpretation and judgment. ▪ The process for applying this method is complicated and requires information to undertake. ▪ Implementing this process leaves open the possibility that someone will disagree and consider triggering an adjudication.

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

GA-3 Groundwater Allocation "Ramp-Down" Gradual Decrease

Once an individual groundwater allocation is determined, the NKGSA may adopt a policy which provides a gradual "ramp-down" allocation decrease over time to arrive at the actual groundwater allocation to allow stakeholders time to adjust to the concept of an allocation. The policy would detail the number of years and amount of reduction each year. The annual changes in groundwater allocation would be provided in the annual correspondence mailer described in the education and outreach management action above, as well as information presented on the NKGSA website.

GA-4 Groundwater Allocation "Adaptive Management" Approach

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

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

Management Action No.: GA1 through GA4
Measurable Objective(s) Addressed - 354.44(b)(1)
The method of evaluation of groundwater extraction in acre-feet depends upon the NKGSA's selected quantification method or combination of methods. The NKGSA evaluation of various methods may consider a wide range of factors including cost, accuracy, reliability, timeliness, functionality, personnel required, and legal defense. Once the NKGSA has established a consistent quantification method, the evaluation of the "ramp-down" gradual allocation decrease could be analyzed in the annual comparison of groundwater extraction. Though the annual groundwater extraction amount would be affected by other factors such as weather and available surface water supplies, the total extraction amount could be normalized to an average water year for comparative purposes. The goals of the groundwater allocation management action would be to ensure a fair groundwater allocation, allow groundwater users time to adjust, provide future flexibility in allocation determinations, and to accurately and efficiently quantify groundwater extractions. The measurable objective is the volume of groundwater extraction in acre-feet GSA wide and on a per acre basis.
Circumstances and Criteria for Implementation - 354.44(b)(1)(A)
The selection of groundwater extraction quantification method may be implemented shortly after the adoption of the GSP for the purposes of the required SMGA annual reporting in coordination with other GSAs in the subbasin. The selected groundwater extraction

Management Action No.:	**GA1 through GA4**

quantification method may change over time. The NKGSA may consider an investigative study to determine the current and future needs of the existing water rights holders, all stakeholder, and unexercised rights to determine the sustainable yield and groundwater allocation.

Process for Public Notification - 354.44(b)(1)(B)

All public notification will take place in the form of regular correspondence from the NKGSA, as well as any supplementary communication between the landowner and the NKGSA or agency as deemed necessary by the Board of Directors.

Permitting and Regulatory Requirements - 354.44(b)(3)

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

Status and Schedule - 354.44(b)(4)

The groundwater extraction quantification method is expected to commence shortly after the adoption of the GSP and be completed within 3 years. The other actions have not been drafted and are not being considered at this time.

Evaluation of Benefits - 354.44(b)(5)

The expected benefits may mitigate overdraft by improving the NKGSA's knowledge of aggregate and individual groundwater extractions. The development of a groundwater allocation per acre may be based on the NKGSA's current sustainable yield in coordination with other GSAs in the subbasin. The groundwater allocation management action alone may generate a negligible quantifiable demand reduction, but it would benefit Education and Outreach and serve as a prerequisite to other management actions.

How will the management action be accomplished? - 354.44(b)(6)

The NKGSA will coordinate with the other GSAs for GA-1 and may adopt necessary policy to assist in establishing quantification methods for obtaining data for the required SGMA reporting requirements. The NKGSA may consider the option to adopt a "Comprehensive Allocation Method" as detailed in the *Groundwater Pumping Allocations under California's Sustainable Groundwater Management Act (Environmental Defense Fund et. al, 2018)* as a possible approach to addressing GA-2.

Estimated Costs - 354.44(b)(8)

The method of evaluation of groundwater extraction will be considered with other GSAs in the subbasin. An estimate of costs is not prepared at this time and requires further evaluation. The other actions are not anticipated for implementation at this time and will be further considered when required.

6.3.4 Fees and Incentives Management Actions

The NKGSA may adopt a management action to levy groundwater fees for agencies or stakeholders that do not mitigate for their estimated groundwater impact. Amounts and specifics have not been defined as these management actions are not required at this time. Implementation of these management actions will require further definition and board approval if the NKGSA decides to implement

6.3.5 Groundwater Pumping Restrictions Management Actions

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

GP-1 Regulate Groundwater Exports

The NKGSA may adopt a policy to prohibit new groundwater exports outside of the NKGSA boundary. The NKGSA may assure performance by enforcing rigid penalties for illegal actions. The NKGSA may approve external exports in limited quantities for emergency situations and levy fees for metering the exported amount.

GP-2 Require New Developments to Prove Sustainable Water Supply

The NKGSA may adopt a policy to require new developments to prove sustainable water supplies. The NKGSA may review and comment on all new development environmental documents to ensure water balance and corresponding mitigation measures are implemented. This policy requires the support and coordination of the member agencies during their typical project permitting process.

GP-3 Pumping Restrictions During Droughts

The NKGSA may adopt a policy to immediately reduce or temporarily suspend groundwater pumping during specific intervals such as extreme drought periods. Immediate restrictions may be the result of minimum threshold exceedances. The NKGSA may consider significant penalties for violators. The NKGSA may consider liens or cease and desist orders for excessive abuse. Municipal agencies within the NKGSA have drought restriction and water conservation programs for drought conditions.

Management Action No.: GP1 through GP3
Measurable Objective(s) Addressed - 354.44(b)(1)
GP1: The goal is to ensure all groundwater supplies within the NKGSA are consumed or retained within the NKGSA boundary. The measurable objective is the metered volume of exported water with the goal of 0.0 acre-feet/year. GP2: The goal is to ensure all new developments have documented sustainable water supply and groundwater supplies are consumed or retained within the NKGSA boundary. The measurable objective is proven new development water balance with the goal of 0.0 acre-feet groundwater overdraft /year.

Management Action No.:	**GP1 through GP3**

GP3: The goal is to immediately reduce groundwater pumping, in the event of a drought. The measurable objective is the volume of groundwater extraction in acre-feet and number of violators.

Circumstances and Criteria for Implementation - 354.44(b)(1)(A)

GP1: Though groundwater exports outside of the NKGSA are not currently a common practice, the NKGSA understands the changing water market conditions may entice beneficial users to seek financial gains by exporting groundwater. The policy may be implemented shortly after the adoption of the GSP and remain indefinitely. The policy fees and penalties may be reviewed by the NKGSA annually.

GP2: The policy may be implemented shortly after the adoption of the GSP and remain until NKGSA overdraft has ended or indefinitely.

GP3: Circumstances of extreme drought or triggers of minimum threshold exceedances may expedite the policy adoption. The policy would remain until extreme drought conditions ended or minimum thresholds were no longer exceeded.

Process for Public Notification - 354.44(b)(1)(B)

The NKGSA will utilize the established methods of correspondence as described in EO-1 and EO-2 to coordinate directly with the extractor to address necessary actions associated with groundwater pumping restrictions. If deemed necessary the Board of Directors will adopt policy to, address, issue warnings and implement pumping restrictions if the circumstances require it.

Permitting and Regulatory Requirements - 354.44(b)(3)

No permit or regulatory process is required for the NKGSA to adopt policies to support the regulations described in this Management Action. No other environmental or regulatory permits would be required.

Status and Schedule - 354.44(b)(4)

The policies have not been drafted. They may commence after 10 years of GSP adoption and be completed within 5 years.

Evaluation of Benefits - 354.44(b)(5)

GP1: The expected benefits may mitigate overdraft by ensuring groundwater supplies are consumed or retained within the NKGSA boundary. Emergency groundwater exports may be metered and recorded by the NKGSA. The method of evaluation may be reviewing the number of emergency export permits.

GP2: The expected benefits may mitigate overdraft by ensuring new developments utilize groundwater supplies in accordance with current NKGSA groundwater allocations and groundwater supplies are consumed or retained within the NKGSA boundary. The method of evaluation may be quantifying the number of new developments within the NKGSA.

GP3: The expected benefits may mitigate local overdraft and minimum threshold exceedances by reducing or temporarily stopping groundwater extractions in a given area. The method of evaluation may be reviewing the financial impacts of reduced or suspended pumping.

How will the management action be accomplished? - 354.44(b)(6)

Management Action No.: **GP1 through GP3**
GP1: The NKGSA may adopt a policy to charge a fee for existing groundwater exports and/or prohibit new groundwater exports outside of the NKGSA boundary. GP2 and GP3: Additionally, the NKGSA will assess groundwater conditions as deemed necessary and may adopt policies to support these actions.
Estimated Costs - 354.44(b)(8)
GP1: Estimated $10,000 cost to draft and adopt policy. Future emergency permits would include fees to cover administrative and monitoring costs. GP2: Estimated $10,000 cost to draft and adopt policy. GP3: Estimated $10,000 cost to draft and adopt policy. Once adopted, the levied fees may fund other projects and management actions.

7 Plan Implementation

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

This section discusses various components of the Plan Implementation including: GSP implementation costs, funding alternatives, implementation schedule, data management system, annual reporting and period evaluations.

7.1 Estimate of GSP Implementation Costs

Regulation Requirements:

§ 354.6. Agency Information When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information: (e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

There are two main types of expenses required to be funded to implement the GSP; Ongoing Administrative Expenses and Project Costs.

Ongoing Administrative Expenses

These include the cost of annually operating the NKGSA including the executive officer's salary, fiscal agent and staff expenses, audit, annual data collection and reporting, outreach, legal, and other administrative costs. This does not include agency specific project implementation costs, but may include NKGSA wide efforts such as identification of construction information for wells in the monitoring network. Costs are estimated to be in the range of $750,000 to $1,000,000 annually. The Administrative/Fiscal Committee will review and develop the anticipated budget each year and present to the Board for consideration and approval.

Project Costs

Projects which may include infrastructure or management programs will be required to achieve groundwater sustainability. Project costs may include planning, capital, financing and operations and maintenance of infrastructure. Each agency within the NKGSA will be responsible for implementing its own projects to reach sustainability. Costs will vary from agency to agency depending on the type and size of projects required to reach sustainability for each service area within the NKGSA. Total costs for the NKGSA are identified in Section 6. The total estimated cost for all the projects described in Section 6 is $800,000,000. Several of these projects have already been constructed and implemented by the agencies within the NKGSA and are included in the GSP as the project benefits are just starting to be realized. Each agency will identify the funding source and plan for their respective projects as discussed in Section 7.2.

7.2 Identify Funding Alternatives

Regulation Requirements**:**

§ 354.6. Agency Information
When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:
(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

The funding of the GSP implementation costs are described below as adopted by the Board of Directors at the June 27, 2019 Board meeting.

Ongoing Administrative Expenses
These annual expenses will be spread to the NKGSA member agencies based on an equal assessment per acre of current service area within the NKGSA. The administrative expenses are determined for each agency and the NKGSA invoices each agency but does not assess or bill landowners directly. Agency boundaries will be based on community water system service areas (sub-area as determined by the NKGSA). Parcels not included in a city or community water system or irrigation or water district will be included in the Fresno County Area. Water systems or districts that are not NKGSA Members, Contracting Entities with Participation Agreements or Interested Parties with MOUs allowing participation, will be invoiced a suggested voluntary cost share on the same basis. Other Interested Parties will also be invoiced a suggested minimum voluntary cost share to be determined by the Board. Any voluntary cost shares received will be credited to the participant that covered the Interested Parties cost share.

The cost of conducting any necessary Proposition 218 elections will be handled by individual agencies. If necessary, upon mutual agreement of the NKGSA and the individual agency, the NKGSA could perform the assessment election for the agency, but the agency will pay all associated costs.

Project Costs
Allocation of project costs to the NKGSA member agency's landowners will be determined by each agency. Costs could be based upon pumpage if metering is available, estimated pumping if metering is not available, land area, or other method as determined by the agency. The projects could also be paid for with existing funding sources, such as capital improvement budgets. Each agency will be required to develop and secure the funding needed to ensure their sustainability by 2040.

Penalties
Penalties for not meeting milestones or exceeding allocation limits set by the NKGSA may be charged to agencies, areas or individual pumpers based on metered usage or estimates of the NKGSA. Penalty revenue could be utilized to fund projects. A determination for penalties has not yet been determined and will be evaluated by the appropriate committee and presented to the Board in the future.

Grant Funding
The NKGSA, through the Kings Coordinated Group, is applying for Proposition 1 Technical Support Services grant funding to offset some of the capital improvement costs associated with the development of new monitoring wells to fill existing data gaps in the monitoring network. The

NKGSA and its member agencies and entities will be exploring other federal and state grant funding opportunities to help finance the initial steps of plan implementation.

7.3 Schedule for Implementation

The schedule for implementation of the projects is based on the agency project specific information provided in Section 6. **Table 6-1** includes an anticipated start and completion date for each project and is sorted by which interim milestone the project will be completed. As noted, the NKGSA would be sustainable if not for increased groundwater pumping from neighboring basins, so reaching the anticipated milestones is largely dependent on neighboring GSAs reducing the groundwater outflow from NKGSA.

7.4 Data Management System

§ 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 NKGSA, in coordination with the other GSAs in the Subbasin, have developed a Data Management System (DMS) to share data and store the necessary information for annual reporting. The GSAs have hired a consultant to build a user-friendly accessible database that standardizes the basin-wide data and allows GSA representatives to input their data and use basic tools for viewing, exporting or printing information for their GSA or the Subbasin. The DMS is a web-based software hosted on a cloud server. The DMS is the single repository for data aggregation and analysis for the subbasin and generates the required annual reporting to DWR. GSA representatives have access to all data in the DMS. The DMS currently includes the necessary elements required by the regulations, including:

- Well location and construction information (where available)
- Water level readings and hydrographs including water year type
- Seasonal groundwater elevation contours
- Estimated groundwater extraction by category
- Total water use by source
- Estimate of groundwater storage change, including map and tables of estimation
- Graph with Water Year type, Groundwater Use, Annual Cumulative Storage Change

The DMS also includes basic data layers for refences including GSA boundaries, topographic information, landuse, 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**.

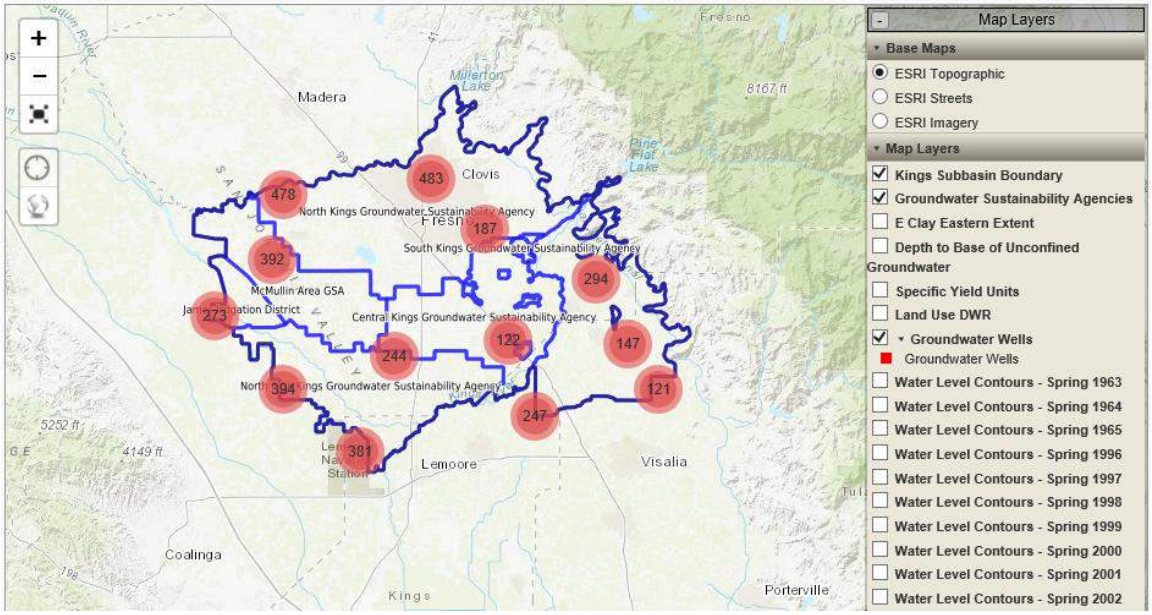


Figure 7-1 Kings Subbasin Data Management System Screenshot

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 NKGSA (and the Subbasin) is not currently measured, the groundwater pumping estimates are also calculated outside of the DMS using the agreed basin-wide water budget approach then uploaded to the DMS for annual reporting and trend analysis. Surface water deliveries are maintained by the surface water agencies in separate systems already, and that data is collected by each GSA and provided to the DMS as an aggregate total by GSA. Table 7.1 provides a summary of how the DMS addresses each required element of the DMS and annual reporting requirements. NKGSA and the other GSAs may choose to have their own separate system for additional analysis.

Table 7-1 DMS Annual Reporting Requirements

Regulation	Requirement	Input to DMS
356.2(b)(1)(B)	Hydrographs incl water year type from Jan 2015	Generated in DMS from water level data input by GSAs
356.2(b)(1)(A)	GW Elevation Contours (spring & fall)	Generated outside DMS using data from DMS then contour lines uploaded into DMS
356.2(b)(2)	GW extraction by water use sector incl method of determination and map	Determined outside DMS. Total use by sector input by each GSA then summarized for basin in DMS
356.2(b)(3)	Surface Water use by source	Total by GSA input to DMS and summarized for basin in DMS
356.2(b)(4)	Total Water use by sector	DMS summary table of water supplies by sector per GSA

Regulation	Requirement	Input to DMS
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

Regulatory Requirements:

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

(a) General information, including an executive summary and a location map depicting the basin covered by the report.

(b) A detailed description and graphical representation of the following conditions of the basin managed in the Plan:

(1) Groundwater elevation data from monitoring wells identified in the monitoring network shall be analyzed and displayed as follows:

(A) Groundwater elevation contour maps for each principal aquifer in the basin illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions.

(B) Hydrographs of groundwater elevations and water year type using historical data to the greatest extent available, including from January 1, 2015, to current reporting year.

(2) Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector, and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions.

(3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.

(4) Total water use shall be collected using the best available measurement methods and shall be reported in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements. Existing water use data from the most recent Urban Water Management Plans or Agricultural Water Management Plans within the basin may be used, as long as the data are reported by water year.

(5) Change in groundwater in storage shall include the following:

(A) Change in groundwater in storage maps for each principal aquifer in the basin. (B) A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.

(c) A description of progress towards implementing the Plan, including achieving interim milestones, and implementation of projects or management actions since the previous annual report.

The NKGSA 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 31st - Deadline for GSAs to provide GSA specific information
- Feb 28th – completion of draft annual report
- March – review by GSA and Board approval
- April 1 – submittal to DWR by Basin Coordinator

The Kings Subbasin annual report will have the following outline:

Chapter 1 - Introduction
Chapter 2 - Landuse and Surface Water Supplies
Chapter 3 - Groundwater Pumping
Chapter 4 - Sustainable Management Criteria
4.1 – Sustainable Goal
4.2 - Groundwater Levels
4.3 - Groundwater Storage
4.4 - Groundwater Quality
4.5 - Land Subsidence
4.6 - Surface to Groundwater Interconnection
Chapter 5 - Monitoring Network Changes
Chapter 6 - Groundwater Projects and Management Actions Status

In addition to the required Basin wide reporting to DWR, the NKGSA will generate an annual report that will include the elements reported with other GSAs to DWR, as well as NKGSA specific information which may include, but is not limited to:

- Member and Participating agency project/program specific progress and status updates
- Newly identify projects and programs added to the project list
- Updates on changes in membership or organizational changes
- Policy changes or modifications
- New information collected in data gaps
- Area specific investigations or improvements
- Stakeholder engagement and outreach efforts
- GSA funding status

7.6 Periodic Evaluations

Regulation Requirements:

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

(a) A description of current groundwater conditions for each applicable sustainability indicator relative to measurable objectives, interim milestones and minimum thresholds.

(b) A description of the implementation of any projects or management actions, and the effect on groundwater conditions resulting from those projects or management actions.

(c) Elements of the Plan, including the basin setting, management areas, or the identification of undesirable results and the setting of minimum thresholds and measurable objectives, shall be reconsidered and revisions proposed, if necessary.

(d) An evaluation of the basin setting in light of significant new information or changes in water use, and an explanation of any significant changes. If the Agency's evaluation shows that the basin is experiencing overdraft conditions, the Agency shall include an assessment of measures to mitigate that overdraft.

(e) A description of the monitoring network within the basin, including whether data gaps exist, or any areas within the basin are represented by data that does not satisfy the requirements of Sections 352.4 and 354.34(c). The description shall include the following:

(1) An assessment of monitoring network function with an analysis of data collected to date, identification of data gaps, and the actions necessary to improve the monitoring network, consistent with the requirements of Section 354.38.

(2) If the Agency identifies data gaps, the Plan shall describe a program for the acquisition of additional data sources, including an estimate of the timing of that acquisition, and for incorporation of newly obtained information into the Plan.

(3) The Plan shall prioritize the installation of new data collection facilities and analysis of new data based on the needs of the basin.
(f) A description of significant new information that has been made available since Plan adoption or amendment, or the last five-year assessment. The description shall also include whether new information warrants changes to any aspect of the Plan, including the evaluation of the basin setting, measurable objectives, minimum thresholds, or the criteria defining undesirable results.
(g) A description of relevant actions taken by the Agency, including a summary of regulations or ordinances related to the Plan.
(h) Information describing any enforcement or legal actions taken by the Agency in furtherance of the sustainability goal for the basin.
(i) A description of completed or proposed Plan amendments.
(j) Where appropriate, a summary of coordination that occurred between multiple Agencies in a single basin, Agencies in hydrologically connected basins, and land use agencies.
(k) Other information the Agency deems appropriate, along with any information required by the Department to conduct a periodic review as required by Water Code Section 10733.

The NKGSA 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 NKGSA 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 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. and Periodic Evaluation by Agency.

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Appendices

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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. Dusoff

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 ______________________________

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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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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 ______________________________

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Date: ______________________________

KINGS RIVER EAST GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By [signature]

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Date: 11/21/2019

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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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 [signature]
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 ______________________________

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 [signature]

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: __________________________

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 ______________________________

____

Date: ______________________________

JAMES GROUNDWATER SUSTAINABILITY AGENCY, a public agency of the State of California

By ______________________________

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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 [signature]

____

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.

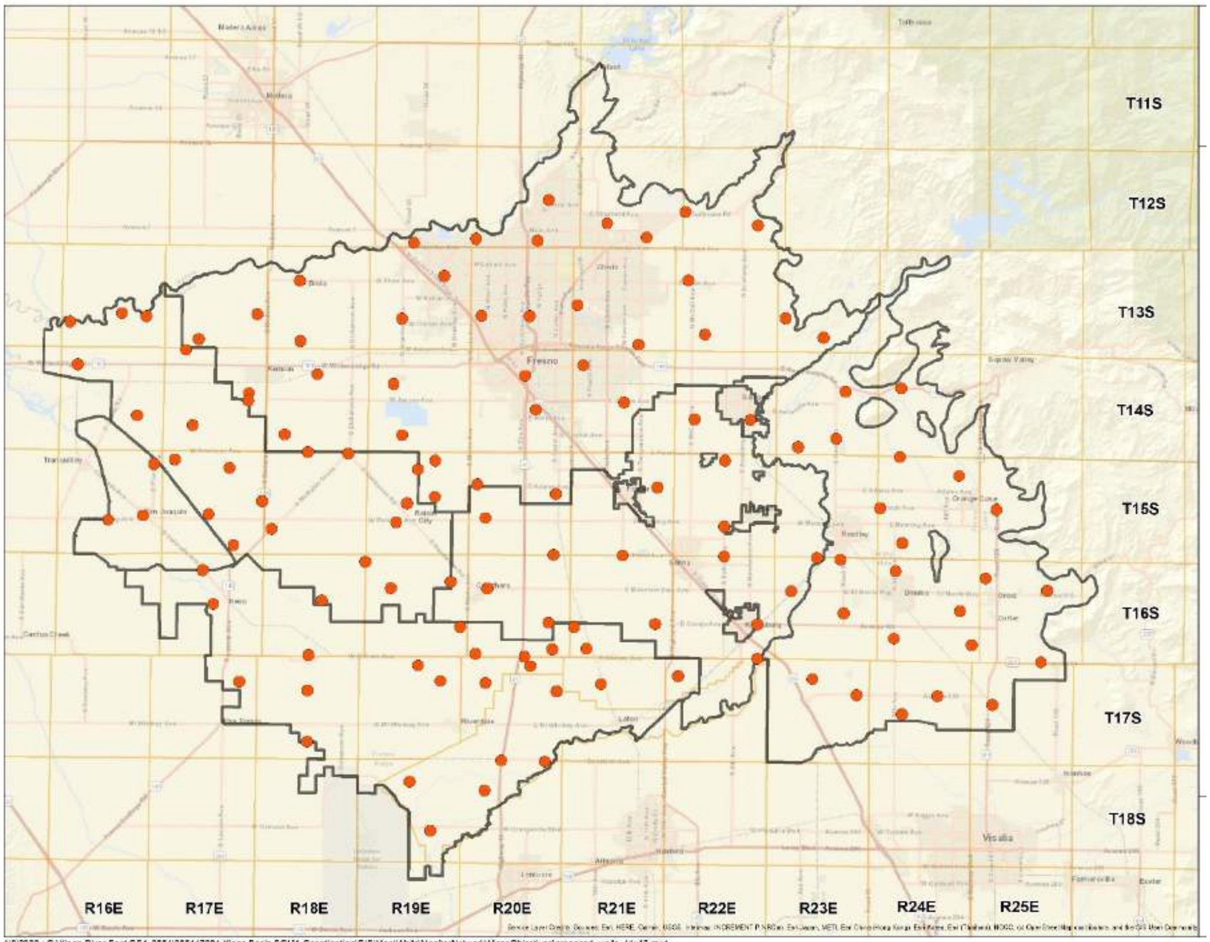
II. Description of Monitoring Networks

The GSAs within the Kings Basin have established three monitoring networks within each GSA for water level, water quality and subsidence.

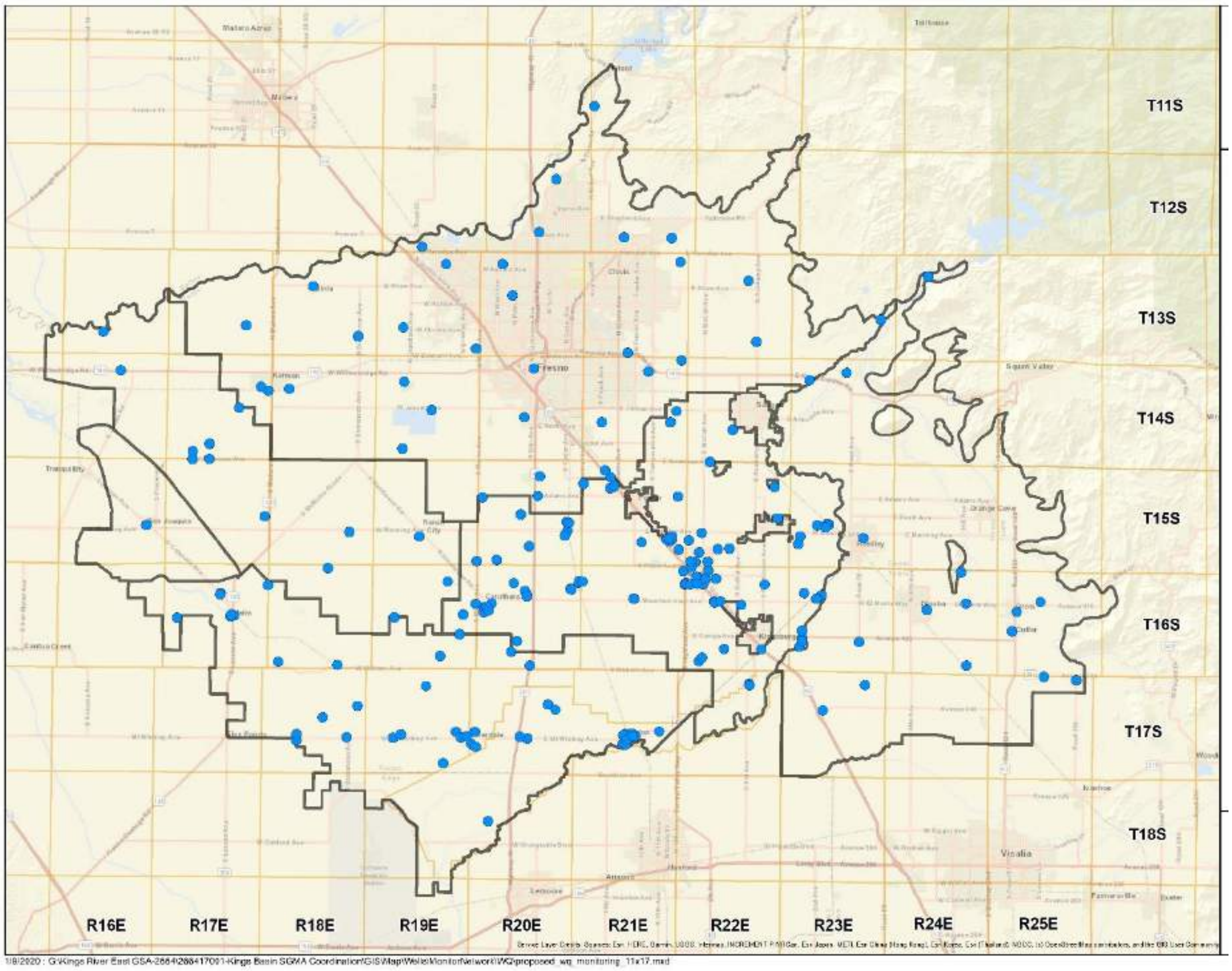
The objectives of the various monitoring programs include the following:

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.

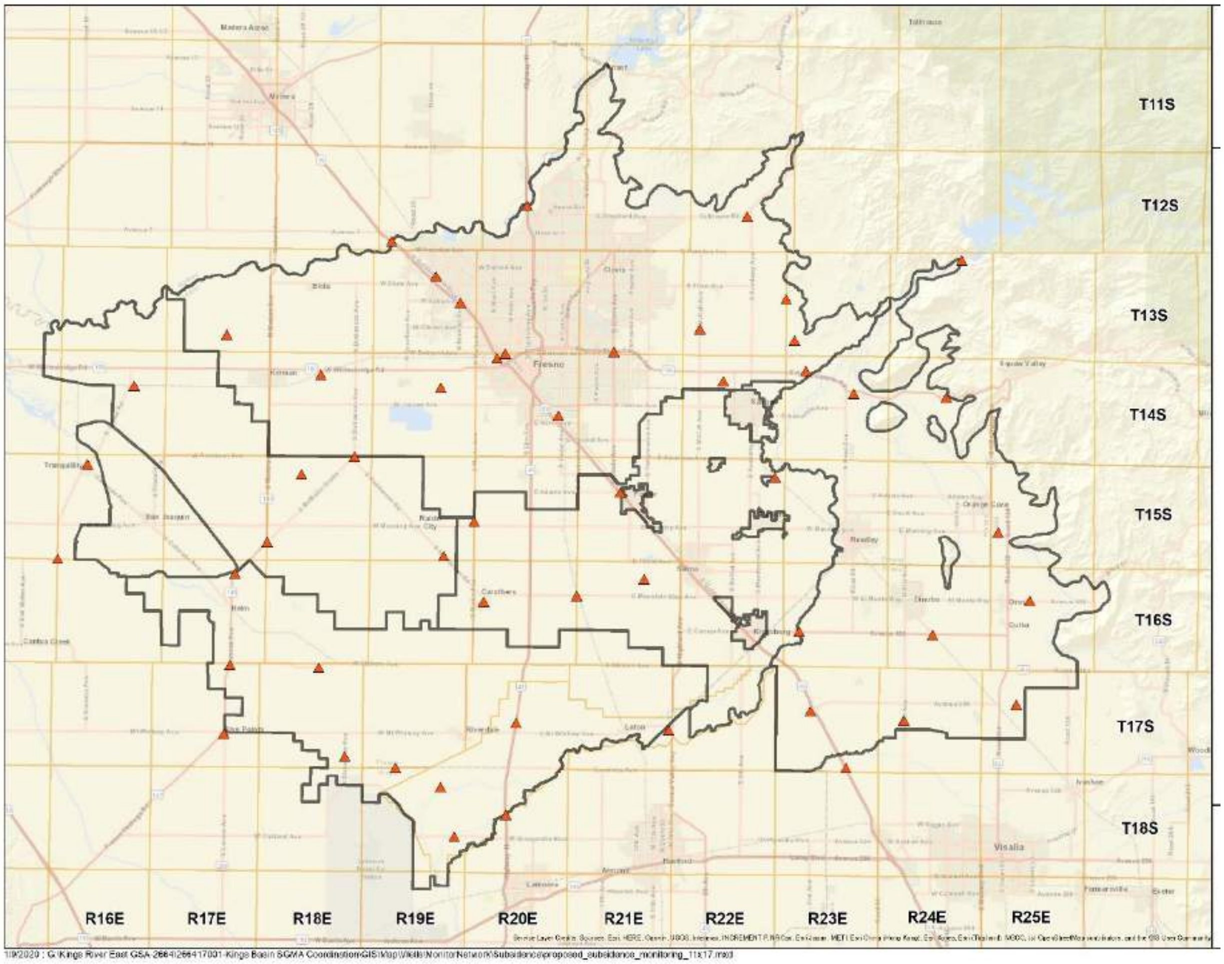
The water level monitoring network will utilize existing wells that have been historically monitored for groundwater level. The GSAs are planning to locate additional monitor wells in areas with limited data, and these will be added to the network. Each GSA will discuss their individual monitoring network 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.



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	Section(s) or Page Number(s) in the GSP
Article 3. Technical and Reporting Standards				
352.2		Monitoring Protocols	• Monitoring protocols adopted by the GSA for data collection and management • Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin	Sections 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	Section ES Appendices and Section 8
354.6		Agency Information	• GSA mailing address • Organization and management structure • Contact information of Plan Manager • Legal authority of GSA • Estimate of implementation costs	Section 1.5 Section 7.1
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	Section 2(**Fig. 2-1, 2-2**) Section 2 (**Figures 2-1**) Section 2 **(Figure 2-2)** Section 2 (**Figure 2-3**) Section 2 (**Figure 2-4**)

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 1. Administrative Information (Continued)				
354.8(b)		Description of the Plan Area	• Summary of jurisdictional areas and other features	Section 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	Section 2.2 Section 2.2.1 Section 2.2.2 Section 2.2.3
354.8(f)	10727.2(g)	Land Use Elements or Topic Categories of Applicable General Plans	• Summary of general plans and other land use plans • Description of how implementation of the GSP may change water demands or affect achievement of sustainability and how the GSP addresses those effects • Description of how implementation of the GSP may affect the water supply assumptions of relevant land use plans • Summary of the process for permitting new or replacement wells in the basin • Information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management	Section 2.3 (2.3.1) Section 2.3.2 Section 2.3.3 Section 2.3.4 Section 2.3.5

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 1. Administrative Information (Continued)				
354.8(g)	10727.4	Additional GSP Contents	**Description of Actions related to:** • Control of saline water intrusion • Wellhead protection • Migration of contaminated groundwater • Well abandonment and well destruction program • Replenishment of groundwater extractions • Conjunctive use and underground storage • Well construction policies • Addressing groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects • Efficient water management practices • Relationships with State and federal regulatory agencies • Review of land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity • Impacts on groundwater dependent ecosystems	Section 2.4 Section 2.4.1 Section 2.4.2 Section 2.4.3 Section 2.4.4 Section 2.4.5 Section 2.2.3 Section 2.4.6 Sections 2.2.1 and 2.2.2 Section 2.4.8 Section 2.4.9 Section 2.3.3 Section 2.4.10
354.10		Notice and Communication	• Description of beneficial uses and users • List of public meetings • GSP comments and responses • Decision-making process • Public engagement • Encouraging active involvement • Informing the public on GSP implementation progress	Section 2.5 (2.5.1) Section 2.5.3 Appendix 2-D Section 2.5.2 Section 2.5.3, 2.5.4 Section 2.5.3 Section 7.5

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 2. Basin Setting				
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	Section 3.1 Section 3.1.7**(Fig 3.7-3.12)** Section 3.1.1-3.1.8 **(Figures 3.1 - 3-15)**
354.14(c)(4)	10727.2(a)(5)	Map of Recharge Areas	• Map delineating existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas	Section 3.1.12 **(Figure 3-19)**
	10727.2(d)(4)	Recharge Areas	• Description of how recharge areas identified in the plan substantially contribute to the replenishment of the basin	Section 3.1.12
354.16	10727.2(a)(1) 10727.2(a)(2)	Current and Historical Groundwater Conditions	• Groundwater elevation data • Estimate of groundwater storage • Seawater intrusion conditions • Groundwater quality issues • Land subsidence conditions • Identification of interconnected surface water systems • Identification of groundwater-dependent ecosystems	Section 3.2 (3.2.1) Section 3.2.3 Section 3.2.4 Section 3.2.5 Section 3.2.6 Section 3.2.7 Section 3.2.8
354.18	10727.2(a)(3)	Water Budget Information	• Description of inflows, outflows, and change in storage • Quantification of overdraft • Estimate of sustainable yield • Quantification of current, historical, and projected water budgets	Section 3.3 (3.3.3) Section 3.3.4 Section 3.3.4 Section 3.3.5
	10727.2(d)(5)	Surface Water Supply	• Description of surface water supply used or available for use for groundwater recharge or in-lieu use	Sections 3.1.10, 3.3.3, 3.4

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 2. Basin Setting (Continued)				
354.20		Management Areas	• Reason for creation of each management area • Minimum thresholds and measurable objectives for each management area • Level of monitoring and analysis • Explanation of how management of management areas will not cause undesirable results outside the management area • Description of management areas	Section 3.5
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria				
354.24		Sustainability Goal	• Description of the sustainability goal	Section 4.1
354.26		Undesirable Results	• Description of undesirable results • Cause of groundwater conditions that would lead to undesirable results • Criteria used to define undesirable results for each sustainability indicator • Potential effects of undesirable results on beneficial uses and users of groundwater	Sections 4.2.1, 4.3.1, 4.4.1, 4.5.1 and 4.6.1
354.28	10727.2(d)(1) 10727.2(d)(2)	Minimum Thresholds	• Description of each minimum threshold and how they were established for each sustainability indicator • Relationship for each sustainability indicator • Description of how selection of the minimum threshold may affect beneficial uses and users of groundwater • Standards related to sustainability indicators • How each minimum threshold will be quantitatively measured	Sections 4.2.2, 4.3.2, 4.4.2, and 4.5.2

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria (Continued)				
354.30	10727.2(b)(1) 10727.2(b)(2) 10727.2(d)(1) 10727.2(d)(2)	Measureable Objectives	• Description of establishment of the measureable objectives for each sustainability indicator • Description of how a reasonable margin of safety was established for each measureable objective • Description of a reasonable path to achieve and maintain the sustainability goal, including a description of interim milestones	Sections 4.2.3, 4.3.3, 4.4.3, 4.5.3 and 4.6.3
Article 5. Plan Contents, Subarticle 4. Monitoring Networks				
354.34	10727.2(d)(1) 10727.2(d)(2) 10727.2(e) 10727.2(f)	Monitoring Networks	• Description of monitoring network • Description of monitoring network objectives • Description of how the monitoring network is designed to: demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features; estimate the change in annual groundwater in storage; monitor seawater intrusion; determine groundwater quality trends; identify the rate and extent of land subsidence; and calculate depletions of surface water caused by groundwater extractions • Description of how the monitoring network provides adequate coverage of Sustainability Indicators • Density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends • Scientific rational (or reason) for site selection • Consistency with data and reporting standards • Corresponding sustainability indicator, minimum threshold, measureable objective, and interim milestone	Section 5.1 Sections 5.2.1, 5.3.1, 5.5.1 5.6.1 and 5.7.1 Sections 5.2.2, 5.3.2, 5.5.2, 5.6.2 and 5.7.2 Section 5.2.4, 5.3.4, 5.5.4, 5.6.4 & 5.7.4

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 4. Monitoring Networks (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	Section 5.2.5, 5.3.5, 5.5.5, 5.6.5 and 5.7.5 Section 5.2.6, 5.3.6, 5.5.6, 5.6.6 and 5.7.6
354.36		Representative Monitoring	• Description of representative sites • Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators • Adequate evidence demonstrating site reflects general conditions in the area	Section 5.2.7, 5.3.7, 5.5.7, 5.6.7, 5.7.7
354.38		Assessment and Improvement of Monitoring Network	• Review and evaluation of the monitoring network • Identification and description of data gaps • Description of steps to fill data gaps • Description of monitoring frequency and density of sites	Section 5.2.8, 5.3.8, 5.5.8, 5.6.8, 5.7.8

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
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	Section 6.2 and 6.3
354.44(b)(2)	10727.2(d)(3)		• Overdraft mitigation projects and management actions	Section 6.2 and 6.3

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 8. Interagency Agreements				
357.4	10727.6	Coordination Agreements - Shall be submitted to the Department together with the GSPs for the basin and, if approved, shall become part of the GSP for each participating Agency.	**Coordination Agreements shall describe the following:** • A point of contact • Responsibilities of each Agency • Procedures for the timely exchange of information between Agencies • Procedures for resolving conflicts between Agencies • How the Agencies have used the same data and methodologies to coordinate GSPs • How the GSPs implemented together satisfy the requirements of SGMA • Process for submitting all Plans, Plan amendments, supporting information, all monitoring data and other pertinent information, along with annual reports and periodic evaluations • A coordinated data management system for the basin • Coordination agreements shall identify adjudicated areas within the basin, and any local agencies that have adopted an Alternative that has been accepted by the Department	Section 1.3 Appendix 1-A

Appendix 2 A North Kings GSA Outreach Plan

NORTH KINGS GROUNDWATER
SUSTAINABILITY AGENCY

Final Draft North Kings GSA Public Outreach Plan

March 12, 2018

Prepared for:

North Kings Groundwater Sustainability Agency

Prepared by:

Communication and Engagement Subcommittee

Executive Summary

Purpose of Public Outreach Plan

The North Kings Groundwater Sustainability Agency (North Kings GSA) Public Outreach Plan provides a high-level overview of near- and long-term outreach strategies, tactics and tools that support public and stakeholder communication actions, as required by the Sustainable Groundwater Management Act (SGMA) of 2014. The Public Outreach Plan identifies and describes both North Kings GSA and member agency actions to inform and engage stakeholders about development of the GSP, deliver clear and consistent messaging about SGMA and comply with the SGMA outreach requirements.

North Kings GSA Outreach Tools

The Public Outreach Plan identifies a number of tools to support communication and engagement activities with stakeholders. These tools include the following:

- Interested Party Database: Pursuant to the requirements of SGMA, the North Kings GSA has developed and will maintain an Interested Party Database. Managed via email marketing service provider Constant Contact, the Interested Party Database will be used to notify stakeholders and public of pending meetings and workshops of the Board of Directors and Advisory Committee, notifications of GSP Development Updates, and notices of other North Kings GSA outreach actions.
- Project Website: The North Kings GSA partner agencies have developed a stand-alone website for the GSA: www.NorthKingsGSA.org. The website provides information about SGMA, the member agencies, Board of Directors (Board) and Advisory Committee meeting notices, public outreach information and frequently asked questions.
- Key Messages: The North Kings GSA has developed an initial list of key messages for use in all North Kings GSA communications. These key messages are included as attachment to the Public Outreach Plan.
- Community Engagement and Activities Database: The Communication Engagement and Activities Database identifies potential stakeholder and outreach audiences. Stakeholders have been divided into three stakeholder "tiers." Pursuant to the requirements of SGMA, any outreach conducted to these stakeholders will be recorded in the Database and listed in the GSP. These tiers are described as follows:
    - **Group 1:** *Collaborated (Inform + Consult + Collaborate)* – This group is closely connected during the planning process through direct engagements aimed to share information and encourage in two-way communication. Scheduled on request of the North Kings GSA, these engagements seek to gather information, and work on solutions to existing and emerging issues.
    - **Group 2:** *Consulted (Inform + Consult)* – This group is connected during planning through written informational materials and scheduled presentations. These presentations are held on request of North Kings GSA. Attendees are invited to provide feedback to presented materials.
    - **Group 3:** *Connected (Inform)* – This group is connected during planning through written informational materials and prepared informational presentations. These presentations are held upon request to the North Kings GSA.
- GSP Development Updates: GSP Development Updates inform stakeholders of the status of the North Kings GSP development process and notify stakeholders about upcoming public meetings.

- Outreach Materials: The North Kings GSA will develop template outreach materials for each phase of the GSP development and implementation process. These materials will be translated into multiple languages, and may include informational flyers, fact sheets, new releases or utility bill inserts.

Groundwater Sustainability Plan Development Outreach

The Public Outreach Plan identifies a variety of outreach activities to provide the public and stakeholders opportunities to be informed and engaged in the North Kings GSA and in the development of the GSP. These outreach activities seek to build and expand public awareness of the North Kings GSA, the Sustainable Groundwater Management Act, and groundwater connections within and adjacent to the North Kings GSA. These activities further seek to actively engage with key stakeholder groups to coordinate and collaborate on technical issues important for development of the GSP. Below is a summary of these engagement activities planned to be on-going from 2018 to mid-2019.

- Board Meetings and Workshops: The first of two standing meetings subject to California's open meetings laws, the monthly meetings of the North Kings GSA Board of Directors is an important opportunity for the public and stakeholders to participate in development of the GSP. Each meeting includes a public comment session for participants to offer insights and request additional information. Meeting notification and summaries are posted to the agency website and via Constant Contact email campaigns.
- Advisory Committee Meetings and Workshops: The second of two standing meetings subject to California's open meetings laws, these monthly meetings support active engagement in the planning process by stakeholders and the public. As with the Board meetings, each Advisory Committee meeting includes a public comment session for participants to offer insights and request additional information. Meeting notification and summaries are posted to the agency website and via Constant Contact email campaigns.
- Member Agency Briefings: These sessions include periodic presentation to member agency boards, councils and commissions by the North Kings GSA staff. Held as part of the member agency's publicly noticed meetings, these briefings are intended to provide an update on plan progress and next steps, and respond to questions. Interested parties will be notified of the agency's participation via Constant Contact.
- Public and Stakeholder Meetings: In support of plan development, the North Kings GSA will periodically host or participate in meetings to present technical findings and exchange information with key stakeholders. These sessions will focus on Tier 1 audiences as described above. Interested parties will be notified of these meetings via Constant Contact.
- Community Presentations: The North Kings GSA anticipates providing brief, high-level overviews of the GSP process and status at meetings hosted by various civic, non-profit, and community groups. These sessions – provided as-needed or upon request – will include Tier 2 and 3 audiences as described above. Interested parties will be notified of these meetings via Constant Contact.

Groundwater Sustainability Plan Adoption Outreach

Formal communication and engagement activities focused on adoption of the North Kings GSP is anticipated to start in mid-2019 with the release of the Public Draft GSP. This outreach is anticipated to include hosting of two public hearings (pursuant to Water Code Section 10728.4) during a period of public review of up to 60-days. These meetings will be noticed by at least two newspaper notices published 14 days prior to the hearing and at least five days apart. Oral and written comments provided following the close of the public comment period will be compiled into a Public Comment Report. Information contained in this report will be considered for incorporation to the Final Draft GSP for adoption no later than Jan. 31, 2020.

PUBLIC OUTREACH PLAN

CONTENTS

Acronyms and Abbreviations

Board	North Kings GSA Board of Directors
CASGEM	California Statewide Groundwater Elevation Monitoring Program
DWR	California Department of Water Resources
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
JPA	Joint Powers Authority
North Kings GSA	North Kings Groundwater Sustainability Agency
SGMA	Sustainable Groundwater Management Act
Water Board	State Water Resources Control Board

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1.0 INTRODUCTION AND OVERVIEW

As part of its development and passage of the Sustainable Groundwater Management Act (SGMA) of 2014, the State legislature intended that local public agency actions pursuant to the new law be conducted in an open public process. This document identifies and presents the public and stakeholder communication and engagement activities to be implemented by the North Kings Groundwater Sustainability Agency (North Kings GSA) in support of development and eventual implementation of a Groundwater Sustainability Plan (GSP) within the agency's jurisdictional boundaries. This document describes planned outreach activities as required by California Code of Regulations Section 354.10:

§ 354.10. Notice and Communication

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

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

(b) A list of public meetings at which the Plan was discussed or considered by the Agency.

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

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

(1) An explanation of the Agency's decision-making process.

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

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

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

Key Sustainable Groundwater Management Act Dates:

- June 30, 2017: Establish Groundwater Sustainability Agencies (or equivalent) for all high and medium priority basins – Water Code § 10724(b)
- July 1, 2017: County must affirm or disaffirm responsibility as Groundwater Sustainability Agency if no Groundwater Sustainability Agency has been established – Water Code § 10724(b)
- Jan. 31, 2020: All critically overdrafted high and medium priority basins must be managed under a Groundwater Sustainability Plan. Water Code § 10720.7(a)(1)
- On April 1 following Groundwater Sustainability Plan adoption and annually thereafter, Groundwater Sustainability Agencies provide report on progress towards sustainability to the California Department of Water Resources. Water Code § 10728

1.1 ABOUT THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT

SGMA was passed in the third year of California's chronic drought that witnessed substantial demand on groundwater resources throughout the state. While the drought was declared over due to near record rainfall in the 2016/17 season, groundwater basins throughout the state have not recovered to pre-drought conditions and, in some cases, experienced permanent groundwater storage capacity losses through land subsidence. The legislation requires local public agencies[1] and newly-formed Groundwater Sustainability Agencies (GSA) in high and medium priority subbasins to sustainably manage California groundwater resources with oversight by the California Department of Water Resources (DWR) and potential intervention by the State Water Resources Control Board (Water Board) if management activities are determined to be inadequate. Passage of SGMA ended an era where sustainable groundwater management was a voluntary action or a court mandated requirement through adjudication.

Following passage of SGMA, the DWR embarked on a series of public and agency meetings to develop Groundwater Sustainability Plan (GSP) Emergency Regulations. These regulations were released in July 2016 and are chaptered under the California Code of Regulations Title 23. Waters (§350-§358.4). In conjunction with release of these regulations, the DWR published *Groundwater Sustainability Plan Emergency Regulations Guide*[2]. The guide summarizes and defines the processes and requirements found in Title 23 for GSA formation, the development and implementation of GSPs, the responsibilities of the DWR and interbasin coordination (§357.2). See Attachment A for a summary of public and stakeholder outreach requirements under SGMA.

1.2 ABOUT THE KINGS SUBBASIN

The Kings Subbasin (DWR Bulletin 116, 5-022.08, Figure 1) is one of 515 groundwater subbasins in California, and is one of 127 subbasins that have been identified as high or medium priority by DWR's California Statewide Groundwater Elevation Monitoring (CASGEM) Program. The CASGEM Program has identified the Kings Subbasin as a high priority critical overdraft basin, a determination that requires implementation of sustainable groundwater management actions by January 31, 2020. The subbasin is primarily located within the County of

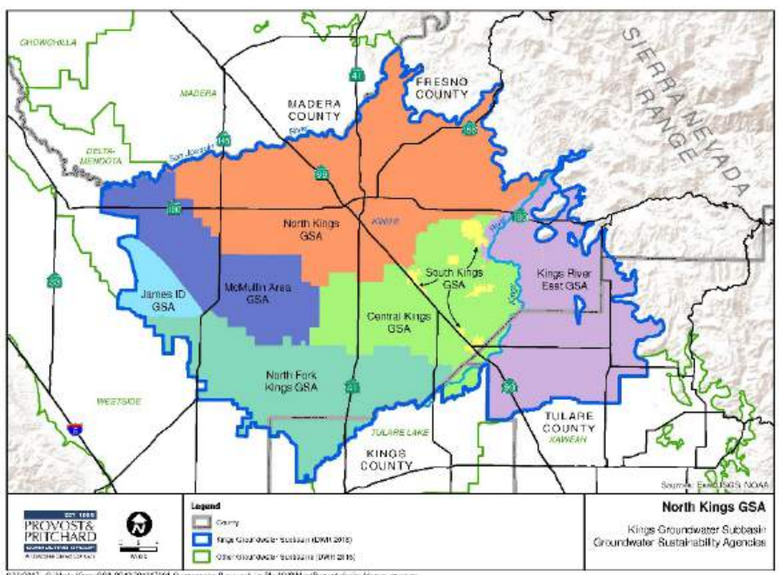


Figure 1-1: Groundwater Sustainability Agencies of the Kings Subbasin

[1] California Water Code §10721(m) – "Local agency" means a local public agency that has water supply, water management or land use responsibilities within a groundwater basin.

[2] http://www.water.ca.gov/groundwater/sgm/pdfs/Groundwater Sustainability Plan_Final_Regs_Guidebook.pdf

Fresno, and includes portions of Kings and Tulare counties. At the time of this plan, seven GSAs have been established within the subbasin pursuant to SGMA, including:

- Central Kings GSA
- James Irrigation District GSA
- Kings River East GSA
- McMullin Area GSA
- North Kings GSA
- North Fork Kings GSA
- South Kings GSA

1.3 ABOUT THE NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY

The North Kings GSA was established in November 2016 as a joint power authority (JPA) of eight local public agencies eligible to serve as a GSA for their jurisdictional boundary. Founding members of the JPA include Fresno Irrigation District, Garfield Water District, International Water District, Biola Community Services District, City of Clovis, City of Fresno, City of Kerman and County of Fresno. Since its formation, the agency's Board of Directors (Board) have executed agreements with Bakman Water Company, a private water company regulated by the California Public Utilities Commission, and Fresno Metropolitan Flood Control District as member agencies. The North Kings GSA is governed by a seven-member Board of Directors, with support of an Advisory Committee. Directors include elected officials who have been appointed to serve on the agency's Board of Directors by their respective boards, councils or commissions, or are the authorized representative of a Member, Contracting Entity or Interested Party. Four of the seven board seats are permanently assigned, while two are shared seats. One seat is appointed by a vote of the Board of Directors from any non-agricultural member not currently serving a board term. Table 1-1 provides the governing body of the Board of Directors.

Table 1-1: North Kings GSA Governing Body

Seat #	Assignment
1	Fresno Irrigation District
2	Garfield Water District, International Water District and Fresno Irrigation District[3]
3	Bakman Water Co., Biola Community Services District, City of Kerman and Fresno Metropolitan Flood Control District
4	City of Clovis
5	City of Fresno[4]
6	County of Fresno
7	At-Large

[3] Fresno Irrigation District ("FID"), International Water District ("IWD") and Garfield Water District ("GWD") have entered into a separate written agreement dealing with how they will exercise the governance responsibilities and voting for Seat # 2, including but not limited to how to exercise the voting rights, succession rights and financial participation in the GSA, and the consequences of any mergers or consolidation of any or all of those districts into municipalities, etc., as it affects voting and participation right of this "Board Seat Portion" # 2 in the North Kings GSA. All members acknowledge that any withdrawal or termination of IWD or GWD from this JPA shall not divest FID' s retaining its interest in Seat 2 under that separate agreement, any §5.03 Member vote under this JPA notwithstanding.

[4] The City of Fresno is governed using a Mayor-Council form of Government, and the Mayor shall serve as the City's representative to the governing body of the Authority. In addition, the Mayor shall appoint the alternates to the Board who shall be an elected official, appointed official or employee of the City of Fresno.

2.0 NORTH KINGS GSA DECISION MAKING

Consistent with the legislature's intent and objective for SGMA, the North Kings GSA is a locally-led effort to develop and implement sustainable groundwater management actions for groundwater users and groundwater dependent ecosystems within the jurisdictional boundaries of the agency.

The decision-making structure of the North Kings GSA is delivered through a hierarchical structure where subcommittees, committees and executive staff advise, and request direction from, the Board of Directors on important topics and issues. Figure 2-1 provides the decision-making structure of the agency.

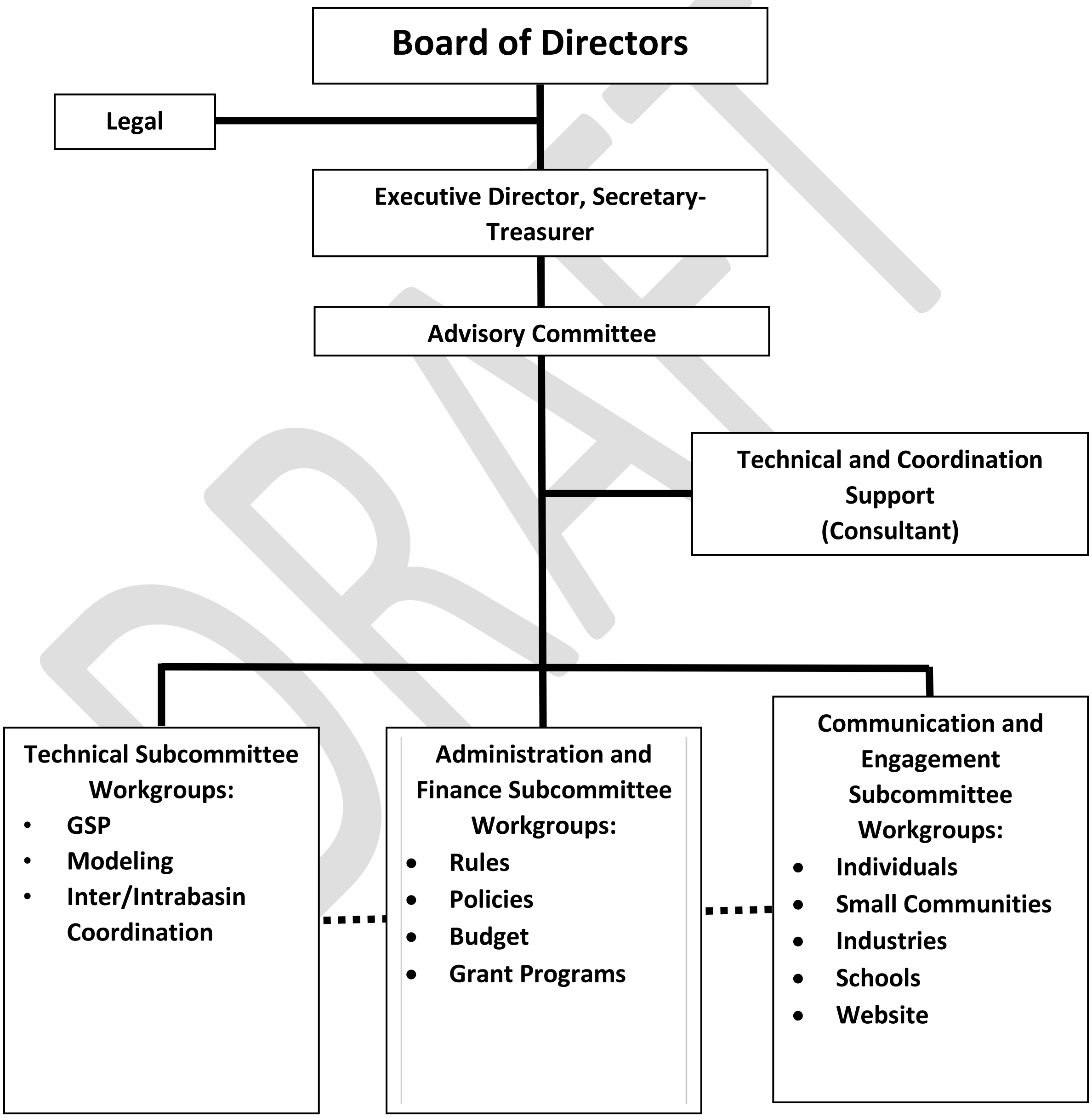


Figure 2-1. North Kings GSA Management Structure

Decisions directly associated with SGMA compliance are subject to a vote of the Board. The board holds its monthly meetings at the Fresno Irrigation District boardroom in Fresno, California.

The North Kings GSA Board members are elected officials who have been appointed to serve as a board member by their respective boards, councils or commissions, or are the authorized representative of a Member, Contracting Entity or Interested Party. Board member decisions are agreed via a simple majority vote unless the issue falls into one of nine pre-identified categories. These categories and the associated voting threshold are identified in Table 2-1.

Table 2-1: North Kings GSA Voting Thresholds

Key Authority	Threshold
Adoption of or amendments to the GSP	Unanimous vote of all Directors
To incur debts, liabilities or obligations on behalf of the Authority	Five Affirmative Votes by Directors
Adoption of or revisions to policies of the Authority	Five Affirmative Votes by Directors
GSA Enforcement	Five Affirmative Votes by Directors
Authorization to obligate the Authority to participate in litigation, or other legal proceedings	Five Affirmative Votes by Directors
Amendment of the Agreement	Unanimous vote of all Directors, subject to ratification by all Members under 7.01[5]
Any Assessment or Fees levied or imposed by the GSA	Unanimous vote of all Directors
Budget allocation among Parties for GSA operations after the initial GSP	Five Affirmative Votes by Directors
Removal of a Member from the GSA	Five Affirmative Votes by Directors

Decision-making support to the Board is defined in Section 3.09 of the North Kings GSA JPA:

The Board of Directors may establish standing committees and ad hoc committees as it deems necessary. The Board of Directors shall establish membership of those committees. The Board of Directors may also dissolve any committee it deems to be no longer necessary.

Standing and ad hoc committees established by the Board of Directors include the Advisory Committee and three ad hoc subcommittees: 1) Technical, 2) Administration and Finance and 3) Communication and Engagement. The Board is further advised by key staff including the executive director and legal counsel.

EXECUTIVE DIRECTOR, SECRETARY-TREASURER

The Executive Director is appointed by a vote of and serves at the pleasure of the Board. This position provides administrative and fiscal management for the GSA. Administrative duties include servicing the needs of the GSA and Board including, but not limited to meeting calendars, notices, agendas, minutes, resolutions and other reports or services required to conduct the business of the GSA. As fiscal agent the duties include payables, receivables, audit data, audits and any other fiscal requirements or fiscal controls needed to conduct the business of the GSA.

[5] Section 7.01 – Amendment. This Agreement may be amended from time to time by the unanimous vote of all of the Members.

LEGAL COUNSEL

Legal counsel will serve at the pleasure of the Board. Counsel selection will be through a process recommended to the Board from the advisory bodies made of the member organizations of the agency.

ADVISORY COMMITTEE

The North Kings GSA Advisory Committee is a standing committee of the Board of Directors and represents one of the primary opportunities for public participation in groundwater planning and management provided by the agency. The Advisory Committee is appointed by the Board of Directors based on nominees provided by member agencies. All Advisory Committee meetings are open to the public, with notifications and meeting records provided pursuant to the Brown Act. The Advisory Committee consists of representatives of each member agency and serves two key functions: 1) to consult and receive direction from the Board of Directors on key topics and process requirements associated with compliance with SGMA, and 2) to direct development of the GSP for the North Kings GSA and other actions pursuant to Board direction in coordination with identified subcommittees.

SUBCOMMITTEES

The Advisory Committee is responsible for the identification and formation of ad hoc subcommittees needed to attend to specific categories of the GSA. Subcommittees are established to perform specific tasks of variable duration depending on complexity and need. The following represents the preliminary type and scope of effort of the subcommittees and their associated work groups. Work group activities will have priority rankings with the most important work efforts addressed first. Representatives of the subcommittees will be recommended/selected by the Advisory Committee and can include agency staff with appropriate expertise, groundwater-user representatives and outside consultants.

Administration and Finance Subcommittee

This committee's duties include development and implementation of all the policies and procedures needed for the GSA, including the rules and regulations needed to implement the goals of any GSPs as well as the actions needed to manage the financial health of the organization.

Work groups for this committee could include: a) general administrative policies and procedures for conduct of business including for Directors, employees, member agencies, etc.; b) policies and procedures for collections, investments and audits; and c) GSA rules and regulations for enforcement of the mission of the organization, groundwater management.

Communication and Engagement Subcommittee

This committee is charged with development of required communication and engagement activities aimed to provide clear, consistent and collaborative outreach to basin stakeholders and other interested parties.

The role of the Communication and Engagement Subcommittee is to:

- Advise and direct development of communication actions required by GSP Regulations defined in Water Code § 354.10.
- Coordinate and respond to stakeholder inquiries associated with the North Kings GSA and GSP development.

- Monitor and provide issue/response recommendations to events/announcements within the Kings Subbasin or the Madera Subbasin that have or can affect North Kings GSA stakeholders.
- Prioritize outreach activities consistent with SGMA and those adopted by North Kings GSA.
- Evaluate the performance of outreach activities and provide recommendations for improvement.
- Coordinate and lead revision to informational materials and website content provided on behalf of member agencies.
- Manage the administrative record for outreach activities as required by SGMA.
- Modify and update this Outreach Plan as required.
- Provide consistency review of documents and other communications provided to subbasin stakeholders by member agencies.

Work Groups could include: a) membership enrollment and database management; b) internal and external correspondence, reporting and outreach; c) website content and management; d) inter-regional groundwater basin communications and coordination.

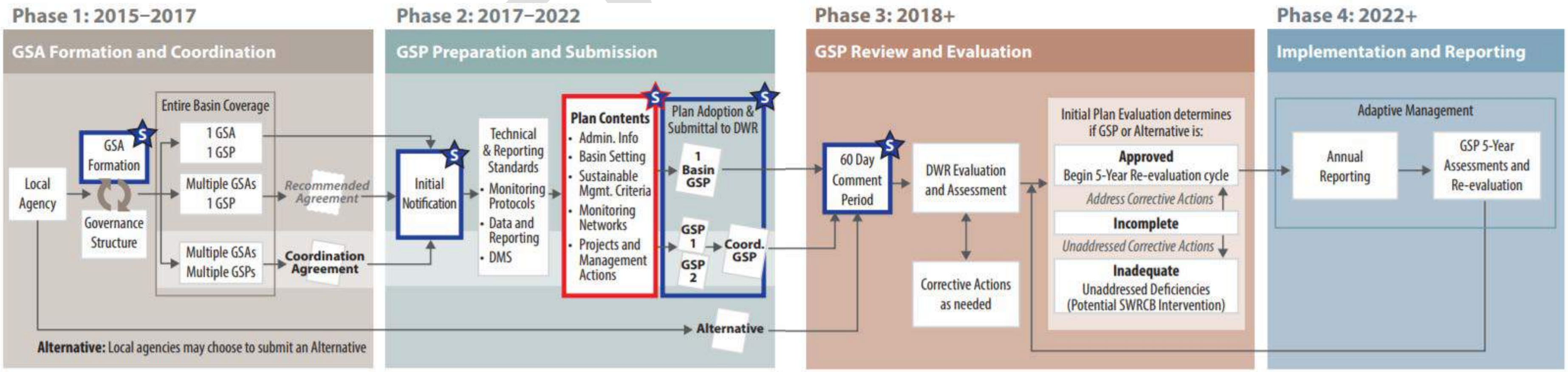
Technical Subcommittee

This committee will be tasked with assessing the technical issues and activities needed to implement groundwater management including the design and implementation of the GSP.

Work groups may include: a) development of a GSP; b) design of the data network, and data management needs/requirements on groundwater conditions including depth, flow paths, quality and volumes both available and used; c) groundwater modeling; d) recommended groundwater use operations necessary to meet the goals of sustainability (well spacing, construction, pumping volumes, recharge locations and operations, etc.).

3.0 DWR OUTREACH GUIDELINES

As part of its release of the GSP Emergency Regulations, the DWR distributed a *Groundwater Sustainability Plan Emergency Regulations Guide* to assist the public and GSAs. The guide describes a four-phased approach to comply with the emergency regulations and meets the DWR requirements for GSA formation, and GSP development and implementation. The guide includes a series of required or recommended outreach and engagement activities for GSAs to consider as part of an active and inclusive engagement with the public and stakeholders. Figure 3-1 provides an overview of the planning phases and associated outreach requirements.



Phase 1 Engagement Requirements

- **Establish and Maintain List of Interested Parties** §10723.4
- **GSA Formation Public Notice** §10723(b)
- **GSA Formation Public Hearing** §10723(b)
- **GSA Formation (due 6/30/17)** §10723(b)
  Notify DWR:
  - Include list of interested parties
  - Explain how parties' interests will be considered
- **Pre-GSP Development** §10727.8
  Provide a written statement describing how interested parties may participate to:
  - DWR
  - Cities within the GSA boundary
  - Counties within the GSA boundary

Phase 2 Engagement Requirements

- **GSP Initial Notification** §353.6*
- **GSP Preparation** §10727.8 and §10723.2
  - Encourage active involvement
  - Consider beneficial uses and users of groundwater when describing *Undesirable Results, Minimum Thresholds, and Projects & Actions*
- **GSP Communications Section** §354.10*
  - GSA decision-making process
  - Opportunities for engagement and how public input is used
  - How GSA encourages active involvement
  - Method of informing the public
- **Public Notice of Proposed Adoption** §10728.4
- **GSP Adoption Public Hearing** §10728.4
- **GSP Submittal** §354.10*
  - Include a summary of communications: description of beneficial uses/users, list of public meetings, comments received/responses

Phase 3 Engagement Requirements

- **60 Day Comment Period** §353.8*
  - Any person may provide comments to DWR regarding a proposed or adopted GSP via the SGMA Portal at http://sgma.water.ca.gov/portal/
  - Comments will be posted to DWR's website

Phase 4 Engagement Requirements

- **Public Notices and Meetings** §10730
  - Before amending a GSP
  - Prior to imposing or increasing a fee
- **Encourage Active Involvement** §10727.8

Engagement Requirements Applicable to ALL PHASES

- **Beneficial Uses and Users** §10723.2
  Consider interests of all beneficial uses and users of groundwater
- **Advisory Committee** §10727.8
  GSA may appoint and consult with an advisory committee
- **Public Notices and Meetings** §10730
  - Before electing to be a GSA
  - Before adopting or amending a GSP
  - Prior to imposing or increasing a fee
- **Encourage Active Involvement** §10727.8
  Encourage the active involvement of diverse social, cultural, and economic elements of the population within the groundwater basin
- **Native American Tribes** §10720.3
  - May voluntarily agree to participate
  - See Engagement with Tribal Government Guidance Document
- **Federal Government** §10720.3
  - May voluntarily agree to participate

Stakeholder Input — *Stakeholders should be informed throughout the development of Plan Content*

Code References: §(#) = SGMA, §(#)* = GSP Regulations

4.0 GSA-SPECIFIC OUTREACH AND COORDINATION

The State legislature, as part of passage of SGMA, placed a high level of emphasis on actions that encourage or require GSAs to develop and implement GSPs in close coordination, consultation and cooperation with stakeholders. Examples of this legislative intent include required public hearings, public notifications and establishment of an interested party database. These requirements were then codified within Water Code §10723.8 (a)(4), and obligate each GSA to provide a detailed explanation of how the interests of beneficial users would be considered in the development and operation of the GSA and development and implementation of the GSP.

Communication and engagement activities described in this section include activities tailored to the unique needs of the North Kings GSA. These GSA-specific activities include consistent and progressive engagement of diverse social, cultural, and economic stakeholder communities within the jurisdictional boundaries of the North Kings GSA. These outreach activities seek to establish and maintain broad community awareness of sustainable groundwater management planning efforts by the North Kings GSA, communicate tools and resources available to stakeholders, and describe the range of opportunities to participate in the planning process. The schedule and sequence of many of these activities are displayed in Attachment B: North Kings GSA Outreach and Coordination Schedule.

4.1 NORTH KINGS GSA OUTREACH TOOLS

Outreach tools are activities for stakeholder identification, tracking engagements with stakeholders, and vehicles to publish and disseminate information to the public and stakeholders. This section describes the suite of tools developed or planned for use by the North Kings GSA and managed by the Communication and Engagement Subcommittee. The agency, on an as-needed basis, intends to provide materials in Spanish, Hmong, Punjabi, or other languages. A common visual identity format will be implemented for all printed and electronic informational materials intended for public and stakeholder audiences. Attachment F contains the visual identity guidelines of the North Kings GSA.

Interested Party Database

Establishment and maintenance of an Interested Party Database is a required communication and engagement action by SGMA. Chaptered in Water Code §10723.4, this section states that any person may request, in writing, to be placed on a list to receive notices regarding plan preparation, meeting announcements and availability of draft plans, maps and other relevant documents. Continuous recruitment of stakeholders to the database is a common element of outreach activities implemented by the North Kings GSA, as the database is the primary platform for dissemination of news and events of the agency and the GSP.

To comply with this section, the North Kings GSA established an online database that is populated by self-selected stakeholders in addition to stakeholders identified, and unilaterally incorporated, by the North Kings GSA. Management of this database is accomplished via a subscription to Constant Contact, a web-based mass email and contact management service. Early outreach activities will encourage stakeholders to self-enroll in the database to receive notices of important meetings and other events. In addition to on-line self-enrollment, the public and stakeholders may also enroll through written request to the agency, and by indicating their preference on sign-in sheets to North Kings GSA hosted events.

The database will seek to include interested parties consistent with Water Code Section §10723.2 as follows:

- Citizens Groups
- General Public
- Disadvantaged Communities[6]
- Agricultural Well Owners
- Domestic Well Owners
- Commercial and Industrial Self-Supplied
- Private and Public Water Purveyors
- Surface Water Users[7]
- Governmental and Land Use Agencies
- Tribal Governments and Communities
- Environmental and Ecosystem Interests
- Remediation and Groundwater Cleanup

The North Kings GSA will use the Interested Parties Database as the email and mailing list for sending notices regarding Board and Advisory Committee meetings, workshops, GSP development meetings and other outreach activities as identified by the Communication and Engagement Subcommittee. In addition, newsletters, GSP Development Updates and other information regarding GSP development milestones will be distributed using the Interested Parties Database.

Community Engagement and Activities Database

The Community Engagement and Activities Database is a Microsoft Excel spreadsheet maintained by the Communication and Engagement Subcommittee for engagement with stakeholder organizations and the media, and for advertising support. The spreadsheet includes four sections as follows:

Stakeholder Database: Stakeholders identified in the database are categorized by type consistent with §10723.2 and assigned to one of three "groups." These groupings serve to define a level of engagement with a given stakeholder based on the content needs of the North Kings GSA's GSP, and the stakeholder's level of interest in, or contribution to, GSP development. These groupings are as follows:

- **Group 1:** *Collaborated (Inform + Consult + Collaborate*) – This group is closely connected during the planning process through direct engagements aimed to share information and encourage in two-way communication. Scheduled on request of the North Kings GSA, these engagements seek to gather information, and work toward solutions to existing and emerging issues.
- **Group 2:** *Consulted (Inform + Consult*) – This group is connected during planning through written informational materials and scheduled presentations. These presentations are held by request of North Kings GSA. Attendees are invited to provide feedback to presented materials.
- **Group 3:** *Connected (Inform*) – This group is connected during planning through written informational materials and prepared informational presentations. These presentations are held upon request to the North Kings GSA.

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

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

The grouping assignment for each stakeholder community is subject to change based on stakeholder interest and GSP content needs. It is anticipated that the grouping placement will be dynamic throughout the planning process. Such changes will be documented consistent with Water Code § 354.10 (b) and 354.10 (d).

Upcoming Outreach: This section identifies pending outreach activities to be implemented by the North Kings GSA. This section defines the date of the activity, the host, the organization type, the identified presenter or task lead and associated action items.

Outreach Record: This section documents all outreach activities completed for the agency. This includes planned outreach actions and those that were in response to a stakeholder group. Outreach activities contained in this section include activities described in section 4.2 North Kings GSA Outreach Activities: media relations, direct mail activitie and other activities as identified by the Communication and Engagement Subcommittee.

Media Database: This section identifies media outlets applicable to the North Kings GSA. The database provides contact information for both reporting and editorial staff, as well as requirements for placement of advertisements.

Project Website

Pursuant to GSP Emergency Regulations Section 353.6 Initial Notification, the North Kings GSA partner agencies have developed a stand-alone website for the GSA. Located at www.NorthKingsGSA.org, this website provides information about SGMA, the member agencies, Board of Director biographies, Board meeting notices and summaries, public outreach and timeline information, frequently asked questions, news, links and a contact list. Visitors can enroll in the agency's Interested Parties Database and ask questions of member agencies. In addition, the site includes a Geographic Information System-enabled application intended to help visitors search by address or geographic location which GSA in the Kings Subbasin has jurisdictional responsibilities. This site is periodically updated by the North Kings GSA.

Key Messages

An initial list of key messages has been developed for use in all North Kings GSA communications. North Kings GSA member agencies may also use these messages as talking points for direct outreach to their constituencies. These key messages are organized to deliver information related to SGMA, GSA formation and GSP development. The messages should be adapted to the target audience (i.e. urban community, rural community, disadvantaged community, grower or industry representative). Each key message is to be periodically revised to ensure consistency with the planning process and effectiveness with the desired target audiences. The initial key messages developed with this Outreach Plan are included in Attachments C and D.

Outreach Materials

Outreach materials for the North Kings GSA carry a common visual identity to assist the public and stakeholder in readily distinguish its work products from the numerous GSAs operating in the Central Valley. A suite of outreach materials is planned for development based on engagement need and phase of groundwater planning. These documents will evolve over time as the GSP is completed, adopted and implemented. As such, these documents are fit-for-purpose outreach tools that include the following:

Letterhead: The North Kings GSA has established a letterhead for formal written communication to the public and stakeholders. This letterhead identifies agency members, the agency Board of Directors, and key staff. This document may serve as a stand-alone communication vehicle or as a companion to other outreach materials. A template for this document is available in Attachment F.

Meeting Summaries: These documents serve to memorialize discussions, decisions and other important milestones associated with a meeting hosted by the North Kings GSA. These documents are available on the agency website and attached to the applicable meeting or event.

Comment Cards: Provided in a postcard format, this document will be provided at most North Kings GSA meetings so that public and stakeholders may contribute written comments, solicit additional information, make suggestions, request addition to the Interested Parties Database, and submit other feedback as appropriate. The document will be pre-addressed for convenient delivery to the agency by U.S. Mail. A template for this document is available in Attachment F.

PowerPoint Presentation: Provided in electronic format, this document will provide visual and text content that support verbal presentations by North Kings GSA members and staff..

Sign-in Sheet: Each meeting will have a common sign-in sheet for those present to note their attendance. The document will include a check box for attendees to request to be added to the Interested Parties Database. A template for this document is available in Attachment F.

GSP Development Updates: These documents are periodic online newsletters intended to keep stakeholders and the public up to date on the GSP development process, notify stakeholders of upcoming public meetings and workshops and address other topics applicable to sustainable groundwater management pertinent to the region. GSP Development Updates will be sent to stakeholders in an e-newsletter format via Constant Contact. It is anticipated that GSP Development Updates will be sent to the stakeholders approximately three times per year during the GSP development process, or as needed. At a minimum, GSP Development Updates will be sent to the Interested Parties Database, but may also be sent to a larger stakeholder or constituent group. GSP Development Updates may include the following content: status of the North Kings GSA GSP development process, upcoming GSP development milestones, key groundwater issues or topics of concern for the subbasin, regional coordination activities, state-wide updates on SGMA and a schedule of planned public meetings, workshops or other events.

Brochures and Fact Sheets: These documents are typically one to two pages in length and formatted to be printed by the GSA or the stakeholder as needed. These may have up to two folds. The purpose of these documents is to provide written information to assist engagement with the public and stakeholders on specific topics. The editorial focus of these documents will be managed by the Communication and Engagement Subcommittee in coordination with the Advisory Committee.

Utility Bill Inserts: Many members of the North Kings GSA are utilities that deliver monthly billing statements to customers. These monthly mailings often have space available to insert additional documents at little or no additional cost provided the utility bill's total weight does not exceed the base rate for first class U.S. Mail. These inserts are often a single-sheet of paper cut to fit a standard #10 envelope (4 1/8 inch by 9 ½ inch) without folding. The North Kings GSA plans to utilize inserts, as available, within two key periods. The first period includes the second quarter of 2018 and is intended to encourage self-enrollment in the Interested Parties Database and visitation to the agency website. The second period – slated for the first quarter of 2019 – is intended to alert the public and stakeholders of pending adoption proceedings for the region's GSP.

Fliers: These one-page documents are focused on stakeholder communities and intended to raise awareness of certain topics or events of the North Kings GSA. The format of these documents draws from the agency's letterhead.

Calendar Advisories: These one-page documents are one of two outreach materials for media relations purposes. These documents often contain two to three paragraphs and serve to promote a North Kings GSA event or milestone (e.g. deadline for receipt of public comment). The purpose of these documents is for the media to publish the milestone as a news brief or add it to a publicly available community calendar. The format of these documents draws from the agency's letterhead.

News Releases: These documents are typically one to two pages in length and serve to draw media attention to a significant event or milestone of the agency. The format of these documents draws from the agency's letterhead.

Social Media: Social media is a rapid and convenient method to reach stakeholders and other interested parties. The North Kings GSA currently has a Facebook presence and is evaluating other social media platforms such as Twitter and Instagram. The Facebook page is managed by the Communication and Engagement Subcommittee. A hyperlink to the Facebook page is included in every Constant Contact notice released by agency staff.

4.2 NORTH KINGS GSA OUTREACH ACTIVITIES

The North Kings GSA plans to conduct a variety of public outreach activities geared to inform, engage and respond to stakeholders and other interested parties during GSP development, adoption and, later, implementation. These activities function to engage and interact with the public and stakeholders during GSP development, and to assist North Kings GSA staff and leadership in collecting information important to groundwater sustainability planning. This engagement and interaction occur in five general areas: Board of Directors meetings and workshops; Advisory Committee meetings and workshops; GSA member agency briefings; public and stakeholder meetings; and existing community meetings. The date and sequence of these engagements is illustrated in Attachment B: North Kings GSA Outreach and Coordination Schedule. Commonly used tools applicable to each form of engagement are included in the descriptions below:

Board Meetings and Workshops

Commonly Used Tools: Sign-in Sheet, Comment Card, Meeting Summary

The North Kings GSA Board of Directors is one of two standing agency meetings that are subject to the Brown Act. Held monthly or by special session, these meetings are the forum where key decisions are presented, discussed and decided. They also serve to engage with the public and stakeholders in the decision-making process for development of a GSP that addresses local requirements consistent with SGMA. Topics presented for Board review and decision are typically brought by the agency Executive Director/Secretary, from the agency's Advisory Committee, from the various subcommittees of the Advisory Committee, or other entities as identified. The timing and format of special sessions are subject to Board discretion and publicly noticed pursuant to the Brown Act. Details of each Board meeting and workshop will be reported on the agency website consistent with Water Code §10725.2.

Advisory Committee Meetings and Workshops

Commonly Used Tools: Sign-in Sheet, Comment Card, Meeting Summary

The North Kings GSA Advisory Committee, formed consistent with Water Code §10727.8(a) and §354.10(d)(3), is the second of two standing agency meetings that are subject to the Brown Act. These meetings are held in the same or a similar format as Board meetings and serve to engage the public and stakeholders in the decision-making process for development of the GSP. The Advisory Committee functions as a coordinator and advisor to the Board of Directors for topics and decision milestones necessary for GSP development. The Advisory Committee is supported by several ad hoc subcommittees as described in Section 2.0. As with the Board of Directors, the timing and format of special sessions, when needed, are subject to the Advisory Committee's discretion and publicly noticed pursuant to the Brown Act. Details of each Advisory Committee meeting and workshop will be reported on the agency website consistent with Water Code §10725.2.

Member Agency Briefings

Commonly Used Tool: Comment Card

As part of plan development, support staff of the North Kings GSA may conduct briefings to councils, boards and commissions of North Kings GSA member agencies. These briefings will be conducted during a member agency's publicly noticed meeting and may include opportunities for public and stakeholder engagement at the discretion of the member agency. It is anticipated that these briefings would be requested by the member agency or scheduled proactively by North Kings GSA staff. The primary purpose of these briefings is to provide updates on plan progress and next steps, and to respond to questions. These presentations provide opportunities to share and describe how elements of the GSP apply to the service area of the member agency. Results of these presentations will be posted on the website of the North Kings GSA and the requesting member agency.

Public and Stakeholder Meetings

Commonly Used Tools: Sign-in Sheet, Comment Card, Meeting Summary

In support of plan development, the North Kings GSA anticipates periodically hosting or participating in meetings to present technical findings and exchange information with stakeholders. These meetings will be planned and implemented by the Communication and Engagement Subcommittee in close coordination of the Advisory Committee. These meetings, as described in the Community Engagement and Activities Database, would focus on specific stakeholder groups, such as school districts, industry groups, agricultural associations, disadvantaged or economically stressed communities and non-governmental agencies. The primary functions of these meetings are: 1) to build and maintain awareness of SGMA, the North Kings GSA and the plan development process; 2) to receive public and stakeholder input and advice during plan development; 3) to encourage the public and stakeholders to attend and participate at agency Board and Advisory Committee meetings; and 4) to encourage public and stakeholder enrollment in the Interested Parties Database. Notification of these meetings will be conducted through the agency website, the Interested Parties Database and other communication vehicles available through GSA member agencies or other partners. These may include newsletters, post cards, fliers, utility bill inserts and social media. Results of these meetings will be posted on the agency website and tracked in the Community Engagement and Activities Database.

Community Presentations

Commonly Used Tool: Comment Card

The North Kings GSA plans to conduct presentations to existing civic, non-profit and other community organizations to build and maintain awareness about SGMA and the agency, to encourage participation at Board and Advisory Committee meetings and to encourage enrollment in the Interested Parties Database. These sessions will occur during the second quarter of 2018. Subsequent presentations may be provided upon request by a stakeholder group or as a follow-on action of the Communication and Engagement Subcommittee. The initial round of presentations will focus on expanding self-enrollment in the Interested Parties Database, increasing awareness of SGMA and increasing awareness and participation in North Kings GSA GSP development. Subsequent rounds of community presentations would serve to continue dialog with stakeholder communities and alert groups to pending key milestones (e.g. public hearings). The Community Engagement and Activities Database identifies the timing, sequence and action items for these presentations. The presentations may be led by North Kings GSA staff, member agency staff or consultant support staff using the key messages (see Attachments C and D). The Communication and Engagement Subcommittee will manage community presentations outreach and assign staff as appropriate

4.3 NORTH KINGS GSA GSP ADOPTION PROCEEDINGS

Adoption of a GSA is governed by Water Code §10728.4 and provides the following requirements:

> *A groundwater sustainability agency may adopt or amend a groundwater sustainability plan after a public hearing, held at least 90 days after providing notice to a city or county within the area of the proposed plan or amendment. The groundwater sustainability agency shall review and consider comments from any city or county that receives notice pursuant to this section and shall consult with a city or county that requests consultation within 30 days of receipt of the notice. Nothing in this section is intended to preclude an agency and a city or county from otherwise consulting or commenting regarding the adoption or amendment of a plan.*

As the Kings Subbasin may have up to seven GSAs, the North Kings GSA anticipates that GSP adoption proceedings may initiate in mid-2019 and take up to seven months to complete. A key driver in the adoption schedule is coordination activities between GSAs in the Kings Subbasin, execution of a Coordination Agreement pursuant to §357.4, and internal reviews of each member agency of the North Kings GSA to the proposed GSP. GSAs within the Kings Subbasin plan to independently perform outreach and communication activities in support of their own GSP. The North Kings GSA may, on an as-needed basis, coordinate with other GSAs in the Kings Subbasin during plan development and plan adoption. Such outreach would focus on providing consistent and clear messages addressing issues of mutual concern. These subbasin outreach coordination efforts will be implemented at the discretion of the North Kings GSA Board of Directors.

Key milestones the North Kings GSA anticipates including during the adoption phase are identified in Attachment B and described below:

Public Comment Period: A 60-day public comment period is proposed upon release of the Public Draft North Kings GSA Groundwater Sustainability Plan. During this public comment period, the agency anticipates to conduct:

- Public Hearing – Draft GSP: At least one public hearing to receive written and verbal comments on the Public Draft GSP. A stenographer may be on site to record all verbal comments.
- Advertising: At least two newspaper advertisements at least five days apart, 14 days prior to a public hearing (Government Code §6066).
- Media Relations: The agency intends to issue a news release and calendar advisories in advance of and during the public comment period to alert the public and stakeholders to the availability of the Public Draft GSP.
- Email and Social Media: The agency will further notify the public and stakeholders of availability of the Public Draft GSP via email notices to those on the Interested Parties Database and via the agency's social media platform(s).

Comment Response: Staff of the North Kings GSA will produce a North Kings GSP Public Comment Report to document comments received during the Public Comment Period, the outreach conducted during this phase and the responses to comments. These comments will be considered during production of the Final GSP and the report will constitute an exhibit to the GSP.

GSP and Coordination Agreement Refinement: During this period, staff of the North Kings GSA anticipate holding a series of briefings with the councils and boards of member agencies to present the proposed GSP, describe the development process and involvement of member agency staff and provide an overview of public and stakeholder comments specific to the member agency.

Public Hearing to Adopt: The North Kings GSA anticipates holding a public hearing pursuant to Water Code §10728.4 for the Final Draft GSP in early December 2019. This hearing will be preceded by newspaper advertisements pursuant to Government Code §6066 and notification to the California Public Utilities Commission pursuant to Water Code §10727.8(a). Agency staff anticipates holding the public hearing as part of a regular or special meeting of the North Kings GSA Board of Directors. Results of this hearing will be published in the Board's meeting minutes.

Post Adoption Proceedings

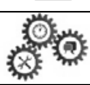
Following submission of the North Kings GSA GSP to the State, the California Department of Water Resources holds a 60-day public comment period (Water Code §10733.4(c)) for the public, stakeholders and other interested parties on submitted plans. Comments submitted to the State assist in the DWR evaluation of the submitted GSPs and are relayed to the submitting agency for their reference. Staff of the North Kings GSA plans to compile all comments submitted to the State into a single report to be incorporated as errata to the adopted GSP during a publicly noticed meeting of the Board of Directors.

Outreach in Support of GSP Implementation

The North Kings GSA expects to continue use of the outreach tools and tactics described in the plan as part of outreach to the public and stakeholder community following adoption of the North Kings GSP. The format and approach of this outreach will be described in an update to this plan based, in part, on results of engagement with stakeholders during the plan development, recommendations by the Advisory Committee and ad hoc subcommittees and direction of the agency Board of Directors.

ATTACHMENT A: GROUNDWATER SUSTAINABILITY AGENCY/GROUNDWATER SUSTAINABILITY PLAN DEVELOPMENT AND IMPLEMENTATION REQUIREMENTS TABLE

This Groundwater Sustainability Agency/Groundwater Sustainability Plan Development and Implementation Requirements Table identifies the required and recommended outreach and engagement activities to be conducted during each of the four planning phases. Activities described for use during Phase 1 (above) will continue to be used by North Kings Groundwater Sustainability Agency member agencies as it initiates development of the Groundwater Sustainability Plan for its portion of the Kings Subbasin. This table, moreover, references applicable state government codes. The table uses the following icons to assist the reader.

Icon	Description
	Denotes a public notification milestone to be completed by the Groundwater Sustainability Agency. These include noticing the public hearings, public meetings, and other related actions.
	Denotes a public hearing and public meeting hosted by the Groundwater Sustainability Agency or the California Department of Water Resources (DWR) consistent with the Sustainable Groundwater Management Act (SGMA) or as defined and implemented by the Groundwater Sustainability Agency.
	Denotes delivery of a notification to DWR such as the Groundwater Sustainability Agency Formation, the Groundwater Sustainability Plan and the Groundwater Sustainability Agency Annual Report.
	Denotes a review and approval period to be completed by DWR.
	Denotes a period of public comment for stakeholders and other members of the public for documents released by the Groundwater Sustainability Agency or DWR.
	Denotes a key milestone of the Groundwater Sustainability Agency.
	Denotes a key action to be taken by DWR consistent with SGMA.
	Denotes a key document to be undertaken by the Groundwater Sustainability Agency as part of its development of documents pursuant to SGMA.
	Denotes communication activities that support development of the Groundwater Sustainability Plan.

Action	Summary	Applicable Code or Section	Completed?
Phase 1 Groundwater Sustainability Agency Formation and Coordination			
Public Notification: Groundwater Sustainability Agency Formation	Two newspaper advertisements at least five days apart, 14 days prior to public hearing	Government Code §6066	✓
Public Hearing: Groundwater Sustainability Agency Formation:	For Groundwater Sustainability Agencies overlying two or more counties, additional public hearings may be required	Water Code §10723(b)	✓
Groundwater Sustainability Agency Action: Develop Groundwater Sustainability Agency Formation Notification Package	Written notification due within 30 days of public hearing. Groundwater Sustainability Agency filing deadline is June 30, 2017. Content requirements for Groundwater Sustainability Agency Formation Notification are as follows:	Water Code §10723.8	✓
☑ Transmittal Letter	Transmittal letter signed by plan manager or other duly authorized person	Article 4. §353.4.	✓
☑ Map	Copy of map of Service Area Boundary in GIS	Water Code §10723.8 (a)(1)	✓
☑ Resolution	Copy of approved resolution	Water Code §10723.8 (a)(2)	✓
☑ Bylaws, ordinance, etc.	Copy of new bylaws, ordinances or authorities adopted by the local agency	Water Code §10723.8 (a)(3)	✓
☑ Interested Parties List	List of interested parties pursuant to §10723.2 and an explanation of how their interests will be considered in the development and operation of the Groundwater Sustainability Agency and the development and implementation of the agency's sustainability plan. *Recommended Action*: Request Native American Contact List from the Native American	Water Code §10723.8 (a)(4)	✓

✓

		Heritage Commission (90 day lead time)[8]		
	Groundwater Sustainability Agency Action: Submit Groundwater Sustainability Agency Notification to DWR	Due within 30 days of public hearing	Water Code §10723.8	
	Resources Review and Approval: Groundwater Sustainability Agency Notification	15-day internal review before publishing on the DWR website	Water Code §10723.8(b)	☑
	Public Review Period: Groundwater Sustainability Agency Formation	90-day period of public comment commencing first day of DWR posting on the DWR website. Copies of written comments submitted to DWR shall be provided to Agency. Assumes no overlap of jurisdictions from other Groundwater Sustainability Agencies	Water Code §10723.8(c)	☑
Phase 2 Groundwater Sustainability Plan Preparation and Submission				
	Due Dates for Groundwater Sustainability Plans	• High or medium priority subbasins in critical overdraft as designated by Bulletin 118: January 31, 2020 • All other high or medium priority subbasins: January 31, 2022	Water Code §10720.7(a)(1) Water Code § 10720.7(2)	☐
	Groundwater Sustainability Agency Action: Develop Groundwater Sustainability Plan Initiation Package	Prior to initiating development of a Groundwater Sustainability Plan, the Groundwater Sustainability Agency shall provide the public and the department the following information in writing:	Water Code §10727.8 (a)	☑
	☑ Describe Engagement	Describe the manner in which interested parties may participate in development and implementation of the Groundwater Sustainability Plan		☑
	☑ Notice Distribution	Written notice to include DWR, any legislative body of any city		

☑

[8] http://nahc.ca.gov/wp-content/uploads/2015/04/Sacred-Lands-File-NA-Contact-Form.pdf

		or county within the area of the plan and the Public Utilities Commission if the plan area includes a Public Utilities Commission-regulated water company		
	☑ Advisory Committee	May state the appointment of an advisory committee of interested parties for developing and implementing the Groundwater Sustainability Plan		☑
	Groundwater Sustainability Agency Action: Notify DWR of Groundwater Sustainability Plan Initiation	Groundwater Sustainability Agency submits the package DWR and other parties as required by the code	Water Code §10727.8 (a)	☑
	DWR Action: Posting of Notification	DWR will post the written notice within 20 days of receipt on the DWR website	§ 353.6 (b)	☑
	Groundwater Sustainability Agency Action: Preparation of Groundwater Sustainability Plan	Formal content development initiated upon notice to DWR to include technical and stakeholder processes consistent with Water Code §10727.8 (a)		☑
	Groundwater Sustainability Agency Action: Notice and Communication content requirements for Groundwater Sustainability Plan	Groundwater Sustainability Plan Emergency Regulations § 354.10. Notice and Communication includes the following required elements:		☐
	☑ Summary of notification and communication	Description of beneficial users and nature of consultation	§ 354.10 (a)	☐
	☑ Administrative Record	List of public meetings where Plan was discussed	§ 354.10 (b)	☐
	☑ Summary of comments and responses	Summary of comment regarding the Plan and any responses	§ 354.10 (c)	☐
	☑ Communication Section	Required subsections/content:	§ 354.10 (d)	☐
		1) Explanation of the Agency's decision-making process		☐

	2) Identification of opportunities for public engagement and a discussion of how public input and response will be used		☐
	3) Description of how the Agency encourages the active involvement of diverse social, cultural and economic elements of the population within the basin		☐
	4) Method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions		☐
Groundwater Sustainability Agency Action: Communication activities to support Groundwater Sustainability Plan development	Activities and tasks consistent with, or supportive of, §354.10 and Water Code §10727.8 (a)		☐
☑ Communication and Engagement Plan	Developed to support notification requirements, state opportunities for Interested Party involvement in the Groundwater Sustainability Agency, and inform content to be provided in the Groundwater Sustainability Plan	Emergency Regulations § 354.10 (d)(1-4) and Water Code §10727.8 (a)	☐
☑ Website	Required as a component of notification and to provide for electronic notice to any person who requests electronic notification	Water Code §10725.2(c)	☐
☑ Interested Party Database	Establish and maintain Interested Party Database	Water Code §10723.4	☐
☑ Committees	Groundwater Sustainability Agency may establish advisory committees and describe their role/function as part of its Groundwater Sustainability Plan Initial Notification; may include Groundwater Sustainability Agency's approach to involvement of diverse social,	Water Code §10727.8 (a) and § 354.10 (d)(3)	☐

		cultural and economic elements of the population within the basin		
	☑ Groundwater Sustainability Agency Meetings	Where consistent with California Public Records Act and Brown Act, posting of meeting agendas and summaries for public, agency and interested party review	Water Code §10725.2	☐
	☑ Other Agency, Public and Interested Party Engagement	Additional communication and engagement actions as determined by the governing body/plan manager		☐
	Public Notification: Groundwater Sustainability Plan Adoption	Two newspaper advertisements at least five days apart, 14 days prior to public hearing	Government Code §6066	☐
	Public Hearing: Groundwater Sustainability Plan Adoption	The Groundwater Sustainability Agency may adopt or amend Groundwater Sustainability Plan after a public hearing. CEQA is not applicable to plan preparation and adoption per the following requirements:	Water Code §10728.4	☐
	☑ Notification	Public hearing held at least 90 days after notice to city and county within area of plan		☐
	☑ Consultation	Groundwater Sustainability Agency shall review and consider comment from city or county and shall consult with any city or county requesting consultation within 30 days of receipt of notice		☐
	DWR Notification: Groundwater Sustainability Plan Submittal and Coordination Agreement	Basins with multiple Groundwater Sustainability Plans are required to develop and execute a Coordination Agreement. No agreement is required in subbasins with one Groundwater Sustainability Plan. Once all Groundwater Sustainability Plans are adopted for the entire basin, the agencies shall provide to DWR:	Water Code §10733.4(a) (b) §10733.4(b)(1) §10733.4(b)(2) §10733.4(b)(3) and §357.4	☐

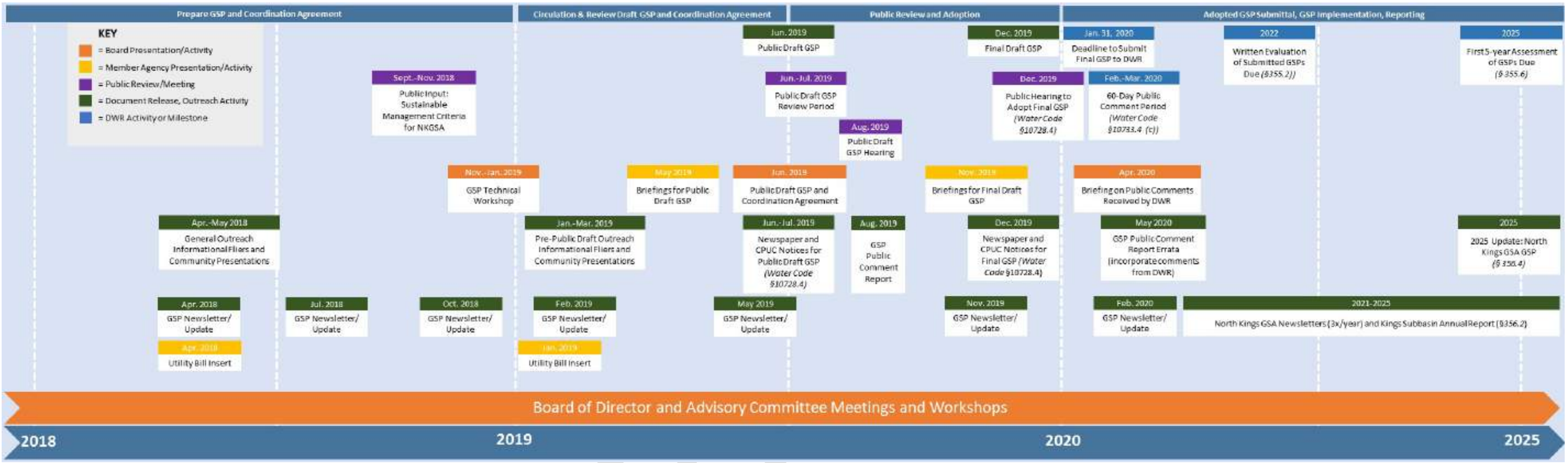
		☑ Copies of all Groundwater Sustainability Plans for the basin ☑ Explanation of how the Groundwater Sustainability Plans implemented together satisfy sections 10727.2, 10727.4 and 10727.6 for the entire basin ☑ Copy of Coordination Agreement		
Phase 3: Groundwater Sustainability Plan Review and Evaluation				
	DWR Action: Post complete Groundwater Sustainability Plan to Department Website	Upon receipt of Groundwater Sustainability Plan consistent with Water Code §10733.4(a) or (b), DWR shall post the Groundwater Sustainability Plan to the department's website	Water Code §10733.4(c)	
	Public Review Period: Basin Groundwater Sustainability Plan	60-day public comment period from date document is posted to the DWR website. All comments to DWR must be copied to the Groundwater Sustainability Agency	Water Code §10733.4(c)	
	DWR Review and Approval: Basin Groundwater Sustainability Plan	Up to 2-year department evaluation of groundwater sustainability plan. The assessment may include recommended corrective actions to address any deficiencies identified by the department	Water Code §10733.4(d)	
	Groundwater Sustainability Agency Action: Implement Basin Groundwater Sustainability Plan	Groundwater Sustainability Agencies shall begin implementation upon submittal to DWR for review	Water Code §10733.4(e)	
Phase 4: Implementation and Reporting				
	Groundwater Sustainability Agency Action: Groundwater Sustainability Plan Annual Report	Developed annually for submittal to DWR, to report on Groundwater Sustainability Plan results, including: a) Groundwater elevation data b) Annual aggregated data identifying groundwater	Water Code §10728	

		extraction for the preceding water year c) Surface water supply used for or available for use for groundwater recharge or in-lieu use d) Total water use e) Change in groundwater storage		
	DWR Notification: Annual Reports	Groundwater Sustainability Agency is obligated to submit Annual Reports on April 1 following adoption of the Groundwater Sustainability Plan and annually thereafter		☐
	Groundwater Sustainability Agency Action: Groundwater Sustainability Plan Evaluation	The Groundwater Sustainability Plan is to be periodically evaluated to assess changing conditions and whether actions are meeting the Plan's objectives and goals "at least every five years" and whenever the Plan is amended [DWR § 356.4]. Coordination Agreements, where present, are to be recirculated and signed by all parties. Action during update would include documentation of Interested Party engagement if such activities are identified as a management action	Water Code 10728.2, Water Code §10728.4 (tiers to §10727.2(b)(1) [9] § 357.4	☐
	Public Hearing: Groundwater Sustainability Plan Adoption	If the Groundwater Sustainability Plan is amended or otherwise subject to adoption, a public hearing may be required. Adoption requirements include:	Water Code §10728.4	☐
	☑ Notification	Public hearing held at least 90 days after notice to city and county within area of Plan		☐
	☑ Consultation	Groundwater Sustainability Agency shall review and consider comment from city or county and shall consult with		☐

[9] (b) (1) Measurable objectives, as well as interim milestones in increments of five years, to achieve the sustainability goal in the basin within 20 years of the implementation of the plan.

		city or county requesting consultation within 30 days of receipt of the notice		
	DWR Notification: Groundwater Sustainability Plan Evaluation	Groundwater Sustainability Agency shall provide a written assessment at least every five years describing whether the Plan implementation, including implementation projects and management actions, are meeting sustainability goals	§ 356.4	☐
	DWR Review: the California Department of Water Resources Groundwater Sustainability Plan Assessment and Re-Evaluation	Developed by DWR for release "at least every five years" following initial submission. May include recommended corrective actions to address deficiencies identified by department. DWR shall issue an assessment for each basin for which a plan or alternative has been submitted	Water Code §10733.8	☐

ATTACHMENT B: NORTH KINGS GSA OUTREACH AND COORDINATION SCHEDULE



ATTACHMENT C: BACKGROUND INFORMATION/FAQS

Groundwater Sustainability Agency Formation
Background/FAQs
DRAFT – February 26, 2018

NOTE: Key messages and talking points included here are draft content developed by North Kings GSA for potential inclusion in the agency's public website. This content is subject to change.

Background Information regarding Sustainable Groundwater Management Act

- The Sustainable Groundwater Management Act, passed in 2014, requires formation of Groundwater Sustainability Agencies to sustainably manage groundwater basins locally.
- "Sustainable groundwater management" is defined as the management and use of groundwater in a manner that can be maintained long-term without causing undesirable results in six areas:
    - Chronic lowering of groundwater levels (not including overdraft if a basin is otherwise managed)
    - Significant and unreasonable reduction in groundwater storage
    - Significant and unreasonable sea water intrusion
    - Significant and unreasonable degraded water quality, including migration of contaminant plumes that impair water supplies
    - Significant and unreasonable land subsidence that substantially interferes with surface land uses
    - Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of surface water
- Groundwater sustainability is particularly critical since groundwater makes up about one-third of California's water supply and is vitally important in dry years, when surface water supplies may be less available.
- Counties that overlie a groundwater basin classified as medium or high priority by the California Department of Water Resources are required to develop a Groundwater Sustainability Plan to manage their local basin(s). The law permits local agencies to do this in lieu of, or in conjunction with, the counties after completing a specific application process. If no other local agency takes responsibility the county is the default manager.
- The law does not permit Groundwater Sustainability Agencies to overlap boundaries. Instead, local jurisdictions are encouraged to work together to determine where the boundaries between their Groundwater Sustainability Agencies should be drawn.
- Those counties that fail to develop an acceptable Groundwater Sustainability Plan are subject to having the State prepare and manage a plan on their behalf.

- North Kings GSA overlies the Kings Subbasin (Bulletin 118). The California Department of Water Resources classifies this subbasin as critically over drafted and a “high priority” basin (See Attachment E: CASGEM Groundwater Basin Prioritization).
- Groundwater Sustainability Agencies must be formed by June 2017 and Groundwater Sustainability Plans must be created and implemented by January 31, 2020.
- There are currently seven GSAs within the Kings Subbasin. Under the new groundwater law, all Groundwater Sustainability Agencies within a subbasin must work collaboratively to manage groundwater resources. The logistics of this will be established as part of the future Groundwater Sustainability Plan(s).
- Since the mid-2000s (well before this Act was passed) the local agencies involved in the North Kings GSA have been partners in sustainable groundwater management as part of the Fresno Area Regional Groundwater Management Plan.
- The work already completed will greatly assist the region in meeting the requirements of the Sustainable Groundwater Management Act. This locally-driven effort will protect the basin from overdraft, create sustainable water supplies and support a stable and growing economy.

Frequently Asked Questions

Sustainable Groundwater Management Act

- **What is the Sustainable Groundwater Management Act?**

  The Sustainable Groundwater Management Act (commonly referred to as “SGMA”), signed into law in 2014, provides a framework for long-term sustainable groundwater management across California. It requires that local and regional authorities in the medium and high priority groundwater basins form a locally-controlled and governed Groundwater Sustainability Agency, which will prepare and implement a Groundwater Sustainability Plan.

- **Is the Sustainable Groundwater Management Act related to the drought?**

  Not directly. Sustainable groundwater management, much like management of surface water resources, is the result of a long-term vision and commitment by one or more water users or communities. That said, now that California has faced several consecutive years of drought, the need to manage groundwater is more relevant than ever. Some of our groundwater basins have reached an all-time historic low. Creating a framework for State oversight ensures a standard, consistent process to maintain and actively monitor and manage basins at the local level, and reduce impacts seen from overuse of these basins.

- **Why was the Sustainable Groundwater Management Act established?**

  Over the years, California water managers, individual well owners and communities that rely on groundwater resources have observed a rapid decline of water levels in some aquifers.[10] Impacts and

[10] An **aquifer** is an underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials (gravel, sand or silt) from which groundwater can be extracted using a water well.

issues related to the decline are apparent. In some areas, groundwater pumping has exacerbated land subsidence, which also threatens infrastructure such as roads, canals and bridges. Drought and low water levels have also impacted water quality and quantity of private well users.

In January 2014, the Governor's Office identified groundwater management as one of ten key action steps in its California Water Action Plan. The Sustainable Groundwater Management Act, signed into law months later, follows up on that action, giving local agencies the ability to manage their respective basins following statewide guidelines.

- **Who is required to comply with the Sustainable Groundwater Management Act?**

  The Act requires the formation of Groundwater Sustainability Agencies to comply with the Act within basins identified by the State as medium or high priority. Entities eligible to serve as a Groundwater Sustainability Agency are defined by the Act as a local public agency that has water supply, water management or land use management responsibilities within a groundwater basin (California Water Code Section 10721(n)). If no local agency steps forward, the county is the default agency. The statutory deadline to form a Groundwater Sustainability Agency was June 30, 2017.

- **What is the North Kings Groundwater Sustainability Agency?**

  The North Kings Groundwater Sustainability Agency is a joint powers authority (JPA) formed in November 2016 by a coalition of local public agencies to provide sustainable groundwater management in a portion of the Kings Subbasin pursuant to the Act on behalf of their constituents. Members of the JPA are Fresno Irrigation District, Garfield Water District, International Water District, Biola Community Services District, City of Kerman, City of Clovis, City of Fresno and County of Fresno. Additional members of the JPA include Bakman Water Company and Fresno Metropolitan Flood Control District.

- **How many GSAs are in the Kings Subbasin?**

  The Kings Subbasin currently has seven groundwater sustainability agencies. In addition to North Kings GSA, the other GSAs are the North Fork Kings GSA, McMullin Area GSA, James ID GSA, Central Kings GSA, South Kings GSA, and Kings River East GSA.

- **How are groundwater users involved?**

  During passage of the Sustainable Groundwater Management Act, the legislature placed a high value on active involvement by groundwater users in planning for and preserving our shared natural resource. Among the requirements in the Sustainable Groundwater Management Act is development of a list of interested parties (Water Code §10723.2) and an explanation of how their interests will be considered in development and operation of the Groundwater Sustainability Agency and the development and implementation of the agency's sustainability plan. The North Kings Groundwater Sustainability Agency team desires to understand and utilize ideas from groundwater user stakeholders throughout development and implementation of the North Kings GSA Groundwater Sustainability Plan. Interested Parties are encouraged to sign up for notifications from the North Kings GSA website, and attend and participate in Board and Advisory Committee meetings.

- **Will the Sustainable Groundwater Management Act affect existing water and property rights?**

  The Sustainable Groundwater Management Act does not change existing groundwater or property rights. Groundwater rights will continue to be subject to regulation under article 10, section 2, of the California Constitution.

- **What is the health of the Kings Subbasin?**

  The Kings Subbasin has been identified by the California Department of Water Resources as being in critical over-draft and a high priority. This is being driven in large part by on-going chronic over-draft in portions of the subbasin that are dependent on groundwater for agricultural and municipal purposes. Domestic and other water users highly dependent on groundwater are typically found along the western and southwestern portion of the subbasin where very little, if any, surface water supplies are available.

- **What is the health of the North Kings GSA portion of Subbasin?**

  Several decades of groundwater management and recharge activities have resulted in a lesser level of chronic over draft within the North Kings GSA as compared to many of the other GSAs within the Kings subbasin. However, the North Kings GSA portion of the subbasin still experiences many of the undesirable results that SGMA was intended to resolve.

- **Is the State trying to take over control of groundwater?**
- The State legislature, in passage of SGMA, communicated its intent that sustainable groundwater management is best left with local government agencies with expertise and responsibilities over water supplies. To help foster local control, the Act provided local agencies with tools and authorities they previously lacked to manage groundwater resources sustainably. However, the legislation also included a series of triggers that would result in intervention by the State Water Resources Control Board in the event a subbasin failed to meet requirements of the Act. This State intervention occurs only if local efforts, including county efforts, to form a Groundwater Sustainability Agency or prepare a viable Groundwater Sustainability Plan are not successful. Where intervention occurs, the State can impose fees and groundwater pumping restrictions that can remain in place until local efforts are able to sustainably manage groundwater resources. The North Kings Groundwater Sustainability Agency partners are committed to maintaining local control and managing groundwater resources on behalf of agricultural water users, rural and urban communities and the environment.

Groundwater Sustainability Agency

- **What is a Groundwater Sustainability Agency?**

  A groundwater sustainability agency is one or more local governmental agencies that implement the provisions of the Sustainable Groundwater Management Act. A local agency is defined as one that has water supply, water management or land management authority. Groundwater Sustainability Agencies assess the conditions of their local groundwater basins, adopt locally-based sustainable management plans to create drought resiliency and improve coordination between land use and groundwater planning.

- **Bakman Water Company is a private company. Why is it included in the Groundwater Sustainability Agency?**

  Bakman Water Company and similar companies that provide water utility service are recognized in the Sustainable Groundwater Management Act as special entities that are regulated by the California Public Utilities Commission. The California Public Utilities Commission–regulated water utilities have an important imperative to manage and sustain water supplies on behalf of their customers. The Sustainable Groundwater Management Act encourages the California Public Utilities Commission-regulated utilities to participate in the management of groundwater basins in their service areas and to share their technical, financial and managerial expertise. Prior to the Sustainable Groundwater Management Act, the California Public Utilities Commission-regulated utilities were regularly parties to the adjudication of groundwater basins and served on the managing watermaster boards. In the Fresno area, Bakman Water Company was involved in the development of the Fresno Area Regional Groundwater Management Plan.

- **When was the North Kings Groundwater Sustainability Agency formed?**

  The North Kings GSA was formed in November 2016 following the September and October 2016 adoption proceedings of the North Kings Groundwater Sustainability Agency Joint Powers Agreement by participating local public agencies. The North Kings GSA notified DWR of its formation on January 3, 2017. The formation deadline for all Groundwater Sustainability Agencies was June 30, 2017.

- **What costs will be associated with forming and administering a Groundwater Sustainability Agency?**

  As part of the JPA that formed the North Kings GSA, North Kings GSA members and contracting entities have agreed to a cost share for activities through development of the GSP. The GSP is anticipated to include development of a funding plan for activities and programs to be identified in the GSP.

- **What authority will Groundwater Sustainability Agencies have?**

  Local Groundwater Sustainability Agencies can choose to implement as many of the legal powers as they deem necessary for management of their basin. The Sustainable Groundwater Management Act as currently enacted empowers all Groundwater Sustainability Agencies to:
    - Adopt rules, regulations, ordinances and resolutions to implement the Act
    - Monitor compliance and enforcement
    - Require registration of groundwater wells
    - Require appropriate measurement devices and reporting of extractions
    - Investigate, appropriate and acquire surface water rights, groundwater and groundwater rights into the Groundwater Sustainability Agency
    - Acquire or augment local water supplies to enhance the sustainability of the groundwater basin
    - Propose and collect fees
    - Adopt and fund a Groundwater Sustainability Plan according to existing laws

Groundwater Sustainability Agencies may use a number of management tools to achieve sustainability goals. The specific tools and methods a Groundwater Sustainability Agency will use to achieve sustainability will be determined in discussion with stakeholders and identified in the Groundwater Sustainability Plan.

It is also important to note that the Sustainable Groundwater Management Act requires local agencies to acknowledge Groundwater Sustainability Plans when a legislative body is adopting or substantially amending its General Plan. General Plans must accurately reflect the information in the Groundwater Sustainability Plan with regards to available water supplies.

- **Will stakeholders or the public have the opportunity to weigh in on the Groundwater Sustainability Plan development?**

  Stakeholders are encouraged to sign up for notifications by the North Kings GSA on its website (www.NorthKingsGSA.org). The primary venues for Stakeholders to get involved in the GSP development process are regularly scheduled North Kings GSA Board and Advisory Committee meetings. The North Kings GSA also anticipates conducting briefings to member agency boards and commissions as well as presentations to civic and non-profit organizations to encourage participation at Board and Advisory Committee meetings. The schedule for Board and Advisory Committees meetings is available on the website.

- **What is the governance structure for the North Kings GSA? How will the agencies work together to run it?**

  The North Kings GSA is governed by a seven-member Board of Directors that includes Members, Contracting Entities and Interested Parties. Directors are elected officials who have been appointed to serve on the JPA's Board of Directors by their respective boards, councils or commissions, or are the authorized representative of a Member, Contracting Entity or Interested Party. To provide a balance of perspective, the Board is segmented across agricultural, city, county, small communities, Contracting Entities and Interested Parties. It includes four seats held exclusively by the City of Clovis, City of Fresno, Fresno County and Fresno Irrigation District. Two seats are shared and one is appointed by the Board from municipal/industrial Members, Contracting Entities or Interested Parties not currently serving on the board. All terms are for a period of two years, with terms for the four exclusive seats starting with a three-year term. The Board is supported by committees and key staff, including an executive officer and legal counsel. The North Kings GSA Board meets on the fourth Thursday of each month.

- **If Groundwater Sustainability Agencies are locally controlled, what is the State's role in this effort?**

  The California Department of Water Resources is the agency responsible for oversight of the formation of Groundwater Sustainability Agencies and Groundwater Sustainability Plans, but the State Water Resources Control Board (Water Board) and California Water Commission also have roles in the implementation of the Sustainable Groundwater Management Act. The Department of Water Resources has a list of regulations, objectives and actions formulated to assist local agencies and Groundwater Sustainability Agencies with the preparation and implementation of Groundwater

Sustainability Plans. Under law, all regulations adopted by the Department of Water Resources become effective only upon approval by the California Water Commission. Under a limited set of circumstances, the Water Board may intervene if local efforts to form a Groundwater Sustainability Agency or prepare a viable Groundwater Sustainability Plan are not successful.

- **How will adjacent Groundwater Sustainability Agencies be handled?**

  The regulations require that all Groundwater Sustainability Agencies coordinate with adjacent Groundwater Sustainability Agencies in a given basin. This coordination will occur through additional discussions with neighboring agencies as Groundwater Sustainability Agencies are formally developed, and the Groundwater Sustainability Plans will describe how the adjacent Groundwater Sustainability Agencies will work together to achieve groundwater sustainability for the entire basin.

Groundwater Sustainability Plan

- **What is a Groundwater Sustainability Plan?**

  A Groundwater Sustainability Plan is the plan developed by a Groundwater Sustainability Agency that provides for sustainably managed groundwater that meets the requirements of the State's new groundwater laws. Groundwater Sustainability Agencies in high- and medium-priority groundwater basins are required to submit a Groundwater Sustainability Plan to the California Department of Water Resources. The plan must outline how the Groundwater Sustainability Agency will implement, manage and measure specific actions for the health and viability of the basins. The California Department of Water Resources will evaluate the Groundwater Sustainability Plan and provide the Groundwater Sustainability Agency with an assessment of the plan and any necessary recommendations within two years following its establishment.

- **When does a Groundwater Sustainability Plan have to be established?**

  Subbasins deemed to be in critical overdraft (which includes the Kings Subbasin) are required to complete and begin implementation of their Groundwater Sustainability Plan by January 31, 2020.

- **What will the process and timing be for development of the GSP?**

  The North Kings GSA is currently working on developing its GSP. The North Kings GSA will tentatively release a Public Draft GSP in June 2019, followed by a 60-day public comment period and public hearing. The GSP will be revised to address public and stakeholder comments. The Final GSP will be adopted at a public hearing, tentatively scheduled for December 2019. All GSPs must be submitted to the California Department of Water Resources no later than January 31, 2020. Throughout the GSP development process, North Kings GSA and member agency staff will be conducting outreach to engage and inform stakeholders and members about the GSP. Check the North Kings GSA website or sign up on the email list to receive notices about GSP workshops, public meetings and opportunities for public comment.

- **What happens after the GSP is completed?**

  Following submittal and acceptance by DWR, the seven GSAs in the Kings Subbasin GSAs will begin implementation. Each year, the agencies are required to submit a combined Groundwater Sustainability Plan Annual Report to the State (Water Code §10728). Pursuant to § 356.4 the agencies are required to evaluate their GSP least every five years and whenever the Plan is amended, and provide a written assessment to the Department.

- **Are GSPs required for new or amended County or City General Plan?**

  Prior to adopting a new or amended General Plan, Government Code §65350.5 requires each planning agency to review any applicable groundwater sustainability plan, groundwater management plan, adjudicated water right or interim plan by the State Water Resources Control Board (commencing with §10735). In addition to this, the GSA (per §653352.5) is required to provide the planning agency the current GSP (or alternative); judgment, decree, agreement or interim plan, if relevant; and a report addressing the anticipated effect on implementation of the GSP by the proposed General Plan update or amendment.

ATTACHMENT D: KEY MESSAGES

SGMA Key Messages

- *State Intervention*: We need to maintain local control over our groundwater within the Kings Subbasin. Basins that do not comply with the Sustainable Groundwater Management Act (SGMA) risk intervention by the State Water Resources Control Board (Water Board). The Water Board has prepared a fee structure to be applied to groundwater users in basins where progress for local management is missing or deemed inadequate. This will result in management actions directed from the State and could impact local land use decisions.

- *Water Supply Context:* While California's recent extended drought impacted many domestic wells in the Kings Subbasin, the effect in the North Kings GSA was less severe due to a large surface water supply and effective groundwater management practices that have prevented excessive groundwater overdraft. Several decades of effective conjunctive use actions by member agencies have led to more stable groundwater conditions in the North Kings GSA as compared to many other GSAs in the Kings Subbasin. Still, the State has identified the full Kings Subbasin as a high priority subbasin due, in part, to chronic overdraft in regions solely dependent on groundwater.

- *Local Management*: The local agencies that make up the North Kings GSA have provided effective sustainable groundwater management for many years and have a proven track record of collaborative and cooperative work with local and State agencies.

- *Sustainable Management*: The northern portion of the Kings Subbasin is currently being managed sustainably for existing demands and projected future demands. The North Kings GSA partners are committed to local stewardship of groundwater and interconnected surface water resources.

North Kings GSA Key Messages

- *Reliability: Groundwater resources in the northern portion of the Kings Subbasin have been effectively managed for many years and continue to serve as a reliable primary and back-up water supply for all beneficial users.*

- *Agricultural Stewardship: The North Kings GSA region is a diverse mix of natural, agricultural, rural, suburban and urban landscapes. The economic development and open space that agriculture provides to the region are among the core community assets that make this region desirable for families and businesses. The North Kings GSA is committed to ensuring the continued existence of a robust agricultural community.*

- *Economic Development*: Reliable water supplies are the core of thriving and robust communities. The North Kings GSA partners recognize that water continues to be a foundation of the region's economic successes and must be protected and preserved.
- *Socioeconomics*: Clean, available and affordable access to drinking water should be accessible for all public and private water systems.
- *Environmental Stewardship*: Along with agriculture, Fresno County's natural areas are among its signature landscapes. The North Kings GSA partners recognize that groundwater-dependent ecosystems are a beneficial use of groundwater and require protection through continued effective planning.

Key Messages – North Kings GSA – Agriculture

Conjunctive Use in North Kings GSA: A history of protecting our water resources.

For nearly a century, North Kings GSA members have put great importance on leveraging surface water and groundwater supplies to improve water supply reliability in the region. The Fresno Irrigation District has a mission statement that includes protecting groundwater resources, and has invested greatly in that effort. This has resulted in the development of thousands of acres of groundwater recharge ponds and groundwater banking facilities, where surplus surface water supplies from the Kings River, Federal Central Valley Project – Friant Division and local streams and runoff (storm water, floodwater, etc.) are captured and utilized to replenish the groundwater aquifer during wet years. The Cities of Fresno and Clovis have partnered with the Fresno Metropolitan Flood Control District (FMFCD) to utilize existing urban storm basins during the summer and fall months for the sole purpose of recharging surface water supplies. During a year like 2017, the North Kings GSA region recharged 130,000 acre-feet of water that would have otherwise left the region. The North Kings GSA will continue to develop projects as we move down the road to groundwater sustainability.

Sharing Water Resources: Will North Kings GSA need to share water with its GSA neighbors or within?

The North Kings GSA is not required under SGMA to send some of its water resources to other areas within the Kings Subbasin that do not have enough water to achieve sustainability. Further, SGMA does not require the North Kings GSA to "redistribute" water within the NKGSA from areas with surface water supplies to areas that do not have surface water supplies.

SGMA Costs: How much is SGMA going to cost growers?

The Groundwater Sustainability Plan (GSP) currently being developed will determine what should be required for the NKGSA to achieve groundwater sustainability by 2040. This may include policies, projects and programs. Until the GSP is developed, costs are unknown, as well as the types of mechanisms for collecting fees (assessments, volumetric extraction costs, etc.). However, with local control, we anticipate SGMA-related fees within North Kings GSA will be significantly less than what the Water Board would charge extractors under State Water Resources Control Board control.

Local Control: What happens if the locals fail?

If the locals (including Fresno County) fail to bring North Kings GSA and the Kings Subbasin into groundwater sustainability by the statutory milestones and 2040 deadline, the State Water Resources

Control Board (Water Board) could step in and regulate groundwater use in our area to achieve sustainability. If this should happen, the Water Board has developed a fee schedule that it would use for every groundwater extraction point (well). Currently, base fees would be $300 per well per year, $10 to $40 per acre-foot of groundwater extracted depending on whether the well is metered or if the basin has a "probationary" status, and $100 per well per year for "de minimus" extractors that pump two acre-feet per year or less. On top of these fees, the Water Board would also charge extractors for the cost of the State to develop its own groundwater sustainability plan.

Projects: Is the State going to pay for the projects we need for SGMA?

As long as the implementation of SGMA remains under local control, the State will not fund the projects and programs necessary to achieve groundwater sustainability. The costs for these will need to be locally funded by groundwater stakeholders. Even under State Water Board control, the stakeholders within the North Kings GSA or Kings Subbasin would likely need to fund any projects or program costs that the State determined to be required.

Groundwater and Surface Water Rights: Can my water be taken away?

SGMA itself does not affect groundwater or surface water rights. Local policies and programs like land use planning may put restrictions on how water can be utilized on various lands.

Land Use Approvals: Will I need approval to change crops or plant a new field?

A goal of the North Kings GSA is not to affect existing land use, but instead to ensure future development is compatible with the path leading to groundwater sustainability. Farmers are encouraged to continue to make responsible decisions and consider water requirements when determining whether to change crops or develop a new field.

Pumping Restrictions: Is someone going to limit how much groundwater I can pump?

In North Kings GSA, we anticipate that involuntary restrictions on groundwater pumping will not be required as long as there is local cooperation among stakeholders, new water supply projects are constructed and smart, effective water and land use policies are in effect.

Land Fallowing: Will I be required to fallow all or part of my land?

In North Kings GSA, we anticipate that involuntary land fallowing will not be required as long as there is local cooperation among stakeholders, new water supply projects are constructed and smart, effective water and land use policies are in effect.

Stakeholder Involvement: How do I have a say in the process?

It is crucial that all stakeholders be involved in the SGMA process early on. Every groundwater extractor is a stakeholder (farmers, cities, rural residential, disadvantaged communities, etc.) and most likely will be affected by SGMA. Stakeholders can get involved by participating in North Kings GSA's Advisory Committee and Board of Directors meetings.

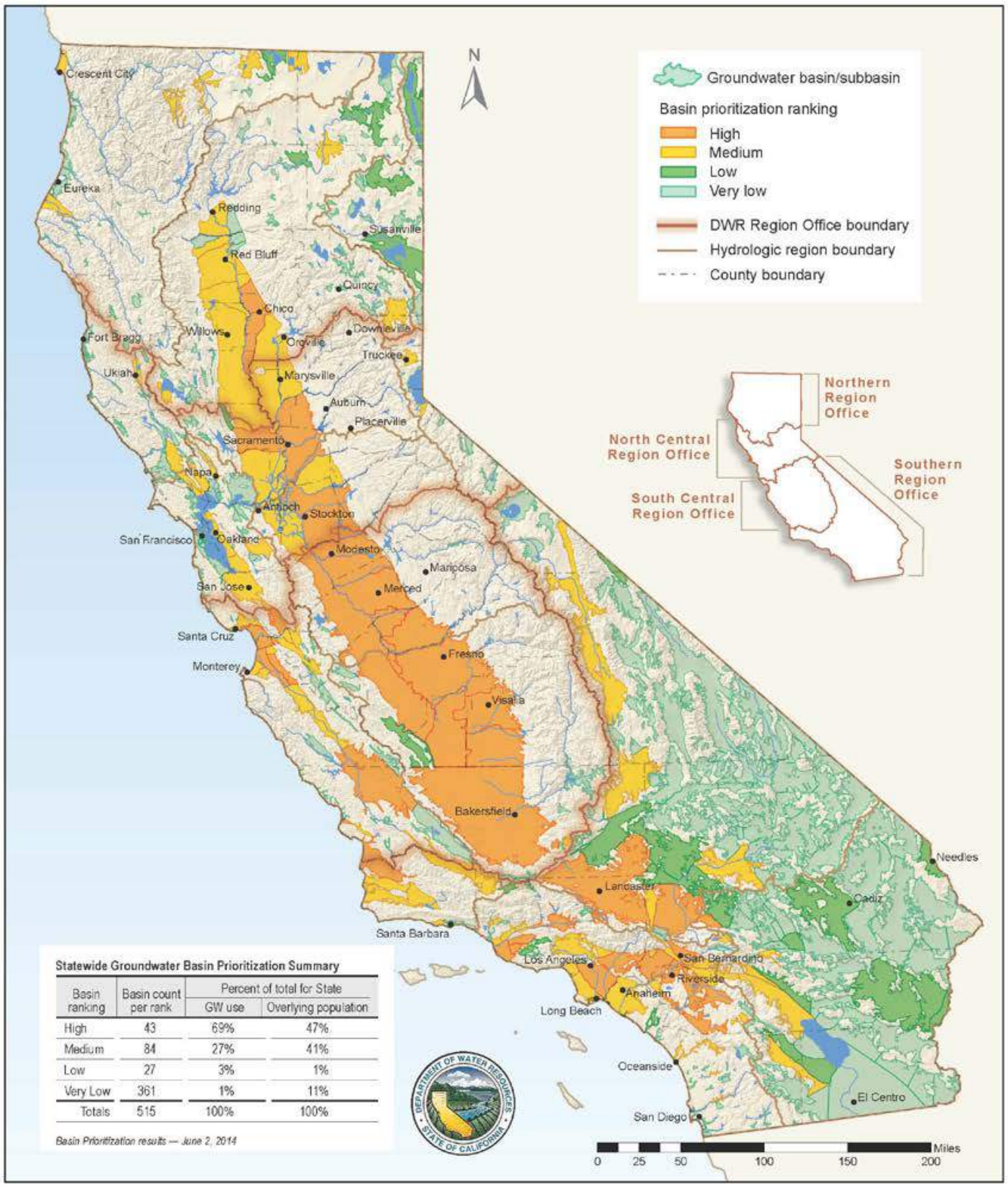
Closing Key Message: Get involved!

The North Kings GSA highly encourages all stakeholders to get involved now in the GSP development process. Do not wait to be told what the policies, projects and programs are after the GSP is finalized and being implemented. Now is the time to get involved. Some ways to get involved include:

- Sign up for our mailing list to receive updates on the status of the GSP development and implementation process and notices about upcoming public meetings.
- Participate in North Kings GSA Board and Advisory Committee meetings.
- Request presentations on SGMA and North Kings GSA to your community group, organization or association.
- Help us spread the word! Provide our informational materials to your friends and neighbors

ATTACHMENT E: CASGEM GROUNDWATER PRIORITIZATION

CASGEM Groundwater Basin Prioritization



Statewide Groundwater Basin Prioritization Summary

Basin ranking	Basin count per rank	Percent of total for State	
		GW use	Overlying population
High	43	69%	47%
Medium	84	27%	41%
Low	27	3%	1%
Very Low	361	1%	11%
Totals	515	100%	100%

Basin Prioritization results — June 2, 2014

ATTACHMENT F: VISUAL IDENTITY GUIDELINES AND TEMPLATES

Color Palette

	Color	Coding	Uses
	Blue	Red: 70 Green: 116 Blue: 157	Primary background fill Headline Text
	Light Brown	Red: 168 Green: 162 Blue: 149	Second level background fill Website links
	Off White	Red: 235 Green: 231 Blue: 224	Third level background fill Accent stripes, highlights

Logo:

NORTH KINGS
GROUNDWATER
SUSTAINABILITY AGENCY

NORTH KINGS
GROUNDWATER
SUSTAINABILITY AGENCY

Letterhead:

NORTH KINGS GROUNDWATER
SUSTAINABILITY AGENCY

Member Agencies
Bakman Water Company
Biola Community Services District
City of Clovis
City of Fresno
City of Kerman
County of Fresno
Fresno Irrigation District
Fresno Metropolitan Flood Control District
Garfield Water District
International Water District

Board of Directors
Chairman Jerry Prieto, Jr.
Fresno Irrigation District
Vice-Chairman Brian Pacheco
County of Fresno
Steve Pickens
Bakman Water Company
Rudy Hernandez
Biola Community Services District
Jose Flores
City of Clovis
Lee Brand
City of Fresno
Karl Kienow
Garfield Water District

Executive Officer
Gary Serrato

Internet
www.NorthKingsGSA.org

Mail
North Kings GSA
c/o Fresno Irrigation District
2907 S. Maple Ave.
Fresno, CA 93725

Phone
559-233-7161

About NKGSA: The North Kings Groundwater Sustainability Agency is a Joint Powers Authority formed in December 2016. Composed of local public agencies and others engaged through binding agreements, the NKGSA is the governing body for of a portion of the Kings Subbasin (DWR Bulleting 118, 5-22.08) in compliance with the Sustainable Groundwater Management Act of 2014. NKGSA members are Bakman Water Company, Biola Community Services District, City of Clovis, City of Fresno, City of Kerman, County of Fresno, Fresno Irrigation District, Fresno Metropolitan Flood Control District, Garfield Water District, and International Water District.

NORTH KINGS GROUNDWATER *SUSTAINABILITY AGENCY*

MEETING NAME

Sign-In

Time/Date:
Location:

Name	Company/Organization	Address/City	Email	Add Me to NKGSA Contact List

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY

COMMENT CARD

Name: Organization:

Address:

Email: Add me to NKGSA Contact List

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY

COMMENT CARD

Name: Organization:

Address:

Email: Add me to NKGSA Contact List

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Postage

North Kings GSA
c/o Fresno Irrigation District
2907 So. Maple Ave.
Fresno, CA 93725

Postage

North Kings GSA
c/o Fresno Irrigation District
2907 So. Maple Ave.
Fresno, CA 93725

NORTH KINGS GROUNDWATER
SUSTAINABILITY AGENCY

c/o Fresno Irrigation District
2907 Maple Ave.
Fresno, CA 93725

Bakman Water Co.
Biola Community Services District
City of Clovis, California
City of Fresno
The County of Fresno
City of Kerman
Fresno Metropolitan Flood Control District
Fresno Irrigation District
Garfield Water District
International Water District

www.NorthKingsGSA.org

Appendix 2 B Community Engagement Activities List

Date	Outreach Activity	Host or Guest	Location/Method	Organization	Type of Organization	Presentation Focus/Presentation Title	Audience	Contact for Organization	Presenter/Task Lead	Action Items/Notes
12/3/2014	Email	Guest	Fresno Bee							
3/25/2015	Meeting	Host	Kerman Community Center	Fresno I.D. Growers Meeting - Kerman	Irrigation District	Water Supply, SGMA, Other Topics	FID growers		FID	
3/27/2015	Meeting	Host	Easton CPDES Hall	Fresno I.D. Growers Meeting - Easton	Irrigation District	Water Supply, SGMA, Other Topics	FID growers		FID	
11/4/2015	Meeting	Host	Clovis Council Chambers	Fresno I.D. Growers Meeting - Clovis	Irrigation District	SGMA Introduction	FID growers		FID	
11/6/2015	Meeting	Host	Easton CPDES Hall	Fresno I.D. Growers Meeting - Easton	Irrigation District	SGMA Introduction	FID growers		FID	
11/10/2015	Meeting	Host	Kerman Community Center	Fresno I.D. Growers Meeting - Kerman	Irrigation District	SGMA Introduction	FID growers		FID	
3/13/2017	Meeting	Host	Kerman Community Center	Fresno I.D. Growers Meeting - Kerman	Irrigation District	Water Supply, SGMA, Potential Prop 218, Other Topics	FID growers		FID	
3/14/2017	Meeting	Host	Clovis Council Chambers	Fresno I.D. Growers Meeting - Clovis	Irrigation District	Water Supply, SGMA, Potential Prop 218, Other Topics	FID growers		FID	
3/15/2017	Meeting	Host	CPDES Hall	Fresno I.D. Growers	Irrigation District	Water Supply, SGMA,	FID growers		FID	

Date	Outreach Activity	Host or Guest	Location/Method	Organization	Type of Organization	Presentation Focus/Presentation Title	Audience	Contact for Organization	Presenter/Task Lead	Action Items/Notes
				Meeting - Easton		Potential Prop 218, Other Topics				
5/17/2017	Meeting	Guest	Fort Washington Country Club - 10272 N Millbrook Ave, Fresno, CA 93730	Building Industry Association	Developer Association	Community Leadership Forum - SGMA Introduction (Gary Serrato, Bernard Jimenez, Ronnie Samuelian)	BIA Members	Mike Prandini	FID/County/P&P	
8/30/2017	Meeting	Host	Fresno ID office Board Room	Kings Subbasin Coordination Meeting w/ DWR Staff	Irrigation Districts	Invite Trevor Joseph and local DWR staff to hear update on Kings Subbasin SGMA efforts and to ask/answer questions. Representatives from each GSA in Kings Subbasin attended.			P&P	
9/30/2017	Meeting	Host	Fresno County Office of Education, Downtown	Self-Help Enterprises	Non-Profit	SGMA Roundtable for Schools and Districts	7 reps from 5 GSAs, including those from	Sue Ruiz	Self Help	

Date	Outreach Activity	Host or Guest	Location/Method	Organization	Type of Organization	Presentation Focus/Presentation Title	Audience	Contact for Organization	Presenter/Task Lead	Action Items/Notes
							Fresno Co.; 15 school districts w/ total of 21 people, not all NKGSA schools, some schools are in multiple GSAs, usually 2 and sometimes 3, and 1 district is in 4 GSA.			
10/26/2017	Meeting	Co-Host	University Square Hotel - 4961 N Cedar Ave, Fresno	Self-Help Enterprises & Union of Concerned Scientists	Non-Profit	Toolkit Release - Getting stakeholders involved in groundwater and GSPs	Scientists, DAC city officials (Porterville), farmers, non-profits. About 30 people			
11/16/2017	Meeting	Guest	Fresno County Grand Jury	Fresno County Grand Jury		Grand jury requested introduction to SGMA	Grand Jury		FID/NKGSA/Gary Serrato	
3/8/2018	Meeting	Guest	Fresno SWRCB DDW Office	State Water Resources Control Board - DDW	State Agency	SWRCB internal staff SGMA implementation training (live webcaste state-wide)	SWRCB staff		FID/SWRCB	

Date	Outreach Activity	Host or Guest	Location/Method	Organization	Type of Organization	Presentation Focus/Presentation Title	Audience	Contact for Organization	Presenter/Task Lead	Action Items/Notes
3/24/2018	Meeting	Host	CPDES Hall	Fresno I.D. Growers Meeting - Easton	Irrigation District	Water Supply, SGMA	FID growers		FID	
3/27/2018	Meeting	Host	Clovis Council Chambers	Fresno I.D. Growers Meeting - Clovis	Irrigation District	Water Supply, SGMA	FID growers		FID	
3/29/2018	Meeting	Host	Kerman Community Center	Fresno I.D. Growers Meeting - Kerman	Irrigation District	Water Supply, SGMA	FID growers		FID	
4/11/2018	Meeting	Guest	Fresno Rotary Club	Fresno Rotary Club	Professional	SGMA	Business leaders		P&P Ronald Samuelian	
4/27/2018	Meeting	Host	Hillview Dairy / McMullin Area GSA	Lower Dry Creek area growers, McMullin Area GSA	Local growers just outside FID	SGMA and new groundwater recharge project	Growers outside FID	Don Cameron	FID	
5/16/2018	Meeting	Guest	Fort Washington Country Club - 10272 N Millbrook Ave, Fresno, CA 93730	Building Industry Association	Developer Association	Community Leadership Forum - SGMA Introduction (Gary Serrato, Bernard Jimenez, Ronnie Samuelian)	BIA Members	Mike Prandini	FID/County/P &P	
7/17/2018	Interview	Guest	Valley Public Radio - Marc Benjamin			"Fresno, Clovis Plan To Mix Recycled	General	Marc Benjamin	FID	http://kvpr.org/post/fresno-clovis-plan-mix-recycled-

Date	Outreach Activity	Host or Guest	Location/Method	Organization	Type of Organization	Presentation Focus/Presentation Title	Audience	Contact for Organization	Presenter/Task Lead	Action Items/Notes
						Sewer Water For Drinking"				sewer-water-drinking
7/24/2018	Meeting	Guest	Malaga County WD Board Meeting	Malaga County W.D.	Urban/commercial water district	SGMA introduction	Malaga board members	Jim Anderson	FID	
8/7/2018	Meeting	Guest	Pinedale County WD Board Meeting	Pinedale County W.D.	Urban/commercial water district	SGMA introduction	Pinedale board members	Jason Franklin	FID	
8/8/2018	Meeting	Guest	Table Mountain Rancheria	Table Mountain Rancheria - Native American Tribe	Native American Tribe	SGMA introduction	Tribal leader		FID	
8/16/2018	Meeting	Guest	Biola Community Center	Biola Community Services District	Urban/commercial water district	SGMA introduction	Biola board members, community public		FID	
9/6/2018	Meeting	Guest	Fresno County Farm Bureau	Fresno County Farm Bureau	Advocacy group	SGMA Introduction	Farmers from multiple GSAs throughout Fresno County	Ryan Jacobsen		
9/19/2018	Meeting	Guest	Kerman City Hall	City of Kerman	City Council Meeting	SGMA Introduction	City council members	Ken Moore	FID	
9/20/2018	Meeting	Guest	Lao Veteran of America, Institute	Asian Business Institute & Resource Center	Serves Asian businesses in the Central Valley	SGMA introduction	Members, small south-east Asian farmers	Dao Lor-Vang	FID	
9/27/2018	Class presentation	Guest	Intro Public Relations class	California State University, Fresno	University	SGMA Introduction - pre-class	Students	Nancy Van Leuven		

Date	Outreach Activity	Host or Guest	Location/Method	Organization	Type of Organization	Presentation Focus/Presentation Title	Audience	Contact for Organization	Presenter/Task Lead	Action Items/Notes
						project info presentation				
10/30/2018	Class presentation/webinar	Guest	Public Relations class/webcast	California State University, Fresno	University	Grant-funded workshop/webinar, "Environmental Communication: Talking in the San Joaquin Valley!"	Students in Fresno State and at the other 2 grantee schools in Ottawa, Ontario and Portland, Maine	Tommy Esqueda and Nancy Van Leuven	Sarge Green, Brandy Swisher from NKGSA	
10/31/2018	Discussion panel	Guest	Panel discussion with audience	WaterWrights and Disinfect Water	Freelance journalist and water treatment company	SGMA Survival Roundtable	Growers, related industry people, local government, others	Don Wright	P&P Ronald Samuelian	
11/14/2018	TV Show Interview	Guest	Hmong TV, Blong Xiong interviewer	Asian Business Institute & Resource Center	Serves Asian businesses in the Central Valley	SGMA Q&A	Members, small south-east Asian farmers	Dao Lor, Blong Xiong	FID - Gary Serrato	
11/28/2018	Postcard mailer	Host	2,869 addresses in County "white area"	Private landowners	Private well pumpers	SGMA workshop invitation	Private landowners outside cities and FID	NKGSA		
12/3/2018	Email	Guest	Biola Chamber of Commerce							
12/3/2018	Email	Guest	Central CA Hispanic							

Date	Outreach Activity	Host or Guest	Location/Method	Organization	Type of Organization	Presentation Focus/Presentation Title	Audience	Contact for Organization	Presenter/Task Lead	Action Items/Notes
			Chamber of Commerce							
12/3/2018	Email	Guest	ClovisChamber of Commerce							
12/3/2018	Email	Guest	Fresno Chamber of Commerce Greater Fresno Area Chamber of Commerce							
12/3/2018	Email	Guest	Fresno County Farm Bureau							
12/3/2018	Email	Guest	Fresno County Women's Chamber of Commerce							
12/3/2018	Email	Guest	Fresno Metro Black Chamber of Commerce							
12/3/2018	Email	Guest	Fresno Rotary Club							
12/3/2018	Email	Guest	John Thompson	County Service Are No 10	Private/Public Water Purveyor					
12/3/2018	Email	Guest	Kerman Chamber of Commerce							
12/13/2018	Meeting	Host	Century Elementary School	North Kings GSA	Private well pumpers	SGMA introduction and update for	Private landowners		Gary Serrato	

Date	Outreach Activity	Host or Guest	Location/Method	Organization	Type of Organization	Presentation Focus/Presentation Title	Audience	Contact for Organization	Presenter/Task Lead	Action Items/Notes
						landowners in undistricted region of the subbasin.	outside cities and FID			
12/13/2018	Public workshop	Host	CUSD Century Elementary School	NKGSA	Mailed out 2800 postcards to invite County "white area" landowners	Intro to SGMA, NKGSA, and County "white area" issues.	County "white area" rural residential, other landowners		FID and County	
12/14/2018	Discussion panel	Guest	Greater Kaweah GSA	Kaweah Subbasin GSAs	Interbasin Coordination	Coordination of technical modeling efforts among GSAs in the Tulare Lake Basin.	Tulare Lake Basin GSA managers and technical staff.	Paul Hendrix, Mid-Kaweah GSA	Ronnie Samuelian, Provost and Pritchard	
12/18/2018	Discussion panel	Guest	Tulare County Agricultural Commissioner	Kaweah Subbasin GSAs	Interbasin Coordination	Share information of status and next steps of GSPs among Tulare Lake Basin GSAs	Tulare Lake Basin GSA managers, technical staff, growers.			
1/31/2019	Meeting	Guest	Clovis PD/Fire Headquarters	WWD 42 Community Advocacy Committee	County water works district (Alluvia/Herndon/168 area)	Intro to SGMA, NKGSA, and County "white area" issues.				
2/22/2019	Meeting	Host	Easton CPDES Hall	Fresno I.D. Growers Meeting - Easton	Irrigation District	Water Supply, SGMA	FID growers			

Date	Outreach Activity	Host or Guest	Location/Method	Organization	Type of Organization	Presentation Focus/Presentation Title	Audience	Contact for Organization	Presenter/Task Lead	Action Items/Notes
2/26/2019	Meeting	Host	Kerman Community Center	Fresno I.D. Growers Meeting - Kerman	Irrigation District	Water Supply, SGMA	FID growers			
2/27/2019	Meeting	Host	Clovis Veterans Memorial Center	Fresno I.D. Growers Meeting - Clovis	Irrigation District	Water Supply, SGMA	FID growers			
3/20/2019	Meeting	Co-Host	UC Cooperative Extension Office (Fresno)	UC CE / ABIRC / FID		SGMA, FID water operations	Southeast Asian small farmers within NKGSA	Ruth Dahlquest (UC CE), Dao Lor (ABIRC)		
4/15/2019	Postcard mailer	Host	1,589 post cards to FID service area	Private landowners	Private well pumpers	SGMA workshop invitation	Private pumpers up to five acres in the FID service area.			
4/22/2019	Postcard mailer	Host	256 postcards to FID service area	Private landowners	Private well pumpers	SGMA workshop invitation	private landowners up to five acres in FID service area; second email to capture properties with missing parcel information.	NKGSA		
5/2/2019	Meeting	Host	West Park Elementary School	North Kings GSA	Private well pumpers	SGMA introduction and update for properties up to 5 acres in	private landowners outside cities and within the		Sue Ruiz, Adam Claes, Gary Serrato	

Date	Outreach Activity	Host or Guest	Location/Method	Organization	Type of Organization	Presentation Focus/Presentation Title	Audience	Contact for Organization	Presenter/Task Lead	Action Items/Notes
						the FID service area	FID service area.			
5/2/2019	TV Event	Guest	ABIRC	ABIRC	Television news program	aired every wednesday. on youtube	SE Asian Community	Dao Lor-Vang	Adam Claes	Every week for May.
5/2/2019	TV Event	Guest	FID	KSEE 24	Television news program	SGMA, City's SE Water Treatment plant and importance of surface water.	General public		Adam Claes	
5/22/2019	Meeting	Guest	Hilton Garden Inn, Clovis	Water Solution Network	Non-profit coalition	SE Asian community and water quality	Non-profit organizations	Adriana Renteria	Dao Vang	
5/23/2019	Meeting	Co-Host	Clovis Council Chambers	City of Clovis	Planning Commission	SGMA introduction to planning commission, update on NKGSA/GSP status	Planning commissioner s, general public	Bryan Araki	Adam Claes	
5/23/2019	TV Event	Guest	Clovis Veterans Memorial Center	KMPH Fox 26 SGMA Townhall Meeting	Television news program - streamed live	SGMA panel discussion, Q&A	General public	KMPH Rich Rodriguez	Gary Serrato	Panel was Gary Serrato (NKGSA), Mark McKean (NFKGSA), Jonny Amaral (FWA), Mario Santoyo (SJVWIA), Thomas Esqueda

Date	Outreach Activity	Host or Guest	Location/Method	Organization	Type of Organization	Presentation Focus/Presentation Title	Audience	Contact for Organization	Presenter/Task Lead	Action Items/Notes
										(CSUF CA Water Institute)
6/6/2019	Meeting	Co-Host	County of Fresno	County of Fresno	Planning Commission	SGMA workshop, initial coordination prior to adoption	Planning commissioners, general public	Roy Jimenez	Adam Claes	
6/10/2019	Meeting	Co-Host	City of Kerman	City of Kerman	Planning Commission	SGMA workshop, initial coordination prior to adoption	Planning commissioners, general public	Olivia Pimentel	Adam Claes	
6/10/2019	Discussion panel	Guest	Riverdale Education Center	KRCD and Self-Help Enterprises	Community event, non-profits	SGMA workshop, water quality, Kings basin GW conditions, reps from 4 GSAs and consultant	General public in rural Riverdale area	KRCD Rebecca Quist & Cristel Tufenkjian	Gary Serrato/Ronnie Samuelian	Panel was Gary Serrato (NKGSA), Mark McKean (NFKGSA), Matt Hurley (MAGSA), Chad Wegley (KREGSA), Ronnie Samuelian (P&P)
7/10/2019	Television	Guest	Channel 18 PBS	Valley Public Television		Subsidence		Sara Sagamonian		
7/24/2019	Radio	Guest	Valley Public Radio	Valley Public Radio		General SGMA panel discussion	Central Valley radio audience		Panel of Gary Serrato, Dave Orth, Madera	

Date	Outreach Activity	Host or Guest	Location/Method	Organization	Type of Organization	Presentation Focus/Presentation Title	Audience	Contact for Organization	Presenter/Task Lead	Action Items/Notes
									Co. Farm Bureau	
8/26/2019	Rural Communities Workshop	Panelist	Dinuba Senionr Citizens Center	Self-Help Enterprises, KRCD & DWR	Non-profit, special district & State	Community Discussion on Groundwater	General public in rural Dinuba area, English & Spanish	Cristel Tufenkjian	Panel of Gary Serrato, Ronnie Samuelian, other GSA reps, KRCD: moderator	

Appendix 2 C Agency Presentation Information


NORTH KINGS
GROUNDWATER
SUSTAINABILITY AGENCY
Sustainable Groundwater Management Act
City of Clovis Planning Commission
May 23, 2019

1

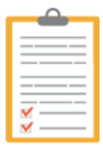

Agenda
1.SGMA Overview
2.About NKGSA
3.Regional Challenge
4.GSP Status
5.Public Involvement

2

Key Terminology

SGMA = Sustainable Groundwater Management Act

GSA = Groundwater Sustainability Agency



GSP = Groundwater Sustainability Plan

3

What is the Sustainable Groundwater Management Act (SGMA)?

- **Comprehensive legislation to manage groundwater to sustainable levels**
- Adopted in 2014
- Gives local public agencies ability to form Groundwater Sustainability Agencies (GSAs) to comply with SGMA
- Local public agencies mean those with water supply, water management, or land use responsibilities within the groundwater basin – Water Code §10721(n)
- Counties are backstop to local agencies
- State will intervene if locals and counties fail

4

SGMA Overview

SGMA was implemented, in part, due to:

Dry Wells and/or Poor Water Quality

Small Rural Communities – i.e. East Porterville
2,780 dry wells in inland CA
Local Example: 25-30% of Easton wells lowered or dry

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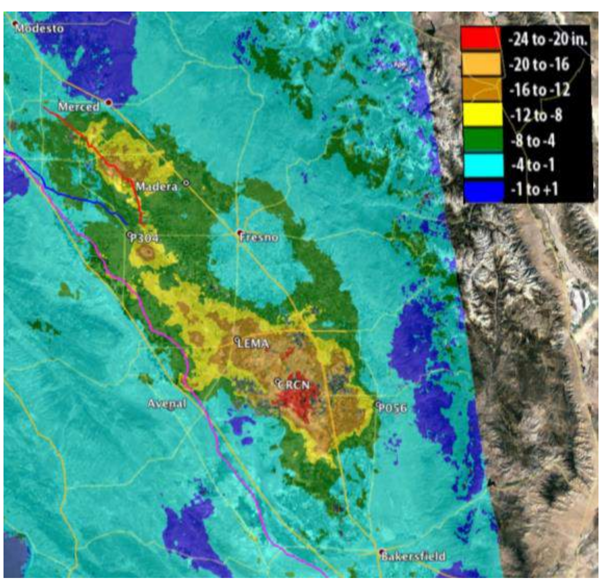
SGMA Overview

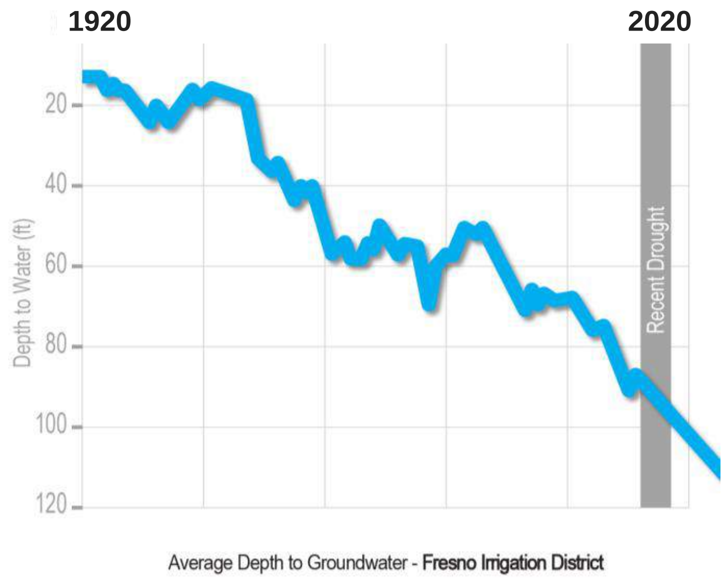


Subsidence 2015 – 2016

Friant Kern Canal
****60% Reduction in Capacity***

6

Chronic Overdraft



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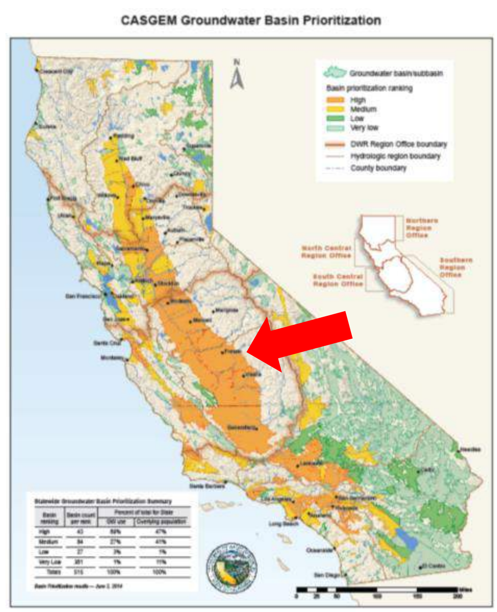
Affected Groundwater Basins

- 515 Statewide
- 127 designated High or Medium priority…they are not in a sustainable condition
- All of the southern portion of the Central Valley is High Priority and identified as in Critical Overdraft



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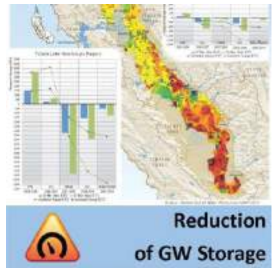
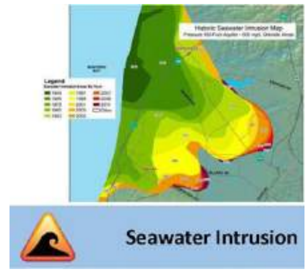
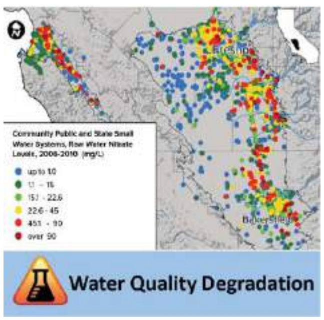
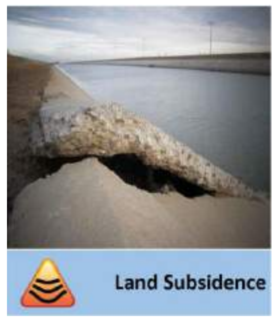
SGMA Overview

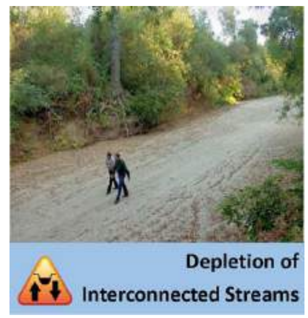
The 6 Undesirable Results











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SGMA Overview

To avoid these results, GSAs are required to develop a GSP that includes:

- ✓ Description of plan area
- ✓ Groundwater conditions
- ✓ Water budget
- ✓ Managements areas
- ✓ Sustainability goals
- ✓ Description of undesirable results
- ✓ Measurable objectives
- ✓ Description of monitoring protocols and data management
- ✓ Description of projects to achieve sustainability

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GSA New and Expanded Powers

- Adopt rules, regulations, and ordinances
- Well registration, metering, reporting, and monitoring
- Regulate groundwater extractions
  - Limiting or suspending groundwater production
- Impose fees and assessments
- Undertake enforcement action for noncompliance

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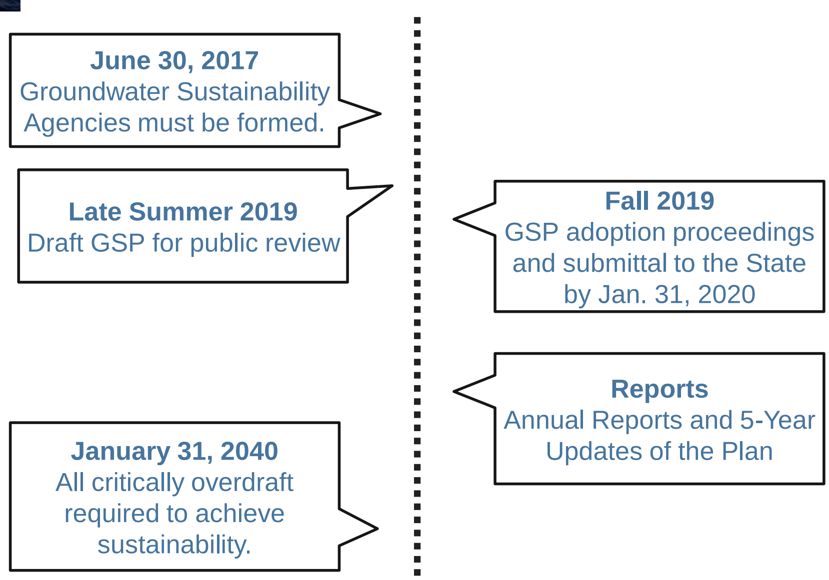
Timeline



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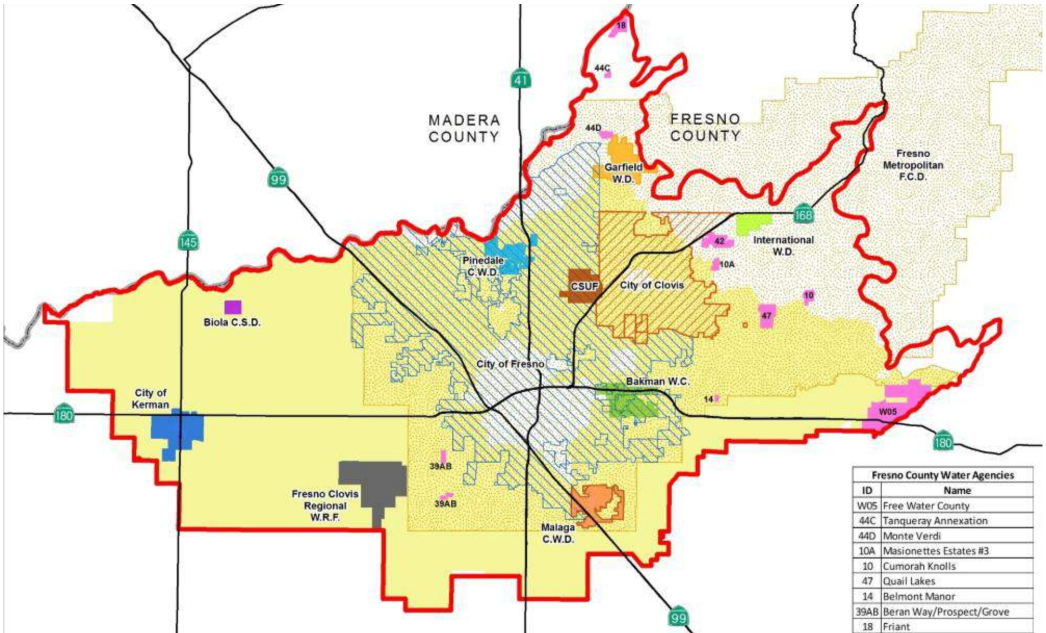

About NKGSA

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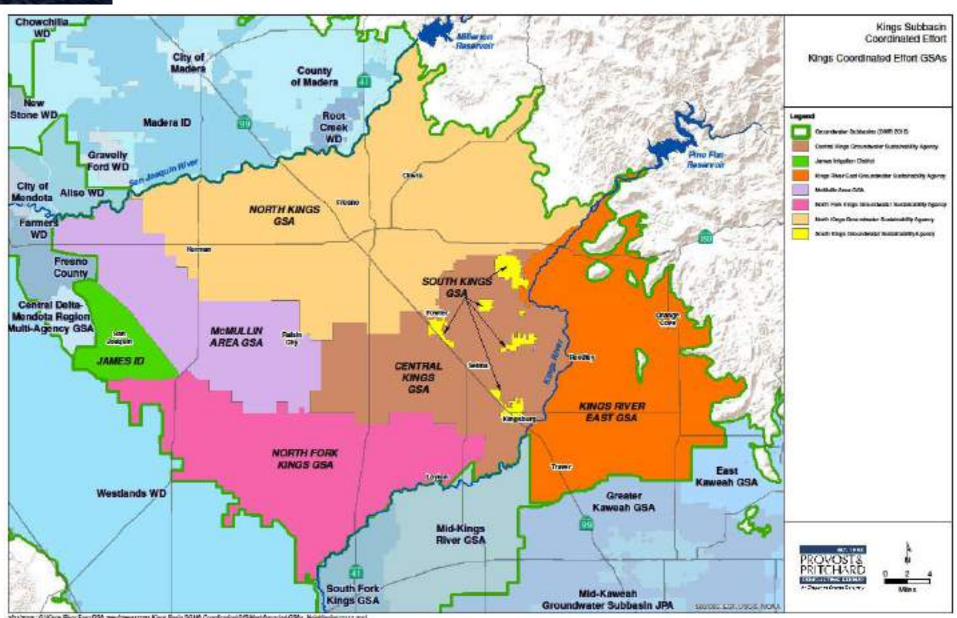
Kings Subbasin GSAs



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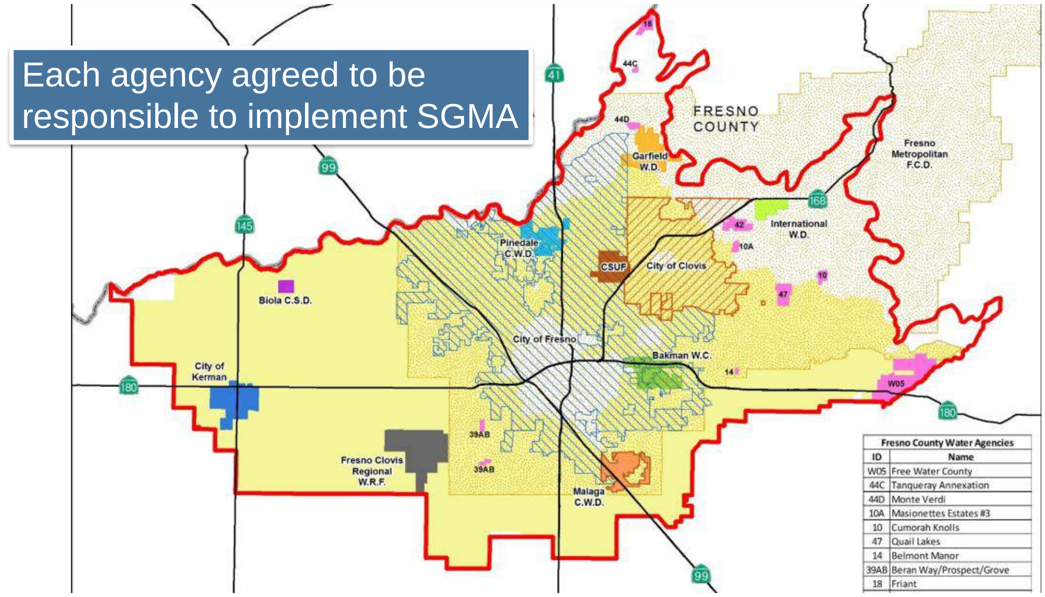
About NKGSA

North Kings GSA

Each agency agreed to be responsible to implement SGMA



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About NKGSA

Members and Governing Structure

Seat Assignment	Member	Current Board Member
#1	Fresno Irrigation District	Jerry Prieto (FID)
#2	Shared irrigation district: Garfield WD, International WD, Fresno ID	Karl Kienow (Garfield W.D.)
#3	Shared "Small Agency": Bakman Water Company, Biola CSD, CSU Fresno*, City of Kerman, FMFCD	Rhonda Armstrong (City of Kerman)
#4	City of Clovis	Jose Flores (City of Clovis)
#5	City of Fresno	Lee Brand (City of Fresno)
#6	County of Fresno	Brian Pacheco (County of Fresno)
#7	At-Large	Steve Pickens (Bakman Water Company)

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Decision-Making Support

- Executive Officer – FID's Gary Serrato
  - Advisory Committee – Chair is Scott Redelfs (Clovis) & Vice Chair is Bill Stretch (FID)
  - Technical Subcommittee – Chair is Adam Claes (FID)
    - Charged with developing GSP
    - Comprised of wide range of stakeholders
    - County is active participant
  - Membership/Outreach/Communications Subcommittee – Chair is Brandy Swisher (FMFCD)
  - Administrative/Fiscal Subcommittee – Chair is Lisa Koehn (Clovis-retired)

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Plan Status

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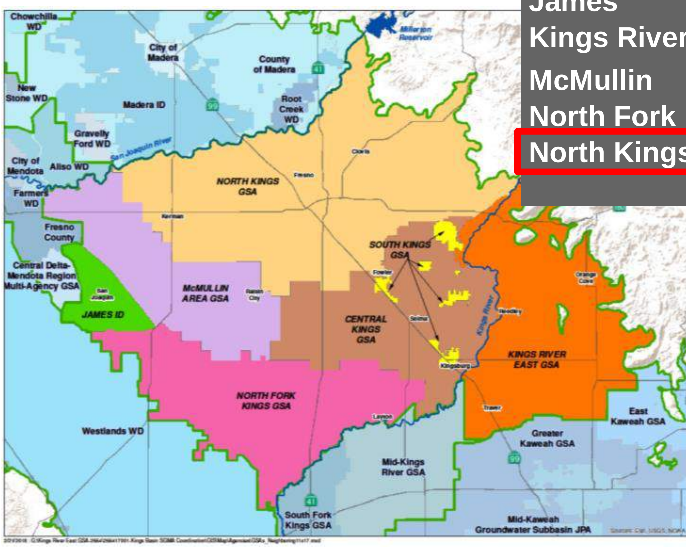
Water Balance

GSA	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



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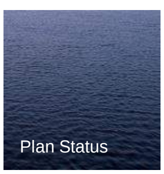
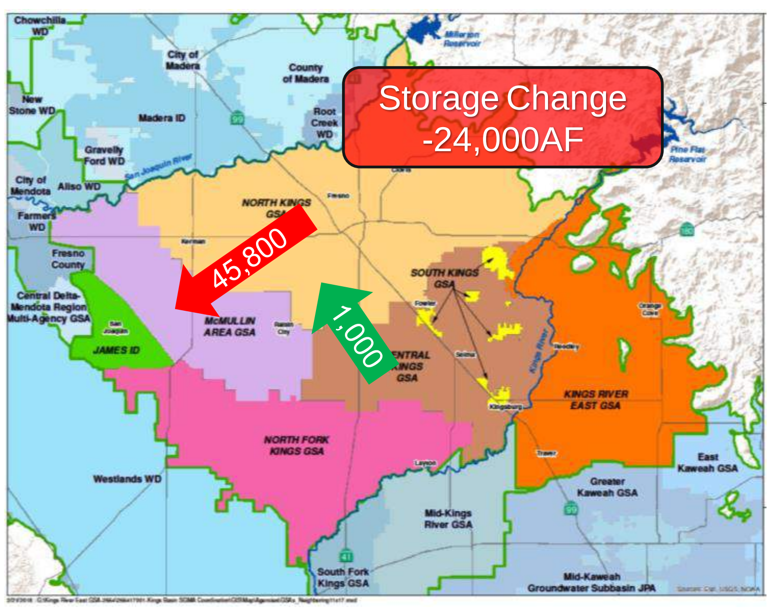


Water Balance

NKGSA in "surplus" ONLY if boundary flows stop



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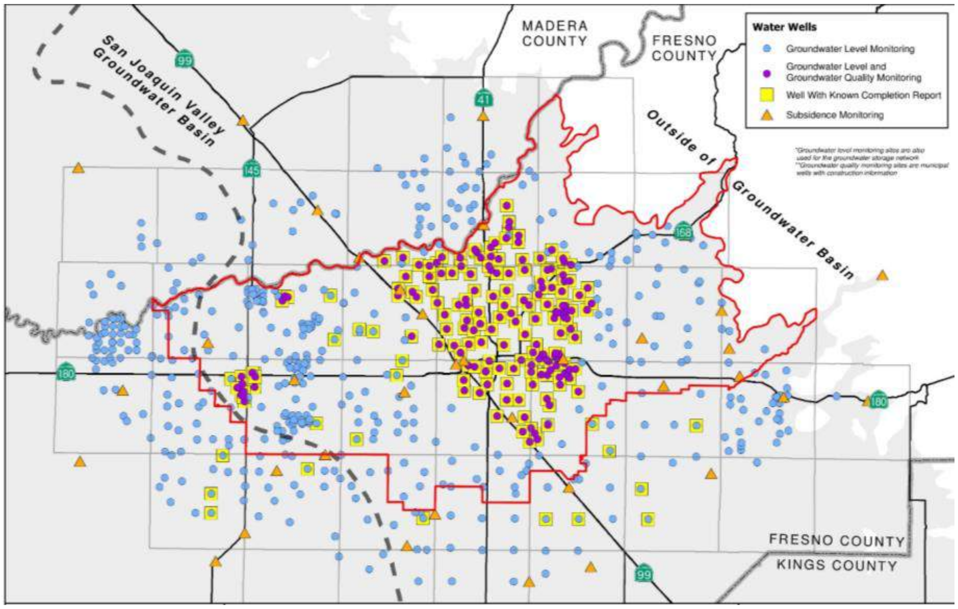
Plan Status

Groundwater Monitoring



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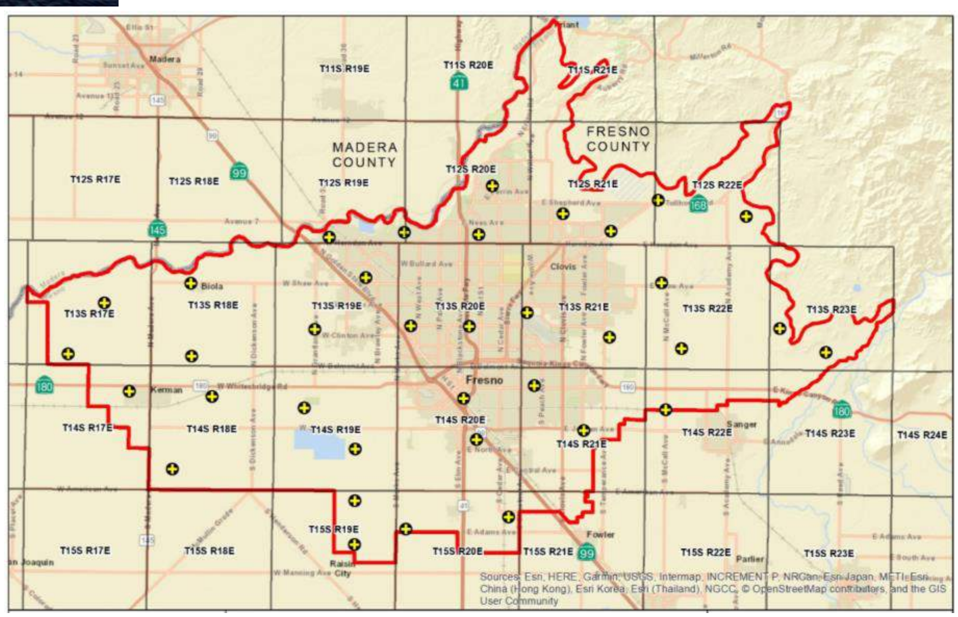
Plan Status

Indicator Wells



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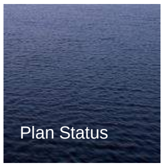
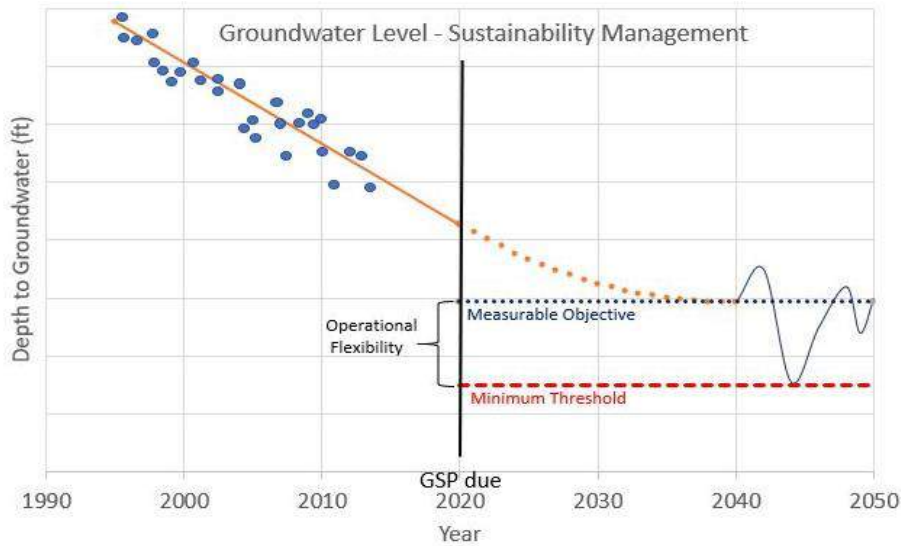


Sustainable Management Criteria



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SGMA Summary

- SGMA is a State law
- Requires the formation of GSAs
- Allows locals to address and solve undesirable results
- State will stay out if locals/County succeed
- If locals/County fail, State could control groundwater pumping in the entire subbasin
- NKGSA is identifying and understanding area's undesirable results and potential solutions

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NORTH KINGS
GROUNDWATER
SUSTAINABILITY AGENCY
ABOUT
MEETINGS
GROUNDWATER SUSTAINABILITY PLAN
OUTREACH & NEWS
CONTACT US
Welcome to the
North Kings
Groundwater Sustainability Agency
Web Portal
www.northkingsgsa.org

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Appendix 2 D City, County and Public Notification Information

NORTH KINGS GROUNDWATER
SUSTAINABILITY AGENCY

August 16, 2019

Member Agencies
Bakman Water Company
Biola Community Services District
City of Clovis
City of Fresno
City of Kerman
County of Fresno
Fresno Irrigation District
Fresno Metropolitan Flood Control District
Garfield Water District
International Water District

Board of Directors
Chairman Jerry Prieto, Jr.
Fresno Irrigation District
Vice-Chairman Brian Pacheco
County of Fresno
Steve Pickens
Bakman Water Company
Jose Flores
City of Clovis
Lee Brand
City of Fresno
Rhonda Armstrong
City of Kerman
Karl Kienow
Garfield Water District

Executive Officer
Gary Serrato

Internet
www.NorthKingsGSA.org

Mail
North Kings GSA
c/o Fresno Irrigation District
2907 S. Maple Ave.
Fresno, CA 93725

Phone
559-233-7161

Attn: Clerk of the Board of Supervisors
Fresno County Board of Supervisors
2281 Tulare Street, Room 301
Fresno, CA 93721-2198

RE: Notice of Proposed Groundwater Sustainability Plan

Dear Fresno County Board of Supervisors,

This letter is intended to provide your agency with the notice of the North Kings Groundwater Sustainability Agency's (NKGSA) proposed adoption of a Groundwater Sustainability Plan (GSP) pursuant to Water Code section 10728.4. Under the Sustainable Groundwater Management Act (SGMA) of 2014 (Water Code 10720 et seq.), a Groundwater Sustainability Agency (GSA) must provide notice to a city or county within the area of the proposed GSP at least 90-days prior to holding a public hearing to adopt a GSP (Water Code 10728.4).

NKGSA is holding a public hearing to consider adoption of its GSP on November 21, 2019 at 6:00pm at the Fresno Irrigation District Office, 2907 S. Maple Avenue, Fresno, CA 93725. As you are well aware, your agency has been involved with the development of the NKGSA, serves on the GSA Board, and staff has been actively involved in the GSP development. However, if you wish to consult with NKGSA regarding the adoption of its GSP, please provide notice to the GSA within 30 days of receipt of this notice. If you have any comments you would like NKGSA to review and consider, please provide them during the comment review period.

The GSP can be found in a downloadable pdf format on the NKGSA's website at the following link: www.NorthKingsGSA.org

If you have any questions, please feel free to contact me at 559-233-7161.

Sincerely,

Gary R. Serrato

Gary Serrato
Executive Officer/Secretary

cc: Steve White, Director
Fresno County Department of Public Works & Planning

About NKGSA: The North Kings Groundwater Sustainability Agency is a Joint Powers Authority formed in December 2016. Composed of local public agencies and others engaged through binding agreements, the NKGSA is the governing body of a portion of the Kings Subbasin (DWR Bulleting 118, 5-22.08) in compliance with the Sustainable Groundwater Management Act of 2014. NKGSA members are Bakman Water Company, Biola Community Services District, City of Clovis, City of Fresno, City of Kerman, County of Fresno, Fresno Irrigation District, Fresno Metropolitan Flood Control District, Garfield Water District, and International Water District.

NORTH KINGS GROUNDWATER
SUSTAINABILITY AGENCY

August 16, 2019

Member Agencies
Bakman Water Company
Biola Community Services District
City of Clovis
City of Fresno
City of Kerman
County of Fresno
Fresno Irrigation District
Fresno Metropolitan Flood Control District
Garfield Water District
International Water District

Board of Directors
Chairman Jerry Prieto, Jr.
Fresno Irrigation District
Vice-Chairman Brian Pacheco
County of Fresno
Steve Pickens
Bakman Water Company
Jose Flores
City of Clovis
Lee Brand
City of Fresno
Rhonda Armstrong
City of Kerman
Karl Kienow
Garfield Water District

Executive Officer
Gary Serrato

Internet
www.NorthKingsGSA.org

Mail
North Kings GSA
c/o Fresno Irrigation District
2907 S. Maple Ave.
Fresno, CA 93725

Phone
559-233-7161

Attn: Clerk of the City Council
Clovis City Council
1033 Fifth Street
Clovis, CA 93612

RE: Notice of Proposed Groundwater Sustainability Plan

Dear City of Clovis Clerk to the Council,

This letter is intended to provide your agency with the notice of the North Kings Groundwater Sustainability Agency's (NKGSA) proposed adoption of a Groundwater Sustainability Plan (GSP) pursuant to Water Code section 10728.4. Under the Sustainable Groundwater Management Act (SGMA) of 2014 (Water Code 10720 et seq.), a Groundwater Sustainability Agency (GSA) must provide notice to a city or county within the area of the proposed GSP at least 90-days prior to holding a public hearing to adopt a GSP (Water Code 10728.4).

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If you have any questions, please feel free to contact me at 559-233-7161.

Sincerely,

Gary R. Serrato

Gary Serrato
Executive Officer/Secretary

cc: Scott Redelfs, Director
City of Clovis Department of Public Utilities

About NKGSA: The North Kings Groundwater Sustainability Agency is a Joint Powers Authority formed in December 2016. Composed of local public agencies and others engaged through binding agreements, the NKGSA is the governing body of a portion of the Kings Subbasin (DWR Bulleting 118, 5-22.08) in compliance with the Sustainable Groundwater Management Act of 2014. NKGSA members are Bakman Water Company, Biola Community Services District, City of Clovis, City of Fresno, City of Kerman, County of Fresno, Fresno Irrigation District, Fresno Metropolitan Flood Control District, Garfield Water District, and International Water District.

NORTH KINGS GROUNDWATER *SUSTAINABILITY AGENCY*

Member Agencies
Bakman Water Company
Biola Community Services District
City of Clovis
City of Fresno
City of Kerman
County of Fresno
Fresno Irrigation District
Fresno Metropolitan Flood Control District
Garfield Water District
International Water District

Board of Directors
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Garfield Water District

Executive Officer
Gary Serrato

Internet
www.NorthKingsGSA.org

Mail
North Kings GSA
c/o Fresno Irrigation District
2907 S. Maple Ave.
Fresno, CA 93725

Phone
559-233-7161

August 16, 2019

Attn: Clerk of the City Council
Fresno City Council
2600 Fresno Street, Room 2133
Fresno, CA 93721

RE: Notice of Proposed Groundwater Sustainability Plan

Dear City of Fresno Clerk to the Council,

This letter is intended to provide your agency with the notice of the North Kings Groundwater Sustainability Agency's (NKGSA) proposed adoption of a Groundwater Sustainability Plan (GSP) pursuant to Water Code section 10728.4. Under the Sustainable Groundwater Management Act (SGMA) of 2014 (Water Code 10720 et seq.), a Groundwater Sustainability Agency (GSA) must provide notice to a city or county within the area of the proposed GSP at least 90-days prior to holding a public hearing to adopt a GSP (Water Code 10728.4).

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If you have any questions, please feel free to contact me at 559-233-7161.

Sincerely,

Gary R. Serrato

Gary Serrato
Executive Officer/Secretary

cc: Michael Carbajal, Director
City of Fresno Department of Public Utilities

About NKGSA: The North Kings Groundwater Sustainability Agency is a Joint Powers Authority formed in December 2016. Composed of local public agencies and others engaged through binding agreements, the NKGSA is the governing body of a portion of the Kings Subbasin (DWR Bulleting 118, 5-22.08) in compliance with the Sustainable Groundwater Management Act of 2014. NKGSA members are Bakman Water Company, Biola Community Services District, City of Clovis, City of Fresno, City of Kerman, County of Fresno, Fresno Irrigation District, Fresno Metropolitan Flood Control District, Garfield Water District, and International Water District.

NORTH KINGS GROUNDWATER *SUSTAINABILITY AGENCY*

August 16, 2019

Internet
www.NorthKingsGSA.org

Mail
North Kings GSA
c/o Fresno Irrigation District
2907 S. Maple Ave.
Fresno, CA 93725

Phone
559-233-7161

Attn: Clerk of the City Council
Kerman City Council
850 S Madera Avenue
Kerman, CA 93630

RE: Notice of Proposed Groundwater Sustainability Plan

Dear City of Kerman Clerk to the Council,

This letter is intended to provide your agency with the notice of the North Kings Groundwater Sustainability Agency's (NKGSA) proposed adoption of a Groundwater Sustainability Plan (GSP) pursuant to Water Code section 10728.4. Under the Sustainable Groundwater Management Act (SGMA) of 2014 (Water Code 10720 et seq.), a Groundwater Sustainability Agency (GSA) must provide notice to a city or county within the area of the proposed GSP at least 90-days prior to holding a public hearing to adopt a GSP (Water Code 10728.4).

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The GSP can be found in a downloadable pdf format on the NKGSA's website at the following link: www.NorthKingsGSA.org

If you have any questions, please feel free to contact me at 559-233-7161.

Sincerely,

Gary R. Serrato

Gary Serrato
Executive Officer/Secretary

cc: Ken Moore, Director
City of Kerman Department of Public Works

About NKGSA: The North Kings Groundwater Sustainability Agency is a Joint Powers Authority formed in December 2016. Composed of local public agencies and others engaged through binding agreements, the NKGSA is the governing body of a portion of the Kings Subbasin (DWR Bulleting 118, 5-22.08) in compliance with the Sustainable Groundwater Management Act of 2014. NKGSA members are Bakman Water Company, Biola Community Services District, City of Clovis, City of Fresno, City of Kerman, County of Fresno, Fresno Irrigation District, Fresno Metropolitan Flood Control District, Garfield Water District, and International Water District.

NORTH KINGS GROUNDWATER
SUSTAINABILITY AGENCY

A multi-agency group formed to meet requirements of the Sustainable Groundwater Management Act of 2014.

Draft Groundwater Sustainability Plan Available for Public Review

The North Kings Groundwater Sustainability Agency (NKGSA) Board of Directors has released the Draft Groundwater Sustainability Plan (GSP) for the lands within the NKGSA's jurisdictional boundary. The Draft GSP is the road map to understanding groundwater conditions, and determining necessary actions to ensure groundwater supplies remain sustainable for future needs.

The Draft GSP is the result of an intensive two-year effort by a wide range of stakeholders, including public agencies, engineers, scientists, farmers, private citizens, non-profit advocacy organizations, and business owners. The public is invited to review the document and provide written comments. The deadline for all written comments to be submitted is Oct. 18, 2019. A public hearing to consider adoption of the GSP will be held by the NKGSA's Board of Directors on Nov. 21, 2019.

NKGSA Groundwater Sustainability Plan Page

Sincerely,

Lynn B. Rowe
Executive Assistant, Fresno Irrigation District
On behalf of the North Kings GSA
559-233-7161

North Kings Groundwater Sustainability Agency
C/O Fresno Irrigation District
2907 S Maple Avenue
Fresno, CA 93725

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The Valley's Lifestyle Magazine

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Account #	Ad Number	Identification	PO	Amount	Cols	Depth
746398	0004354115	#4354115 NOTICE OF PUBLIC HEARING NORT		$399.00	2	2.50 In

Attention: Laura Castillo

STANTEC
3301 C STREET SUITE 1900
SACRAMENTO, CA 958163394

PUBLIC NOTICE

#4354115

NOTICE OF PUBLIC HEARING

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY (NKGSA)

BOARD OF DIRECTORS MEETING

NOTICE IS HEREBY GIVEN that on Thursday, November 21, 2019 at 6:00 p.m. or as soon thereafter as the matter can be heard, the NKGSA will hold a public hearing at the office of the Fresno Irrigation District at 2907 S. Maple Avenue, Fresno, CA to consider the adoption of its Groundwater Sustainability Plan (GSP) in accordance with CA Water Code § 10728.4. The draft GSP is available for download at www.northkingsgsa.org, and hard copies available for viewing at locations identified on the website. The deadline for written comments to be submitted is Oct. 18, 2019. Written comments can be submitted by U.S. Mail to the address above, by email to northkingsgsa@gmail.com, or via an online form available on the website. Any questions regarding this notice should be directed to northkingsgsa@gmail.com or the NKGSA (c/o Fresno Irrigation District) at 559-233-7161.

COUNTY OF DALLAS
STATE OF TEXAS

The undersigned states:

McClatchy Newspapers in and on all dates herein stated was a corporation, and the owner and publisher of The Fresno Bee.

The Fresno Bee is a daily newspaper of general circulation now published, and on all-the-dates herein stated was published in the City of Fresno, County of Fresno, and has been adjudged a newspaper of general circulation by the Superior Court of the County of Fresno, State of California, under the date of November 28, 1994, Action No. 520058-9.

The undersigned is and on all dates herein mentioned was a citizen of the United States, over the age of twenty-one years, and is the principal clerk of the printer and publisher of said newspaper; and that the notice, a copy of which is hereto annexed, marked Exhibit A, hereby made a part hereof, was published in The Fresno Bee in each issue thereof (in type not smaller than nonpareil), on the following dates.

August 28, 2019

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Dated August 28, 2019

LIZBETH AILEEN CORDERO
My Notary ID # 131068068
Expires January 25, 2023

Extra charge for lost or duplicate affidavits.
Legal document please do not destroy!

The Fresno Bee
fresnobee.com
Central Valley
The Valley's Lifestyle Magazine
Sierra Star
Serving Eastern Madera Since 1957
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AFFIDAVIT OF PUBLICATION

Account #	Ad Number	Identification	PO	Amount	Cols	Depth
746396	0004361852	#4361852 NOTICE OF PUBLIC HEARING NOR		$399.00	2	2.50 In

Attention: Laura Castillo

STANTEC
3301 C STREET SUITE 1900
SACRAMENTO, CA 958163394

PUBLIC NOTICE

#4361852

NOTICE OF PUBLIC HEARING

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY (NKGSA)

BOARD OF DIRECTORS MEETING

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The undersigned is and on all dates herein mentioned was a citizen of the United States, over the age of twenty-one years, and is the principal clerk of the printer and publisher of said newspaper; and that the notice, a copy of which is hereto annexed, marked Exhibit A, hereby made a part hereof, was published in The Fresno Bee in each issue thereof (in type not smaller than nonpareil), on the following dates.

September 04, 2019

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Dated September 04, 2019

[signature]

AMANDA DAWN GRISHAM
My Notary ID # 132031326
Expires May 30, 2023

Extra charge for lost or duplicate affidavits.
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The Fresno Bee
fresnobee.com

Central Valley
The Valley's Lifestyle Magazine

Sierra Star
Serving Eastern Madera Since 1957

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AFFIDAVIT OF PUBLICATION

Account #	Ad Number	Identification	PO	Amount	Cols	Depth
746398	0004383889	#4361852 NOTICE OF PUBLIC HEARING NOR		$399.00	2	2.50 In

Attention: Laura Castillo

STANTEC
3301 C STREET SUITE 1900
SACRAMENTO, CA 958163394

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The undersigned is and on all dates herein mentioned was a citizen of the United States, over the age of twenty-one years, and is the principal clerk of the printer and publisher of said newspaper; and that the notice, a copy of which is hereto annexed, marked Exhibit A, hereby made a part hereof, was published in The Fresno Bee in each issue thereof (in type not smaller than nonpareil), on the following dates.

September 18, 2019

[illegible]

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Dated September 18, 2019

Extra charge for lost or duplicate affidavits.
Legal document please do not destroy!

PUBLIC NOTICE

#4361852

NOTICE OF PUBLIC HEARING

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY (NKGSA)

BOARD OF DIRECTORS MEETING

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Appendix 2 E Summary of Public Comments Received

Public Comments Table. - Review of NKGSA 8-15-19 DRAFT GSP

No.	From	Section	Page	Comment	Response
1	California Rural Legal Assistance, Inc.	3 2	3-57 2-20 2-18 2-18	**The NKGSA Basin Setting Chapter Fails to Adequately Identify Contaminant Sites and Plumes** The Sustainable Groundwater Management Act (SGMS) mandates that GSAs include a "Basin Setting" section in the GSP that provides an overview of the groundwater conditions in the Subbasin. This section must include "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." 23 CCR 354.16(d). The NKGSP contains information on some groundwater contaminant sites and plume locations (GSP p. 3-57) but fails to include any rural communities that have water contamination and are unserved by a public water system. The plume location map presented on page 2-20 fails to identify any groundwater plume locations outside of the Fresno metropolitan area. Nor are plumes outside of the Fresno metropolitan area discussed elsewhere in the GSP. The GSP states that "similar maps for the rest of the NKSA are not known to exist." (GSP p. 2-18) There is no evidence of any further effort to identify plumes in other locations, despite the NKGSP acknowledging that "maintaining a current map of known plumes is important for the regions." (GSP p. 2-19) Maintaining a current map of known plumes is necessary to comply with North Kings GSA's obligations to address groundwater quality issues, including plume migration. These legal obligations are not contingent on the availability of preexisting maps. North Kings GSA should develop additional plume maps, or include information on contaminant plumes outside of the Fresno metropolitan area from other sources. The groundwater quality basin setting also fails to identify contaminant sites affecting domestic well users by focusing solely on public water systems for contaminant information. There are a substantial number of contaminated domestic wells and domestic well clusters throughout the Kings Subbasin that are not reflected in the draft GSP. The draft GSP states that "in some small communities, many domestic wells exceed water quality standards and residents continue to use the water due to lack of alternatives," (GSP p. 2-18) yet provides no further information on these communities. These individual communities and domestic well clusters must be included by name or location in the NKGSP and their contaminant levels identified. The NKGSP must address drinking water quality issues for domestic well users, and it is unlikely that the North Kings GSA will do so if the GSP does not even identify the communities in need of assistance. The North Kings GSA must make a dedicated effort to locate information related to contaminant plumes and sites in rural communities. Sources of such information include but are not limited to: domestic well testing results conducted by residents, community organizations, or technical assistance providers, funding application for water infrastructure related to groundwater remediation, or through new investigatory efforts. The North Kings GSA may develop new monitoring wells in rural communities or install monitors on existing domestic wells if insufficient data exists to identify contamination in rural areas.	The NKGSA has developed voluminous data and will continue to develop more data for evaluating and implementing the GSP.

2	California Rural Legal Assistance, Inc.	4	4-5	**The North Kings Groundwater Sustainability Plan Must Protect the Interests of Domestic Well Users and Disadvantaged Communities** *a. SGMA mandates that all beneficial users be represented* Groundwater Sustainability Agencies (GSAs) are required to consider the interests of all users of groundwater, specifically including domestic well owners and disadvantaged communities reliant on groundwater; the interests of these users must be protected throughout the development of the GSP. Water Code 10723.2(a)(2); 10723.2(i); CCR 354.26. The obligation to protect the rights of domestic well owners and disadvantaged communities is not secondary to the protection of other beneficial users such as industrial, agricultural, or commercial groundwater users; the rights of domestic well owners and disadvantaged communities must be given the same weight as these other users and policies and management actions within the GSP must reflect that equality. *b. The NKGSA fails to adequately address the needs of domestic well users and disadvantaged communities.* The NKGSP fails to provide sufficient protections to domestic well users and disadvantaged communities. The GSP does not identify or address the specific needs and water issues affection domestic well users and disadvantaged communities except in passing, and includes no policies or projects designed to specifically protect these beneficial users' groundwater resources. The NKGSP minimum thresholds for groundwater elevation fail to address the rights of domestic well users. The minimum threshold is set by identifying the lowers groundwater levels expected by a five-year drought, rather than by identifying the levels necessary to sustain residential water users. The minimum threshold on many wells identified in the NKGSP is set below the average well depth for domestic wells throughout the Subbasin. Even the measurable objective for some wells is below the depth of most domestic wells. Domestic well users are typically low-income residents, a group specifically identified for protection in SGMA, that lack the necessary resources to drill a deeper well to reach groundwater once aquifer levels decline—resources that many agriculatural, industrial, and commercial users possess. Setting the minimum thresholds lower than average domestic well depth ensures that many wells will fail while the aquifer levels are still considered "sustainable." The NKGSP deals with this issue dismissively by stating that 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 (GSP p. 4-5) The North Kings GSA demonstrates that it does not take its legal obligation to protect all beneficial users seriously by summarily dismissing well failures as an undesirable result. Well failures are the most significant negative result from groundwater changes that impacts residential well owners and disadvantaged communities. These residents simply do not have the resources to address this issue individually. The North Kings GSA should set groundwater level minimum thresholds that will protect residential well owners by being equivalent to or higher than average domestic well depths to comply with its legal obligations under 23 CCR 354.26. The NKGSP fails to include any projects or policies aimed at assisting domestic well owners whose wells are at risk of failure or have failed. These policies must be included, especially if North Kings GSA sets minimum thresholds below the depths of residential well; they must be concrete and measurable. Examples of such policies include restriction on pumping near communities reliant on domestic wells to slow groundwater depletion in the aquifers these communities rely on, funding programs to assist domestic well owners in drilling deeper wells, and measuring and tracking domestic well levels to identify areas of dewatering that should be addressed. Priority should be given to recharge projects near domestic well communities to recharge the aquifers these users rely on.	The NKGSA has developed voluminous data and will continue to develop more data for evaluating and implementing the GSP. GSP changed in 4.2.2.3 to discuss analysis of the impacts of the water level measurable objectives and minimum thresholds on domestic wells. GSP changed in 4.2.2.3 to discuss analysis of the impacts of the water level measurable objectives and minimum thresholds on domestic wells. GSP changed in 4.2.2.3 to discuss analysis of the impacts of the water level measurable objectives and minimum thresholds on domestic wells. The NKGSA has developed voluminous data and will continue to develop more data for evaluating and implementing the GSP.
			4-5		
3	California Rural Legal Assistance, Inc.			**The Groundwater Sustainability Plan Fails to Adequately Protect Drinking Water Quality** *a. Protection of groundwater quality is a mandatory component of SGMA* SGMA mandates that GSAs adopt policies, plans, and projects in their GSP that protect against six undesirable results, including degraded groundwater quality. Water Code 10727.2(d). GSAs must specifically protect against "significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies." Water Code 10721 (x). The legal mandate to prevent degraded groundwater quality is of equal importance to the other five sustainability indicators, and North Kings GSA must address groundwater quality degradation with proactive, substantial efforts. *b. The NKGSP fails to adequality identify groundwater quality issues* The NKGSP fails to adequately address water quality issues by failing to adequately identify contamination throughout the Subbasin. The NKGSP states that the GSA will use monitoring wells from public water agencies to evaluate the water quality for the Subbasin, excluding domestic well contaminant levels (GSA p. 4-21). North Kings GSA's reliance on data from public water systems will exclude critical information about the location and severity of groundwater contamination and risks misrepresenting the contamination in the aquifer. Many domestic wells in the Kings Subbasin contain high levels of contaminants such as nitrates, sometimes much higher than the state Maximum Contaminant Levels (MCLs). Public groundwater wells are often	Thank you for your comments. All comments are given due consideration. The NKGSA has developed voluminous data and will continue to develop more data for evaluating and implementing the GSP.

				deeper than private water wells; water drain from deeper wells often contains lower levels of the contaminants that impact domestic wells. The severity of these contaminants will not be reflected in the NKGSP unless data from private wells is included in the plan.	Thank you for your comments. All comments are given due consideration.
			4-21	Creating a monitoring network based on the location of existing public water systems without including the location of groundwater contaminant plumes will result in a data set that fails to accurately represent water conditions throughout the Subbasin. Public water systems are not located throughout all rural areas in the Subbasin; thousands of acres of land will lack data showing water quality or contaminant plumes. The current GSP proposes using two water quality monitoring wells in each township, (GSP p. 5-19), but this is insufficient to represent water quality variations in large rural areas such as Fresno County. Smaller contaminant plumes exist in various areas in the Subbasin are not reflected on the contaminant plume map (see Section 1, above) despite having a significant detrimental public health effect on residential well users. For example, domestic well users adjacent to the community of West Park have high levels of nitrates; DBCP and Uranium have also been identified in the water. Because those residents are reliant on domestic wells, and the community water system serving West Park has no wells in the area, the contamination is not reflected anywhere in the GSP. Adequate mitigation measures and projects to address domestic well contamination cannot be developed if the contamination is not even recognized in the plan. A higher density monitoring system that includes wells near or in domestic well communities must be utilized.	Thank you for your comments. All comments are given due consideration.
				c. The undesirable result standard for groundwater quality must be revised The NKGSP "undesirable result" for groundwater quality fails to protect human health and the needs of domestic well owners and disadvantaged communities. The GSP defines and undesirable result for groundwater quality as 15% of the representative monitoring wells experiencing degradation of water quality to below MCLs, or a statistically significant increase in groundwater degradation in areas where contamination has historically been above MCLs. At least one of these conditions must be met for two consecutive years before the GSP will consider the situation an undesirable result.	Thank you for your comments. All comments are given due consideration.
			5-19	This standard for identifying undesirable water quality results is insufficient and must be more protective of human health. It is inappropriate for the GSP to wait two years before water quality degradation triggers an undesirable result classification. This approach delays development and implementation of mitigation measures to address the contamination, further endangering public health by delaying the overall time for the aquifer to return to drinkable standards. The impact of this will especially be felt by domestic well users that do not have the same protections and infrastructure to address water quality as users of public water systems, which will be required to address contamination issues expeditiously.	GSP changed on page 4-32, to state that actions may be conducted as adverse water quality changes are observed to prevent an undesirable result.
				It is also inappropriate to require 15% of monitoring wells to reflect the same degradation of water quality before and unreasonable result classification will be triggered. Monitoring wells in rural areas are few and distant from each other and water quality can vary significantly in different areas. The 15% threshold requirement may result in substantial groundwater degradation being unrecognized as an undesirable result simply because monitoring wells are located far apart and can therefore not meet the 15% requirement. Water degradation at a single well should be sufficient to trigger an undesirable result classification, especially in rural areas where monitoring wells are sparse.	GSP changed on page 4-32, to state that actions may be conducted as adverse water quality changes are observed to prevent an undesirable result.
				The North Kings GSA must take additional steps to address these issues. Additional well monitoring must occur in rural areas to present a more accurate picture of groundwater contaminant plumes and to gather data on contaminant levels. The monitoring network must include shallow wells that are reflective of domestic water systems. The triggering time period to reach an undesirable result for groundwater quality must be shortened. The number of wells that must be affected by contamination before an undesirable result classification is triggered must be reduced dur to the rural nature of the Subbasin.	The NKGSA has developed voluminous data and will continue to develop more data for evaluating and implementing the GSP.
				d. The NKGSP fails to utilize available tools to address groundwater quality degradation The North Kings GSA fails to fully exercise its authority to address groundwater contamination issues in the Subbasin. The NKGSP states that the North Kings GSA will simply monitor annual public reporting on groundwater quality and does not commit to any proactive actions to address groundwater quality issues. The NKGSP also states that the only authority the North Kings GSA possesses to address groundwater contamination is to "regulate and manage groundwater pumping." (GSP p. 4-23). This is inaccurate. The North Kings GSA has the power to register and monitor domestic wells and should utilize this power. The NKGSP identifies a data gap for the water quality of domestic wells yet proposes no plans or programs to address this inaccuracy. Collecting data from private wells is a critical first step towards complying with the North Kings GSA's legal obligations to prevent worsening groundwater quality throughout the Subbasin. The North Kings GSA should develop voluntary or mandatory private well monitoring programs or drill additional monitoring wells throughout the area to address the data gaps.	Thank you for your comments. All comments are given due consideration.
				The North Kings GSA has additional powers. Proposed projects can be designed and implemented in a manner that is protective of groundwater quality. Recharge projects should include soil testing to ensure that groundwater recharge does not unintentionally cause additional contaminants	

				to leach into the aquifer, worsening contamination. This is especially true for on-farm recharge projects where fertilizers and other agricultural chemical products may have been used. Recharge should be prioritized in areas where the specific contaminants would be reduced by increasing water levels. Domestic well quality data can be gathered and tracked to identify additional plumes in the Subbasin that are not currently reflected in the Fresno Metropolitan plume map. Additional contaminant monitoring can be added to irrigation wells already being regularly tested. The North Kings GSA must use the full extent of its powers in proactive and creative ways to address groundwater quality issues for disadvantaged communities and users of domestic wells; these communities are the most highly impacted by groundwater contamination and are specifically protected under SGMA.	Thank you for your comments. All comments are given due consideration.
4	John Ulam (undated letter)			Puzzled by the fact that not many of my neighbors have been informed about SGMA. No immediate neighbors knows anything about it. At the meetings Gary Serrato indicated that two and five acre parcels are to be restricted to pumping two acre feet annually. This thought process is unfair to five acre parcel owners. 1. While two acre feet for a two acre parcel is fair, two acre feet for five acres is not. I have developed my five acre parcel with a vineyard, fruit trees, landscaping and a goat herd. I am more than willing to remove grass etc. to save water, but letting trees die? Don't scientists agree that trees recycle carbon and many say we have a climate change problem. 2. Also addressing a comment from a county representative at the September meeting in Clovis stated that an acre of open land can capture an acre feet of water annually, at normal rainfalls totals, approximately 12 inches. Therefore, I believe that I should be able to pump five acre feet annually, owning a five acre parcel. 3. If a property owner such as myself has a catch basin on the natural swale or low areas to capture and percolate winter runoff, can that increase pumping allowed in the summer? I believe this should be taken into consideration. 4. Another consideration that could be looked at is that a landowner that has no landscaping, trees or animals could be allowed to either sell or give their unused pumping allotment of water to their neighbors? 5. Contrary to what was stated at the September meeting in Clovis, forty acre parcels are being subdivided in this area with no new water sources. One was divided at the 11,000 block of East Herndon. Others are also being considered in the Academy/Shaw area. In closing we can see that the State of California seems to be contributing to this overdraft by taking away more surface water for "environmental" reasons, even in very wet years. No new dams are being allowed, even, the raising of Shasta Dam is stopped in the courts. It is of my opinion that members of the NKGSA board should be of this area we live in to represent us properly. I believe this letter represents the position of most residents in this area that are more than willing to protect the ground water and do their part, but do no want meters forced onto them along with all the fees that will come with it.	Thank you for your comments. All comments are given due consideration.
5	Katharine Wilson			Cannot be at Thursday Sept 12 meeting. Questions: Will you (GSA) ignore water rights?	Thank you for your comments. All comments are given due consideration.
6	Robert Havay	6		1. No provision to build/repair ground water storage. 2. Moratorium on building new housing. The explanation developers must submit plan for "new water source" is disingenuous. 3. Page 47, $600 Installation fee for well meter plus $300 annual. If I am restricted by meter on usage or charged for how much water I use then the $300 annual fee becomes a cash cow for the state. 4. Limits of 55 gal per person per day-what's that all about?	Thank you for your comments. All comments are given due consideration.
7	Diana Curtis	7		I am opposed to more government intervention. This is only a Stepping stone to a meter on our well on our property. We paid for the well and the electricity to pump water. If something goes wrong with the well we have to pay for it. There is no maintenance involved as in public water supply. Bad idea.	Thank you for your comments. All comments are given due consideration.
9	Brad Lopez	4		The comments contained in this document are taken for the 2 April 2019 email sent to Adam Claes, North Kings GSA, Fresno Irrigation 2907 S Maple Ave, Fresno, CA 93725 Please include the following written recommendations and comments in the 12 September 2019, 6-8PM meeting tonight, the notes and protocol at the Clovis Veterans Memorial. Comment #1 Measures for landowners within SIGMA Action: Amend the GSP draft to include current homeowner with wells permanent exemptions for those who have made useful, practical,	Thank you for your comments. All comments are given due consideration.

				sustained installation/modifications to measurably retain water to recharge the groundwater. Examples for Landowners: a) Install and maintain adjustable levies to increase sizable sustainable ground water. b) Excavate and create water basins in property safe areas to catch and retain water to percolate and constantly recharge aquifers. c) Change existing landscape to drought resistant plants and trees to minimize water use. Retain existing trees to absorb carbon dioxide from the atmosphere. Comment #2 Measures for the California State Legislature and Governor specified in SIGMA Action: Urge and implore the California State Legislature and Governor to enact legislation to increase sustainable water to divert and restore water in counties to regenerate aquafers throughout the San Juaquin Valley. Examples for state legislators and governor: a) Build a dam near the San Francisco Bay Area to prevent brackish salt water backflow into the Delta. b) Along with the new dam divert 70-80% more water to the California Aqueduct to prevent the reprehensible annual waste of millions of acre feet of fresh water that goes through the Bay Area into the Pacific Ocean. c) Create more aqueducts to supply fresh water to farmland with the most need to increase food production, reverse unemployment, and save indigenous wildlife and fauna. d) Implement regulations to establish very large fines for any and all entities that discharge any material in or near the Delta and the San Francisco Bay that contributes to poor water quality. Close any and all violators and businesses with three violations that harm water quality.	
10	Pinedale County Water District	2	13	Page 2-13 Description of Pinedale County Water District While almost all of the district is in fact located in the City of Fresno, the description of the Pinedale County Water District should be amended to include that there are parts of the District that remain in the unincorporated County. The area served by the District for water service is approximately 886 acres, not 850, which includes approximately 120 acres of unincorporated land located in County of Fresno (three county islands). This means that more than 90% of the water pumped by Pinedale is delivered to and for the benefit of residents and businesses in the City of Fresno with the small amount of water being delivered to the County islands de minimis. This overlap with the City of Fresno raises substantial concerns about groundwater management within the District which includes but is not limited to: ability of Pinedale to engage in recharge activities within the District, how credits for recharge activities will be apportioned between the City of Fresno and the District, the extent that City of Fresno and Pinedale groundwater supply, demand, and recharge activities are intertwined and the impacts of the City of Fresno's land use planning and issuance of development entitlements have had Pinedale's groundwater use, supply and ability to recharge groundwater supplies including the development and utilization of CO2 basin located within Pinedale's boundary. The City of Fresno is currently denying Pinedale the use of basin CO2 for groundwater recharge. These issues must be addressed in the GSP, particularly as these issues related to Projects and Management Actions as described in the GSP. If these issues are not addressed and resolved in the GSP prior to approval, the GSP will be inadequate and subject to legal challenge.	GSP changed to reflect 886 acres. Thank you for your comments. All comments are given due consideration.
11	Pinedale County Water District	2	36	**Page 2-36 Description of Municipal and Industrial Well Operators** States that "[w]hile Malaga and Pinedale CWD's meet SGMA eligibility criteria as a GSA, the governing bodies for these local agencies elected to be represented in the North Kings GSA by Fresno Irrigation District and the City of Fresno, respectively." This statement as it relates to the Pinedale County Water District is completely false and not supported by the record. First, while it is true that Pinedale meets the criteria to be a GSA, Pinedale did no elect to become a GSA therefor, by default, it is part of the North Kings GSA. Second, at no time did the Board of Directors of the Pinedale County Water District elect to be represented by the City of Fresno nor does the City of Fresno have any authority to represent the Pinedale County Water District or its interests on the North Kings GSA board, other than its duty as a member of the North Kings GSA to act in the best interest of all of those within the jurisdiction of the North Kings GSA.	GSP changed to clarify that Pinedale elected to not be on the NKGSA board.
12	Pinedale County Water District	6	2	The GSP identifies several projects being undertaken by the member agencies and entities individually but the GSP fails to identify any policy or mechanism for the development of multi-agency basin-wide projects that NKGSA members and non-members and stakeholders could participate in for the benefit of the entire basin or north-kings sub-basin. The GSP should include a policy that encourages regional groundwater recharge projects facilitated by the NKGSA which non-members and other stakeholders could participate in to take advantage of the economies of scale provided by such projects as opposed to individual agencies being required to engage in individual groundwater mitigation/recharge projects.	Thank you for your comments. All comments are given due consideration.

13	The Nature Conservancy	2.5.1	2-35	Environmental and Ecosystem Interests were listed as Beneficial Users of groundwater. Surface water users were also listed as Beneficial Users, as long as there is hydrologic connection between surface water and groundwater bodies. No further description of the environmental or ecosystem interests or surface water users was given. The Kings River Fisheries Program and the San Joaquin River Restoration Program (SJRRP) are described in Section 2.2.2 (Limits to Operational Flexibility). The Kings River program includes year-round flows, improved temperature control, and monitoring requirements. The SJRRP program also increases flows to benefit fisheries. The benefits and requirements of these programs should be discussed here. Please describe whether other beneficial uses and users of groundwater in the NKGSA area are present, including protected Lands, preserves, refuges, conservation areas, recreational areas; managed wildlife areas, and other protected lands; and Public Trust Uses, including wildlife, aquatic habitat, fisheries, and recreation. The types and locations of environmental uses, species and habitats supported, and the designated beneficial environmental uses of surface waters that may be affected by groundwater extraction in the NKGSA area should be specified. To identify environmental uses and users, please refer to the following: • Natural Communities Commonly Associated with Groundwater dataset (NC Dataset) - https://gis.water.ca.gov/app/NCDatasetViewer/ • The list of freshwater species located in the Kings Subbasin in Attachment C of this letter. Please take particular note of the species with protected status. • CDFW's CNDDB - https://www.wildlife.ca.gov/Data/CNDDB • USFWS's IPAC report for the NKGSA area -https://ecos.fws.gov/ipac/	Thank you for your comments. All comments are given due consideration.
14	The Nature Conservancy	2.2.1	2-16 to 2-17	Groundwater Level Monitoring (p. 2-16) programs have been implemented by the Fresno Irrigation District since 1920. They collect data from other irrigation districts and agencies and prepared annual reports. Most of the agencies within the North Kings GSP were formerly part of the Fresno Area Regional Groundwater Management Group. The Kings River Conservation District (KRCD) also collects water level data in the NKGSA area. Please describe how existing groundwater monitoring programs are protective of GDEs or propose additional monitoring that specifically targets GDEs. The Surface Water Monitoring section (p. 2-17) briefly describes the types of monitoring by the Fresno Irrigation District, Kings River Water Association (KRWA), the Friant Water Authority, the cities of Fresno and Clovis, and other water districts. There is no mention of ISWs or GDEs and how they are monitored. Please explain the relationship of existing stream flow monitoring to the protection of ISWs and GDEs.	Thank you for your comments. All comments are given due consideration.
15	The Nature Conservancy	2.2.2	2-18 to 2-23	The SJRRP requires the release of flows from Friant Dam to the confluence with the Merced River to support the life-stages of salmon and other fish. These restoration flows will allow more groundwater seepage when the system is fully operational, which is estimated to be after 2029. Table 2-3 (p. 2-22) lists potential impacts in reduced water deliveries from the San Joaquin River. This section should discuss or reference any instream flow requirements, especially flow needs for critical species, including the amount, time of year when the flow minimum is specified, the duration, the species for which it applies, associated permits that set forth the requirements, and the regulating agency setting forth the compliance requirements. Please discuss the potential impact of the SJRRP on the aquatic species and habitat present along the river and within adjacent habitats supported by the river.	Thank you for your comments. All comments are given due consideration.
16	The Nature Conservancy	2.3	2-24 to 2-28	There are three city general plans (Fresno, Clovis, and Kerman) and the Fresno County General Plan within the NKGSA area. All were completed prior to the development of the GSA. The plans should be modified to include a discussion of General Plan goals and policies related to the protection and management of GDEs and aquatic resources that could be affected by groundwater withdrawals. Please include a discussion of how implementation of the GSP may affect and be coordinated with General Plan policies and procedures regarding the protection of wetlands, aquatic resources and other GDEs and ISWs. This section should identify Habitat Conservation Plans (HCPs) or Natural Community Conservation Plans (NCCPs) within the NKGSA area and if they are associated with critical habitat, GDE or ISW habitats. Please identify all relevant HCPs and NCCPs within the NKGSA area and address how GSP implementation will coordinate with the goals of HCPs or NCCPs. Please refer to the Critical Species Lookbook to review and discuss the potential groundwater reliance of critical species in the basin. Please include a discussion regarding the management of critical habitat for these aquatic species and their relationship to the GSP.	Thank you for your comments. All comments are given due consideration.

17	The Nature Conservancy	2.3.4	2-27 to 2-28	Please include a discussion of how future well permitting will be coordinated with the GSP to ensure achievement of the Plan's sustainability goals. The State Third Appellate District recently found that counties have a responsibility to consider the potential impacts of groundwater withdrawals on public trust resources when permitting new wells near streams with public trust uses (ELF v. SWRCB and Siskiyou County, No. C083239). The need for well permitting programs to comply with this requirement should be stated in the text.	GSP changed in 1st paragraph of 6.1 to include… The NKGSA will also be an active participant and reviewer of proposed project impacts through the project development and CEQA process.
18	The Nature Conservancy	2.4.4	2-32	The County of Fresno has the authority to require permits for well abandonment and/or well destruction, but due to staffing and funding limitations the GSP notes that enforcement of this requirement is limited. The Cities of Clovis and Fresno also require that wells be properly destroyed within their city limits. Please describe what actions will be taken by the NKGSA to make sure that wells are properly abandoned. The GSP also states that well owners will be encouraged to convert the wells into monitoring wells. Please include text to clarify that only wells screened in one aquifer and are appropriate for monitoring will be included in the monitoring program.	Thank you for your comments. All comments are given due consideration.
19	The Nature Conservancy	3.1.7	3-14	Basin wide cross sections provided in Figures 3-7 through 3-12 (pp. 3-15 through 3-20) are regional, and do not include a graphical representation of the manner in which shallow groundwater may interact with ISWs or GDEs that would allow the reader to understand this topic. The cross-sections have been taken from a 1969 source and as reproduced in the GSP, are very difficult to read and understand. Please reproduce the regional cross-sections so that they can be understood by the reader and update them to illustrate data obtained from more recent well installations. Include an example near-surface cross section that depicts the conceptual understanding of shallow groundwater and river interactions at different locations, as well as any potential GDEs.	Thank you for your comments. All comments are given due consideration.
20	The Nature Conservancy	3.1.8.1	3-21 to 3-22	The first aquitard is the extensive iron-silica hardpan layer of the Riverbank Formation, which is important in identifying where groundwater recharge can occur. The text states later in this section that the two clay layers, A and C clays are not present in the NKGSA area (p. 3-22). The E-clay, commonly known as the Corcoran Clay, is present in the western part of the NKGSA area and confined conditions exist below the Corcoran Clay. In the past, it was assumed that only one aquifer existed in the eastern part where the E-clay is absent. However, this assumption is being reevaluated. KDSA has described in Appendix 3A how locally extensive clay layers can function as an aquitard, forming a confined aquifer below. This evaluation will continue and NKGSA stated later in Section 5 that the confined aquifer may be monitored separately in the future. Please discuss the importance of clearly defining which aquifer any given well is monitoring. Wells monitoring the unconfined aquifer measure the true water table and these elevations should be contoured separately. These groundwater elevations then help determine representative conditions within GDE units.	Thank you for your comments. All comments are given due consideration.
21	The Nature Conservancy	3.1.8.2	3-26	In the NKGSA area, the base of the usable aquifer corresponds with the base of freshwater, generally defined as groundwater with total dissolved solids (TDS) of 2,000 milligrams per liter (mg/l) (KDSA, 2010), except one area to the east. In the far eastern part of the NKGSA area, the base of the aquifer is defined by the top of the basement complex. As noted on page 9 of DWR's Hydrogeologic Conceptual Model BMP (https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_HCM_Final_2016-12-23.pdf) "the definable bottom of the basin should be at least as deep as the deepest groundwater extractions". Thus, groundwater extraction well depth data should also be included in the determination of the basin bottom. Properly defining the bottom of the basin will prevent the possibility of extractors with wells deeper than the basin boundary from claiming exemption from SGMA due to their well residing outside the vertical extent of the basin boundary.	Thank you for your comments. All comments are given due consideration.
22	The Nature Conservancy	3.1.12	3-40 to 3-41	Wetlands were mapped along the Kings river, San Joaquin River, and several intermittent streams including Redbank Creek, Dog Creek, Pup Creek, and Big Dry Creek, as shown on Figure 3-22 (p. 3-43) as identified from US Forest Service's Wetland Inventory, according to the GSP. In this section, please refer to the discussion of GDEs in Section 3.2.8 and mapped on Figure 3-38. Also, if the Wetland Inventory was in fact the US Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI), then correct the text and reevaluate the data. The NWI does not always include or segregate separate existing wetlands that are on the periphery of other features. Please describe the wetland types in more detail. If they are truly vernal pools confined by a clay layer then they are not GDEs, but they must meet the criteria of a vernal pool as described by the California Rapid Assessment Methodology or the United States Army Corps of Engineers to qualify.	Thank you for your comments. All comments are given due consideration.

23	The Nature Conservancy	3.2.1	3-45 to 3-49	The NKGSP notes that "The dramatic lowering of hydraulic heads in the confined parts of the aquifer has resulted in a large net downward movement of water through boreholes. This vertical flow occurs in both pumped and un-pumped wells during the growing season" (Faunt, CC ed. 2009) (p. 3-47). Vertical gradients have been measured recently indicating that there are head differences between wells screened above and below the Corcoran Clay in several locations. Please refer to a map in this section to show the locations where the vertical gradients have been measured. Please expand this section to include a discussion of the impacts of vertical flow on ISWs and GDEs.	Thank you for your comments. All comments are given due consideration.
24	The Nature Conservancy	3.2.7	3-75 to 3-79	ISWs are best estimated by first determining which reaches are completely disconnected from groundwater. This approach would involve comparing groundwater elevations with a land surface Digital Elevation Model (DEM) that could identify which surface waters have groundwater consistently below surface water features, such that an unsaturated zone would separate surface water from groundwater. Please provide or refer to depth to groundwater contour maps in this section. See Attachment D for best practices for completing this step. Specifically, ensure that the first step is contouring groundwater elevations, and the subtracting this layer from land surface elevations from a DEM to estimate depth to groundwater contours across the landscape. This will provide much more accurate contours of depth to groundwater along streams and other land surface depressions where GDEs are commonly found. Contours developed from depth to groundwater measurements at wells assumes that the land surface is constant, which is a poor assumption to make. The regulations [23 CCR §351(o)] define ISWs 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". This GSP states that "the location specific data from the SJRRP indicate that there may be connection at some locations. Limited data is available from the DWR from shallow wells on ISW systems along the Kings River where it borders the NKGSA boundary" (p. 3-75). The locations along the San Joaquin River, where shallow wells are available (Figure 3-37, p. 3-77), are described, indicating that the river may be connected during times of high flows. No graphs were included to show the relationship between the depth to groundwater and the river bed. Please provide cross-sections at these locations to show the relationship between the depth to groundwater and the bed of the river channel. Near the Kings River between Highway 180 and Sanger, shallow wells were installed at proposed gravel processing facilities and wastewater facilities by KDSA (KDSA 2017). The GSP states that the "KDSA further indicates that along the reach of the Kings River, upstream of the Reedley narrows, the groundwater is indicated to be in direct hydraulic communication with streamflow in the Kings River" (p. 3-79). The groundwater in this area is shallow based on DWR measurements. This finding needs to be illustrated using cross-sections with measured channel bed elevations and depths to groundwater. Again, please provide a cross-section at this location to show the relationship between the depth to groundwater and the bed of the river channel.	Thank you for your comments. All comments are given due consideration.

25	The Nature Conservancy	3.2.8	3-80	The NC dataset is a starting point for GSAs to identify GDEs in their basin/subbasin. The NC dataset has 1,959 acres of potential GDEs mapped within the NKGSA area, representing a significant amount of GDEs to be considered. Note that this is a starting point and not all potential GDEs are mapped and not all ecosystems mapped are GDEs. Please refer to Attachment D of this letter for best practices for using local groundwater data to verify whether polygons in the NC dataset are supported by groundwater in an aquifer. If insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons in the GSP until data gaps are reconciled by the monitoring network. Specifically, please note:
				• Figure 3-23 provides groundwater depth contours for Spring of 2017. Please provide more details on how this figure was developed by confirming:
				    o that wells monitoring the upper unconfined aquifer are being used to verify whether polygons in the NC dataset are supported by groundwater;
				    o the wells used for interpolating depth to groundwater sufficiently close (<5km) to NC Dataset polygons reflect local conditions relevant to ecosystems;
				    o the wells used for interpolating depth to groundwater are screened within the surficial unconfined aquifer and capable of measuring the true water table; and
				    o depth to groundwater is contoured using groundwater elevations at monitoring wells to get groundwater elevation contours across the landscape. This layer can then be subtracted from land surface elevations from a DEM to estimate depth to groundwater contours across the landscape. This will provide much more accurate contours of depth to groundwater along streams and other land surface depressions where GDEs are commonly found. Depth to groundwater contours developed from measurements at wells assume that the land surface is constant, which is a poor assumption to make. It is better to assume that water surface elevations are constant in between wells, and then calculate depth to groundwater using a DEM of the land surface to create the contour map.
					Thank you for your comments. All comments are given due consideration.

				• It is highly advised that seasonal and interannual groundwater fluctuations in the groundwater regime are taken into consideration. Utilizing groundwater data from one point in time (e.g., Spring 2017) can misrepresent groundwater levels required by GDEs, and inadvertently result in adverse impacts to the GDEs. We highly recommend using depth to groundwater data from multiple seasons and water year types (e.g., wet, dry, average, drought) to determine the range of depth to groundwater around NC dataset polygons. Ensure that groundwater condition data prior to the SGMA benchmark date of January 1, 2015 is included in the analysis. Please refer to Attachment D of this letter for best practices for using local groundwater data to verify whether polygons in the NC Dataset are supported by groundwater in an aquifer. If insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons in the GSP until data gaps are reconciled in the monitoring network. • Please provide rationale for the 30-foot criteria cited in the text. The text states (p. 3-80): "Recognizing that much of the Kings Subbasin has a depth to groundwater greater than the deepest vegetative GDE rooting depth of thirty feet, many of the GDEs identified in the NC Dataset Viewer were mischaracterized." In TNC's GDE Guidance, the depth criteria of 30 feet is presented as a criterion for inclusion, not a standalone criterion for exclusion. In other words, if groundwater is within 30 feet of the ground surface, then a GDE can be identified. If it is not, then further analysis must be conducted (see Appendix III of the GDE Guidance). Please indicate what vegetation is present in all NC dataset polygons. The actual rooting depth of vegetation growing in the area should be considered, and this will vary by species dominance and habitats present. For example, some phreatophytes can root to 120-feet deep in more arid and drought stressed environments. Furthermore, rooting depths are likely to spatially vary based on the local hydrologic conditions available to the plant. Maximum rooting depths do not take capillary action into consideration, which will vary with soil type and is an important consideration since woody phreatophytes generally do not like to have their roots submerged in groundwater for extended periods of time, and hence can access groundwater at deeper depths. • The text states: "The Kings Subbasin also categorized GDEs within 100 feet of the Kings River and the San Joaquin River as "Possible GDEs." Please clarify how the 100-foot buffer was used to include or exclude GDEs in the NKGSA area, and how this is supported by groundwater level and plant physiological data. If there is a potential GDE near the river, we recommend that the entire GDE be included, rather than using an arbitrary 100-foot cutoff.	GSP changed to reference 100' buffer from (https://dot.ca.gov/programs/environmental-analysis/coastal-program/coastal-act-policy-resource-information/wetlands) Reference to webpage also added.

26	The Nature Conservancy	3.2.8	3-80	Please provide information on the historical or current groundwater conditions in the GDEs or the ecological conditions present. Refer to GDE Pulse (https://gde.codefornature.org; See Attachment E of this letter for more details) or any other locally available data (e.g., leaf area index, evapotranspiration or other data) to describe depth to groundwater trends in and around GDE areas, as well as trends in plant growth (e.g., NDVI) and plant moisture (e.g., NDMI). Below is a screenshot example of data available in GDE Pulse for NC dataset polygons found within the NKGSA area:
				
				• Please provide an ecological inventory (see Appendix III, Worksheet 2 of the GDE Guidance) for all potential GDEs that includes the vegetation types or habitat types and rank the GDEs as having a high, moderate or low value; and what characterizes the rank.
				• Please identify whether any endangered or threatened freshwater species of animals and plants, or areas with critical habitat were found or are expected to occur within any of the GDEs. The list of freshwater species located in the Kings Subbasin can be found in Attachment C of this letter.
				• For each identifiable GDE unit with supporting hydrological datasets please include the following:
				  o Plot and provide hydrological datasets for each GDE.
				  o Define the baseline period in the hydrologic data.
				  o Classify GDE units as having high, moderate, or low susceptibility to changes in groundwater.
				  o Explore cause-and-effect relationships between groundwater changes and GDEs.
				• For each identifiable GDE unit without supporting hydrological datasets please describe data gaps and / or insufficiencies.
				• Compile and synthesize biological data for each GDE unit by including:
				  o Biological datasets for each GDE unit, and when possible provide baseline conditions for assessment of trends and variability.
				  o Describe data gaps and insufficiencies.
				• Provide a description of the potential effects on GDEs, land uses, and property interests, including:
				  o Cause-and-effect relationships between GDE and groundwater conditions.
				  o Potential impacts to GDEs that are considered to be "significant and unreasonable".
				  o Known hydrological thresholds or triggers (e.g., instream flow criteria, groundwater depths, water quality parameters, critical habitat constraints, etc.) for significant impacts to relevant species or ecological communities.
				  o Land uses that and consider recreational uses (e.g., fishing/hunting, hiking, boating, etc.).
				  o Property interests, such as privately and publicly protected conservation lands and opens spaces, wildlife refuges, parks, and natural preserves.
					Thank you for your comments. All comments are given due consideration.

27	The Nature Conservancy	3.3.6	3-94	"Confined groundwater outflows were not calculated due to a lack of confined groundwater level information in NKGSA" (p. 3-98). This is a significant data gap. The confined outflow was estimated as 35,000 acre-feet per year (AF/year) based on data for other parts of the Kings Basin, compared to the total estimated outflow of 122,000 AF/year. Please expand on how this data gap will be filled in the proposed monitoring program described in Section 5.	The NKGSA has developed voluminous data and will continue to develop more data for evaluating and implementing the GSP.
28	The Nature Conservancy	3.3.8	3-100	Please clarify whether a term is included for native or riparian vegetation evapotranspiration and for wetlands in the North Kings historical, current, and future water budgets. The groundwater outflow to McMullin GSA was estimated by comparing the flow before development in the 1920's to the present. The induced outflow was estimated to be 43,000 AF from the North Kings GSA to McMullin GSA (p. 3-101). This amount is stated as included in the historical water budget but not in future water budgets, since McMullin is expected to mitigate this imbalance from 2020 to 2040. However, the historical, current, and 2040 (without projects) budgets had the same groundwater outflow of 122,000 AF/year. This seems inconsistent with the statement in the text. Please revise or clarify the text as necessary.	Thank you for your comments. All comments are given due consideration.
29	The Nature Conservancy	3.3.10	3-107	The Friant Water Authority estimated climate change impacts on the San Joaquin River using the Water Storage Investment Program (WSIP) data sets. "In general, the data showed a slight reduction in future supplies" (p. 3-110). Given the uncertainty associated with the Kings River supplies in the future, the assumption was made that the historical water delivery from the Kings River would be maintained. Please consider using the WSIP data to discuss potential impacts to groundwater conditions due to climate change on GDEs and aquatic ecosystems.	Thank you for your comments. All comments are given due consideration.
30	The Nature Conservancy	4.1	4-2	The Sustainability Goal does not consider GDEs or ISWs. Since GDEs are likely present in the NKGSA area (see comments under Checklist Items 16-20) they should be recognized as beneficial users of groundwater and should be included in the Sustainability Goal. In addition, a statement about any intention to address pre-SGMA impacts should be included. The Plan states that there are ISWs along the Kings River. In addition, there are multiple small creeks including Big Dry Creek, Pup Creek, Dog Creek, Redbank Creek, and Fancher Creek that may have ISWs. Further evidence that supports the presence of ISWs along these water courses include Figure 3-38 (p. 3-81) that identifies potential GDEs, and the depth to water measurements in wells for spring 1997 and 2012 presented in Appendix 3D (Technical Memorandum 4 Attachment 3). Please identify and describe all ISWs for these areas and include them in the GSP. GDEs are dependent, in part, on suitable water quality; however, the GSP only considers water quality for irrigation and domestic use. TNC recommends including ISWs and their potential GDEs in the sustainability goal and criteria. Since GDEs may be affected by water quality, they should be included in the Sustainability Goal.	Thank you for your comments. All comments are given due consideration.
31	The Nature Conservancy	4.2.3	4-12	This Measurable Objective does not consider GDEs. GDEs are often adjacent to streams or associated with riparian corridors where ISWs exist, even if only seasonally or discontinuously along a longitudinal or lateral profile. Please include GDEs (see comments under Checklist Items 8-10) in this section and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	Thank you for your comments. All comments are given due consideration.
32	The Nature Conservancy	4.4.3	4-31	This Measurable Objective does not consider water quality needs of GDEs. Please include a discussion about GDEs and water quality and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	Thank you for your comments. All comments are given due consideration.
33	The Nature Conservancy	4.6.3	4-63	This Measurable Objective does not consider ISWs. Please include ISWs (see comments under Checklist Items 16-20) in this section and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	Thank you for your comments. All comments are given due consideration.

34	The Nature Conservancy	4.2.2	4-7	This Minimum Threshold does not consider GDEs or ISWs. Please include GDEs and ISWs in this section and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	Thank you for your comments. All comments are given due consideration.
35	The Nature Conservancy	4.4.2	4-26	This Minimum Threshold does not consider water quality needs of GDEs. Please include a discussion about GDEs and water quality and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	Thank you for your comments. All comments are given due consideration.
36	The Nature Conservancy	4.6	4-48	This Minimum Threshold does not consider GDEs. GDEs are often adjacent to streams or associated with riparian corridors where ISWs exist, even if only seasonally or are discontinuous along a longitudinal profile. Please include GDEs in this section and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment. The Plan states that there are time periods of ISWs along the San Joaquin River; however, they are dismissed because they are not continuously connected. ISWs that are not continuously connected spatially and/or temporally are still ISWs and should not be excluded from this GSP. Even when ISWs are not continuously connected they should be included in the Minimum Thresholds. The analysis for potential depletion of ISWs in Section 4.7 should include all beneficial uses and users of surface water that could be affected by groundwater withdrawals, including environmental users. The SJRRP identifies instream flow requirements for salmon in Reach 1a and potentially 2a which forms the northern border in the Plan area (http://www.restoresjr.net/about/overview-map/). Please include instream flow requirements and critical habitat designations in this section and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	Thank you for your comments. All comments are given due consideration.
37	The Nature Conservancy	4.2.1	4-3	This section only describes undesirable results relating to human beneficial uses of groundwater and neglects environmental beneficial uses and users that could be adversely affected by chronic groundwater level decline. Please add "potential adverse impacts to GDEs and native freshwater species" to the list of potential undesirable results presented in Section 4.2. The GDE Pulse web application developed by TNC provides easy access to 35 years of remote sensing data to view trends of vegetation metrics, groundwater depth (where available), and precipitation data. This satellite imagery can be used to observe trends for NC dataset polygons within and near the GSA. Over the past 10 years (2009-2018), some NC dataset vegetation polygons have experienced adverse impacts to vegetation growth and moisture along the San Joaquin River and Kings River. An example screen shot from the GDE Pulse tool is presented under Checklist Items 11-15 above.	Thank you for your comments. All comments are given due consideration.
39	The Nature Conservancy	4.4	4-22	This section only describes undesirable results in terms of meeting drinking water standards. The following is a link to a paper by Smith, Knight and Fendorf (2018) titled "Overpumping leads to California groundwater arsenic threat": (https://www.nature.com/articles/s41467-018-04475-3). The section should be modified to state that overpumping and dewatering of aquitards has been identified as a potential source of elevated arsenic concentrations above drinking water standards in San Joaquin Valley aquifers. In addition, any potential undesirable results from degradation of water quality that may impact GDEs and freshwater species in the area should be discussed in this section.	Thank you for your comments. All comments are given due consideration.
40	The Nature Conservancy	4.6	4-48	This section does not consider Undesirable Results for ISWs. The Plan states that there are time periods of ISWs along the San Joaquin River; however, they are dismissed because they are not continuously connected. Even though the ISWs are not continuously connected they should be included in the Undesirable Results. The analysis for potential depletion of ISWs in Section 4.7 should include all beneficial users of surface water that could be affected by groundwater withdrawals, including environmental. The SJRRP identifies instream flow needs for salmon in Reach 1a and potentially 2a which forms the northern border in the Plan area (http://www.restoresjr.net/about/overview-map/). Please include instream flow requirements and critical habitat designations in this section and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	Thank you for your comments. All comments are given due consideration.

41	The Nature Conservancy	5.2	5-3 to 5-12	Please address how the requirement to link and correlate groundwater level declines to biological responses, and significant and adverse impacts to GDEs and ISWs will be addressed by the monitoring network. The proposed wells to be used for monitoring groundwater levels in the unconfined aquifer are shown in Figure 5-2 (p. 5-4). Many of the monitoring wells are missing well construction information. The missing well information is a known data gap and was acknowledged on p. 5-10. To accurately characterize GDEs, please clarify how the unconfined aquifer will be monitored and how many wells will be used. The text states that the intent is to monitor the unconfined aquifer at present. "Groundwater level data from wells in the NKGSA will continue to be collected and evaluated to gain a better understanding of whether the confined groundwater conditions east of the Corcoran Clay are present" (p. 5-5). Wells that monitor the deeper confined or semi-confined aquifer will be added in the future. Monitoring of the confined aquifer may become a separate program in future years. Please clarify how many of the wells on Figure 5-2 represent the unconfined aquifer.	GSP has been changed to clarify GSA's plan to collect missing well construction information. The following text was added: "The NKGSA has applied for grant funding to video log wells where construction information is currently unknown. Additionally, dedicated monitoring wells will be installed in the future which will have known construction information."
42	The Nature Conservancy	5.7	5-32 to 5-39	The NKGSA intends to use data from wells near the San Joaquin and Kings Rivers in the current monitoring network for depletion of ISWs monitoring. The data obtained by the SJRRP will be reviewed as it becomes available to supplement that well information. The long-term monitoring network shown on Figure 5-2 shows only a few wells that are near rivers and the well depths and screened intervals are not provided. Please reconcile data gaps in monitoring for ISWs with specific recommendations (shallow monitoring wells, stream gauges, and nested/clustered wells) along surface water features to improve ISW mapping and inform an adequate analysis.	Thank you for your comments. All comments are given due consideration.
43	The Nature Conservancy	6.1	6-4 to 6-11	The NKGSA area includes many GDEs and ISWs (see our comments under checklist items 8-10 and 16-20 above) that are beneficial uses and users of groundwater, and may include potentially sensitive resources and protected lands. Environmental resource protection needs should be considered in establishing project priorities. In addition, and consistent with existing grant and funding guidelines for SGMA-related work, priority should be given to multi-benefit projects that can address water quantity as well as providing environmental benefits or benefits to disadvantaged communities. Please include environmental benefits and multiple benefits as criteria for assessing project priorities.	Thank you for your comments. All comments are given due consideration.
44	The Nature Conservancy	6.2	6-4 to 6-11	This Section identifies many important projects; however, the descriptions for these projects only identify benefits to groundwater level and supply. Since maintenance or recovery of groundwater levels, or construction of recharge facilities, may have potential environmental benefits in many cases it would be advantageous to demonstrate multiple benefits from a funding and prioritization perspective. • For the projects already identified, please consider stating how ISWs and GDEs will benefit or be protected, or what other environmental benefits will accrue. • If ISWs will not be adequately protected by those listed, please include and describe additional management actions and projects targeted for protecting ISWs. • Recharge ponds, reservoirs and facilities for managed stormwater recharge can be designed as multiple-benefit projects to include elements that act functionally as wetlands and provide a benefit for wildlife and aquatic species. In some cases, such multiple-benefit projects and facilities have been incorporated into local HCPs and NCCPs, more fully recognizing the value of the habitat that they provide and the species they support. For projects that construct recharge ponds, please consider identifying if there is habitat value incorporated into the design and how the recharge ponds will be managed to benefit environmental users. • There are wetlands shown on Figure 3-19 (p. 3-37), which include recharge basins of the cities, irrigation districts, wastewater treatment facilities, and flood control district. Please indicate whether the existing recharge basins are operated (or could be operated) as habitat suitable for migrating birds or other species and could be included in an HCP or NCCP. • For examples of case studies on how to incorporate environmental benefits into groundwater projects, please visit our website: https://groundwaterresourcehub.org/case-studies/recharge-case-studies/	Thank you for your comments. All comments are given due consideration.

45	The Nature Conservancy	6.3	6-12	This section discusses the Management Actions for GSP implementation and SGMA compliance; however, these actions are focused on meeting groundwater level and supply measures and do not include support for GDEs or ISWs. Please consider modifying the Management Actions to include education and outreach for protection of GDEs and ISWs, as well as specific management of these ecosystems and the species they provide for.	Thank you for your comments. All comments are given due consideration.
46	Malaga County Water District	2	2-13	Describes ponds at Malaga's wastewater treatment facility as being used to "percolate a portion" of treated effluent from the WWTF. All of the treated effluent from the Districts WWTF is discharged into percolation ponds for recharge. Describes Malaga's groundwater as being delivered from its 900-foot-deep wells. The reason the District utilizes 900-foot-deep wells is due to the presence of DBCP which requires the District to have wells of this depth. The necessity of the well depth due to DBCP contamination should be added to this description. Further discussion of DBCP contamination of the groundwater in the Malaga area is discussed below.	GSP has been changed. Thank you for your comments. All comments are given due consideration.
47	Malaga County Water District	2.3.4	2-27	Section 2.3.4 related to Permitting New or Replacement Wells, contains a discussion of Fresno County's permitting process including Policy PF-C.20 which states that the County shall not permit new private water wells within areas served by a public water system. The District agrees with this policy and encourages the County and the North Kings GSA to develop policies that will also require the all review of all permit applications within the sphere of influence of an agency that operates a public water system by the agency both to monitor the groundwater quantity and the quality of the groundwater supply (see discussion of DBCP plume contamination in the Malaga area below). Additionally, there is a discussion in this section of Malaga's special legislation, (Water Code Section 31144.7 et. seq.) as the Districts authority to require the County to route all applications for new water wells within Malaga's boundaries to Malaga for review. That legislation also gives Malaga the authority to manage groundwater supplies within its jurisdiction which read together with Water Code section 10750.6 means that Malaga has the authority to manage the ground water supply within its boundaries and that authority is not affected by the Groundwater Management Act. The GSP should include a discussion of Malaga's special legislation as it relates to the Groundwater Management Act and Malaga's authority to manage groundwater within its jurisdiction.	Thank you for your comments. All comments are given due consideration.
48	Malaga County Water District	2	2-36	States that "[w]hile Malaga and Pinedale CWD's meet SGMA eligibility criteria as a GSA, the governing bodies for these local agencies elected to be represented in the North Kings GSA by the Fresno Irrigation District and the City of Fresno, respectively." This statement as it relates to the Malaga County Water District is completely false and not supported by the record. First, while it is true that Malaga meets the criteria to be a GSA, Malaga did not elect to become a GSA in part because of the Districts authority to manage groundwater as described above. At no time did the Board of Director of the Malaga County Water District elect to be represented by the Fresno Irrigation District nor does the Fresno Irrigation District have any authority to represent the Malaga County Water District or its interests on the North Kings GSA board. However, since the District has the authority to manage groundwater within its boundaries, the District is not under the jurisdiction of the North Kings GSA however, the District will co-ordinate and cooperate with the NKGSA and all of the GSA's within the Kings Basin to achieve groundwater sustainability.	GSP changed to clarify that Malaga elected to not be on the NKGSA board.
49	Malaga County Water District	3.2.5 & 4.4	3-58 & 4-21	There is a description of Dibromo-Chloropropane (DBCP) in the groundwater quality issues section of the GPS (Sections 3.2.5 and 4.4) fails to identify that the Malaga County Water District has had to shut several of its public water system wells due to DBCP contamination. Further, due to the contamination Malaga's current wells have been required to be constructed to a depth of 900 feet and have required significant study and mitigation measures to prevent contamination of the public water supply resulting in significant increase in the costs of delivering potable water. The GSP should reflect that the depth of Malaga's wells are the result of DBCP contamination rather than any lowering of the water table in the Malaga area here an on pages 2-13.	Thank you for your comments. All comments are given due consideration.
50	Malaga County Water District	3	3-112	Future water assumptions. This section states that Malaga's water demand is assumed to increase from 1600 AF/year (2016/2017) to 1900 AF/year (2040). Malaga anticipates that is consumption will decrease from 1600 AF/year (2016/2017) to 1000 AF/year (2040) due to a combination of changes of use (industrial to commercial) or use of recycled water for industrial use).	Demand projection provided by Malaga is 1900AF in 2040. Use of recycled water does not reduce demand number, but rather changes source of supply to meet demand.
51	Malaga County Water District	6	6-2	The District looks forward to working with and cooperating with the NKGSA in projects within its boundaries, such as the Basin CF project and other projects as they are identified.	Thank you for your comments. All comments are given due consideration.

52	California Poultry Federation (Bill Mattos)			The California Poultry Federation ("CPF" appreciates this opportunity to comment on the draft North Kings Groundwater Sustainability Plan (the "Draft GSP"). CPF is the trade association for California's diverse and dynamic poultry industry. Our members include growers, hatchers, breeders, and processors from across the industry that work with chickens, turkeys, ducks, game birds, and squab. Water is essential for all of them—both for nutrition and for maintaining sanitary conditions. CPF therefore supports effective measures to assure reliable water supplies. In this regard, CPF commends that Draft GSP for making its first priority the development of projects that augment available water supplies. We encourage the North Kings GSA to continue identifying and implementing measures to increase groundwater recharge and obtain additional surface water. We further recommend adopting sufficient incentives—such as additional extraction rights—for landowners to propose and support private participation in initiatives to enhance supplies. To the extent demand reductions may be necessary, CPF trusts the public will have a meaningful opportunity to participate fully in their development, including by submitting written comments on the proposals and supporting data. It will be particularly important to consider the associated costs, which, as the Draft GSP recognizes at (6-23), require further evaluation. CPF appreciates your consideration of these comments. Please let me know if you need any further information.	Thank you for your comments. All comments are given due consideration.
53	Asian Business Institute & Resource Center Southeast Asian (SEA)			***Background*** Due to language barriers and the mere fact that we have no equivalent words in translation, the Southeast Asian (SEA) population that the Asian Business and Resource Center (ABIRC) serves barely understands the SGMA enough to provide fruitful comments and they are deeply concerned about the potential impact of the recommended policy. In fact, after speaking with non-SEA, English speaking farmers across many GSAs, they too agree that the language is complex and not easily understandable in terms of day-to-day impact. Many of the SEA farmers clearly do not have the same access and resources as the big farmers. A small SEA farmer is also a small business. They are the CEO, Accountant, Planter, Harvester, Pest Control, and Janitor. Technically, they operate on their farm from sunrise to sunset. Even if they were to attend the local Groundwater Sustainable Agency meetings, there are also language barriers, cultural barriers, and systematic barriers. Even the average English-speaking native may have difficulty understanding the GSP for themselves; the challenge will be at multi-fold the amount for a non-English speaking individual. According to the University of California Cooperative Extension Fresno County, there are about 2,000 SEA farmers/growers, many of whom operate on leased property, working on small (5 to 10) acres. Unlike the big farmers, a typical SEA farm operates in a distinct community-specific pattern. In a one parcel plot of land, there will be one primary lessee who will then have multiple sub-lessees. The owners of the farm may not communicate SGMA information to the primary lessee, thereby impacting many farmers on one plot of land. Adding to the complexity of the issue, the majority of SEA farmers are older, do not read English, do not use social media and are not internet savvy. Keeping with tradition, information is passed on one-by-one or in a community forum in SEA languages. Mainstream outreach methods such as mailing post-cards and posts via social media are highly ineffective for our constituents. We believe that when push comes to shove and wells become strictly monitored, it will be the small SEA farmers who will be impacted the hardest. They will lack representation, resources, and dollars.	Thank you for your comments. All comments are given due consideration.
				Collaborative work Throughout the one-year period that ABIRC staff have been educating the SEA community about the Sustainable Groundwater Management Act (SGMA), we can conclude that 99.9% of the SEA community did not know about the SGMA and how the upcoming policy will affect the SEA farmer. During this year of engagement with the SEA community we have been welcomed by the North Kings GSA to represent the community we served. Some of the intentionality of collaboration was due to the lack of SEA staff at the North Kings GSA. As representatives of the SEA community, we submit recommendations about SGMA on their behalf.	Thank you for your comments. All comments are given due consideration.
				Stakeholder inclusion The Stakeholder Inclusion[1] premises that have not been held up during the planning period need to be promoted during SGMA implementation: • SGMA requires consideration of the interests of diverse, social, cultural, and economic elements of the populations within the basin during implementation. • GSAs are encouraged to send *appropriate* notices. Postcards and emails are not the appropriate way to engage older SEA farmers who may be monolingual. • Describe GSA outreach efforts to disseminate changes and updates once the law is to disadvantaged communities per California Code of Regulations, § 354.10(d)(3)).	GSP Section 2.5.5 changed to include…The GSA will continue to pursue effective methods of communication with stakeholders, including rural domestic pumpers and small farmers, to provide local seasonal and annual

[1] https://www.waterboards.ca.gov/water_issues/programs/gmp/docs/sgma/sgma_stakeholder_inclusion.pdf

				• The Dymally-Alatorre Bilingual Service Act (Gov. Code, § 7290 et seq.) applies to all local agencies that serve a substantial number of non-English speaking people. The goal of this act is to ensure that information and services are provided in the language of non-English speakers. We encourage the North Kings GSA to determine the languages spoken by the substantial number of non-English speakers in the area of the basin plan and send notices in those languages. Note that diesemination of information via email may still not reach the majority of the SEA farmers because they do not have internet access and the last thing that they want to do at the end of a 14-hour day is to goto a tea/coffee shop to access the internet. • While local agencies have discretion in determining what constitutes a substantial number of non-English speaking people and a sufficient number of qualified bilingual staff persons (Gov. Code, § 7293.), GSAs should work with community organizations to assist them to fulfill the language needs. *Policy Recommendations* 1) Commitment to follow GSA regulations identified above with regard to community outreach and engagement 2) Commitment to support community outreach dollars for the SEA small farming community 3) Commitment to continue to work with non-profit and community organizations that serve the SEA small farming community 4) Proactively look for mitigation dollars or activities that will support sustainability and growth of the SEA small farmers within the GSA basin 5) Commitment to utilize ethnic media tools for outreach and education 6) Commitment to hire a SEA staff member who can assist nonprofits and community organizations to better outreach to the SEA small farming community 7) Work with nonprofit and community organizations to come up with a plan/strategy to provide sustainable outreach 8) Commitment to include SEA small farming issues when discussing GSA policy issues Commitment to bring in additional SEA small farmers, community partners, and individuals to join and participate in committees	groundwater conditions and basic groundwater and well information.
54	Sue Ruiz	2	2-6 & 2-7	**Determining the number of domestic wells and defining well communities (found mostly in Ch 2 Plan Area, I believe)** • Page 2-6 and 7 describe how the number of active wells was determined with best available data. However, this data is most likely inaccurate since many domestic wells were constructed prior to 1975 in addition to the likelihood that County records are not accurate as described in the Plan. The GSA can't know the number of vulnerable wells that will go dry or have drinking water quality impacted by decreasing GW levels without a better understanding of how many wells there really are and where they are located. • Communities of domestic wells- There are three large ones I'm aware of (Easton, Centerville, and I believe Rolinda) as well as several "neighborhoods" such as those near CSA 39 A&B (West Park), south of Fresno near Central and Cherry Avenue and Orange Avenue, NE of Clovis, and perhaps others not known. I don't feel there has been enough effort to identify and map all of those communities. Nor do I feel the "community profile" of these domestic well communities is sufficient. The number of wells in each is not listed, the approximate depth of most wells is not identified, the level or type of contamination is not described, the economic and cultural profile of each community is lacking. An accurate "profile" of each community's number of wells, existing water contamination status, well depths, and economic level is foundational to the GSA's ability to monitor, prevent and mitigate undesirable results. I believe a "profile" is required to be part of the GSP. I recommend the GSA continue to work with the County, non-profits, TA providers, and the communities themselves to gather more data.	The NKGSA has developed voluminous data and will continue to develop more data for evaluating and implementing the GSP.

55	Sue Ruiz			**Identification and monitoring of GW contamination and plumes**
				I am aware of the following:
				• The NK GSA recognizes the amount of data regarding domestic well contamination is lacking, thus the GSP in its released version (8-15-2019) also lacks significant data.
				• NKGSA desires to gather more data.
				• Gathering such data is challenging due to the following:
				    o Lack of available information directly from private well owners
				    o Lack of County records for contaminants other than those identified at the owner's request when a new well is constructed. Contaminants typically tested at this time are usually nitrate and bacteria. Most owners don't know what to test for and/or County does not fund tests for other contaminants (DBCP, 123 TCP, uranium, arsenic, others).
					Thank you for your comments. All comments are given due consideration.

				o It is my understanding confidentiality of individual well water quality is protected from public release. Therefore, tests conducted by community groups and TA providers should not be released per specific address unless written permission has been obtained from the well owner. o County well log records, DWR well logs, GAMA and other state monitoring programs provide limited information due to minimal contaminants tested and/or lack of records pre 1970's. • The GSA intends to rely on CVSalts, ILRP, and other State contaminant monitoring programs to provide data. • "On farm recharge" and ponding basins are critical to sustainable GW levels. However, I offer the following recommendations and requests, some of which may already being done: • It was recommended that public water systems located within domestic well communities be used to establish a very basic contaminant profile for the community. These wells will help identify existing contaminants and can also become monitoring wells for contaminant flows and behaviors. I believe the GSA did, or started to, gather this information from the SWRCB DDW public records. This effort would, at the very least, be a start. • Nonprofits and TA providers that have conducted community well samplings could probably provide that information in a manner that does not break confidentiality, but still provide a community profile of existing contaminants. • If data has not yet been gathered, results from tests conducted by the County will help identify data points of contaminants in either domestic well communities or individual wells throughout the GSA. • The GSA should provide, seek funds for, and/or work with the County to educate well users about local contaminants, assist with the funding of well sampling (in a manner to be determined), and collect this data in order to better identify and monitor plumes of contamination. • The GSA should overlay a map of GSA monitoring wells with communities/neighborhoods of domestic wells. The GSA should work with the County, DDW and the State programs (ILRP and CV Salts) to monitor all contaminants, not just nitrate, in the GSA monitoring wells and public water systems within the area of domestic well communities/neighborhoods. • Because many contaminants (such as nitrate) are present in shallower aquifers, the GSA needs to acknowledge and respond to the fact that using the deeper monitoring wells spread throughout the GSA will not provide contamination data that accurately monitors contamination plumes in shallower domestic wells. • While ponding basins have been shown to decrease nitrate levels near them, and while "on farm" recharge is critical to sustaining GW levels, the Plan doesn't provide evidence that the GSA has considered or intends to monitor plumes where these recharge activities will take place. Again, without knowing existing contamination levels and without designated monitoring wells drawing from the aquifers used by most domestic wells, how will this monitoring be provided? • CRLA's comments in Section b on pages 3- 4 of their public comment document dated October 16, 2019 describes very well my personal feelings about the need to increase and improve plume monitoring. Therefore, I concur with their comments on this matter. Real case scenario to consider: Several acres of a crop were planted during the year 2018 in the center of Easton. What monitoring well will determine the existing level of contaminants near those crops and continue to monitor those contaminants? What monitoring well will track how plumes are impacted by declining GW levels in this community, levels that may decline more rapidly now that this crop is located directly in the center of the community? Or is that not the responsibility of the GSA? Is that farmer going to be held responsible for creating "undesirable results" that didn't exist prior to the implementation of SGMA? Or is there no responsibility until after 2040? These are questions that need to be considered within the GSP.	
56	Sue Ruiz	4	4-3	**Identifying and monitoring domestic wells going dry** In my view, the GSA has set the "minimum threshold" and "undesirable result" in regard to domestic wells going dry at a dangerous level. "Significant and unreasonable" are, as stated, described by the GSA, beneficial users, etc. (p 4-3). How will "significant" and "unreasonable" be determined when a base line has not been established? How many wells are there? How many are at risk of going dry before 2040? Nobody knows. The GSA should know. Example: I live in Easton, a community of approximately 400 or more wells. The water level has declined an average of approximately 2 feet per year since the 1960's, based on FID monitoring wells in the region. The current GW level is approximately 97 feet below ground level. My well is approximately 150 feet deep. At the historic rate of decline, my well will be nearly dry by 2040. At that point my husband and I will be in our mid-80's. We won't be able to afford a new well. To me, a beneficial user, this is highly significant and undesirable.	GSP changed in 4.2.2.3 to discuss analysis of the impacts of the water level measurable objectives and minimum thresholds on domestic wells.

				The way I understand SGMA, the GSA isn't held responsible to ensure no significant, unreasonable or undesirable results until 2040. I also recognize that "without SGMA lots of wells will go dry, with SGMA less wells will go dry." But without sufficient base knowledge of how many wells will be impacted during the 20-year period prior to reaching sustainability, how does the GSA truly determine "undesirable", "unreasonable" or "significant" impacts? The GSA needs to work further with the County, the State, local non-profits, TA providers, and the well owners directly to help develop a base-line so everybody, (GSA included) can monitor, prevent as much as possible, and prepare for declining GW levels until the 2040 target sustainable target date.	
57	Sue Ruiz			**Educating and informing domestic well owners and users** I honestly don't know if the GSAs will be held responsible for undesirable results prior to 2040. I'll leave that argument to the lawyers. However, at the VERY least the NK GSA needs to develop a strong, solid, consistent mechanism to inform all domestic well users about GW levels and water quality. • Ground water levels: Many/most well owners don't know the depth of their wells. Nearly all don't have a clue what the GW level is, how to find out, or what it's doing over time. How can they prepare for a well going dry without this information? • Water quality: Many/most well users don't know what contaminants are present in their region, how to test for them, or how to ensure they have safe drinking water. And they certainly don't have any way of knowing how the contaminants are behaving- moving, declining, staying stagnant, or increasing. • What to do: The NK GSA, via FID and the County in the non-FID area need to develop and utilize a consistent education mechanism that informs domestic well users of these issues, how to monitor for themselves, how to mitigate contamination, and to prepare for drilling a new well if that looks imminent prior to 2040. Once a year "SGMA reports" will not work. Domestic well users need information that is relevant to their understanding of groundwater and needs. A quarterly, or at least semi-annually, newsletter geared directly for domestic well users would help well users become informed and prepare for contamination and dry well conditions. The GSA should budget for this education providing the information directly or by contracting with a non-profit, TA provider, and/or consultant who best knows how to communicate with rural communities and well users.	GSP Section 2.5.5 changed to include…The GSA will continue to pursue effective methods of communication with stakeholders, including rural domestic pumpers and small farmers, to provide local seasonal and annual groundwater conditions and basic groundwater and well information.
58	Sue Ruiz			**Small Farmers** In my work with the NK GSA I have been privileged to learn about the small farmers, particularly the Hmong farmers, in the area. I want to comment on how critical all of the above statements are to them as well. Without the shallower domestic wells to irrigate their small farms, their livelihood will become non-existent. Without skills to support their families in other ways, they will be forced to used welfare programs, a situation that isn't beneficial to anybody. In addition to supporting their families, I have recently read of how the crops most Asian and small farmers grow is showing to be beneficial to soil health and attracts natural pollinators more abundantly that traditional annual or permanent crops large farms grow. Plus, we all love and benefit from the diversity of the "leafy greens" and flavorful dishes from the smaller farms. I'd like to encourage the NK GSA to strongly support and pay attention to how all policies and decisions will impact these beneficial water users as well.	Thank you for your comments. All comments are given due consideration.
59	League of Women Voters of Fresno	ES		**Executive Summary** The section of the GSP that members of the public are most likely to read is the Executive Summary. The public should be made aware of the role of water conservation in achieving sustainability, as this management action will involve the general public. Plan Area Section 2.4.8 - Efficient Water Management Practices – provides an excellent and concise explanation of the importance of water conservation to achieving sustainability. "Water conservation has been and will continue to be an important tool in local water management, as well as a key strategy in achieving sustainable groundwater management. All of the member agencies engage in some form of water conservation including water use restrictions, water metering, education, tiered rates, etc. These water conservation programs were tested during the 2014-2015 drought, which included State-mandated urban water restrictions for the first time. Details of water conservation programs can be found in various documents, including Urban Water Management Plans and USBR (United States Bureau of Reclamation) Water Management Plans. Many agencies also have multi-stage water shortage contingency plans to help conserve water in droughts. Efficient water management practices will include maximizing the beneficial uses of water along with recycled water use as it can replace potable water use in some instances. Future efforts will include an	GSP changed on page ES-16 to include Plan Area Section 2.4.8 paragraph.

				increased focus on elevating awareness on groundwater overdraft and land subsidence and explaining the requirements of SGMA. Some or all of these conservation efforts will be necessary to achieve groundwater sustainability." Recommendation: Incorporate the information in Plan Area Section 2.4.8 - Efficient Water Management Practices - into the Projects and Management Actions Section of the Executive Summary	
60	League of Women Voters of Fresno	6		**Projects and Management Actions-Chapter 6** California's Human Right Water Act recognizes that "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes." The human right to water extends to all Californians, including disadvantaged individuals and groups and communities in rural and urban areas. The League of Women Voters of California supported this legislation, and also the implementation of projects and water management practices to make the human right to water a reality in communities that lack this basic necessity of life. Disadvantaged Communities in the NKGSA are identified on Page 2-37 of the Plan Area section of the Draft GSP. "As shown in Figure 2-8 Disadvantaged and Severely Disadvantaged and Severely Disadvantaged Communities in the North Kings GSA, much of the urban areas within North Kings GSA boundaries is designated as a disadvantaged community (DAC) based on American Community Survey Median Household Income data. These areas include the City of Kerman, City of Fresno, and the unincorporated communities of Biola, West Park, Calwa, Easton, Malaga, Pinedale, and Friant. Additionally, Bakman Water Company services an area defined as a Disadvantaged Community." Since the time that NKGSA's Draft GSP was released for public review and comment, legislation was passed and signed by Governor Newsom to establish a Safe and Affordable Drinking Water Fund. It will provide $130 million in funding over 10 years for projects to address drinking water issues in disadvantaged communities. We hope that member organizations in the NKGSA will take the initiative to identify projects and apply for funding during this 10 year period to address drinking water quality and quantity issues in disadvantaged communities in the NKGSA. Obtaining grant funding is essential for small disadvantaged communities with water quality and/or water quantity problems. This includes small community water systems and rural residential communities with individual household wells. These communities can have difficulty funding water system improvements and on-going operations and maintenance. Consolidation is the preferred option if a community is located near a larger community with better water quality and quantity. In projects involving consolidation grant funding is important to avoid rate impacts and potential capacity constraints to the larger community. In the NKGSA, it is likely that the larger community will also be a disadvantaged community. In reviewing the Chapter 6 Project and Management Actions section of the Draft GSP, we are pleased that the list of planned groundwater recharge projects include the small disadvantaged communities of Biola and Malaga. • Recommendation: LWVF encourages the NKGSA member organizations to identify and apply for funding, especially grant funding such as the Safe and Affordable Drinking Water Fund, for projects to address water quality and quantity issues in disadvantaged communities, including those in rural residential areas, and to do so early in the 2020 to 2040 SGMA implementation period. The California Water Boards recently released a "Sustainable Groundwater Management Act: Water Quality Frequently Asked Questions" guidance document to provide clarity and assistance to GSAs as they prepare their GSPs. https://www.waterboards.ca.gov/water_issues/programs/gmp/docs/sgma/sgma_water_quality_faq.pd The FAQ document states that "A GSA must consider potential impacts to water quality when planning groundwater recharge projects. Recharge methods vary from surface infiltration (e.g., using recharge ponds or flooding agricultural lands) to groundwater well injection. Sources of water for recharge may include treated wastewater, stormwater, irrigation return flow, purchased water, or streamflow diverted under a permit or other basis of right. Depending on the source, the project may require a permit from the Regional Water Quality Control Board and may need to comply with waste discharge requirements, which include extensive water levels and quality monitoring around the recharge site. Even relatively unpolluted water used for recharge, such as most purchased water or streamflow, may contain constituents of concern. For treated wastewater, stormwater, or irrigation return flows, contaminants such as pesticides, sediments, nutrients, salt, pathogens, and heavy metals should be	Thank you for your comments. All comments are given due consideration.

				considered. Potential changes in the receiving groundwater due to geochemical reactions with the recharge water or causing the mobilization of existing constituents of concern may also be a factor. A GSA can find out more information about water quality concerns associated with recharge projects by contacting its respective Regional Water Board." 9) Recommendation: When identifying and planning groundwater recharge projects, consult with the Central Valley Regional Water Quality Control Board regarding potential water quality concerns in the area in and around the proposed project.	
61	League of Women Voters of Fresno	2.3		Fresno County overlies all, or part, of four groundwater subbasins that are subject to SGMA. The Kings, Westside and Delta-Mendota subbasins are critically overdrafted, and GSPs must be submitted to the State by January 31, 2020. A GSP for the Pleasant Valley Subbasin is due to the State by January 31, 2024. In the Kings Subbasin alone, six of the seven GSAs contain unincorporated areas that fall under the County's land use planning jurisdiction. Portions of the Kings, Westside, and Delta-Mendota subbasins are in other counties. The County of Fresno is a member organization of the NKGSA and nearly all other GSAs in Fresno County. At the same time that GSPs are being drafted and finalized for submission to the State, Fresno County is in the process of updating its General Plan. The last General Plan update was in 2000. In the age of SGMA, this general plan update will be a complex and challenging task for the County, as land use characteristics and water conditions vary greatly between the groundwater subbasins. For example, according to population figures on Plan Area page 2-11, over 60 percent of Fresno County's total population resides in the Fresno and Clovis Metropolitan area. In contrast, some valley areas of the County are sparsely populated. It is our understanding that the County plans to review and incorporate information from the GSPs submitted to the State in January 2020 into the process of updating the General Plan. At a SGMA presentation to the Fresno County Board of Supervisors on May 14, 2019, Fresno County Water and Natural Resources Division Manager Glenn Allen explained to the Board the arduous task of implementing the GSPs after they are submitted to the State. "We'll continue to partner with local agencies [after January 31, 2020] to assist in GSP implementation. That's going to be a heavy lift for us because there's going to be a lot of evaluation and potential revisions to our County General Plan that we will be bringing back to you [Board of Supervisors]." Of concern are any remaining Fresno County General Plan policies and programs from 2000, and related ordinances, which would allow groundwater, and/or surface water to be transferred out of the critically overdrafted groundwater subbasins in the County. Policy PF-C., adopted in 2000, is listed as a relevant land use policy in NKGSP Plan Area Section 2.3.3. Its related Program is PF-C.F, and its related ordinance is Chapter 3 of Title 14 of the Ordinance Code. • Recommendation: Following submission of the NKGSA GSP to the State, we encourage the County of Fresno and other member organizations in the NKGSA to review and consult on any pertinent updates to the Fresno County General Plan and the general plans of the cities of Fresno, Clovis, and Kerman. • Recommendation: Remove Fresno County General Plan Policy PF-C., Program PF-C.F, and Chapter 3 of Title 14 of the Ordinance Code and replace them with General Plan water policies and programs, and ordinances that are more appropriate for the critically overdrafted groundwater subbasins in Fresno County, including the North Kings.	Thank you for your comments. All comments are given due consideration.
62	California Department of Fish and Wildlife	3.2.7.1	3-75 to 3.79	Interconnected Surface Water Systems (pages 3-75 to 3-79). Analysis of interconnected surface waters appears to characterize all 'losing' streams as disconnected without providing evidence of no hydraulic connectivity between a stream and an underlying aquifer. a. Issue: Multiple times the GSP identifies stream reaches where groundwater elevations are lower than streambed elevations and subsequently characterizes these reaches as disconnected. Examples include: i. "When the river is flowing at low flow or base flow, the groundwater elevation is below estimated channel elevation, indicating a lack of interconnection " (page 3-78). ii. "…the two closest wells in this location north of the river, are below the estimated channel bed elevation except during periods of high flow which indicates that the river is connected to the north only during periods of high flows" (page 3-78).	GSP changed to state that because data does not show evidence of interconnection, an estimate of the quantity and timing of depletions is not included.

				iii. "At times when the river is flowing at low flow or base flow, the groundwater elevation in the wells is near the estimated channel elevation potentially indicating a lack of interconnection" (page 3-78). According to SGMA regulations, "'Interconnected surface water' refers to 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" [23 CCR S 351 (o)]. This means that even if groundwater elevation is lower than streambed elevation, there may still be hydraulic communication between the aquifer and streamflow if there is a saturated layer connecting the two and pumping from the aquifer may yet cause streamflow depletion (Barlow and Leake, 2012). This saturated zone may not be captured in data from proximate monitoring wells. It is therefore unclear in the GSP analysis if 'losing' . streams were thoroughly evaluated for hydraulic connectivity. The interconnected surface water narrative also lacks specific estimations of the quantity and timing of streamflow depletions as specified in 23 CCR S 354.16(f). b. Recommendation: The Department recommends the careful review of existing information on surface water-groundwater interconnectivity and recommends the GSA: i. Clarify methods used to categorize 'losing' streams as disconnected. ii. Identify the estimated quantity and timing of streamflow depletions in the Subbasin. If this information is not available, identify an expeditious and specific path to estimating these values.	
63	California Department of Fish and Wildlife	3.2.8	3-80 to 3-81	The GDE identification section, pursuant to 23 CCR S 354.16 (g), is based on very limited information to demonstrate exclusion of ecosystems that may depend on groundwater. a. Issue: Methods applied to the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset to eliminate potential GDE's are not robust. b. Depth to Groundwater: The removal of areas with a depth to groundwater greater than 30 feet in Spring 2017 relies on a single-point-in-time baseline hydrology, specifically a point in time that is several years into a historic drought when groundwater levels were trending significantly lower due to reduced surface water availability. Exclusion of potential GDEs based on this singular groundwater elevation measurement is questionable because it does not consider representative climate conditions (i.e., seasons and a range of water type years) and it does not account for GDEs that can survive a finite period of time without groundwater access (Naumburg et al. 2005), but that rely on groundwater table recovery periods for long term survival. c. Adjacent to Surface Water: The GSP did not fully evaluate potential GDEs that depend on adjacent losing surface water bodies and a GDE's adaptability and opportunistic nature in accessing water supply. The GSP assumption that these potential GDE's are accessing and primarily dependent on surface water is based on proximity to a surface water source, but this assumption is poorly justified and there is no acknowledgement of the potential for shifting reliance between surface and ground water. Additionally, GDEs that are near interconnected surface water bodies may depend on sustained groundwater elevations that stabilize the gradient or rate of loss of surface water, meaning that ecosystems near interconnected surface waters may depend on sustainable groundwater elevations. Therefore, it is possible that any of these potential GDEs rely on groundwater during specific seasons or water year types. d. Recommendations: The Department recommends the NKGSA consider the following for information gathering related to GDE's: i. Depth to Groundwater: Develop a hydrologically robust baseline which includes areas with a depth to groundwater greater than 30 feet that relies on multiple, climatically representative years of groundwater elevation and that accounts for the inter-seasonal and inter-annual variability of GDE water demand. ii. Adjacent to Surface Water: Re-evaluate potential GDEs that are in proximity to a losing surface water body. The Department recommends the GSP be more conservative and all-inclusive until there is evidence that the overlying ecosystem has no significant dependence on groundwater across seasons and water year types. The Department advises that these riparian GDE beneficial users of groundwater and surface water are carefully considered in the analysis of undesirable results and minimum thresholds for depletions of interconnected surface waters. iii. Include additional references for evaluation: The Department recognizes that NCCAG (Klausmeyer et al. 2018) provided by Califomia Department of Water Resources (CDWR) is a good starting reference for GDE's; however,	Thank you for your comments. All comments are given due consideration.

				the Department recommends the GSP include additional resources for evaluating GDE locations. The Department recommends consulting other references, including but not limited to the following tools and other resources: the California Department of Fish and Wildlife (CDFW) Vegetation Classification and Mapping Program (VegCAMP) (CDFW 2019A); the CDFW California Natural Diversity Database (CNDDB) (2019B); the California Native Plant Society (CNPS) Manual of Califomia Vegetation (CNPS 2019A); the CNPS California Protected Areas Database (CNPS 2019B); the U.S. Fish ahd Wildlife Service (USFWS) National Wetlands Inventory (2018); the USFWS online mapping tool for listed species critical habitat (2019); the U.S. Forest Service CALVEG ecological grouping classification and assessment system (2019); and other publications by Klausmeyer et al. (2019), Rohde et al. (2018), The Nature Conservancy (TNC) (2014), and Witham et al. (2014).	
64	California Department of Fish and Wildlife	4, 4.2, 5, 5.7	4-5, 4-48, 4-56, 4-59, 5-32	Sustainable Management Criteria. Section 4. Sustainable Management Criteria, 4.2 Groundwater Levels and Section 5 Monitoring Network 5.7 Depletion of Interconnected Surface Water (page 5-32). The Groundwater Level and Interconnected Surface Water sustainable management criteria demonstrate limited consideration of undesirable results for environmental beneficial uses and users of groundwater and interconnected surface waters. a. Issue: Groundwater Level 'undesirable results' and 'effects of undesirable results' do not specify impacts to environmental beneficial users such as GDE's, nor does this section explicitly identify fish and wildlife or habitat as beneficial users of interconnected surface water. Depletions of interconnected surface water 'undesirable results' also appear to disregard potential interconnected 'losing' streams (page 4-48 and see Comment #1 above), and are otherwise assumed to not exist, meaning no sustainable management criteria are developed for interconnected surface waters. Depletions of interconnected surface water 'undesirable results' and 'effects of undesirable results' do not specify potential adverse impacts to environmental beneficial users other than to identify the Kings River Fisheries Management Program as a relevant effort (page 4-56) and mention 'environmental flow proponents' as a potentially impacted party (page 4-59). The proposed sustainability criteria suggest that groundwater elevations at all representative wells in the subbasin can continue to decrease for the next 20 years, dropping further from historically low groundwater elevations during drought years, without witnessing undesirable results. The subbasin is characterized by CDWR as 'Critically Overdrafted,' meaning "continuation of present water management practices [in the basin] would probably result in significant adverse overdraft-related environmental, social, or economic impacts" (CDWR "Critically Overdrafted"). However, according to the GSP, the basin has not experienced undesirable results, and for most of the basin, minimum thresholds are set above the level of expected undesirable results (page 4-4); therefore, minimum thresholds effectively allow for 20 years of groundwater table declining trends that mirror trends that contributed to the subbasin's Critically Overdrafted status. Conceptually, there is a disconnect between the subbasin's 'Critically Overdrafted' designation and the GSP's claim that the basin has not experienced undesirable results, nor will it if groundwater levels continue to decrease. The NKGSP states that the GSA does not view a well going dry as an undesirable result (page 4-5). Although CDWR will have the final decision as to what an undesirable result is considered, the Department considers a well going dry as a significant event and considers this a very undesirable result. b. Recommendation: The Department recommends the NKGSA clarify how species and habitat groundwater needs were considered in the identification of sustainable management criteria and identify specific potential adverse impacts on environmental beneficial users of groundwater (e.g., terrestrial GDE stress/loss, increased instream temperatures, etc.). The Department advises the NKGSA identify specific habitats and species that depend on groundwater in the subbasin and define for these beneficial users relevant undesirable results and related causes. Reference the Critical Species Lookbook for threatened and endangered species in your basin as well as for narrative on species and habitat groundwater dependence that can be a model for describing environmental beneficial uses and users of groundwater in the GSP. Reevaluate sustainable management criteria based on a thorough analysis of interconnectivity of 'losing' streams. The Department also recommends the NKGSA reconsider minimum thresholds and measurable objectives, accounting for undesirable results for fish and wildlife beneficial uses and users of groundwater and interconnected surface water. Design sustainable management criteria that reflect a 'Critically Overdrafted' subbasin designation by seeking to improve current groundwater conditions rather than allowing for continued aquifer depletions over the next two decades.	Thank you for your comments. All comments are given due consideration.

65	California Department of Fish and Wildlife	5, 5.7.8.3	5-39	Monitoring Network. Section 5. Monitoring Network, 5.7.8.3 Plans to Fill Data Gaps (page 5-39). Th GSP indicates that there are no identified data gaps in the depletion of interconnected surface water monitoring network. a. Issue: As previously stated above in Comment #1 , analysis of interconnected surface water appears to characterize all "losing" streams as disconnected without providing scientific support of any hydraulic connectivity between a stream and an underlying aquifer. Additionally, the interconnected surface water narrative also lacks specific estimations of the quantity and timing of streamflow depletions as specified in 23 CCR s 354.16(0. b. Recommendation: As defined in 23 CCR S 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. The Department recommends that the GSA identify areas and install additional shallow groundwater monitoring wells to gather the necessary information on surface water-groundwater interconnectivity near rivers and stream (including reaches designated as intermittent) to properly evaluate and characterize surface-groundwater interactions.	GSP changed to state that because data does not show evidence of interconnection, an estimate of the quantity and timing of depletions is not included.
66	California Department of Fish and Wildlife	5, 5.7.8.3	5-39	Monitoring Network. Section 5. Monitoring Network, 5.7.8.3 Plans to Fill Data Gaps (page 5-39). The GSP states in Section 3.2.8 (page 3-80) Groundwater Dependent Ecosystems, "The Kings Subbasin will continue to evaluate the rejected and possible GDE's and their relationship to the groundwater conditions through monitoring efforts identified in Chapter 5 regarding groundwater level and interconnected surface water monitoring'. a. Issue: Within Chapter 5 (specifically in the Depletions of interconnected Surface Water section), there is no indication as to the planned approach to verify rejected and/or possible GDE's. The GSP needs to provide a description of how impacts to GDE's and environmental surface water users, as detected by biological responses, will be monitored and which monitoring methods will be used in conjunction with hydrologic data to evaluate cause-and-effect relationships with groundwater conditions. • b. Recommendation: As defined in 23 CCR S 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: 3) Adverse impacts to beneficial uses and users of groundwater. The Department recommends that the GSA identify within the GSP areas and install additional shallow groundwater monitoring wells to gather the necessary information on surface water-groundwater interconnectivity near rivers and stream (including reaches designated as intermittent) to properly evaluate and characterize GDE's interactions with surface-groundwater.	Thank you for your comments. All comments are given due consideration.
67	Ruth M Dahlquist-Willard (UC Coop Ext)	4	4-4, 4-5, 4-11	**Analysis of wells that may go dry under measurable objectives and minimum thresholds** The GSP states that "SGMA does not require the GSA to maintain current water levels or prevent any wells from going dry" (page 4-5) and that the NKGSA "recognizes that some shallow wells will go dry prior to water levels reaching stabilization" (page 4-11). However, the experience of Southeast Asian and other small-scale, socially disadvantaged farmers during the recent drought illustrates the social and economic consequences of shallow wells going dry due to groundwater overdraft. The minimum thresholds in the GSP were set based on the actual decline during the 2012-2016 drought (page 4-4), during which 22% of Hmong farmers surveyed by UCCE in 2015 reported that their well had gone dry. This implies that if minimum thresholds are reached under the GSP during a future period of drought and reduced surface water availability, similar problems could occur. Most Hmong farms in the UCCE survey had well depths between 80-120 feet. This matches the information in the GSP, which states that depths of irrigation wells east of the city of Fresno can be as shallow as 100 feet or less (page 3-46). Under the proposed measurable objectives and minimum thresholds, it is likely that some of these farms would lose their wells. While NKGSA is not required to prevent these shallow wells going dry, we recommend seeking funding to develop a well mitigation program similar to those being proposed for domestic wells that may go dry, in order to prevent the undesirable socioeconomic consequences of small-scale immigrant and refugee farmers losing their farms. To analyze the potential for well outages under the designated measurable objectives and minimum thresholds, we used publicly available data from the Online State Well Completion Report (OSWCR) database, which contains well location and depth information for all wells that filed Well Completion Reports in the state. We mapped all 15,781 domestic and irrigation wells within the NKGSA boundary. A 3-mile radius was assumed around each of the GSP's designated monitoring wells (since we did not find it otherwise specified in the Plan), and we compared the MOs and MTs set for each monitoring well to the depths of the wells within the 3-mile buffer. We focused only on agricultural wells. All wells where the total depth is less than the MO or MT for the closest monitoring well are assumed to go dry if those MOs and MTs are met.	Thank you for your comments. All comments are given due consideration. GSP changed in 4.2.2.3 to discuss analysis of the impacts of the water level measurable objectives and minimum thresholds on domestic wells.

				• Our analysis estimated that, at a *minimum*, 33 agricultural wells will go dry under the proposed MOs, and 75 agricultural wells would go dry under the proposed MTs. These represent 2.8% and 6.4% of all agricultural wells in the GSA, respectively. Many Southeast Asian farmers are renting land on parcels with older wells that are less likely to be recorded in the database. The maps in figures 1 and 2 show the spatial analysis of agricultural wells that will go dry under the MOs and MTs for each monitoring well. We interpret these numbers as an *underestimate* of the potential well outages given the following limitations of the data available for the following reasons: 1) The analysis relies on total completed depth information of the well, but wells will go dry before hitting their absolute depth; 2) The OSCWR database is incomplete and may be missing older wells or wells where the well completion reports were not filed; 3) The analysis could not be completed for over 300 wells that were either missing information about total completed depth information (about 200 agriculture wells in the GSA boundary) or fell outside of the 3-mile radius around a monitoring well (141 agriculture wells in the GSA boundary).	
68	Ruth M Dahlquist-Willard (UC Coop Ext)			**Effects of GSA operational costs and project costs on small farms** It is beneficial to small farms that they will not need to sign up or register to be members of NKGSA, as this prevents adding to the already substantial membership and reporting requirements from other agencies and regulatory programs in the state. Small-scale farmers will likely pay GSA operational costs through increased property tax assessments paid by landowners within the Fresno Irrigation District (FID). Those owning land would pay the increased assessment directly to FID, while farmers renting land might see increases in land rental rates if the assessment is passed on to them in the cost of the lease. The financial impact of this assessment is likely to be low, at least in the early stages of SGMA implementation, although it is difficult to determine given that the amount of the assessment is not specified in the GSP. To pay project costs, the NKGSA proposes leveraging fees to landowners based on volumetric pumping if metering is available, estimated pumping if not, land area, or another method as determined by each agency (page 7-2). These new project costs could have a financial impact on small farms through increased operational costs, but the extent and severity of this impact cannot be estimated without details on magnitude and cost structures. One clear issue, however, is the information asymmetry between landowners and renters (who are often small-scale, socially disadvantaged farmers) that is implicit with this management plan, and which we believe NKGSA should work to address. Despite the collaborative Board structure, there is no distinct entity on the board that is likely to represent the specific interests of small-scale farmers and the unique characteristics of their farms. The NKGSA outreach committee has worked with the Asian Business Institute and Resource Center (ABIRC) and the University of California Cooperative Extension (UCCE) Fresno County to inform small-scale Southeast Asian farmers about SGMA implementation (page 2-44). However, outreach and education should not be equated with farmers providing feedback to the GSA or with participation and engagement in the decision-making process. Including representation of small-scale, socially disadvantaged farmers on additional committees, such as the technical committee and advisory committee, would improve consideration of the interests of these farmers in the implementation of the GSP.	Thank you for your comments. All comments are given due consideration.
69	Ruth M Dahlquist-Willard (UC Coop Ext)			**Effects of the GSP management plan on small farms** In addition to potential well outages if MOs and MTs are reached, the management plan has the potential to raise operational costs and limit access to groundwater through pumping restrictions. We are concerned that if implemented, these management actions could cause financial hardship to the small farming community in the NKGSA service area. However, the extent of these impacts are challenging to assess without specific details and timelines about project implementation. The GSP provides a 12-page description of potential management actions that will be used only if necessary, but does not explain the details and timelines of initiating or implementing any of the projects. We understand that this permits flexibility to the GSA to adaptively manage and determine an appropriate course of action if and when MOs and MTs are met; however the current lack of detail prevents us from analyzing how these projects may impact small-scale farmers in the NKGSA. We point out concerns about the three following management actions: ● A moratorium on new wells during periods of droughts (page 6-24) could have severe impacts on all agriculture in the GSA service area, if growers are unable to drill deeper wells to access groundwater. Small-scale farmers who rely almost entirely on groundwater, already have limited resources to adapt to decreasing groundwater levels, and may have shallower wells than their neighbors could be disproportionately limited by a moratorium on new wells. ● Additional well-head requirements with new well construction requirements and new permit criteria (page 6-15) could increase costs for small-scale farmers. Similarly, requirement of flow meters or self-reporting twice a year will require financial and/or human resources that are more limited on small-scale farms. We recommend working with local partners on grants to assist small-scale farmers with potential new infrastructure costs. ● Groundwater allocations and pumping restrictions per acre could reduce agricultural production in the area. Table 6-4 outlines five possible methods for quantifying groundwater use. Potential problems exist for small-scale, diversified specialty vegetable farms	Thank you for your comments. All comments are given due consideration.

				with several of the approaches. Use of flow meters will require farmers to install equipment that will have a proportionally larger financial impact on small-scale farmers if costs are not defrayed. If the irrigated area hybrid method is used, estimation of groundwater use will be difficult because crop coefficients are not established for many crops grown by small-scale farmers in the region (such as many of the Asian specialty vegetable crops), and diversified farms may contain up to 100 different crops grown in seasonal rotations. If methods that use crop type to estimate groundwater use are employed, we recommend that an estimate for groundwater use for a category such as "mixed vegetables" be developed. Also, estimation of pumping by crop does not reflect rotation with fallow areas within a farm, and might overestimate groundwater use for farmers rotating parcels within their farms.	Thank you for your comments. All comments are given due consideration.
70	Ruth M Dahlquist-Willard (UC Coop Ext)	2	2-39	**Suggestions for improving outreach and participation by small-scale farmers** The NKGSA outreach plan separated beneficial users of groundwater into three categories: 1) Collaborated; 2) Consulted; and 3) Connected (page 2-39). While outreach events were conducted in collaboration with ABIRC, and one with UCCE, these events focused more on outreach than on feedback and participation, and it is not clear how input from the farmers who attended was incorporated into the development of the GSP. Outreach during GSP implementation would benefit from action items to increase communication with farmers who are harder to reach, such as developing bilingual materials or partnering with groups connected to these farmers. Adding members representing the Southeast Asian farming community and other socially disadvantaged farmers to the advisory and/or technical committees would improve participation by a diversity of small-scale farmers.	GSP Section 2.5.5 changed to include…The GSA will continue to pursue effective methods of communication with stakeholders, including rural domestic pumpers and small farmers, to provide local seasonal and annual groundwater conditions and basic groundwater and well information.
71	Local Government Commission, Audubon, Union of Concerned Scientists, etc..	2.5, 2.5.1, 3.2.5, 4.4.2	81, 84, 232-242, 463	The GSP provides a detailed description of the beneficial users in the basin. Figure 3-32, which identifies Cr(VI) concentrations by comparison with the USGS Health-Based Screening Level pf 20 µg/l , provides a misleading impression of the seriousness of the threat to drinking water quality posed by this contaminant in this subbasin. While the MCL of 10 µg/l was withdrawn, the SWRCB still has a responsibility to set the revised MCL as close to the Public Health Goal (PHG) as economically and technically feasible. Therefore, a more accurate depiction of threat would be to use the PHG of .02µg/l as the comparison level in Figure 3-32. The GSP should describe whether other beneficial uses and users of groundwater in the NKGSA area are present, including protected Lands, preserves, refuges, conservation areas, recreational areas; managed wildlife areas, and other protected lands; and Public Trust Uses, including wildlife, aquatic habitat, fisheries, and recreation. The types and locations of environmental uses, species and habitats supported, and the designated beneficial environmental uses of surface waters that may be affected by groundwater extraction in the NKGSA area should be specified in the GSP. The GSP should discuss how environmental groups were engaged during the GSP development process. To identify environmental uses and users, please refer to the following: - The NC Dataset (https://gis.water.ca.gov/app/NCDatasetViewer/) which identifies potential presence of groundwater dependent ecosystems in this basin - The list of freshwater species located in the Kings Subbasin: h ttps://groundwaterresourcehub.org/sgma-tools/environmental-surface-water-beneficiaries/. Take particular note of the species with protected status. - CDFW's California Natural Diversity Database (CNDDB) (https://www.wildlife.ca.gov/Data/CNDDB) - USFWS's IPAC report for the North Fork Kings Area of the Subbasin (https://ecos.fws.gov/ipac/) . The benefits and requirements of the Kings River Fisheries Program and the San Joaquin River Restoration Program should be discussed in the GSP.	Thank you for your comments. All comments are given due consideration.
72	Local Government Commission, Audubon, Union of Concerned Scientists, etc..	App 2-A, 2.5.1, 2.5.5, 2.5.3.2, 2.5.3.3	83, 88, 90, 92, 93, 97, 104, 113, 114, 115	The GSP includes a communication plan and details how the public was engaged through the GSP development process, including where and when meetings were held. It is important that stakeholder engagement be maintained through the development of future projects and management actions and other SGMA compliance and implementation steps.	Thank you for your comments. All comments are given due consideration.

73	Local Government Commission, Audubon, Union of Concerned Scientists, etc..			The GSP should provide the locations and depths of all domestic and public supply wells in the GSA area using the best available information. If this information is not available in the County database, it can be downloaded from the DWR-provided resource: https://www.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37. Locations of potentially impacted wells should be provided in order to assess the well impacts specific to ACs, small water systems, and other sensitive users within the NKGSA. Refer to TNC Best Practices for Using the NC Dataset for using local groundwater data to verify whether polygons in the NC dataset are supported by groundwater in an aquifer. How the depth to groundwater contours in Figure 3-23 were developed should be further confirmed. Ideally, the wells used for interpolating depth to groundwater should be sufficiently close (<5km) to NC Dataset polygons and screened within the surficial unconfined aquifer and capable of measuring the true water table. Depth to groundwater contours should be developed by first contouring groundwater elevations measured at monitoring wells, then subtracting this layer from land surface elevations extracted from a Digital Elevation Model (DEM) to estimate depth to groundwater contours across the landscape. This will provide much more accurate contours of depth-to-groundwater along streams and other l and surface depressions where GDEs are commonly found. It is recommended that depth to groundwater data from multiple seasons and water year types are used to determine the range of depth to groundwater around NC dataset polygons, as utilizing groundwater data from one point in time (e.g., Spring 2017) can misrepresent groundwater levels required by GDEs, and inadvertently result in adverse impacts to the GDEs. Ensure that groundwater condition data prior t o t he SGMA benchmark date of January 1, 2015 is included in the analysis. The GSP should provide rationale for the 30-foot criteria and the 100-foot buffer cited in the text. The GSP should consider what vegetation is p resent in the potential GDEs and the estimated maximum rooting depths for those species. If insufficient data are available to describe groundwater conditions within or near polygons from the N C dataset, include those polygons in the GSP until data gaps are reconciled by future data collection. If there is a potential GDE near the river, the entire GDE should be included, rather than using an arbitrary 100-foot cutoff. When describing G DEs, provide information on the historical or current groundwater conditions underlying the GDEs or the ecological conditions present. Also provide an ecological inventory for all potential GDEs that includes the vegetation types or habitat types and rank the GDEs as having a high, moderate or low value; and what characterizes the rank. Identify whether any endangered or threatened freshwater species of animals and plants, or areas with critical habitat were found in or near any of the GDEs. The GSP should compile and synthesize supporting hydrological datasets and biological data for each GDE unit, and/or describe data gaps and insufficiencies. A description of the potential effects on GDEs, land uses, and property interests should also be provided. The GSP should provide or refer to depth to groundwater contour maps in Section 3.2.7. Refer to TNC Best Practices for Using the NC Dataset for best practices for completing the contouring and subsequent analysis. Also provide cross-sections at locations where there may be groundwater-surface water connection to show the relationship between the depth to groundwater and the bed of the river channel.	Thank you for your comments. All comments are given due consideration.
74	Local Government Commission, Audubon, Union of Concerned Scientists, etc..			The GSP should include multiple climate scenarios, such as single dry years and multiple dry years. The GSP should clearly identify and quantify surface water outflows and water uses for native vegetation and/or wetlands in the water budget. The GSP does not quantify the number of domestic well users or associated water demand. These demands should be included in the historical, current, and future water budgets for full consideration of all demands on the basin. The GSP should clarify whether a term is included for native or riparian vegetation evapotranspiration and for wetlands in the North Kings historical, current, and future water budgets. The GSP should also provide discussion of the potential impacts to groundwater conditions due to climate change on GDEs and aquatic ecosystems.	Thank you for your comments. All comments are given due consideration.

75	Local Government Commission, Audubon, Union of Concerned Scientists, etc..	5		The GSP does not clearly and transparently present the impact of the proposed MOs/MTs on domestic wells, DACs and other key communities within the NKGSA area, nor does it present an assessment of how many and which domestic wells are expected to go dry if the MOs/MTs are reached. Therefore, an impact analysis should be performed in the GSP to evaluate the potential impacts to subbasin wells associated with the MTs/MOs developed by the NKGSA. The GSP should describe how the monitoring network will be sufficient to address the potential correlation between groundwater level declines and biological responses, and to monitor impacts to GDEs and ISWs. To accurately characterize GDEs, clarify how the unconfined aquifer will be monitored and how many wells will be used. The GSP should also reconcile data gaps in monitoring for ISWs with specific recommendations (shallow monitoring wells, stream gauges, and nested/clustered wells) along surface water features to improve ISW mapping and inform an adequate analysis.	Thank you for your comments. All comments are given due consideration.
76	Local Government Commission, Audubon, Union of Concerned Scientists, etc..	4.2, 4.6		The GSP should include the impacts of groundwater extraction on DACs. It should also document clearly how stakeholders' input was considered in the development of URs, MOs, and MTs. The GSP should describe how the proposed approach to developing MOs/MTs is protective of the diverse drinking water users in the NKGSA and develop a proactive assistance program for potentially impacted beneficial users, including DACs, small water systems, and domestic wells, to mitigate potential future adverse impacts. At the proposed MOs, the water levels in the representative monitoring wells (RMWs) would decline up to 60 ft; at the proposed MTs, the water level in the RMWs would decline between 11 ft to 107 ft. In addition to dewatering wells, changes to groundwater flow gradients could potentially result in changes to water quality. Therefore, it is recommended that the impacts to groundwater gradients at the proposed MOs and MTs be analyzed and described in the GSP, as well as impacts to drinking water wells. Given that the subbasin is in critical overdraft, the GSP should explain how the projected additional water level declines will result in sustainable conditions for beneficial users. The GSP should describe how the degree of decreasing water level prior to reaching the UR definition is considered to be insignificant and reasonable, and how this approach is protective of beneficial users in the basin, particularly those with limited financial resources, including, but not limited to, members of DACs. The GSP should further clarify the disconnect between the UR definition for chronic lowering of water levels and the definition of MT exceedances that trigger action by the NKGSA. It is also recommended that the GSP present a thorough and robust analysis, supported by maps, that identifies: (1) what domestic wells are likely to be impacted (including partially dewatered) at the MTs and at the MOs and (2) the location of the likely impacted wells with respect to DACs and other communities and systems dependent on groundwater. Interim milestones (IMs) are not presented in Appendix 4-A. Table 4-3 of the draft GSP lists MTs and MOs for each representative monitoring well but not interim milestones for the monitoring wells. Per 23 CCR § 354.30, each agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of plan implementation. The GSP should clearly identify the specific numeric MOs and MTs for each chemical/constituent of concern at the representative monitoring wells, and present this information clearly and transparently in tables and maps so that the public and DWR may evaluate the proposed sustainability management criteria. The GSP should include GDEs and ISWs in the development of MOs and MTs for groundwater levels and depletions of ISWs. It is recommended the GSP add "potential adverse impacts to GDEs and native freshwater species" to the list of potential undesirable results presented in Section 4.2. Section 4.4 should be modified to state that overpumping and dewatering of aquitards has been identified as a potential source of elevated arsenic concentrations above drinking water standards in San Joaquin Valley aquifers. In addition, any potential undesirable results from degradation of water quality that may impact GDEs and freshwater species in the area should be discussed in this section.	GSP changed in 4.2.2.3 to discuss analysis of the impacts of the water level measurable objectives and minimum thresholds on domestic wells. GSP will call out interim milestones in table and hydrographs. GSP Table 4-7 will be revised to include MCLs, including most recent measured values. GSA staff is working with FID and other agencies in basin on response to Nature Conservancy comments.

				The analysis for potential depletion of ISWs in Section 4.6 should include all beneficial users of surface water that could be affected by groundwater withdrawals, including environmental. The GSP should also include instream flow requirements and critical habitat designations in this section and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.	
77	Local Government Commission, Audubon, Union of Concerned Scientists, etc..	6		The GSP should identify the potential impacts of the proposed projects or management actions on DACs. If impacts are expected, the GSP should include plans to mitigate such impacts, calculate the estimated costs, and document the funding sources. The GSP should clarify whether the land conversion mentioned in the water budget section is part of the management actions. The GSP should include discussion of the environmental benefits and multiple benefits as criteria for assessing project priorities. The GSP should consider modifying the Management Actions to include education and outreach for protection of GDEs and ISWs, as well as specific management of these ecosystems and the species they provide for. The GSP should also include funding mechanisms for projects and management actions.	Thank you for your comments. All comments are given due consideration.
78	Self Help Enterprises, Leadership Counsel			The GSP should describe how the degree of water level lowering before meeting the UR definition is considered to be insignificant and reasonable, and how this approach is protective of beneficial users in the basin, particularly those with limited financial resources, including, but not limited to, members of DACs. The GSP should further clarify the disconnect between the UR definition for chronic lowering of water levels and the definition of MT exceedances that trigger action by the NKGSA.	GSP changed in 4.2.2.3 to discuss analysis of the impacts of the water level measurable objectives and minimum thresholds on domestic wells.
79	Self Help Enterprises, Leadership Counsel			An impact analysis should be performed in the GSP to evaluate the potential impacts to sub basin wells associated with the MTs/MOs developed by the NKGSA. Furthermore, locations of potentially impacted wells should be provided in order to assess the well impacts specific to DACs, small water systems, and other sensitive users within the NKGSA.	GSP changed in 4.2.2.3 to discuss analysis of the impacts of the water level measurable objectives and minimum thresholds on domestic wells.
80	Self Help Enterprises, Leadership Counsel			GSP should describe how approach is protective of the diverse drinking water users in the NKGSA. And develop an assistance program for potentially impacted beneficial users, including DACs, small water systems, and domestic well users to mitigate adverse impacts.	Thank you for your comments. All comments are given due consideration.
81	Self Help Enterprises, Leadership Counsel			Given that the sub basin is in critical overdraft, the GSP should explain how the projected additional water level declines will result in sustainable conditions for beneficial users. The GSP should also consider and quantify both the potential dewatering of wells and the increased pumping costs associated with the increased lift at the projected water levels in order to more fully and transparently consider the impacts to beneficial users	GSP changed in 4.2.2.3 to discuss analysis of the impacts of the water level measurable objectives and minimum thresholds on domestic wells.
82	Self Help Enterprises, Leadership Counsel			It is recommended that the impacts to groundwater gradients at the proposed MOs and MTs be analyzed and described in the GSP, as well as impacts to drinking water wells	GSP changed in 4.2.2.3 to discuss analysis of the impacts of the water level measurable objectives and minimum thresholds on domestic wells.
83	Self Help Enterprises, Leadership Counsel			Recommend that the GSP present a thorough and robust analysis, supported by maps, that identifies: 1) what domestic wells are likely to be impacted (including partially dewatered) at the MTs and at the MOs and 2) the location of the likely impacted wells with respect to DACs and other communities and systems dependent on groundwater	GSP changed in 4.2.2.3 to discuss analysis of the impacts of the water level measurable objectives and minimum thresholds on domestic wells.

84	Self Help Enterprises, Leadership Counsel			However the details of this evaluation and the potential actions [when a minimum threshold is exceeded] are not identified in the draft GSP. The draft GSP should clearly identify the potential actions that would be implemented and the funding source(s) that would be utilized if such actions are implemented	GSP changed in 6.1 to state that…If project development is not able to achieve the interim sustainability milestones or if minimum thresholds are exceeded, then management actions or programs will be needed. And text in 6.3 changed to state… The NKGSA and its member agencies believe sustainability will be reached with the projects identified in Section 6.2, however a listing of management actions is included should interim milestones not be reached or minimum thresholds exceeded.
85	Self Help Enterprises, Leadership Counsel			Water level interim milestones are not included in Appendix 4-A or Table 4-3.	GSP will call out interim milestones in table and hydrographs.
86	Self Help Enterprises, Leadership Counsel			The GSP should clearly identify the specific numeric MOs and MTs for each COC at the RWMs and present this information clearly and transparently in tables and maps so that the public and DWR may evaluate the proposed sustainability management criteria.	GSP Table 4-7 will be revised to include MCLs, including most recent measured values.
87	Self Help Enterprises, Leadership Counsel			The GSP should fully consider all available water quality data in its analysis of groundwater conditions and the hydrogeologic conceptual model. The wealth of available data should not be omitted because of its volume, given that it could add substantial value in understanding spatial and temporal trends in water quality.	The NKGSA has developed voluminous data and will continue to develop more data for evaluating and implementing the GSP.
88	Self Help Enterprises, Leadership Counsel			The GSP should explicitly describe how the risks of inadvertent water quality impacts associated with projects will be evaluated and monitored as a part of each identified project and management action.	Thank you for your comments. All comments are given due consideration.
89	Self Help Enterprises, Leadership Counsel			The GSP should clearly demonstrate how the proposed water quality monitoring network in the eastern portion of the City of Fresno is sufficient to monitor for impacts to beneficial users in this area.	Thank you for your comments. All comments are given due consideration.
90	Self Help Enterprises, Leadership Counsel			The GSP identifies RMWs for water level and water quality in Tables 4-3 and 4-7 but does not include well construction information for these wells. Pursuant to 23 CCR Section 352.4, this information is required to be provided for all monitoring wells.	GSP will be changed to identify which wells have construction info and clarify its plan for obtaining construction info for wells lacking this info.
91	Self Help Enterprises, Leadership Counsel			The GSP should specifically identify the RMW owners and operators and identify a plan to obtain adequate monitoring data, should for any reason the well owners do not obtain and make this data available to the NKGSA.	Thank you for your comments. All comments are given due consideration.

92	Self Help Enterprises, Leadership Counsel			The draft GSP indicates the NKGSA has no control over or access to the water quality RMWs. The GSP should identify what plans and mechanisms are in place to allow for this contingent, increased water quality sampling at the water quality RMWs, should water quality MTs be exceeded.	Thank you for your comments. All comments are given due consideration.
93	Self Help Enterprises	2.5	2-36, 2-37	Expand Section 2.5 of the GSP, (page 2-36 and 37) to include a more detailed description of the region's broad and diverse groundwater users and DACs' dependence on groundwater for drinking water purposes. For example: *The NKGSA area includes over 8,300 domestic wells, seven DWR designated DACs (i.e., Fresno, Kerman, Biola, Calwa, Malaga, Mayfair, and West Park) with a collective population of over 537,000 people reliant on groundwater for drinking water use, including several communities dependent on private wells, such as the community of Easton whose population is over 2,300 people. Other severely disadvantaged communities include Rolinda, Double L Neighborhood, Centerville, Double L Mobile Ranch Park, Britten, Daleville, and Communities 152, 168, 180 and 192. Overall, within the NKGSA area, there are 107 community water systems, 101 of which have less than 300 service connections but collectively serve over 88,000 people. NKGSA population is also diverse, including a significant non-English speaking population and an active group of Southeast Asian including Hmong growers.*	GSP modified to include additional descriptions of DACs
94	Self Help Enterprises	2.5		Develop and incorporate a formal GSP Implementation Outreach and Engagement Strategy. When developing such a strategy, the NKGSA should evaluate the outreach and engagement strategies utilized during GSP development phase, success and constraints encountered and develop recommendations to improve public participation during plan implementation. Effective outreach and engagement strategies for DACs, include hosting localized neighborhood evening meetings, providing bilingual (English and Spanish) materials, interpretation services, tailoring materials to the intended audience. All communication materials should include key messages, visuals and information that is relevant to the groundwater user. We recommend identifying and working with known and respected community leaders, community based organizations and nonprofits. Nonprofits working within the NKGSA boundaries include but are not limited to, LCJA, SHE, and California Rural Legal Assistance. The GSP Implementation Outreach and Engagement Strategy should include a DAC communications campaign and regular and ongoing workshops in order to solicit feedback, keep the public informed and engaged, and establish trusting relationships. At a minimum, the GSP implementation outreach and engagement strategy should proactively provide information to the public during plan updates, and prior to critical decisions. Critical decision points may include but are not limited to the adoption of groundwater fees, development and adoption of the Groundwater Allocation Framework, and the Pumping Restriction Program.	GSP Section 2.5.5 changed to include…The GSA will continue to pursue effective methods of communication with stakeholders, including rural domestic pumpers and small farmers, to provide local seasonal and annual groundwater conditions and basic groundwater and well information.
95	Self Help Enterprises	2.5		Fund appropriate and effective outreach strategies to engage diverse groundwater users (i.e. DAC residents served by public water systems and private domestic wells and others). Account for DAC outreach, engagement and translation services when establishing and approving operating budgets and enacting groundwater fees and applying for state funding. Utilize appropriate consultants. The NKGSSA should hire qualified consultants who have a record of proven demonstrated success in and clear qualifications for working with these stakeholders.	GSP Section 2.5.5 changed to include…The GSA will continue to pursue effective methods of communication with stakeholders, including rural domestic pumpers and small farmers, to provide local seasonal and annual groundwater conditions and basic groundwater and well information.
96	Self Help Enterprises	3.2		Provide the locations and depths of all domestic and public supply wells in the GSA area using the best available information. If this information is not available in the County database, at least some of this data can be downloaded from the DWR-provided resource	Thank you for your comments. All comments are given due consideration.
97	Self Help Enterprises	3.2		Utilize our technical focused review, (in particular Figures 2A, 2B, and 3) the Draft Tulare Kern Funding Area Preliminary Needs Assessment report and the NKGSA Water Budget to develop a more detailed description of the historical and currently known groundwater challenges impacting the drinking water supplies of DACs. The GSP should provide a better description of the unique challenges that S/DACs face, including the susceptibility to groundwater changes due to their shallower wells and financial constraints. The locations of potentially impacted wells should also be provided in order to assess the well impacts specific to DACs, small water systems, and other sensitive users within the NKGSA.	Thank you for your comments. All comments are given due consideration.
98	Self Help Enterprises			Include a description of the impacts experienced during the 2012-2016 drought. A good understanding of what happened, including which programs and strategies worked well to effectively address impacts to drinking water and what strategies could be improved, can aid with the development of management actions that adequately prepares the GSA to prevent and mitigate the impacts of future droughts. According to the CA Household Water Supply Shortage Report, which provides an estimate of the cumulative number of household water	Thank you for your comments. All comments are given due consideration.

				supply shortages or problems occurring from dry or failing groundwater wells or surface water supplies through January 6, 2019, a total of 77 households have reported outages and 21 households still have verified active outages in Fresno County. Due to the volunteer nature of the reporting and limitations on reporting agencies, data discussed in the CA Household Water Supply Shortage report are undoubtedly under-representative of all shortages to have occurred. In addition, reports are received from multiple sources and there are occasionally errors and omissions, non- household water supply reporting, and under-reporting. Self-Help Enterprises (SHE), assisted families and communities in the San Joaquin Valley in pursuing funding, interim and long-term solutions during the drought, has helped 104 homes and 7 schools in Fresno County to receive bottled water, install 86 water tanks as a temporary measure (2 water tanks are still pending approval). In addition, SHE assisted 44 families with financing new water wells (3 water wells are still pending approval) as a long-term solution. To document specific impacts within the NKGSA (i.e. number of wells that were dewatered, number of households that participated in the interim household water tank program and costs associated with emergency drinking water services, grants/loan awarded for replacement wells, and current households without a permanent source of water), please consider seeking additional information from Fresno County and the drought team at Self-Help Enterprises. The GSA should also evaluate whether there is a need to conduct further analysis in order to determine whether historical, current and/or future impacts to these drinking water supplies are associated with or will be caused by changes in groundwater levels, plume migration, increase of groundwater quality degradation, and subsidence.	
99	Self Help Enterprises	3.3		Under Groundwater Pumping for Irrigation (draft GSP, page 3-94), include a summary of the information on land use and crop evapotranspiration so that these values can be assessed.	Thank you for your comments. All comments are given due consideration.
100	Self Help Enterprises	3.3		Under Uncertainty in Water Budgets (draft GSP, page 3-104), present the uncertainty in groundwater storage change due to a plausible range in groundwater storage properties and compare that to the storage change calculated from the water budget. We also recommend clarifying in the text whether NKGSA applied a water budget correction factor to the current and future water budgets with the intent to align the water budget storage change with the storage change estimated from water levels and groundwater storage properties.	Thank you for your comments. All comments are given due consideration.
101	Self Help Enterprises	3.3		In Table 3-10, page 3-112, please include more detailed information on how the future water demand assumptions were determined for each water agency, including the underlying population growth estimates and crop patterns.	Thank you for your comments. All comments are given due consideration.
102	Self Help Enterprises	3.3		To develop the projected water budget (draft GSP Section 3.3.10), include multiple climate scenarios available from DWR climate change datasets: extreme warming scenario, and the wetter, moderate warming scenario.	Thank you for your comments. All comments are given due consideration.
103	Self Help Enterprises	3.3		Include a discussion and analysis in the GSP evaluating the projected water budget conditions, specifically focusing on climate change impacts for domestic well users, S/DACs, and community water systems.	Thank you for your comments. All comments are given due consideration.
104	Self Help Enterprises	4.2		Include a more clear statement on groundwater quality and human consumption in the final language for the sustainability goal. This will make the statement stronger, demonstrate to residents that their water needs are a priority, and overall help the GSP meet SGMA standards. Kings Subbasin GSAs should also consider including a more broadly-stated description towards what exactly the goal will strive to fulfill. One such example would be: "*Through implementation of projects and management actions tailored to each GSA, the broadly-stated Sustainability Goal for the Kings Subbasin is to ensure that groundwater production will preserve the viability of cities and existing agricultural enterprises as well as the viability of school districts, smaller communities, and households relying on shallow domestic wells. The Goal will also strive to fulfill the water needs of existing populations that commit to continued economic and population growth within the Subbasin boundaries.*"	Thank you for your comments. All comments are given due consideration.
105	Self Help Enterprises	4.2		Document clearly how stakeholders' input was considered in the development of Sustainability Goal.	Thank you for your comments. All comments are given due consideration.

106	Self Help Enterprises	4.3		Document clearly how stakeholders' input was considered in the development of URs, MOs, and MTs.	Thank you for your comments. All comments are given due consideration.
107	Self Help Enterprises	4.3		Revise the UR definition for chronic lowering of water levels of "*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"*(draft GSP Section 4.2.1.1) to a definition that is consistent with the objectives of SGMA, the Human Right to Water, the MOs and MTs and one that takes into account input from all groundwater users, including DACs, residents served by private domestic wells and other sensitive beneficial users. Revising the definition will strengthen the GSP, meet SGMA regulations and be consistent with the MT/MOs definition. It will also demonstrate to residents that their water needs were incorporated.	Thank you for your comments. All comments are given due consideration.
108	Self Help Enterprises	4.3		Analyze and describe in the GSP the impacts to groundwater gradients and drinking water wells at the proposed MOs and MTs and reconsider the approach to set minimum thresholds and measurable objectives for groundwater levels. The revision of sustainable management criteria should be based off a thorough and robust analysis, supported by maps, that identifies: (1) whether changes in groundwater levels may be exacerbated in specific areas by pumping volume or location, conjunctive management or other forms of active management as part of GSP implementation; (2) what domestic wells are likely to be impacted (including partially dewatered) at the MTs and at the MOs and (3) the location of the likely impacted wells with respect to DACs and other communities and systems dependent on groundwater.	GSP changed in 4.2.2.3 to discuss analysis of the impacts of the water level measurable objectives and minimum thresholds on domestic wells.
109	Self Help Enterprises	4.3		Include the interim milestones for water level for each monitoring well on the hydrographs in Appendix 4-A and Table 4-3 of the draft GSP. Per 23 CCR § 354.30, each agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of plan implementation.	GSP will call out interim milestones in table and hydrographs.
110	Self Help Enterprises	4.3		Identify the specific numeric MOs and MTs for each contaminant of concern at each of the RWMs, and present this information clearly and transparently in tables and maps so that the public and DWR may evaluate the proposed sustainability management criteria.	GSP will be changed on Table 4-7 to include MCLs and recent data results.
111	Self Help Enterprises	4.3		Develop a warning system that informs NKGSA and stakeholders when contaminants of concern have reached 80% of the MCL and when there is an increasing trend in groundwater quality degradation near drinking water users. This system is especially important for wells with COC concentrations less than 80% the MCL that experience impacts due to groundwater management activities. Based on recent conversations with GSA staff, consultants and members, we understand that the GSA intends to coordinate with the well owner/operator to discuss possible reasons for change and may require additional monitoring. However, there are several limitations with this approach. Well owners/operators may not have the appropriate monitoring systems, technical expertise or financial resources to determine a reason for increasing groundwater degradation and, ultimately, it is the responsibility of NKGSA to implement monitoring strategies and actions plan capable to evaluate increasing trend in groundwater quality degradation. For wells with contaminant levels approaching the MCL or if there is an increasing trend in groundwater quality degradation near drinking water users, NKGSA should consider taking the following actions: notify nearby domestic well owners and community water systems; undertake an analysis to pinpoint the cause; provide information to groundwater users regarding impacts of groundwater management actions; reassess pumping allocations; and/or if the contaminant is clearly under the purview of another agency, confer with that agency to confirm a plan to address the groundwater quality problem.	GSP changed on page 4-32, to state that actions will be conducted as adverse water quality changes are observed to prevent an undesirable result.
112	Self Help Enterprises	4.3		Clarify how the GSA plans to align the sustainable management criteria with any emerging contaminants of concern and new MCLs.	Thank you for your comments. All comments are given due consideration.
113	Self Help Enterprises	4.3		Clarify how plume migration will be evaluated and monitored by NKGSA.	Thank you for your comments. All comments are given due consideration.
114	Self Help Enterprises	5		Identify which monitoring wells will be used to assess impacts to drinking water wells caused by changes on groundwater levels and quality and describe how that assessment will be conducted. As required by 23 CCR § 354.28, DWR will evaluate the ability of the proposed monitoring	GSP changed to include the GSAs efforts to ensure each water quality sampling event

				program to properly assess impacts to beneficial users of groundwater and to protect beneficial users within the subbasin. In particular, it is important to clarify how the NKGSA plans to monitor and assess drinking water wells at risk of dewatering or of further contamination.	results in a complete set of information including water level monitoring, when possible, at the time of sampling. The water level monitoring wells closest to the drinking water well with a water quality concern will be used to evaluate how the water level may have contributed to a change in contaminant level.
115	Self Help Enterprises	5		Expand water quality monitoring network or clearly demonstrate how the proposed network in the eastern portion of the City of Fresno is sufficient to monitor for impacts to beneficial users in this area. According to the draft GSP Basin Setting, concentrations of DBCP and TCP exceeding MCLs are present in the area near the shared border of Clovis and Fresno, and this area does not appear to be sufficiently covered by the proposed water quality monitoring network.	Thank you for your comments. All comments are given due consideration.
116	Self Help Enterprises	5		Clarify how NKGSA plans to increase water quality sampling at the water quality representative monitoring wells should water quality MTs be exceeded if, based on the information presented in the draft GSP, the NKGSA has no control over or access to the water quality RMWs (draft GSP Section 4.4.3.1). Based on recent conversations with the GSA, we understand that the GSA intends to conduct outreach to the well owners and operators of public water systems that have been identified as RMWs in the draft GSP and will be considering development of a policy to ensure data is available for each RWM. This policy should be developed within the first year following submittal of GSP and should not rely solely on the PWS to provide additional information. The GSA should establish a GSA boundary-wide funding mechanism to cover potential costs associated with additional monitoring. Doing so would better position the GSP to comply with SGMA and not limit financial impacts to low income well owners and public water systems serving DACs.	Thank you for your comments. All comments are given due consideration.
117	Self Help Enterprises	6.2 & 6.3		Identify the potential impacts of the proposed projects on DACs in Table 6-1 and the proposed management actions in Section 6.3. If impacts are expected, the GSP should include plans to mitigate such impacts, calculate the estimated costs, and document the funding sources. The GSP should clarify whether the land conversion mentioned in the water budget section is part of the management actions.	Thank you for your comments. All comments are given due consideration.
118	Self Help Enterprises	6.2 & 6.3		Describe how the risks of inadvertent water quality impacts associated with projects will be evaluated and monitored as a part of each identified project and management action. We recommend the NKGSA consider developing a set of criteria for recharge projects that prevent unintended impacts to drinking water and allows early consultation and collaboration between project proponents and the GSA. For example, the GSA could consider requiring water quality monitoring and soil sampling through which water will percolate to ensure that contaminated soils or contaminated surface water do not degrade groundwater. It is also recommended that strategies be identified that can avoid/prevent/mitigate for any potential short and/or long term impact to drinking water wells, including domestic wells. For more information please refer to the guide, Protecting Drinking Water Quality Under SGMA	GSP changed in 1st paragraph of 6.1 to include… The NKGSA will also be an active participant and reviewer of proposed project impacts through the project development and CEQA process.
119	Self Help Enterprises	6.2 & 6.3		Include a map that overlays all of the potential recharge projects onto one map and include the location of DAC, domestic wells, and public water systems. This would help stakeholders to effectively evaluate the collective potential benefits or impacts of recharge projects for drinking water users in the NKGSA.	Thank you for your comments. All comments are given due consideration.
120	Self Help Enterprises	6.3.3		Further clarify the circumstances and criteria for the implementation of a groundwater allocation management action in NKGSA (draft GSP, page 6-22).	Thank you for your comments. All comments are given due consideration.
121	Self Help Enterprises	6.3.3		Consider the proposed analysis and framework development to be of high priority and, thus, be conducted within the first year of GSP implementation.	Thank you for your comments. All comments are given due consideration.

122	Self Help Enterprises	6.3.3		Include appropriate provisions that ensure the protection of important drinking water supplies for small water systems serving disadvantaged communities. Key considerations for establishing such a program are provided in Appendix B.	Thank you for your comments. All comments are given due consideration.
123	Self Help Enterprises			Provide a robust layout and work plan detailing the schedule and actions that will be required to develop a Drinking Water Assistance Management Action. A Drinking Water Well Assistance Program could include a combination of different strategies including: replacing impacted wells with new, deeper wells, connecting domestic well users to a nearby public water system, or providing interim bottled water. A plan to reestablish the emergency water tank program paired with a bottled water delivery may be an appropriate short-term solution, but is not an adequate long-term solution. Key considerations for establishing such a program are provided in Appendix C.	Thank you for your comments. All comments are given due consideration.
124	Self Help Enterprises			Preventing Common DAC Water Planning and Implementation water challenges - NKGSA's Responsibility to Comply with SGMA Exempt private well communities and water systems serving DACs from GSA use permits and penalty fees and from the proposed estimated groundwater impacts framework. Considering their small water usage, the NKGSA should consider exempting these vulnerable groundwater users from any GSA fees and from the proposed estimated groundwater impacts framework to support their efforts to provide affordable and safe water. If the NKGSA considers implementing a penalty and/or fee for agencies or stakeholders that do not mitigate for their estimated groundwater impacts, at a minimum the NKGSA should consider 1) creating a more flexible warning and appeal process with these users, 2) proactively assisting small drinking water systems in project development and securing funding, and 3) conditional forgiveness and reduction of penalties. This would encourage transparency and working collaboratively with the NKGSA to take corrective actions addressing the underlying causes of overuse. The NKGSA should establish a formal funding mechanism in order to prevent common DAC water planning challenges and in order to ensure proper compliance of SGMA. Specifically, the NKGSA should consider establishing a technical assistance fund that can be used by the County of Fresno for the benefit of households relying on private domestic wells, schools operating their own water systems and or public water systems serving DACs. The technical assistance fund could fund project development actions, Proposition 218 studies, water quality monitoring/ investigations and DAC outreach and engagement activities. We believe such funding could be utilized to prevent common DAC water planning challenges experienced in other water management programs (i.e. Integrated Regional Water Management). This action will also enable the GSA to ensure proper and prompt compliance with SGMA.	Thank you for your comments. All comments are given due consideration.
124	Leadership Counsel for Justice & Accountability			**North Kings GSA is responsible for the disproportionate and disparate impacts that its policies and activities will have on domestic well users and disadvantaged communities.** North Kings GSA must prioritize drinking water as an essential pillar of the proposed groundwater sustainability plan. The Draft GSP erroneously attempts to avoid responsibility for significant and disparate impacts on protected groups resulting from its actions. The draft North Kings GSP states that, " [w]ithout SGMA and the proposed incremental mitigation by the NKGSA, these wells would have gone dry sooner, requiring the landowner to deepen existing wells." With this point, the GSA seeks to evade responsibility for drinking water impacts from its policy decisions. This stance is incorrect, however; while in the past there has been no limitation on the right to pump groundwater, SGMA establishes a new regime in which the state has recognized that unlimited pumping harms this common good and that pumping therefore must be regulated. The GSAs are now tasked with determining how to regulate the use and management of groundwater, and must do so in a way that complies with state law. Under SGMA, the GSA is tasked with managing groundwater in a way that does not cause "significant and unreasonable impacts" to the beneficial uses and users of groundwater in the subbasin. The GSA's activities cannot avoid impacts only on certain types of beneficial users; under SGMA it must "consider the interests of" an enumerated list of all types of beneficial users, including domestic well users and disadvantaged communities on domestic wells and community water systems. Furthermore, state law provides that no person shall, on the basis of race, national origin, ethnic group identification, and other protected classes, be unlawfully denied full and equal access to the benefits of, or be unlawfully subjected to discrimination under, any program or activity that is conducted, operated, or administered by the state. In addition, the state's Fair Employment and Housing Act guarantees all Californians the right to hold and enjoy housing without discrimination based on race, color, or national origin. Lastly, the Department of Water Resources is required to consider the Human Right to Water in its evaluation of the GSA's proposed Groundwater Sustainability Plan, so the drinking water impacts of the GSP are of utmost importance in its approval	Thank you for your comments. All comments are given due consideration.

				Small disadvantaged communities of color within the San Joaquin Valley are disproportionately impacted by unsustainable groundwater use, falling groundwater tables, dry drinking water wells, subsidence, and water quality degradation. As described in more detail below, and analyzed in the attached Focused Technical Review, the proposed sustainable management criteria will cause harm to drinking water for disadvantaged communities and domestic well users by putting their water supply at risk of dewatering and further pollution due to lack of water quality oversight. Furthermore, there are no projects or management actions proposed in the Draft GSP to prevent or mitigate these drinking water impacts. The negative impacts discussed in this letter, which will be allowed by the Draft GSP, will therefore be disproportionately felt by low income communities of color, and are thus discriminatory on the basis of race, color, ancestry, and national origin. In order to prevent disparate impacts, the North Kings GSA must reassess the GSP's potential disparate impacts and include robust and proactive policies, projects, and management actions to protect vulnerable disadvantaged communities and domestic wells from disparate impacts.	
125	Leadership Counsel for Justice & Accountability			**Inadequate Transparency, Public Process, Consideration of Public Input and Representation Undermine the Value and Efficacy of the Draft GSP** The Draft GSP incorrectly states that our organization "directly or indirectly" represented disadvantaged communities "on the North Kings GSA Board of Directors." We would like to clarify that we did not have a vote on the board, and were not able to engage with the GSP process consistently due to our limited funding and capacity. While we were invited to be a part of the GSA's outreach committee, our capacity to engage in GSP development was hindered because the North Kings GSA denied our request for a support letter which would have allowed us to be active participants in this process. A support letter from the GSA was a requirement for use of Prop 1 funding. Furthermore, to the best of our knowledge, the North Kings GSA never conducted outreach to the communities we work with in the GSA area. The GSA conducted outreach in Northern Fresno and West Park, but did not reach out to many other communities in disadvantaged areas in and around Fresno. If the GSA had approved our funding, we would have been able to collaborate with the GSA to engage communities in Britten Avenue, Three Palms, and neighborhoods in and around West Fresno as well as the broader South Fresno community.	Thank you for your comments. All comments are given due consideration.
126	Leadership Counsel for Justice & Accountability			**The Monitoring Network Is Inadequate With Respect to Groundwater Levels and Groundwater Quality** The GSA's Monitoring Network is insufficient because its representative monitoring wells do not cover the entirety of the subbasin, and will not detect impacts on many beneficial users. In shaping its monitoring network, the GSA must consider the interests of beneficial users including domestic well owners and disadvantaged communities, and must avoid disparate impacts on protected groups pursuant to state law. The Draft GSP lacks representative monitoring wells in areas of the subbasin where drinking water users may be particularly vulnerable to groundwater supply and quality issues, leaving the GSA with no ability to measure and avoid significant and unreasonable impacts to those users. The GSA must add representative monitoring wells and prioritize measures to address these data gaps. The insufficiency of the representative monitoring network poses a significant threat to the validity of the plan at large, and therefore must be addressed immediately.	Thank you for your comments. All comments are given due consideration.
127	Leadership Counsel for Justice & Accountability			**Representative Monitoring Wells for Groundwater Levels** Pursuant to 23 CCR § 352.4, the draft GSP is required to include well construction information for all monitoring wells. Without well construction information for monitoring wells included in the GSP, the public and DWR cannot evaluate if the monitoring wells are adequate for evaluating water levels relative to the measurable objectives and minimum thresholds over the long term. Additionally, the Draft GSP acknowledges that they have insufficient data for unincorporated areas on domestic wells, but does not propose a substantial plan to fill that data gap. They propose a suite of options to fill the data gap, but do not commit to any of them. Additionally, they do not include a substantive timeline as to when this data gap will be filled and instead elected to include a general 2025 deadline, by which they will "either collect information on these wells or identify other wells to be used instead". To ensure that the representative wells within the monitoring network accurately monitor impacts to groundwater management for drinking water beneficial users, and does not create a disparate impact on protected groups, we make the following recommendations: • The draft GSP must include well construction information for monitoring wells in order for the public and DWR to be able to evaluate the adequacy of the monitoring network.	GSP modified to include well construction info in Table 4-7 for the wells that construction information is available for, and clarify its plan for obtaining the well construction info for wells with no construction info.

				• Commit to a plan to fill data gaps in the GSP, and include an aggressive timeline to ensure prompt implementation of the plan. The above plan should include installation of representative monitoring wells measuring levels in DAC areas not currently covered by the monitoring network.	
128	Leadership Counsel for Justice & Accountability			**Representative Monitoring Wells for Groundwater Quality** As per the Draft GSP, the representative monitoring network will be relying on selected public wells to monitor for groundwater quality. As stated in Section 5.5.1 of the draft GSP, "publicly available groundwater quality data from selected representative wells will be obtained annually and evaluated against sustainable management criteria." The Draft GSP has no discussion regarding access agreements for water quality representative monitoring wells. Therefore, we understand that the North Kings GSA plans to rely solely on water quality data collected by other agencies for monitoring compliance with groundwater quality sustainable management criteria. While these wells will integrate existing public water system monitoring into the GSA's monitoring network, it will not capture the impact of groundwater management activities on groundwater quality for domestic wells and disadvantaged community water systems. The Draft GSP shows that there are many known contamination plumes in the GSA area. Since domestic wells are most vulnerable to groundwater contamination, and least able to treat for harmful drinking water contaminants, the GSA must ensure that its monitoring network captures groundwater quality impacts on domestic wells. Section 4.4.3.4 of the draft GSP states that "If an undesirable result occurs with regard to groundwater quality, actions may include increased frequency of monitoring well sampling". However, based on the information presented in the draft GSP, the North Kings GSA has no control over or access to the water quality representative monitoring wells. Choosing to only include public well data impacts the North Kings GSA's ability to adequately address contamination when it is detected and gives the GSA no oversight of how, when, and to the degree of accuracy, the monitoring is occurring. Finally, in the Draft GSP, the North Kings GSA states that there are no data gaps in regards to groundwater quality. However, concentrations of DBCP and TCP exceeding MCLs are present in the area near the shared border of Clovis and Fresno, and this area does not appear to be sufficiently covered by the proposed water quality monitoring network. In general, the location of the water quality representative monitoring wells appear to be inconsistent with concentrations of contaminants of concern over MCLs as identified in Figures 3-27 through Figure 3-32 of the draft GSP. The GSA must expand its monitoring network to cover this area where contamination exists and could increase or spread. To ensure that the representative monitoring network is protective of groundwater quality of all users in the basin, the GSA should do the following: • The GSP should identify what plans and mechanisms are in place to allow the GSA to collect more frequent groundwater quality testing. • In order to make sure the management actions of the GSA are not impacting groundwater quality, the GSA must do its own sampling in areas where domestic wells are located. • In order to make sure the GSA has access to monitoring and testing water quality, the North Kings GSA could also consider conducting its own water quality analysis of wells and establish access agreements to water quality representative monitoring wells. The GSP should include a clear plan for expanding its representative monitoring wells in the eastern portion of the City of Fresno, and clearly demonstrate how the monitoring network is sufficient to monitor for impacts to beneficial users in this area.	GSP will be modified to include well construction info in Table 4-7 for the wells the GSA has construction information for.
129	Leadership Counsel for Justice & Accountability			**Confusion in Representative Monitoring Chapter** It is not clear which wells in the monitoring network will be used for monitoring which sustainability indicators from the maps provided in the Draft GSP. In order for the public and DWR to evaluate whether the monitoring networks will adequately detect impacts to beneficial users in the GSA area, the GSA must include separate maps and provide data for the wells that will be monitoring for compliance with each sustainability indicator. The Draft GSP also does not make it clear which wells will be used as general monitoring wells, and which wells will be used for measuring compliance with the sustainable management criteria. The GSA must include make this distinction clear by labeling the wells clearly in its maps of the monitoring networks for each sustainability indicator. In order to make sure information about the monitoring network is presented in a clearly and concisely, the GSA should do the following: • Include separate maps of the monitoring sites and wells that will be monitoring for compliance with each sustainability indicator.	Thank you for your comments. All comments are given due consideration.

				The GSA must clarify which wells will be monitoring for compliance with the sustainable management criteria for each sustainability indicator.	
130	Leadership Counsel for Justice & Accountability			**The Draft GSP's Sustainable Management Criteria for Groundwater Levels are not Adequate** The sustainable management criteria for groundwater levels must be made after considering the interests of all beneficial user groups, including domestic well users and disadvantaged communities. These policy decisions must also avoid disparate impacts on protected groups pursuant to state and federal law. The North Kings GSA area includes over 8,300 domestic wells, seven DWR- designated disadvantaged communities (i.e., Fresno, Kerman, Biola, Calwa, Malaga, Mayfair, and West Park) with a collective population of over 537,000 people, and the community of Easton, whose population of over 2,300 is dependent on private wells for drinking water. The North Kings GSA also includes 107 community water systems, 101 of which have less than 300 service connections but collectively serve over 88,000 people. Despite this broad and diverse dependence on groundwater for drinking water use, the Draft GSP proposes groundwater levels sustainable management criteria that will likely lead to disparate impacts on protected groups pursuant to state and federal law.	GSP modified to include additional descriptions of DACs. See comment 93.
131	Leadership Counsel for Justice & Accountability			**The Proposed Undesirable Result for Groundwater Levels is Inadequate** Undesirable results are the point at which "significant and unreasonable" impacts on beneficial users are caused by declining groundwater levels. The SGMA regulations require GSAs to justify their undesirable results by including the " [p]otential effects on the beneficial uses and users of groundwater." As it is currently written, North Kings GSA's undesirable result for groundwater levels will not be triggered until "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." This definition implies that it is feasible for beneficial users to continuously install new wells until essentially the bottom of the basin is reached or until the water quality exceeds available treatment technologies, and that any condition short of that does not constitute an undesirable result. This undesirable result does not "consider the interests of" the impact of this policy on disadvantaged communities on domestic wells or shallower community water system wells, who will not be able to drill a new productive well if their wells go dry. Given that there are 8,300 domestic well users in the GSA, and many of those wells and shallow community wells serve households in disadvantaged communities in the GSA area, this policy will disproportionately negatively affect these communities, and will cause disparate impacts under state civil rights law. This policy therefore violates the GSA's obligations under SGMA and state civil rights law. Further, Section 4.2.1.2 of the draft GSP states that the "[w]ater level declining below the minimum threshold in one of the GSA's indicator wells in the monitoring network will be considered significant...with the monitoring network having indicator wells represent large areas, the exceedance of the minimum threshold at just one well location is significant based on how the basin has determined the minimum thresholds...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 NKGSA and potential action." This statement is unclear as it shows a disconnect between the undesirable result for chronic lowering of water levels and the definition of minimum threshold exceedances that trigger action by the North King GSA. Lastly, the GSA dismisses its responsibility for any well going dry by stating that SGMA does not require the GSA to maintain current water levels or prevent any wells from going dry that it only requires the GSA to stabilize and correct groundwater level decline. Additionally, the GSA states that until water levels have been stabilized and the basin has reached sustainability, the GSA will not view a well going dry as an undesirable result. As discussed above, under state law, it is in fact the GSA's responsibility to ensure that it has fully considered whether these impacts to these beneficial user groups are "significant and unreasonable," and that it does not cause a disparate impact on protected groups pursuant to state civil rights law. In order to avoid these disparate impacts and avoid causing significant and unreasonable impacts as required by the SGMA, the GSA must include the following elements in the GSP: • The GSA must describe how it considered the impact of the proposed undesirable result on the domestic wells user and disadvantaged communities in the GSA area. In order to do this, the GSA should conduct a drinking water impact analysis to determine how many wells are at risk of being fully or partially dewatered if the GSA were to come close to reaching or reach the proposed undesirable result. The GSA must make that analysis available to the public in the GSP, and show how all GSA committees	GSP changed in 4.2.2.3 to discuss analysis of the impacts of the water level measurable objectives and minimum thresholds on domestic wells.

				and the GSA board have taken this analysis into account when recommending, creating and evaluating the proposed undesirable result. • The GSP should further clarify the disconnect between the undesirable result for chronic lowering of water levels and the definition of minimum threshold exceedances that trigger action by the North Kings GSA. The North Kings GSA should consider the dewatering of any well that is currently in use, without mitigation measures in place to assist with recovery of safe drinking water resources, to be a significant and unreasonable result.	
132	Leadership Counsel for Justice & Accountability			**Measurable Objectives and Minimum Thresholds** GSAs must set groundwater levels sustainable management criteria that, "if exceeded, may cause undesirable results." Therefore it must have the purpose of avoiding "significant and unreasonable" impacts on beneficial users caused by declining groundwater levels. The GSA must also consider the needs of and impacts to domestic well users and disadvantaged communities, and avoid causing a disparate impact on groups protected under state civil rights law. The GSA has set its measurable objectives and minimum thresholds at drought levels. While drought levels may not be an issue for irrigation and urban water wells who have supplemental surface water supplies to utilize during drought periods, the same is not true of domestic well users. The GSP does not clearly and transparently present the impact of the proposed minimum thresholds/measurable objectives on domestic wells, disadvantaged communities and other key communities within the North Kings GSA area, nor does it present an assessment of how many and which domestic wells are expected to go dry if the minimum thresholds/measurable objectives are reached. Pursuant to 23 CCR § 354.28, assessments of the impacts of proposed minimum thresholds must be included in the GSP in order for the public and DWR to able to fully evaluate the ability of the proposed sustainable management criteria and monitoring program to protect beneficial users within the subbasin. Based on the attached Focus Technical Review of the North Kings Draft GSP, we find that many wells are located outside of a 1.5-mile radius from monitoring wells, and, as the minimum thresholds and measurable objectives are currently proposed, approximately 43% of these domestic wells would be expected to be fully dewatered and an additional 14% of these wells would be expected to be partially dewatered. Many of these wells are likely to be located in communities of color that are low income, and are less likely to be able to address these impacts. No such analysis of drinking water impacts on disadvantaged communities has been done by the GSA. Therefore not only has the GSA not considered these impacts, it has proposed a minimum threshold that will likely cause a disparate impact on communities of color who are protected under state civil rights law. The North Kings GSA must set minimum thresholds and measurable objectives that consider the interests of drinking water beneficial users and do not create a disparate impact on protected groups by doing the following: An impact analysis should be performed in the GSP to accurately evaluate the number of wells that will be impacted should water levels reach the proposed minimum thresholds and measurable objectives and present a thorough and robust analysis, supported by maps, that identifies: (1) which domestic wells are likely to be impacted (including partially dewatered) at the proposed minimum thresholds and measurable objectives and (2) the location of the likely impacted wells with respect to DACs and other communities and systems dependent on groundwater. Consider drinking water impacts in shaping minimum thresholds and measurable objectives, and ensure that disadvantaged communities and domestic well users are protected from disparate and disproportionately negative impact. In order to protect drinking water users, the GSAs should place the minimum threshold at a level above where the shallowest domestic well is screened. Provide a robust drinking water protection program to prevent impacts to drinking water users and mitigate drinking water impacts that occur.	GSP changed in 4.2.2.3 to discuss analysis of the impacts of the water level measurable objectives and minimum thresholds on domestic wells.

133	Leadership Counsel for Justice & Accountability			**The Draft GSP Sustainable Management Criteria for Groundwater Quality are not Adequate** As it is currently written the Draft GSP leaves drinking water users in the subbasin vulnerable to increased drinking water contamination from the GSAs' groundwater management activities or from the lack of adequate groundwater management in the subbasin. The North Kings GSA has not shown how they have considered the interests of beneficial users including domestic well owners and disadvantaged communities in shaping groundwater quality sustainable management criteria.	Thank you for your comments. All comments are given due consideration.
134	Leadership Counsel for Justice & Accountability			**The Draft GSP must protect groundwater quality through groundwater management** SGMA charged GSAs with the responsibility to protect water quality through groundwater management, and requires that the GSA consider the interests of all beneficial users including domestic well users and disadvantaged communities. Additionally, the GSA must also consider that drinking water use has been recognized as the "highest use of water" by the California legislature, and should consult with stakeholders to ensure that the minimum threshold is set is such a way as to guarantee the human right to drinking water to all individuals in the subbasin. The draft GSP fails to incorporate performance measures and management criteria with respect to contaminants that impact human health including those contaminants with established primary drinking water standards, and in so, fails to conform with the requirements of SGMA. The draft leaves drinking water users in the subbasin vulnerable to increased drinking water contamination from the GSAs' groundwater management activities or from the lack of adequate groundwater management in the subbasin. In order to set the minimum threshold, measurable objectives, and undesirable result, that are protective of groundwater quality for all beneficial users in the basin, the GSP must include the following: • All representative monitoring wells must monitor all drinking primary drinking water contaminants. Set a protective minimum threshold, measurable objective, and undesirable result for all constituents with primary drinking water standards that may be impacted by groundwater management activities, or failure to manage groundwater in a way that does not negatively impact groundwater quality.	Thank you for your comments. All comments are given due consideration. GSP will be modified to reflect the GSA plans to ensure WQ monitoring at RMWs will include all COCs at all RMWs in the water quality network.
135	Leadership Counsel for Justice & Accountability			**Undesirable Results** For it's undesirable result, the North Kings GSA states that the "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 have a recent history of being below MCLs; and 2) a statistically significant increase in groundwater degradation where concentrations of chemicals of concern have a recent history of being above MCLs. The occurrence of an undesirable result will be defined as 15% of the representative monitoring wells having reached either of these two criteria for two consecutive years at the same wells". This is an unreasonably lax contamination threshold. By the time 15 percent of representative wells show increases in contamination for two consecutive years, it is more than likely that a high percentage of vulnerable drinking water users will be experiencing severe, long-term drinking water contamination problems before the undesirable result is triggered. The SGMA regulations require GSAs to justify their undesirable results by including the " [p]otential effects on the beneficial uses and users of groundwater." 32 North Kings GSA has included inadequate information or criteria to explain how drinking water will be impacted if this undesirable result is reached, and therefore does not set forth adequate information to justify this decision. In order to set an undesirable result that is protective of groundwater quality for all beneficial users in the basin, the GSP must include the following: • A detailed explanation as to how the groundwater quality undesirable result will result in the protection of groundwater for DACs and other drinking water users in the subbasin • Ensure that this undesirable result does not cause a disparate impact on protected groups under state civil rights law.	GSP changed on page 4-32, to state that actions may be conducted as adverse water quality changes are observed to prevent an undesirable result.
136	Leadership Counsel for Justice & Accountability			**Minimum Thresholds and Measurable Objectives** Per 23 CCR §354.28 and 23 CCR §354.30, GSAs must establish quantitative values for minimum thresholds and measurable objectives for each applicable sustainability indicator at each representative monitoring site. The draft GSP identifies nitrate as NO3, arsenic, dibromo-chloropropane, 1,2,3-TCP, methyl tert-butyl ether, uranium, tetrachloroethylene, trichloroethylene, and hexavalent chromium as chemicals of concern for the North Kings GSA. A multi-scenario methodology for determining minimum thresholds and measurable objectives is described in the draft GSP; however, the draft GSP does not identify which representative monitoring network wells "have a recent history of being above	GSP changed on Table 4-7 to include MCLs and recent data results. Trend lines for each monitoring well will be established and evaluated after each monitoring event to

				MCLs" and which "have a recent history of being below MCLs" (Section 4.4.3.1) and consequently what the actual quantitative water quality minimum thresholds and measurable objectives are. Furthermore, without this information, there is no way of knowing when minimum thresholds and the undesirable result are being triggered. To bring the groundwater quality minimum thresholds and measurable objectives into compliance with SGMA and state civil rights law, the GSP must: • Clearly identify the specific numeric minimum thresholds and measurable objectives for each contaminant of concern at the representative monitoring network wells, and present this information clearly and transparently in tables and maps so that the public and DWR may evaluate the proposed sustainability management criteria. • Clearly state when the minimum thresholds and the measurable objectives are being triggered and concurrent actions to be taken.	ensure early detection of any negative impacts to water quality at the wells in the RMW network.
137	Leadership Counsel for Justice & Accountability			**The GSP Should Ensure No Further Land Subsidence** The GSA has proposed a measurable objective of " annual land subsidence rate at 2.5 in/yr over an area of 36 square miles, with maximum cumulative land subsidence at 0.5ft over 20 years. " 34 The increase in pumping during the recent drought has led to an acceleration in land subsidence. Because the basin is in critical overdraft, the GSA should aim to prevent any subsidence as a result of groundwater management activities, or from failure to manage groundwater in a way that does not aggravate land subsidence. North Kings GSA makes it a point to state several times that land subsidence is not an issue in their area. However, if land subsidence is not an issue, then the North Kings GSA should have no problem setting a more protective measurable objective. To ensure that the GSA sets a more stringent measurable objective, the GSP must do the following: • Establish the measurable objective for land subsidence as zero change in subsidence resulting from groundwater management actions.	Thank you for your comments. All comments are given due consideration.
138	Leadership Counsel for Justice & Accountability			**Projects and Management Actions** The GSA must consider the interests of all beneficial users including domestic well owners and disadvantaged communities and avoid disparate impacts on protected groups. In light of the impacts on domestic well users and disadvantaged communities from the policy decisions discussed above, the GSP must therefore include Projects and Management Actions that protect domestic well users and disadvantaged communities from the drinking water impacts that will occur from the GSA's policy decisions.	Thank you for your comments. All comments are given due consideration.
139	Leadership Counsel for Justice & Accountability			**Projects** The GSA has not shown how it has considered the interests of all beneficial users including domestic well owners, in choosing which projects to adopt and does not show how these projects will benefit protected groups. Projects proposed by the GSA disproportionately benefit agricultural water users over other users. Several of the projects are recharge projects that are for the benefit of agricultural users. Augmenting groundwater and surface water supply is important to diminishing overdraft, but in order to ensure long-term sustainability the GSA must also reduce groundwater demand in the GSA area. Additionally, the draft GSP states that "[e]ach agency within the NKGSA will be responsible for implementing its own projects to reach sustainability." This policy decision is overly burdensome to some agencies in the GSA that are comprised majorly by low income communities, like Biola Community Services District and Del Rey Community Services District, which are dependent on groundwater for their critical drinking water needs, yet may not have the ability to pay for expensive projects and management actions to protect their local drinking water supplies. The following must be incorporated into the Projects section of the GSP in order to avoid a disparate impact on domestic well users in the subbasin: • Include a map of all the proposed projects that have locations. This would allow the public and DWR to identify which areas and communities will benefit from the proposed projects. • Establish a subbasin wide fund for projects to ensure that everyone within the subbasin benefits from proposed projects, particularly communities and households that depend on groundwater for drinking water supplies.	Thank you for your comments. All comments are given due consideration.

				• Include projects that directly and specifically protect drinking water supplies for disadvantaged communities, and ensure that these projects include specific timelines and commitments.	
140	Leadership Counsel for Justice & Accountability			**Management Actions** As per the Draft GSP, the GSA has included a suite of management actions that the board can choose to adopt in order to ensure that the subbasin is sustainable by 2040. While some of the management actions proposed could help protect drinking water needs in the basin, the GSA is not committing to any actions. In order to protect drinking water resources for all beneficial users in the GSA area, and avoid a disparate impact on protected groups, we recommend that the GSA include the following management actions: • Metering: In order to ensure precise measurement of groundwater use and to ensure achievement of the GSA's sustainability goal by 2040, GSAs are prescribed the authority to meter all production wells in the subbasin. North Kings GSA must acknowledge and utilize the authority vested by the state of California to collect relevant groundwater management data and to identify the largest water users. North Kings GSA must reach sustainability therefore metering will be essential to effectively and accurately measuring water use. California Water Code section 10727.4 states that "a groundwater sustainability plan shall include, where appropriate and in collaboration with the appropriate indices" include "efficient water management practices...for the delivery of water and water conservation methods to improve the efficiency of water use." With the data available North Kings GSA and the Kings basin at large will be better equipped to reach sustainability. We recommend that the GSA prioritize subbasin-wide metering on large scale groundwater users. • Drinking Water Warning System: Implementing a warning system so that the North Kings GSA and stakeholders are aware of when wells are going dry, or when wells are going to become contaminated from groundwater management activities, so it can take action to prevent drinking water impacts. If drinking water wells are at risk of impacts, the North Kings should help connect communities and individual homes to nearby reliable water systems. If consolidation is not possible, the North Kings should deepen wells, install treatment facilities or POE/POU treatment in homes. In the interim, the GSA should provide emergency bottled water. • Demand Reduction: The GSA should propose potential programs for requiring and incentivizing demand reduction. Drinking Water Protection Program: If the GSA's policy decisions will lead to drinking water impacts on disadvantaged communities and communities protected from disparate impacts under state civil rights law, including wells going dry and increased drinking water contamination, the GSA must create a fund that will prevent these impacts, or mitigate those impacts should they occur. Such a fund should pay for projects including but not limited to digging deeper wells, replacing wells, connecting communities to a reliable drinking water source, and paying for the increased pumping costs of accessing water at deeper depths. We will gladly speak with you more in detail about how such a program could be structured and financed, and how residents would qualify.	Thank you for your comments. All comments are given due consideration.
141	Leadership Counsel for Justice & Accountability			**The Plan Implementation chapter does not contain adequate information regarding the public process, annual reporting, or the potential to make amendments to the GSP.** The GSA states that it will continue to engage the public during the implementation of the process, but fails to state how it will engage stakeholders in the process. Public engagement has been a critical component to the SGMA implementation process and must continue to be in the GSP implementation process. Additionally, in the annual report outline proposed by the GSA, stakeholder engagement and outreach efforts is not included in any of the key sections. As the Draft GSP is currently written, it is unclear how and when reconsiderations can be proposed. Through its GSP, the GSA must establish processes by which it will seek and incorporate feedback from the public on an ongoing basis through direct outreach to disadvantaged communities and public workshops that are held at convenient locations and times and accessible in multiple languages. Additionally, proposed reconsiderations must be publicly noticed and circulated for public review and comment prior to final adoption. To ensure that the GSP is implemented properly, the GSA must do the following:	GSP Section 2.5.5 changed to include…The GSA will continue to pursue effective methods of communication with stakeholders, including rural domestic pumpers and small farmers, to provide local seasonal and annual groundwater conditions and basic groundwater and well information.

				• The GSA must include a plan for public outreach for the GSP implementation process. This plan should include translation services in order to meaningfully consult with and consider the interest of all beneficial users. Workshops and meetings must be at an accessible time and locations for all stakeholders • The GSA must include public outreach as part of the annual reporting. • The GSA must budget for public outreach. The budget should include translation services in order to meaningfully consult with and consider the interest of all beneficial users. • Clarify in the GSP that the plan may be modified as data becomes available, and that the GSA will seek and accept feedback from the public on an ongoing basis throughout plan implementation. Clarify that any modification to the GSP must be in writing, noticed and provide sufficient time for public review and feedback.	Thank you for your comments. All comments are given due consideration.
142	Leadership Counsel for Justice & Accountability			**The Draft GSP Threatens to Infringe on Water Rights** • In enacting SGMA, the legislature found and declared that "[f]ailure to manage groundwater to prevent long-term overdraft infringes on groundwater rights." The test of SGMA further notes that "[n]othing in this part, or in any groundwater management plan adopted pursuant to this part, determines or alters surface water rights or groundwater rights under common law or any provision of law that determines or grants surface water rights." As discussed in detail above, the Draft GSP allows continued overdraft above the safe yield of the basin, such that drinking water wells (especially domestic wells) will continue to go dry, infringing on the rights of overlying users of groundwater. The GSP must be revised to protect the rights of residents of disadvantaged communities and/or low-income households who hold water rights to groundwater.	Thank you for your comments. All comments are given due consideration.
143	Leadership Counsel for Justice & Accountability			**The Draft GSP Conflicts with the Reasonable And Beneficial Use Doctrine** The "reasonable and beneficial use" doctrine, to which SGMA expressly must comply, is codified in the California Constitution. It requires that "the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare." (Cal Const, Art. X § 2; see also United States v. State Water Resources Control Bd. (1986) 182 Cal.App.3d 82, 105 ["...superimposed on those basic principles defining water rights is the overriding constitutional limitation that the water be used as reasonably required for the beneficial use to be served."].) • The reasonable and beneficial use doctrine applies here given the negative impacts of the Draft GSP on groundwater supply and quality, which are likely to unreasonably interfere with the use of groundwater for drinking water and other domestic uses. As the Draft GSP authorizes waste and unreasonable use, it conflicts with the reasonable and beneficial use doctrine and the California Constitution.	Thank you for your comments. All comments are given due consideration.
144	Leadership Counsel for Justice & Accountability			**The Draft GSP Conflicts with the Public Trust Doctrine** • The "public trust" doctrine applies to the waters of the State, and establishes that "the state, as trustee, has a duty to preserve this trust property from harmful diversions by water rights holders" and that thus "no one has a vested right to use water in a manner harmful to the state's waters." The "public trust" doctrine has recently been applied to groundwater where there is a hydrological connection between the groundwater and a navigable surface water body. In Environmental Law Foundation, the court held that the public trust doctrine applies to "the extraction of groundwater that adversely impacts a navigable waterway" and that the government has an affirmative duty to take the public trust into account in the planning and allocation of water resources. The court also specifically held that SGMA does not supplant the requirements of the common law public trust doctrine. In contrast to these requirements, the Draft GSP does not consider impacts on public trust resources, or attempt to avoid insofar as feasible harm to the public's interest in those resources.	Thank you for your comments. All comments are given due consideration.

Appendix 3 A Kings Subbasin 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.

KDSA
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).

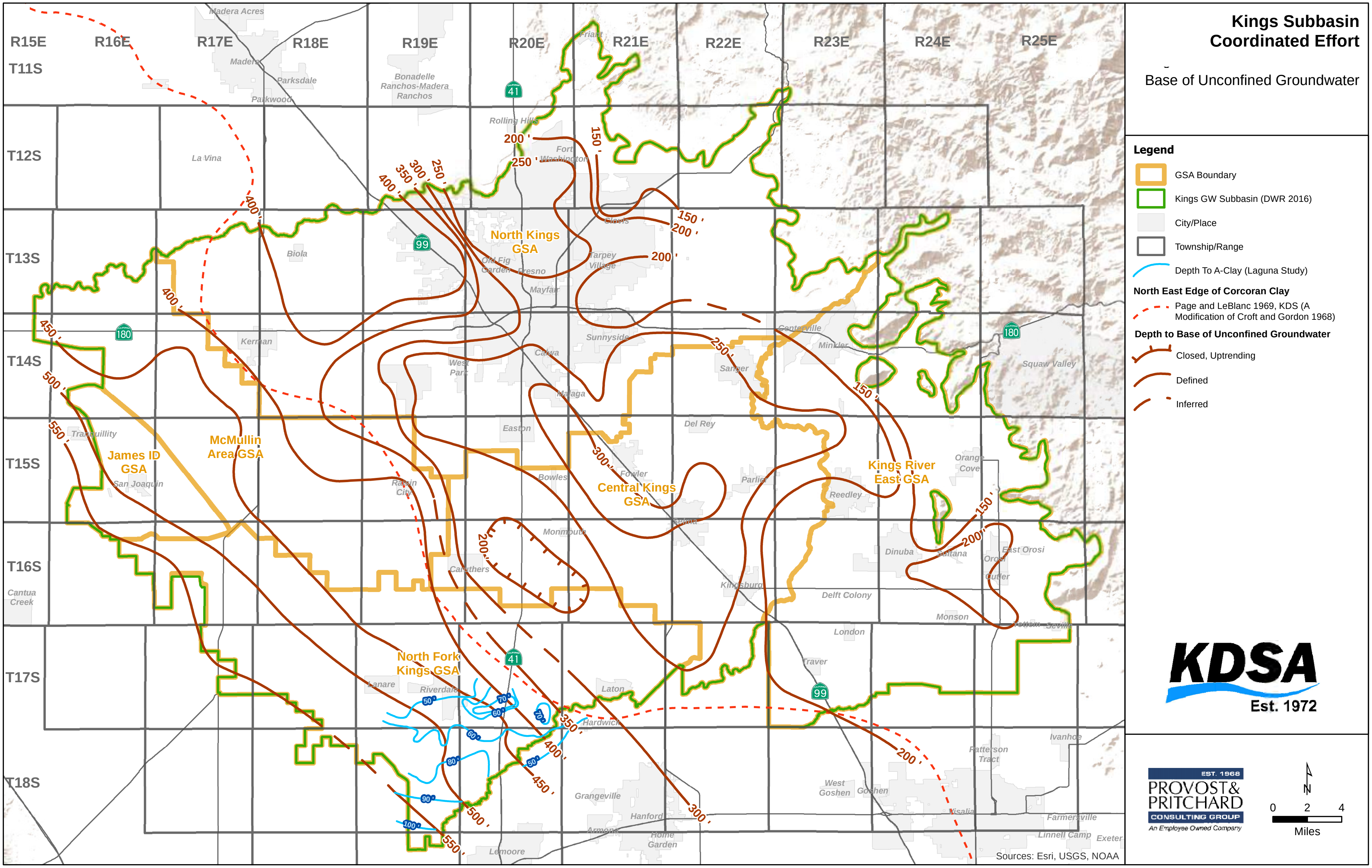
UNCONFINED GROUNDWATER IN THE KINGS SUB-BASIN

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

KDSA Est. 1972

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	the San Joaquin Valley, California		
Page and Leblanc, 1969	Geology, Hydrology, and Water Quality in the Fresno Area, California	San Joaquin Valley, except portions of Fresno Slough Area and locations against the foothills	O - 300 feet
USGS PP 1401-D, (Williamson, Prudic and Swain, 1989)	Ground-Water Flow in the Central Valley, California	San Joaquin Valley, except locations against the foothills	Variable from 150 feet near the foothills to greater than 600 feet to the west
Kings River Conservation District, 1992	Alta Irrigation District, Groundwater Study	Alta Irrigation District and portions of Orange Cove Irrigation District	Unknown
USBR, 1947	Geologic Study of the Orange Cove Irrigation District	Orange Cove Irrigation District	20 to 234 feet
* See **Attachment 1**			

USGS WSP 1469

In USGS Water-Supply Paper (WSP) 1469 specific yield was estimated down to depths of 200 feet for most of the valley floor. The general method employed by USGS 1469 was to group the 300 drillers' terms commonly used to describe alluvial subsurface materials into five principal classes. These groupings were then assigned specific yield values that ranged from 25 percent for Group G – gravels, sand and gravel and similar materials down to a low of 3 percent for Group C materials - clay and related material. The data for the total footage for each Group of material were summarized for a given well and an average specific yield calculated for the depth intervals of 10 to 50 feet, 50 to 100 feet, and 100 to 200 feet by Township and Range. The Township and Range grid was modified by groundwater storage units so that the data more accurately represented the varying geologic conditions in the valley. Therefore, a given Township and Range may have two or more specific yield values, depending on how many different geologic units (which in USGS 1469 are referred to as storage units) are intersected by the overlying Township and Range. The authors recognized that in 1959 water levels in certain parts of the valley already exceeded depths of 200 feet, but the methodology they used could readily be made to determine specific yield in strata deeper than 200 feet. USGS 1469 data covers most of the Kings Basin, except in some areas near the foothills, and areas of lake beds deposits and overflows lands (the area termed the Fresno Slough Area in the Kings Basin). The extent of the Kings Basin covered by USGS 1469 is shown in **Attachment 1**.

Page and Leblanc (1969)

Page and Leblanc (1969) working for the USGS derived specific yield estimates based on geologic facies. Facies is a geologic term that means the appearance and characteristics of a sedimentary deposit that is used to distinguish a subsurface material from contiguous subsurface materials. The facies data are based on descriptions of alluvial texture. Six facies categories were defined from Facies A with an estimated specific yield of 5.3 percent to Facies F with an estimated specific yield of 18.7 percent. These data were plotted on a map and an average specific yield was generated by Township and Range based on the relative percentage of each facies. The data were compared to USGS 1469, and in general are within 2 to 3 percent, which is considered good agreement. There is a general trend between the two data sets where in the northeast portion of the basin, the Page and Leblanc (1969) estimated specific yields tend to be slightly higher than those in USGS 1469, and in the western portion of the basin the Page and Leblanc (1969) estimated specific yields tend to be slightly lower.

USGS PP 1401-D

USGS Professional Paper (PP)1401-D, was one of the original groundwater modeling efforts by the USGS in the Central Valley. Specific yield was estimated using methods and groupings of deposits by descriptions into five categories with similar properties as described in USGS 1469. The authors indicated that more than 7,400 driller's logs in the San Joaquin Valley were coded for analysis. Specific yield was assigned to subsurface materials according to a model grid oriented northwest along the axis of the valley. This report did not report specific yield by depth range but rather for the entire saturated thickness of the aquifer. Specific yield data from this report appears to be reasonable along the east side of the Kings Basin near the foothills where bedrock is shallow, and in most of North Fork GSA area. These data are not reasonable in areas where wells are much deeper than the upper confined groundwater.

KRCD 1992

The Kings River Conservation District (KRCD) prepared a groundwater study for the Alta Irrigation District (KRCD 1992). This study addressed a list of objectives through a District-wide water balance and groundwater/surface water model. As part of model development, KRCD used unpublished data from the California Department of Water Resources (DWR) that we could not verify. The KRCD report indicates that the DWR data was developed for each quarter-Township and Range from well drillers logs. This data was mapped as specific yield contours, and, to compare these data to USGS 1469, the average specific yield was used between two specific yield contours. For example, the area between the 11 percent and 12 percent specific yield contours would be 11.5 percent. The KRCD specific yields were averaged by Township and Range and compared to USGS 1469 specific yield data. The two sets of data matched within 2 or 3 percent where they overlap except for two small areas on the north part of the KRCD study area where the differences were 4.3 and 3.5 percent. A limitation of this information is that the depths of deposits corresponding to specific yield was not provided.

USBR 1947

The U.S. Bureau Reclamation prepared a Geologic Study and a Water Supply Study both for the Orange Cove Irrigation District (OCID) in 1947 (USBR 1947a & USBR 1947b). They divided the OCID into seven investigational subareas and estimated specific yield for each sub area. Specific yield values for standard textural descriptions were based on previous work done in the Mokelumne area (115 miles northwest of OCID) and from twenty percolation tests in OCID. These values were used along with the stratigraphy in 52 local well logs, and 115 large diameter auger holes drilled along the Friant Kern Canal, to estimate local specific yield. Specific yields ranged from a low of 6.5 percent to 8.3 percent. In most areas where USBR 1947 and USGS 1469 overlap, specific yields from both sources are within less than one percent. The maximum difference in specific yields between the studies is 2.1 percent in the south part of the investigational area. For those areas outside of USGS 1469 coverage, mainly near the foothills, the specific yields from USBR 1947 was used.

USDA Technical Bulletin 1604

USDA Technical Bulletin 1604 provides estimates of specific yield in the Fresno-Clovis northeast area at depths from 0 to 20 feet, 0 to 50 feet, 50 to 100 and 100 to 150 feet. This report develops estimated specific yield from soil texture as described on well drillers logs and in similar groupings as USGS 1469. However, for this study the descriptive terms were regrouped into four categories that reflected the reduced number of descriptive terms on the area's well logs. This report and analysis was done to aid in recharge investigations and is a resource for that purpose, but does not provide detailed specific yield coverage in some areas, and to the depths desired. The intent of this publication was to help focus future recharge studies, so areas where specific yield is higher are clearly delineated. However, there are significant portions of the USDA study area where specific yield data is sporadic or not estimated, and thus is not readily comparable to the more extensive data from the other sources.

McMullin Area Evaluation

KDSA prepared a memorandum documenting their estimates of specific yield in the McMullin Area GSA, James ID GSA and the northwestern most portion of North Fork Kings GSA area (**Attachment 3**). Additional evaluation was needed in this area where USGS PP 1401-D specific yields were estimated over the entire saturated thickness of the aquifer, i.e., down to depths of several thousand feet or more. As noted by Page and Leblanc (1969) the deeper Continental Deposits of Tertiary and Quaternary are finer grained than the overlying deposits of Quaternary age. These deep, finer deposits have lower specific yield and therefore the overall specific yield based on the entire saturated thickness of the aquifer are lower than specific yields in the unconfined aquifer above the Corcoran Clay. As previously noted the change in groundwater storage is based on water level changes in the unconfined aquifer, and in this area the base of the unconfined aquifer is the top of the Corcoran Clay. The KDSA analysis was based on electric logs, geologic logs and DWR Well Completion Reports with good descriptions of texture. The data were used to develop several subsurface geologic cross sections in the area. On the subsurface cross sections, three types of deposits; sand or coarser materials, clay or silt, and intermediate type materials such as sandy clay were shown. These deposit types were assigned specific yield values of 20 percent, 3 percent, and 8 percent, respectively. Specific yield was estimated from the Spring 2005 water table to the top of the Corcoran Clay. Based on this evaluation, average specific yields in the area above the Corcoran Clay range from 10 percent southwest of the City of San Joaquin to 15 percent south of the City of San Joaquin near McMullin Grade and the Fresno Slough (**Attachment 2**). Proposed specific yields for deposits above the Corcoran Clay in this area based on the KDSA evaluation are shown on **Attachment 2**.

Friant Area Evaluation

The northernmost portion of the North Kings GSA is not covered by any of the referenced specific yield data sources. Previous work by KDSA in 2012 (described in **Attachment 11**) included development of a subsurface geologic which extends from near Friant to south of Little Dry Creek. Specific yield was estimated for three segments along the subsurface cross section as follows; from near Friant to the southern part of Beck Ranch, south end of Beck Ranch to north end of Ball Ranch, and from Ball Ranch to near Little Dry Creek. Specific yield was estimated to be 25 percent, 20 percent and 14 percent, respectively, for a proposed average of 20 percent for this portion of the North Kings GSA (**Attachment 10**).

Depth to Water and Specific Yield

For the overall Kings Basin, USGS 1469 appears to have the best data for the area covered in the publication. As mentioned above, USGS 1469 provides specific yield estimates in the depth range from 10-50 feet, 50 to 100 feet and 100-200 feet, and therefore does not apply in areas where depth to water is greater than 200 feet. In the areas covered by USGS 1469 and water levels shallower than 200 feet, the depth to water will be used to determine which depth interval specific yield is appropriate to use for calculating storage change, if the water levels are shallower than the base of the unconfined aquifer. For example, if an average depth to water of 185 feet is obtained for a Township and Range, then the depth interval specific yield used would be 100 to 200 feet from USGS 1469. However, recent depth to water maps indicate that in some areas, the depth to water has already exceeded 200 feet. In those areas, providing there is coverage by USGS 1969, the average specific yield from that study would be used for depths to water between 200 and 300 feet. The subsurface geologic cross section derived specific yield is proposed to be used in the west part of the Kings Basin where the base of the unconfined groundwater is deeper.

Kings Basin – Eastside Specific Yield Coverage

The three main sources consulted for this study, USGS 1469, USGS 1969, and USGS 1401-D all have gaps in coverage on the valley floor near the foothills on the east side of the Kings Basin. A few gaps are covered by the USGS PP 1401-D model grid which indicate that specific yield in those areas is about 6 to 7 percent for most of the area, which is in the interfan area, and is likely about 20 percent along the San Joaquin River below Friant, based on subsurface geologic cross sections available in this area. Because of the shallow depth to bedrock, USGS PP 1401-D can be used along the east edge of the area. In those areas not covered by one of the USGS studies, use of KRCD 1992 or USBR 1947 is appropriate where information from these reports is available. However, this still leaves gaps in coverage against the foothills, and, as the sources indicate that specific yield is lower in these areas, it is proposed that a specific yield of 6 percent is used along the foothills in interfan areas lacking data coverage. A specific yield of 6 percent, except near Friant, appears reasonable and agrees well with adjacent USGS 1401-D model grid cells, USGS 1969 and USGS 1469 estimates of specific yield. In addition, these areas are relatively small and probably have few wells, so the impact to storage change estimates will likely be minimal.

Conclusions

The following is a list of specific yield data prioritized by publication source:

1. USGS 1469 – use in areas covered by that study
2. Page and Leblanc (1969) – use in areas lacking USGS 1469 coverage and for areas where base of unconfined water is between 200 and 300 feet where covered by this study.
3. Use subsurface geologic cross sections evaluation in west part of area, near Friant, and in parts Fresno urban area.
4. USGS 1401-D – use in North Fork Kings GSA Area where base of unconfined aquifer is greater than 300 feet, and along foothills in areas not covered by other studies or additional evaluation.
5. In areas along the foothills in interfan areas lacking specific yield coverage, use a specific yield of 6 percent.
6. Use only values below the water level, i.e., only for saturated strata.

Attachment 4 shows the recommended sources of specific yield data for all areas in the Kings Basin. **Attachment 5 to 10** are maps of each GSA showing the recommended specific yields for use in calculating storage change.

Attachments

1 – Kings Basin, Specific Yield Data Sources Coverage
2 – McMullin GSA Area of Evaluation, Location of Subsurface Geologic Cross Sections and Specific Yield Values
3 – KDSA, Memorandum on Specific Yield Estimates from Subsurface Geologic Cross Sections, June 19, 2017
4 – Kings Basin, Recommended Sources of Specific Yield
5 – Central Kings GSA, Data Sources and Recommended Specific Yield
6 – James ID GSA, Data Sources and Recommended Specific Yield
7 – Kings River east GSA, Data Sources and Recommended Specific Yield
8 – McMullin 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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Cehrs, D., Soenke, S., and Bianchi, W.C., (1980), *A Geologic Approach to Artificial Recharge Site Selection in the Fresno-Clovis Area, California*, U.S. Department of Agriculture, Technical Bulletin 1604

Davis, G.H., Green, J.H., Olmstead, F.H., and Brown, D.W., (1959), *Ground-Water Conditions and Storage Capacity in the San Joaquin Valley, California*, U.S. Geological Survey Water-Supply Paper 1469. Prepared in cooperation with the California Department of Water Resources.

Meinzer, O.E., (1932), *Outline of Methods for Estimating Ground-water Supplies*, U.S. Geological Survey Water Supply Paper 638-C

Page, R.W., and Leblanc, R.A., (1969). *Geology, Hydrology and Water Quality in the Fresno Area, California*, U.S. Geological Survey, Water Resources Division, Open File Report. Prepared in cooperation with the California Department of Water Resources

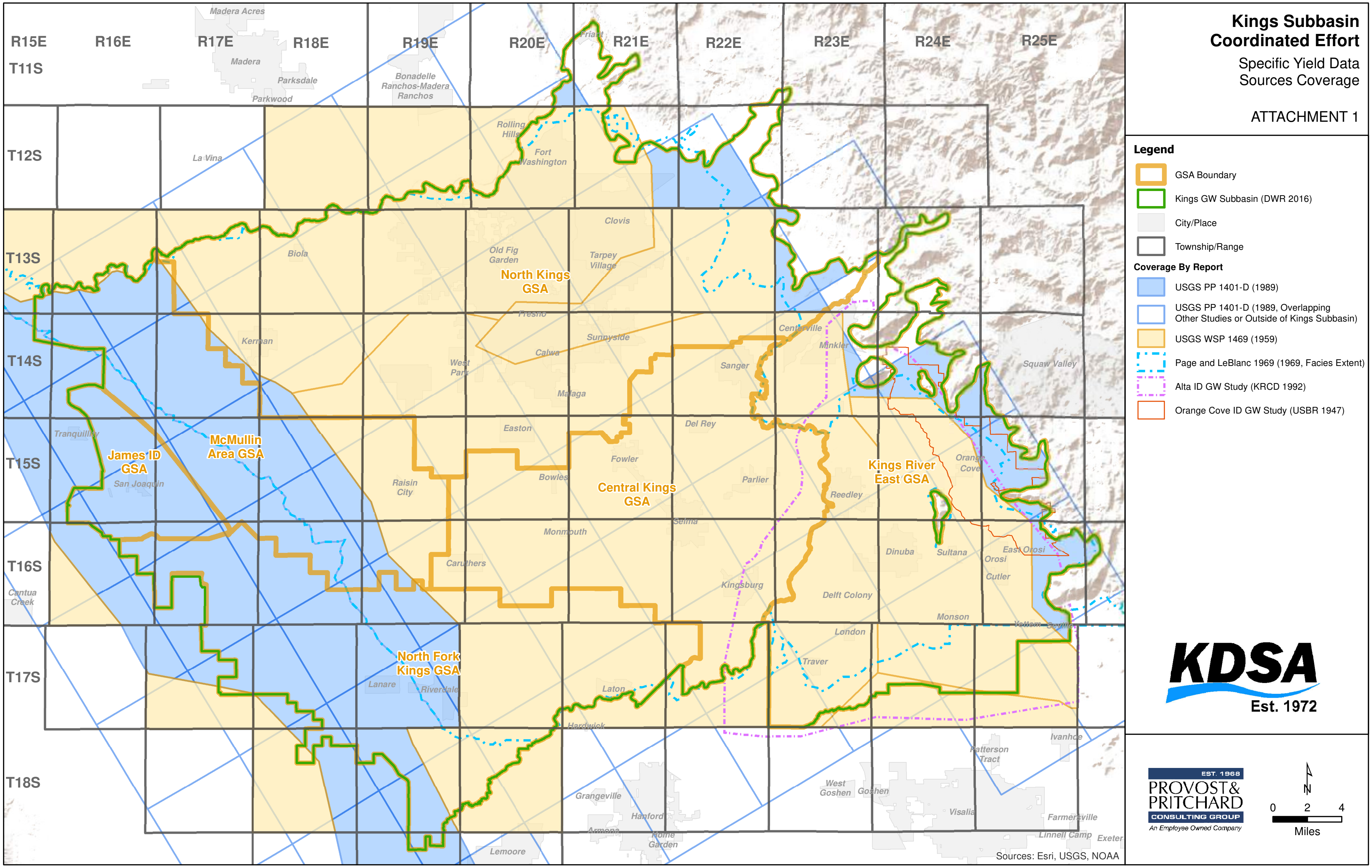
U.S. Bureau of Reclamation, Tulare Basin District (1947a), *Geologic Study of the Orange Cove Irrigation District*.

U.S. Bureau of Reclamation, Tulare Basin District (1947b), *Water Supply Study, Orange Cove Irrigation District.*

Williamson, A.K., Prudic, D.E., and Swain, L.A., (1989). *Ground-Water Flow in the Central Valley, California, Regional Aquifer System Analysis-Central Valley, California*, U.S. Geological Survey Professional Paper 1401-D.

Attachments 1

Kings Basin, Specific Yield Data Sources Coverage



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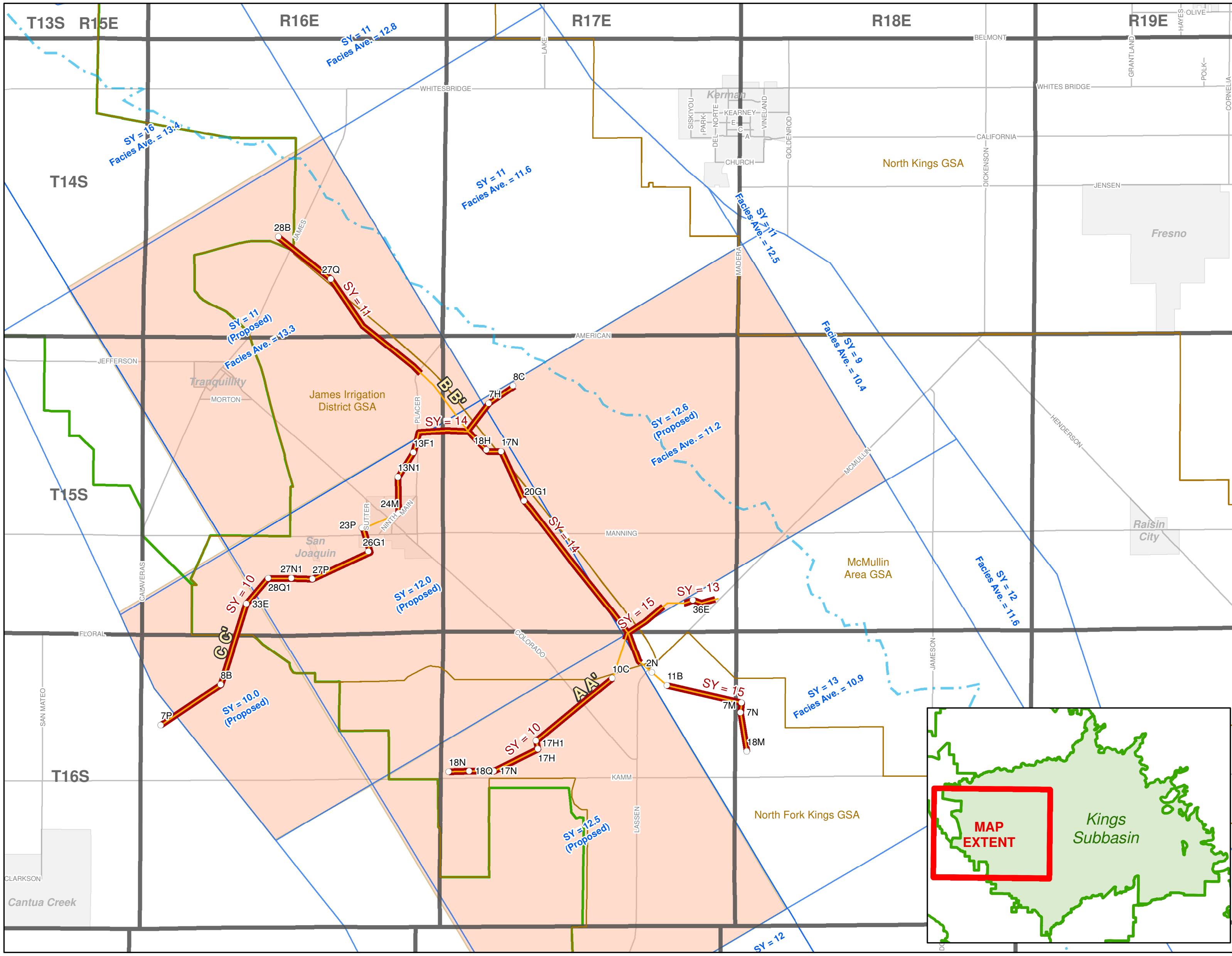
Attachments 2

McMullin GSA Area of Evaluation,
Location of Subsurface Geologic Cross Sections and Specific Yield Values



Kings Subbasin Coordinated Review

McMullin Area GSA Evaluation

Location of Subsurface Geologic Cross Sections and Specific Yield Values

ATTACHMENT 2

Legend

- Well Used in Cross Section
- Page and LeBlanc 1969 (1969, Facies Western Extent)
- Cross Sections (KDSA)
- Portion of Cross Sections Evaluated For Specific Yield
- USGS PP 1401-D (1989)
- KDSA Evaluation (From 2005 Water Level to Base of Unconfined Aquifer)
- GSA Boundary
- Groundwater Subbasins (DWR 2016)
- City/Place
- Township/Range

LABEL EXPLANATION

SY = 11 (USGS 1401-D, 1989)

Facies Ave. = 11.6 (USGS, Page and Leblanc, 1969 in area of 1401-D model grid)

SY = 15 (Subbasin geologic cross sections)

KDSA Est. 1972

PROVOST & PRITCHARD CONSULTING GROUP EST. 1968 An Employee Owned Company

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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.

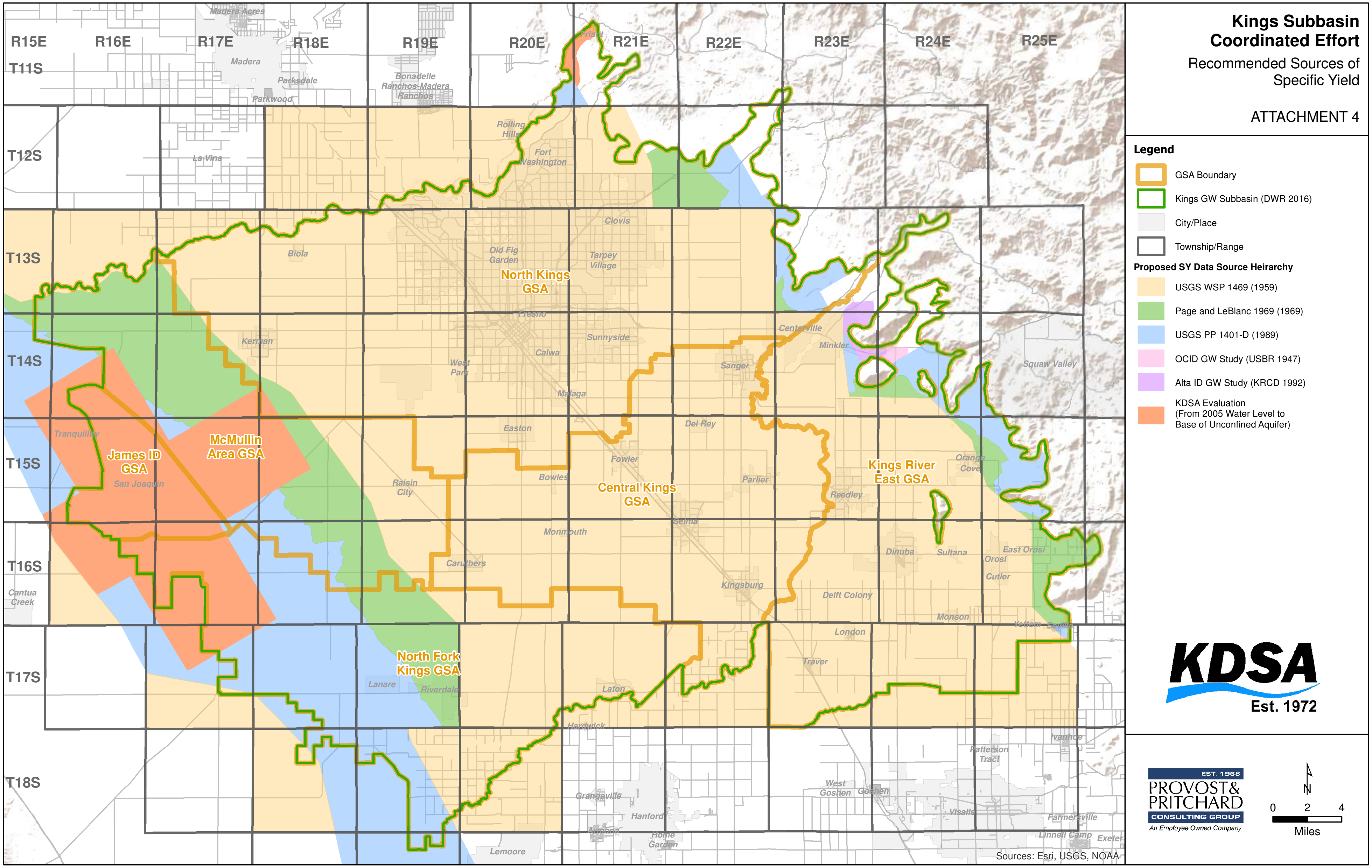
Cross Section B-B′ extends along the Fresno Slough. Fifteen wells with good logs were selected for evaluation. The northwestmost segment evaluated comprised five wells (28B to C-65). Specific yields ranged from 9 to 15 percent and averaged 11 percent. The closest 1401-D T&R values ranged from 10 to 11 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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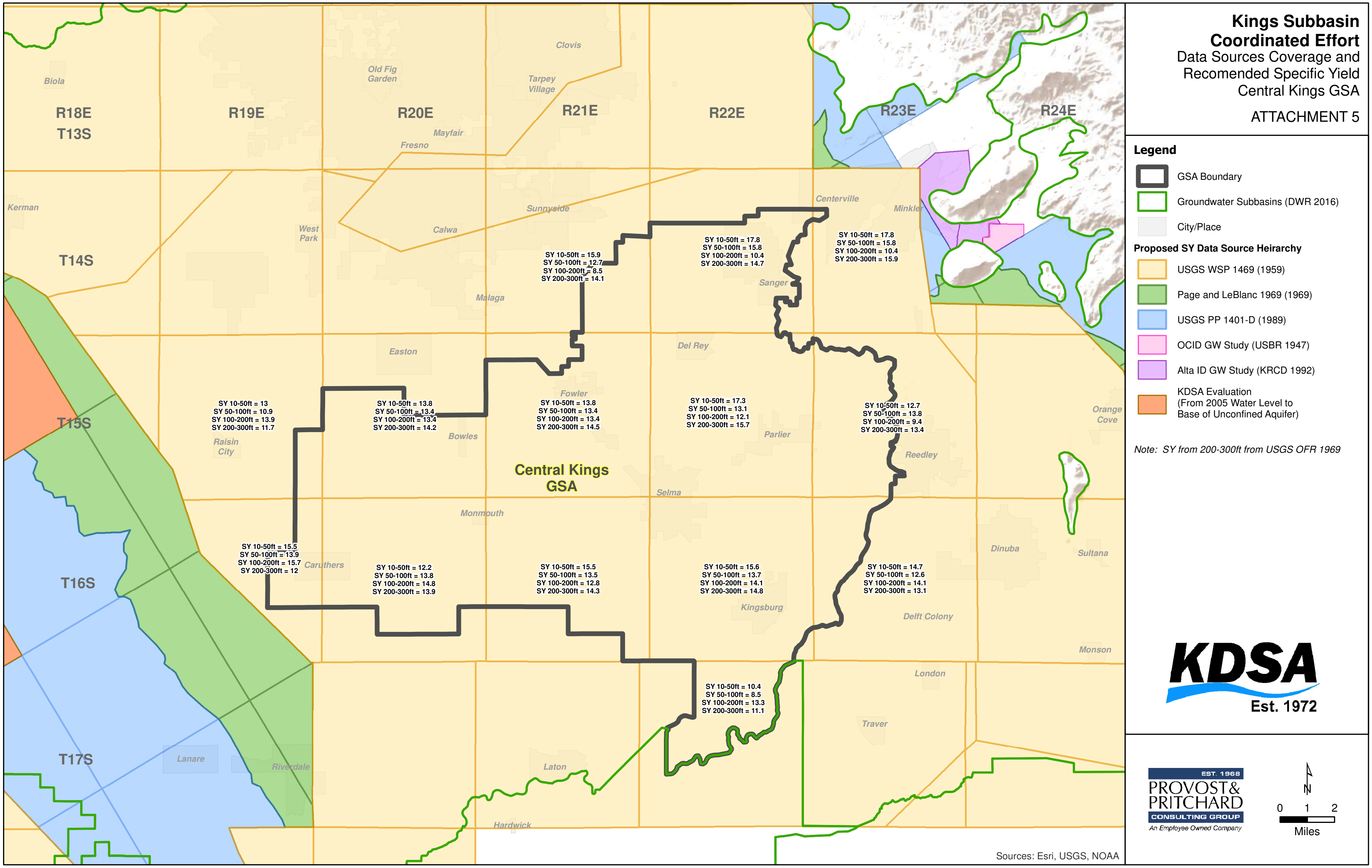
Attachments 5

Central Kings GSA, Data Sources and Recommended Specific Yield



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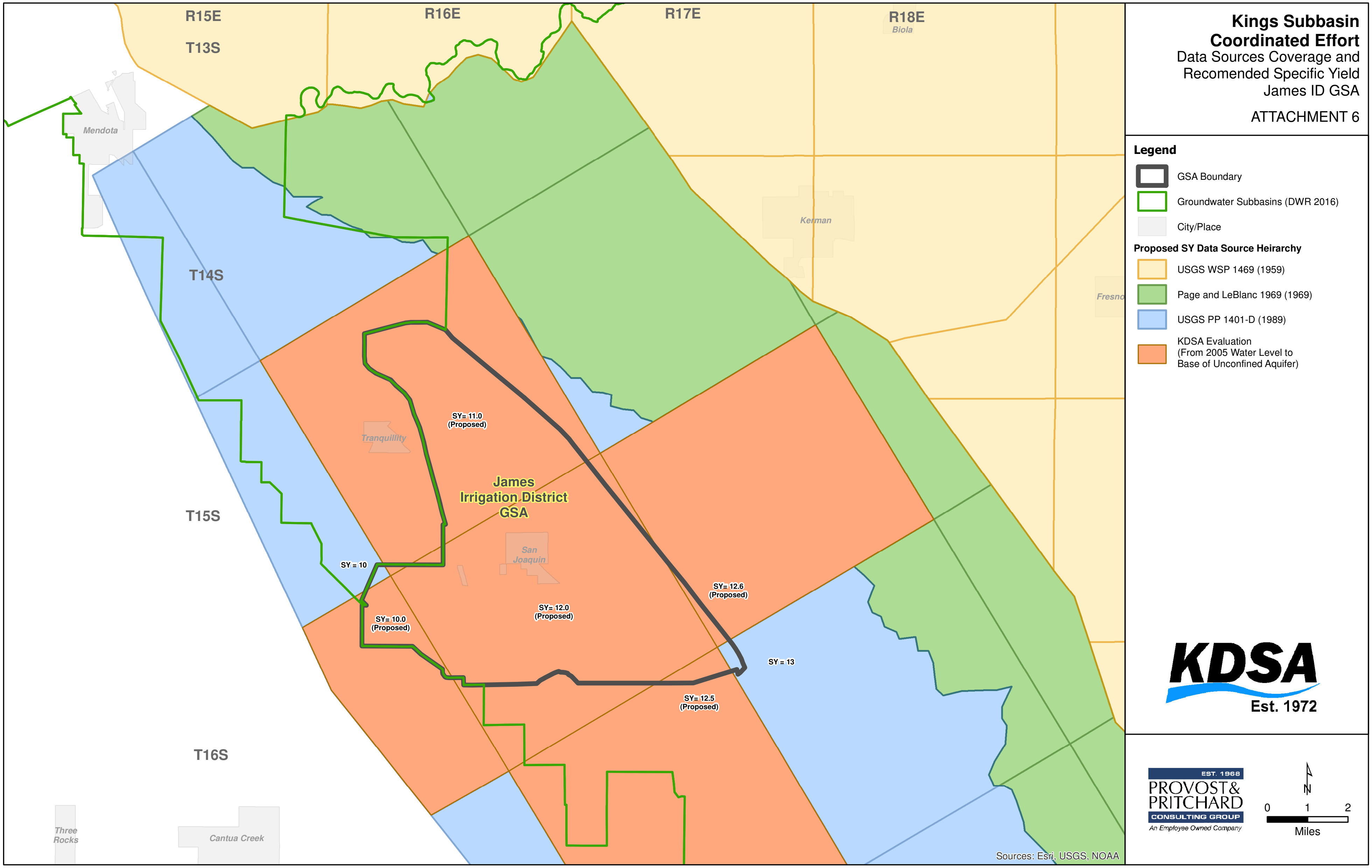
Attachments 6

James ID GSA, Data Sources and Recommended Specific Yield



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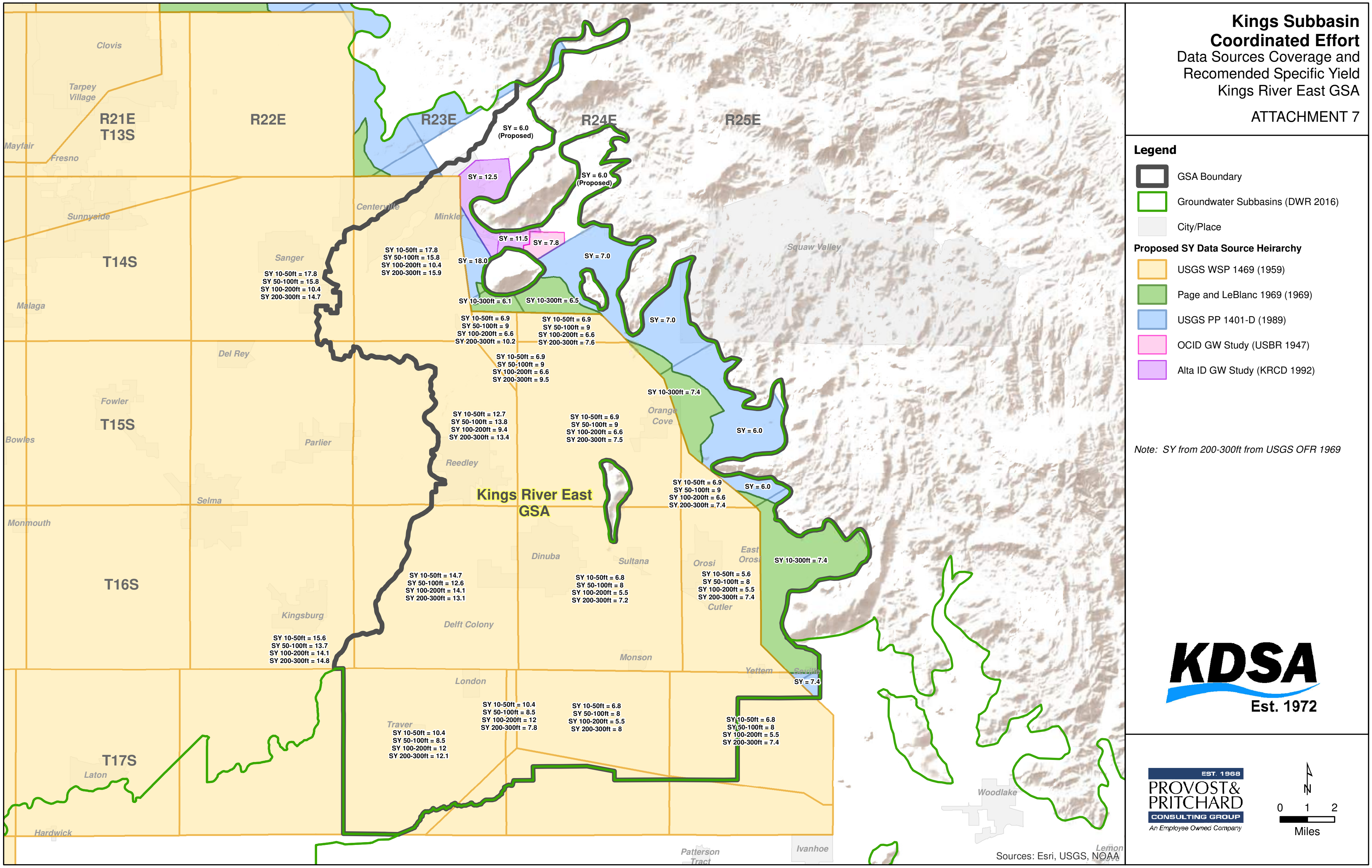
Attachments 7

Kings River east GSA, Data Sources and Recommended Specific Yield



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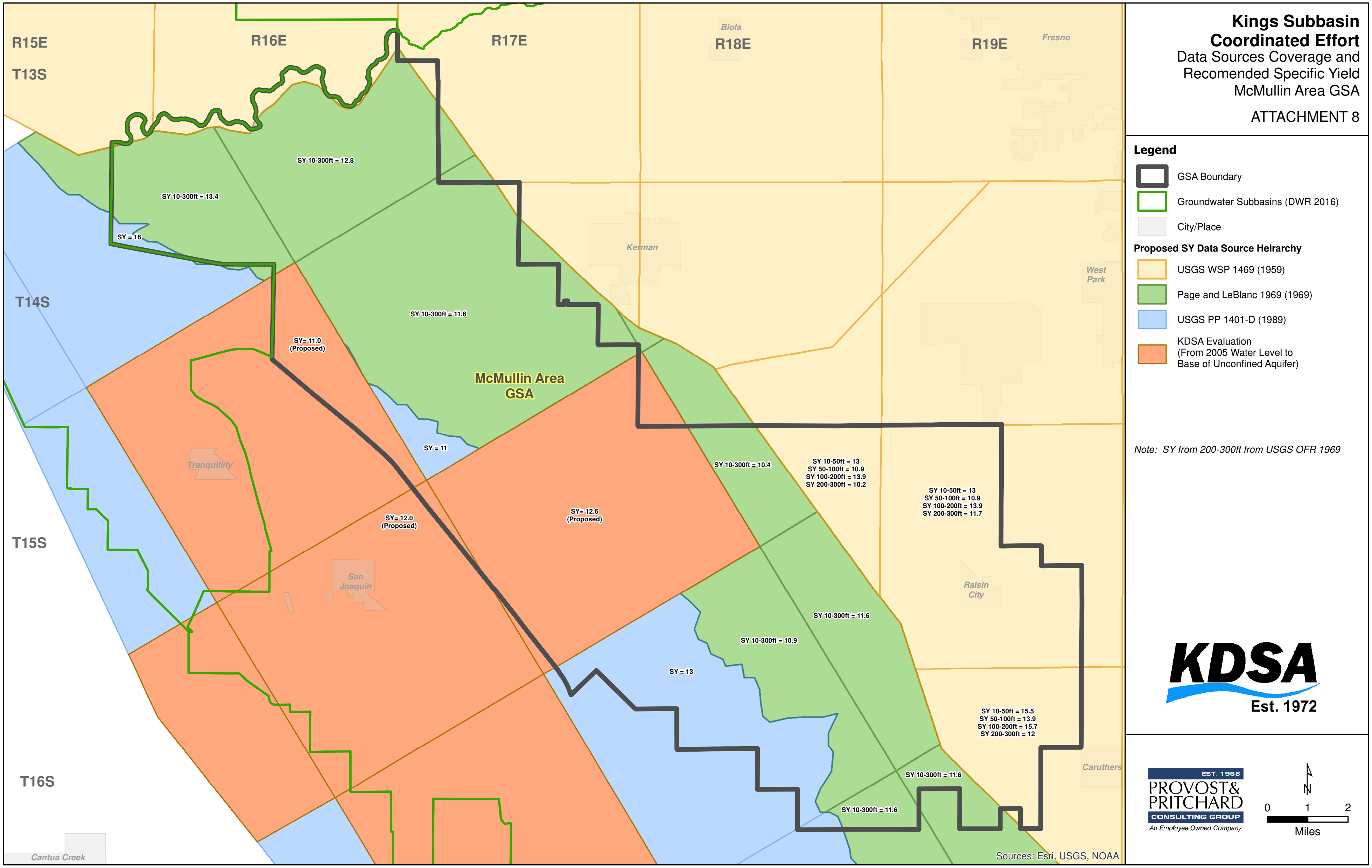
Attachments 8

McMullin Group GSA, Data Sources and Recommended Specific Yield



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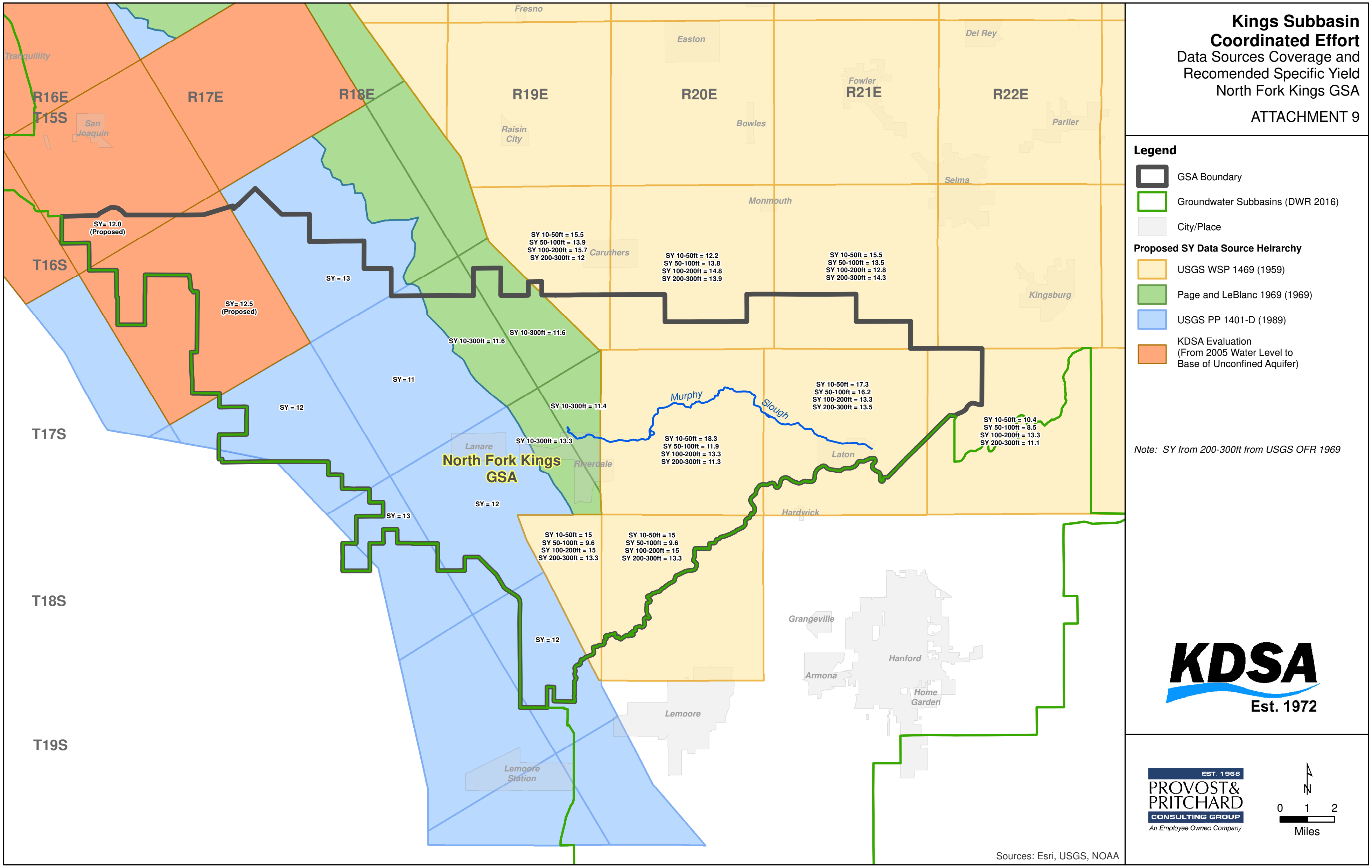
Attachments 9

North Fork Kings GSA, Data Sources and Recommended Specific Yield



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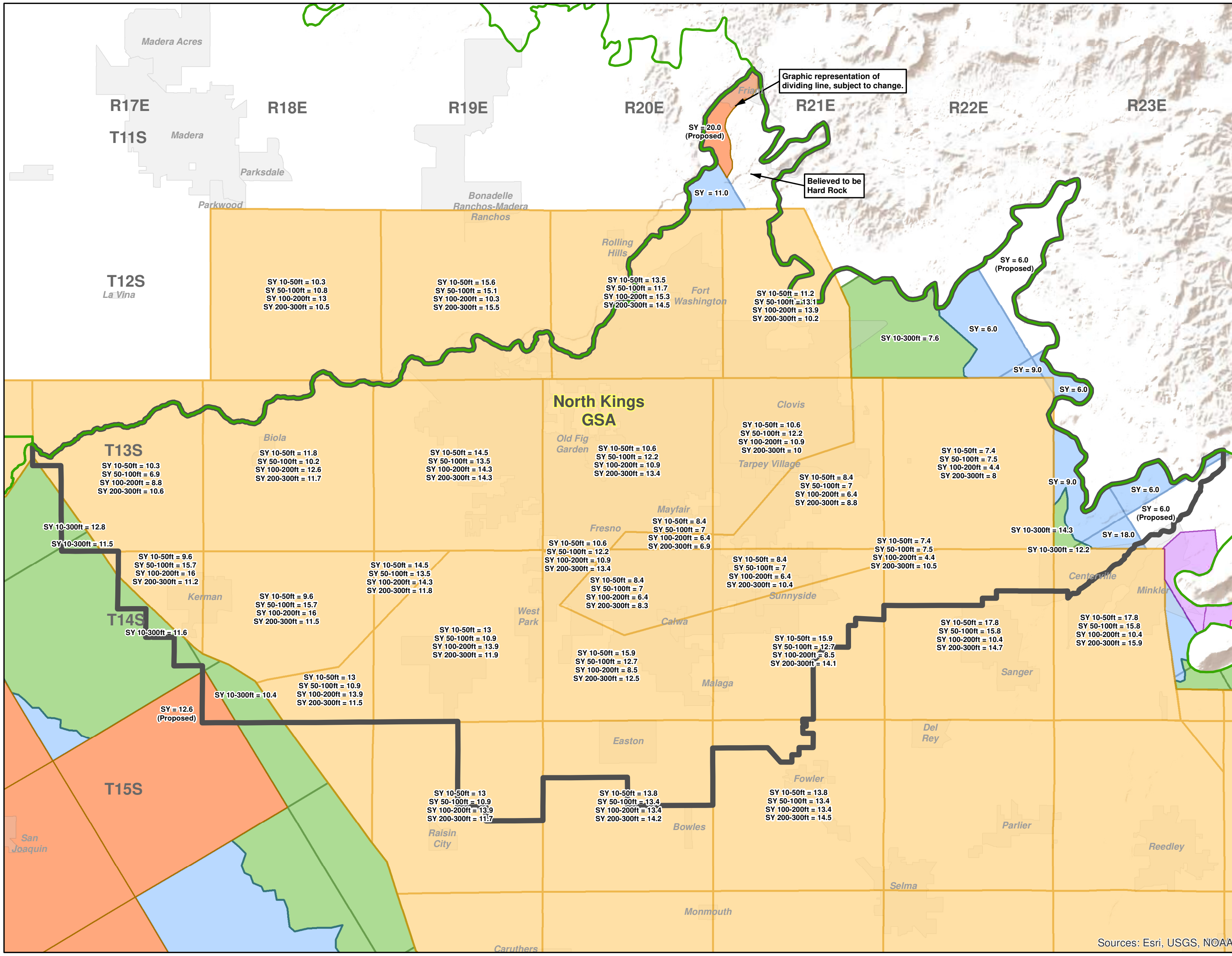
Attachments 10

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

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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

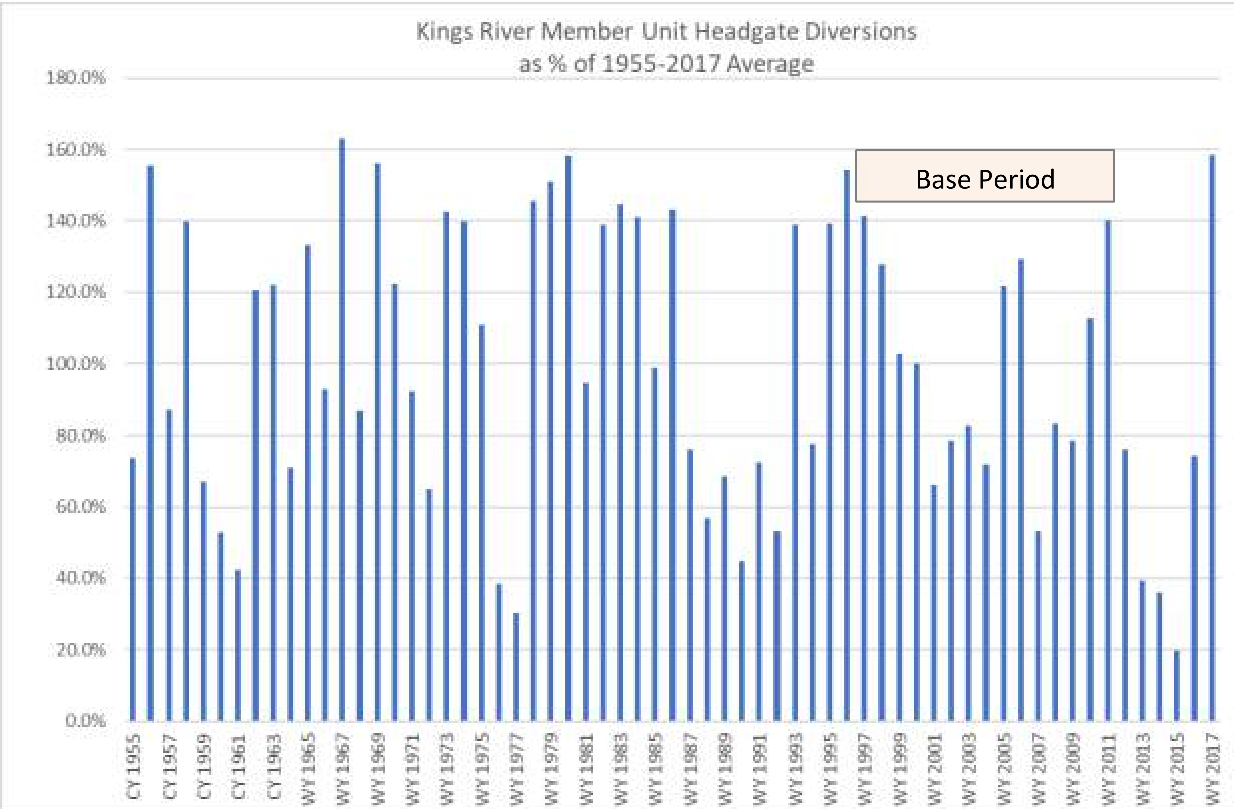
This memo identifies the recommended hydrologic period to utilize as part of the Kings Groundwater Sub-basin (Kings Basin) effort to evaluate historical changes in groundwater storage. Determination of a recent hydrologic period that approximates long-term average conditions is needed to consider the 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

GSA	Kings River SW Deliveries into each GSA: Historical Member Unit Diversions from KRWA Records **1955-2016/2017 Average**	Kings River SW Deliveries into each GSA: Base Period **WY 1996/1997-2010/2011**	Other Surface Water Supplies	Total Surface Water Supplies during Base Period
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**

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.

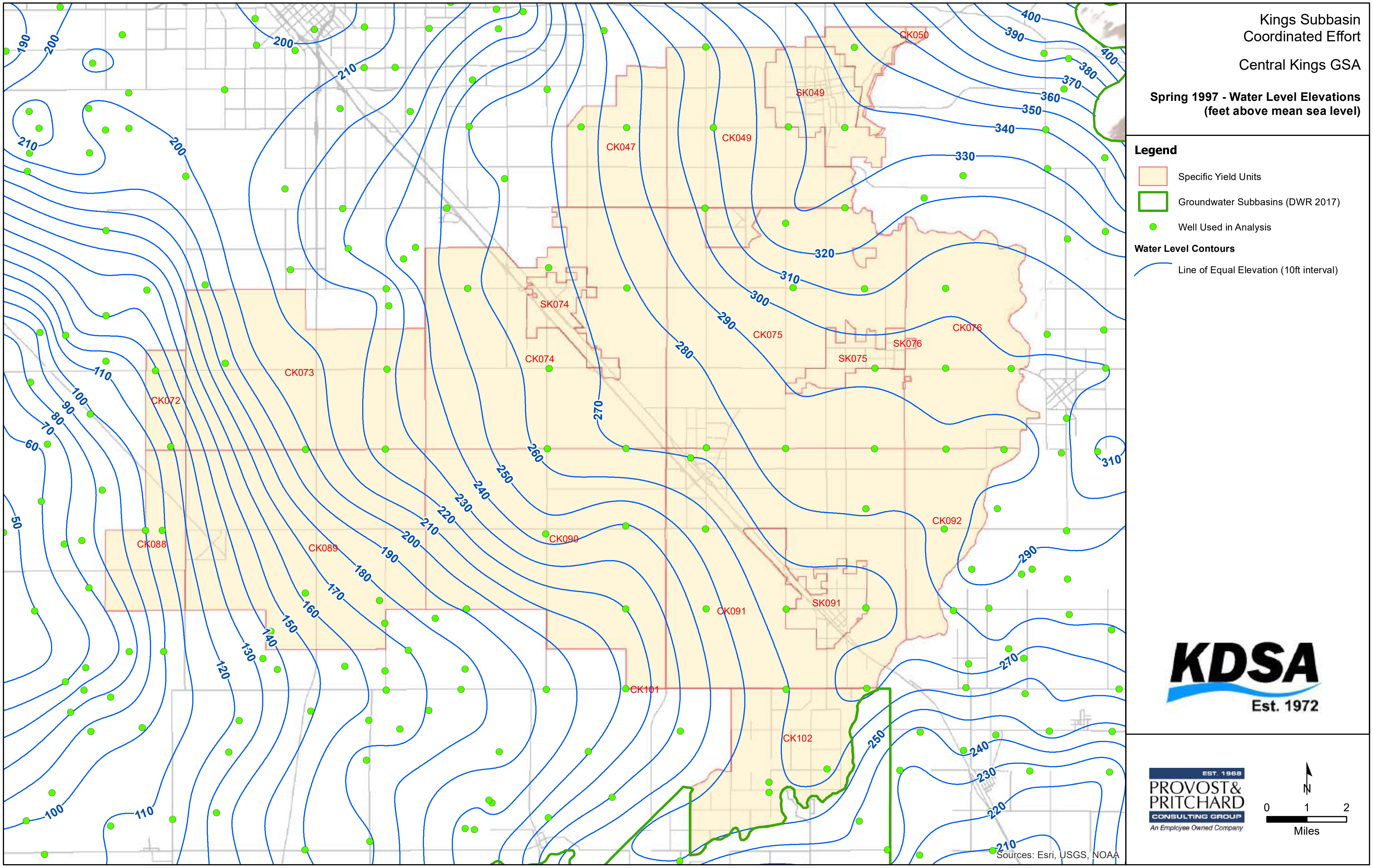
Results of Initial Estimation

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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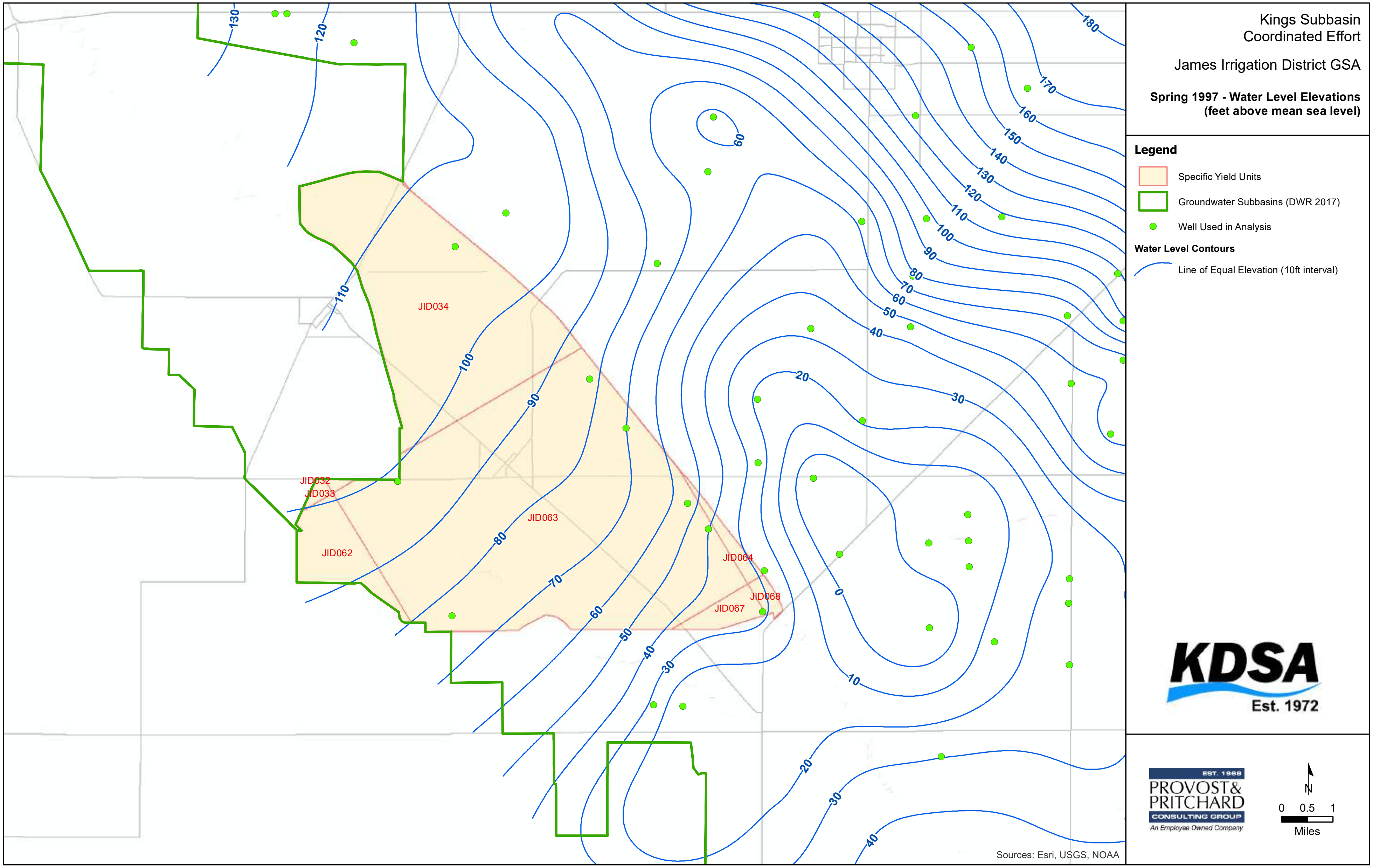
Kings Subbasin
Coordinated Effort
James Irrigation District GSA
Spring 1997 - Water Level Elevations
(feet above mean sea level)
Legend
Specific Yield Units
Groundwater Subbasins (DWR 2017)
Well Used in Analysis
Water Level Contours
Line of Equal Elevation (10ft interval)
KDSA
Est. 1972
EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company
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Miles
Sources: Esri, USGS, NOAA
JID034
JID032
JID033
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JID062
JID064
JID068
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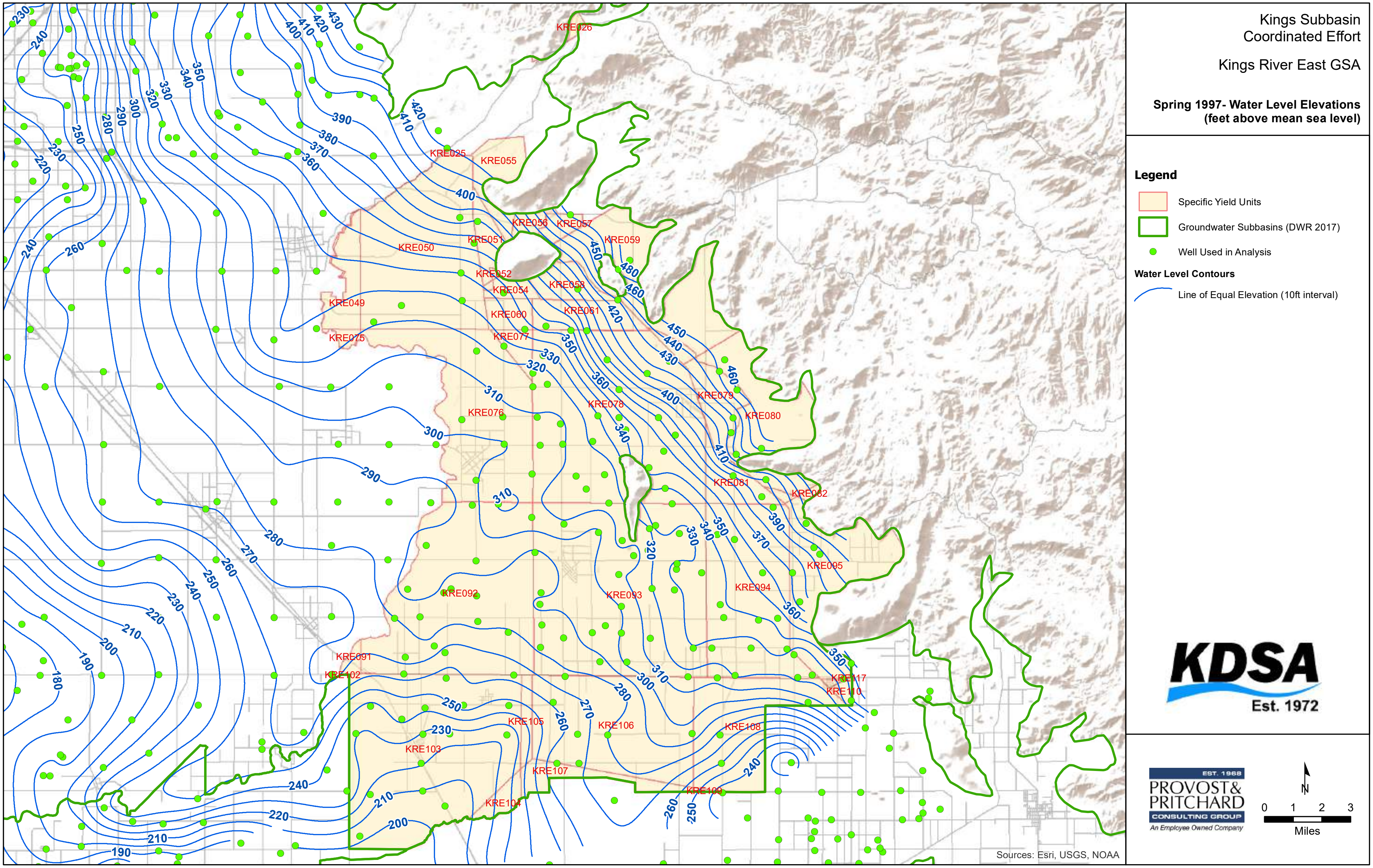

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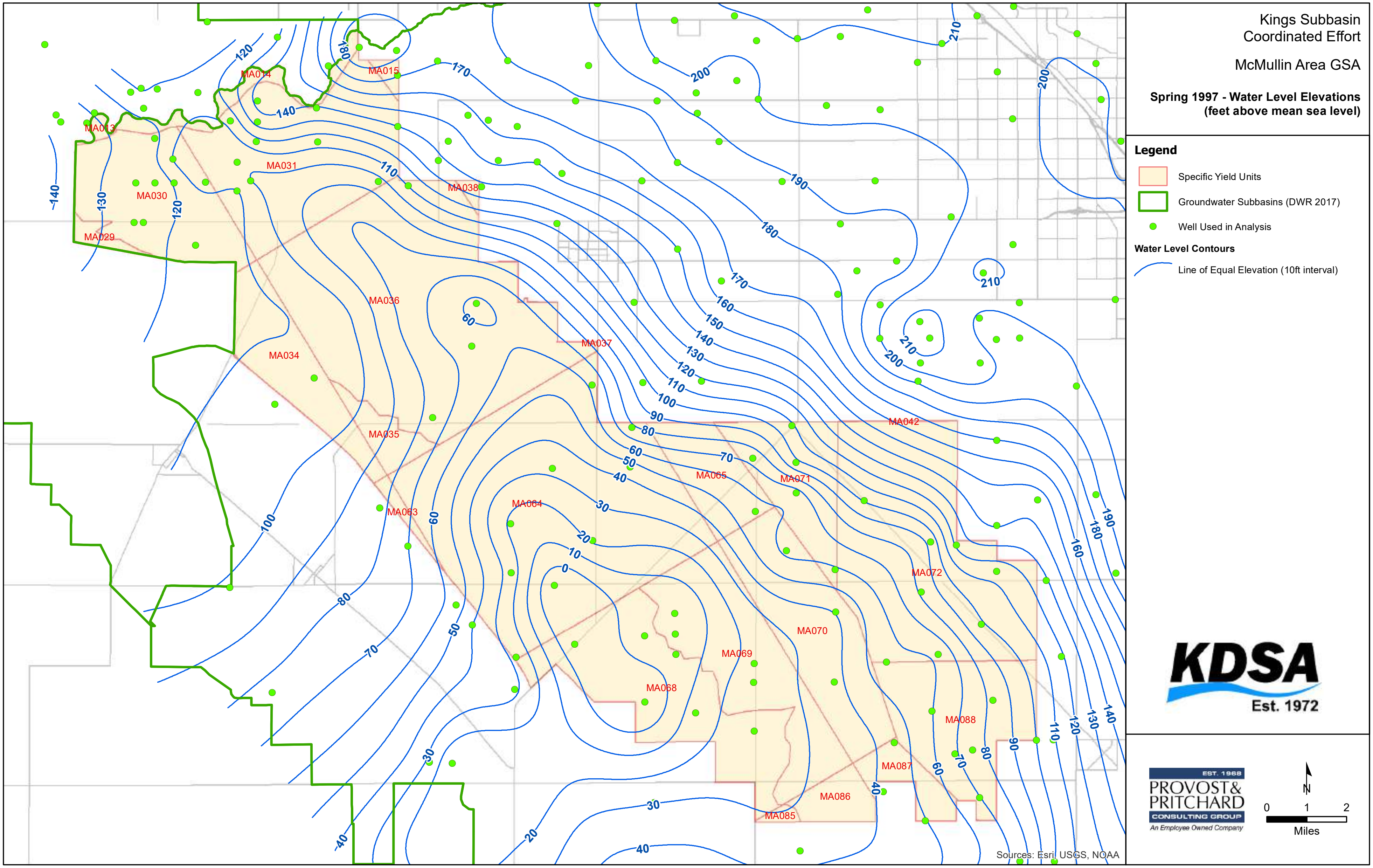

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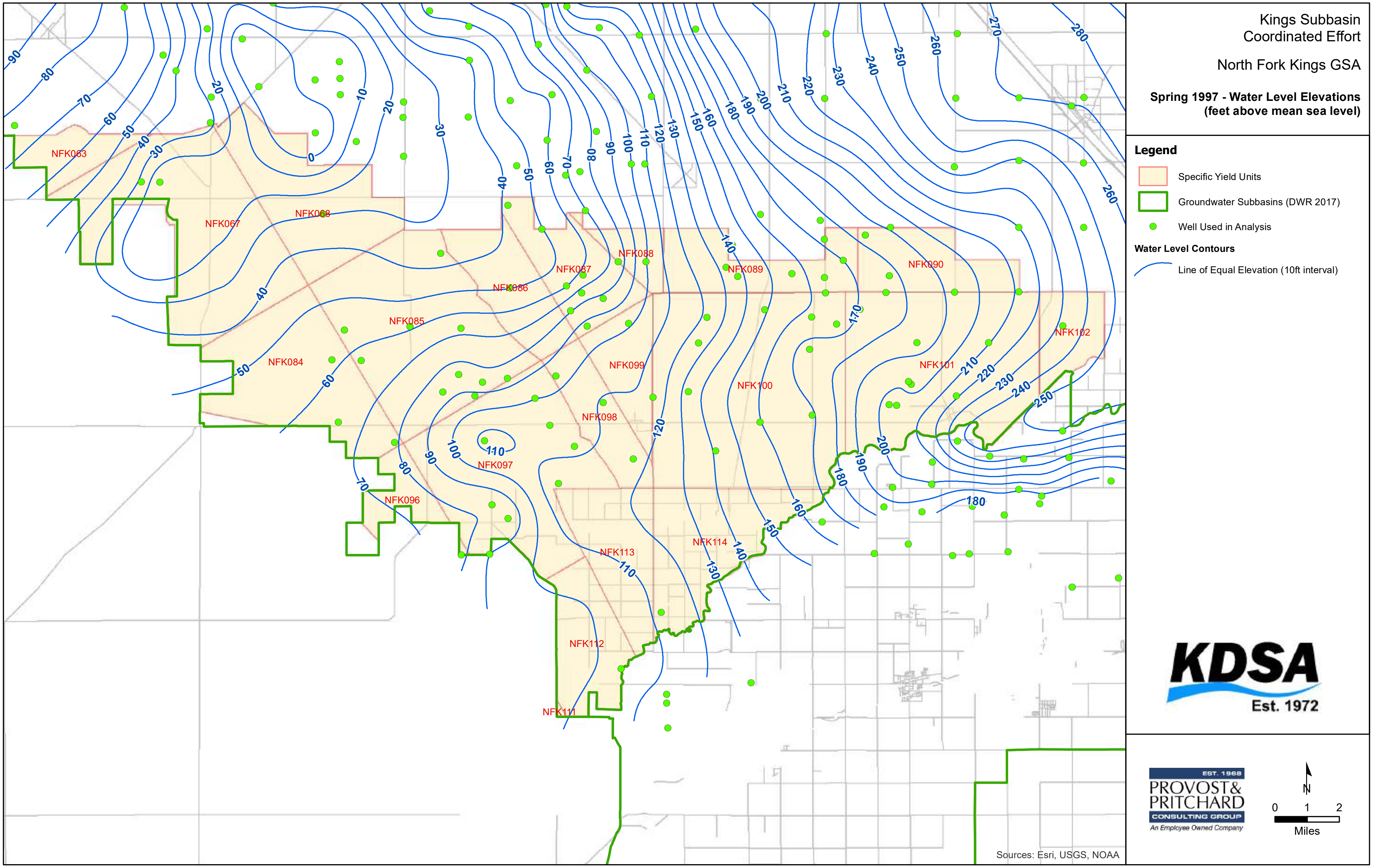

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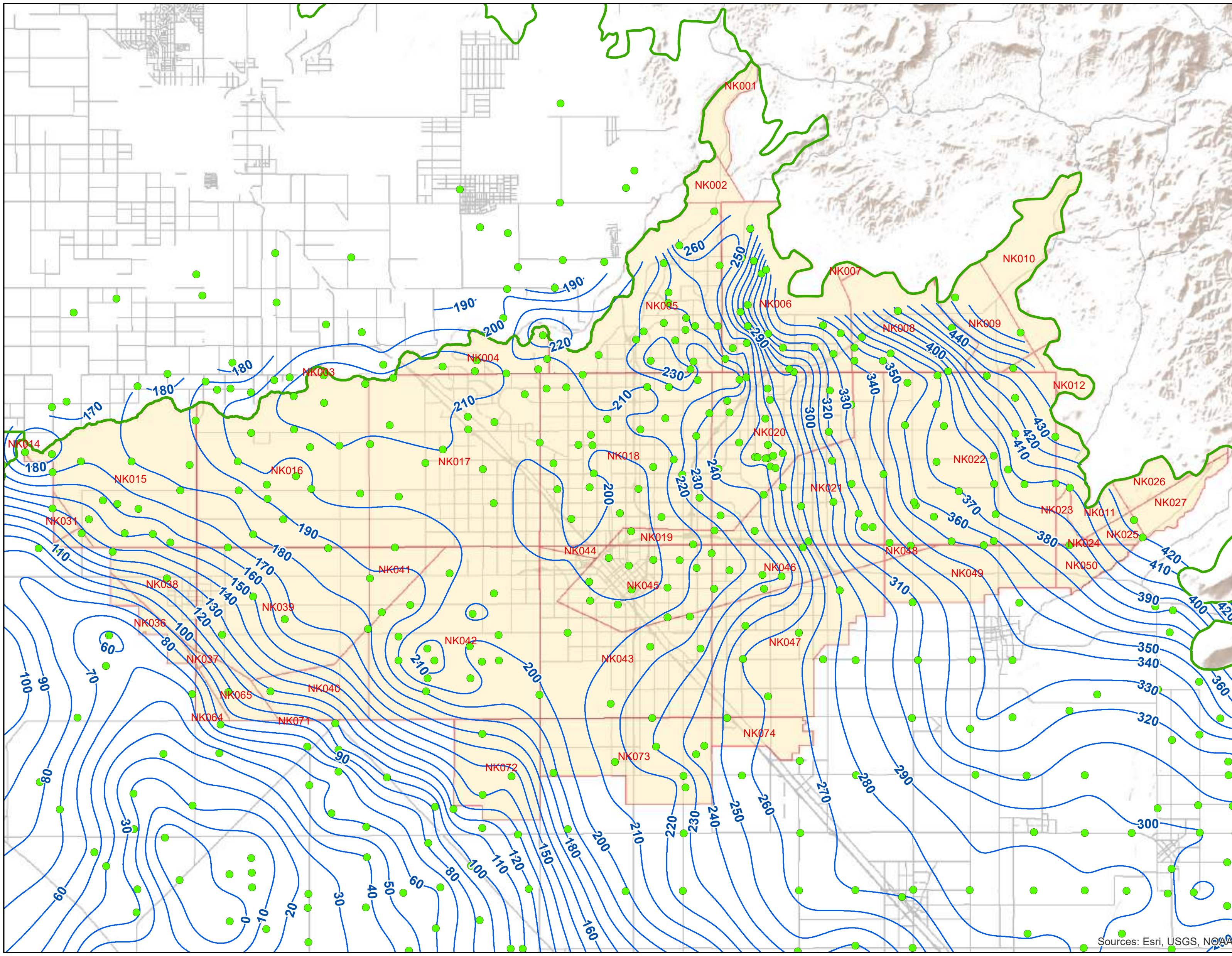
Kings Subbasin
Coordinated Effort

North Kings GSA

Spring 1997 - Water Level Elevations
(feet above mean sea level)



Legend

Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

KDSA Est. 1972

EST. 1968 PROVOST& PRITCHARD CONSULTING GROUP An Employee Owned Company

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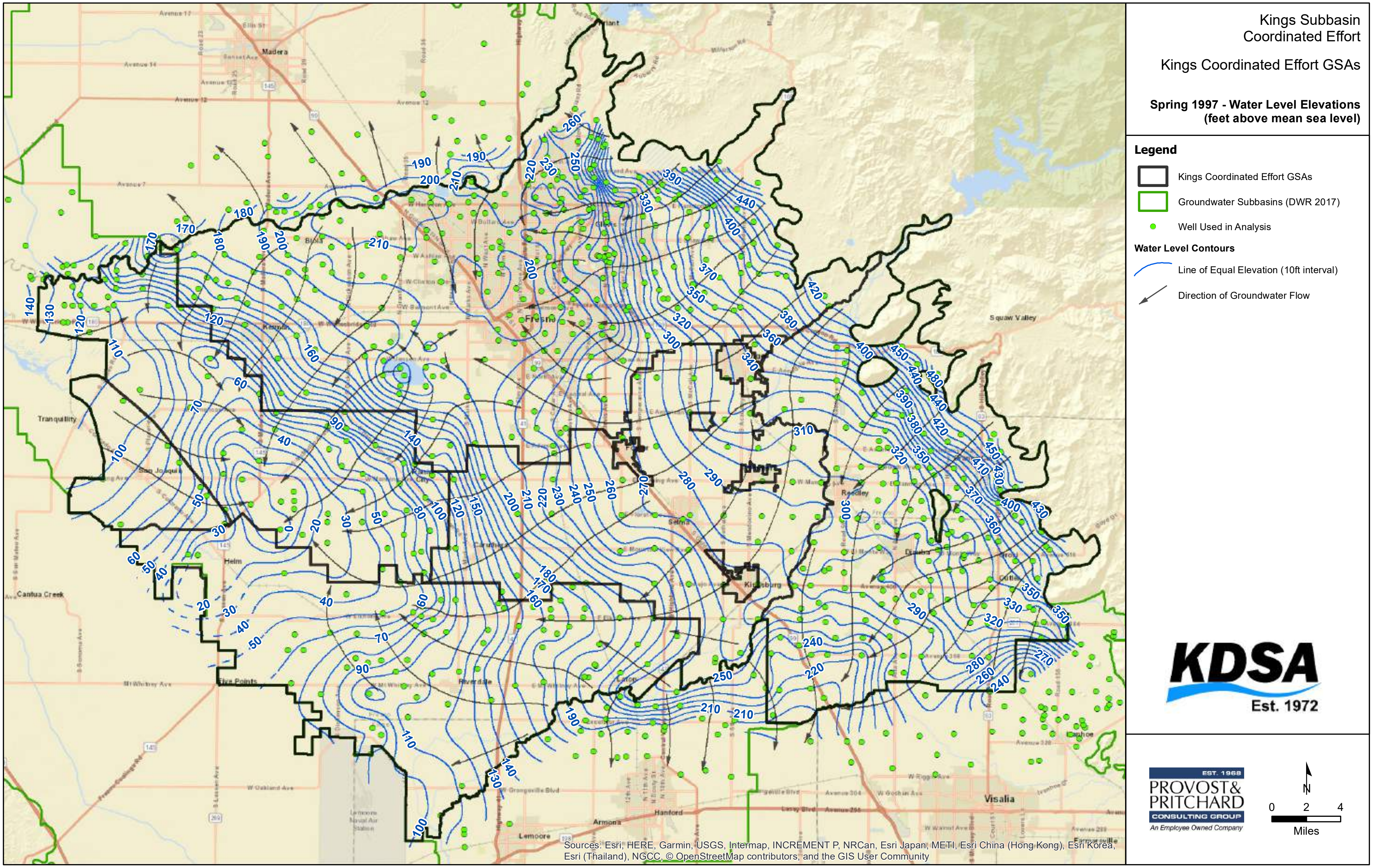

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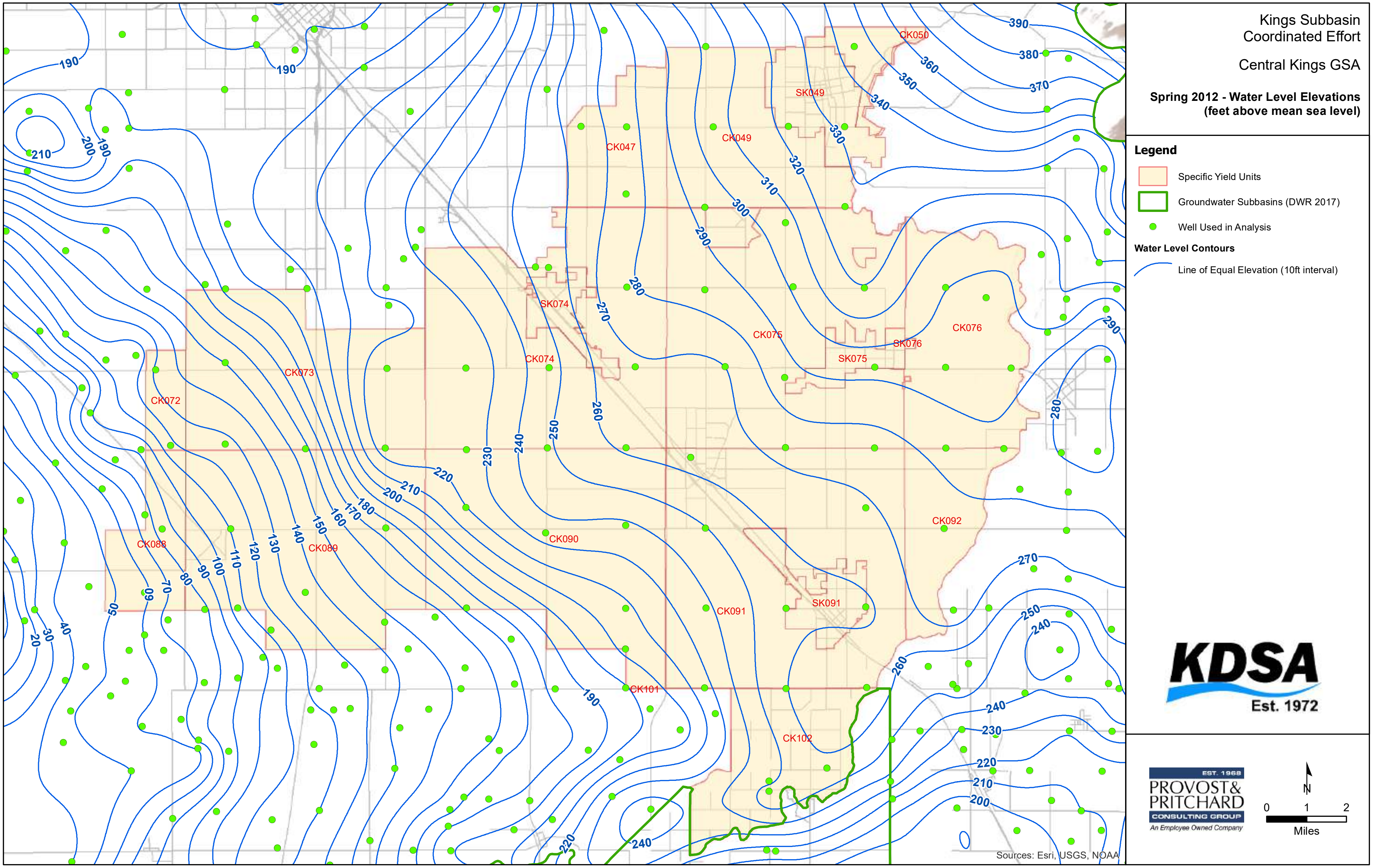

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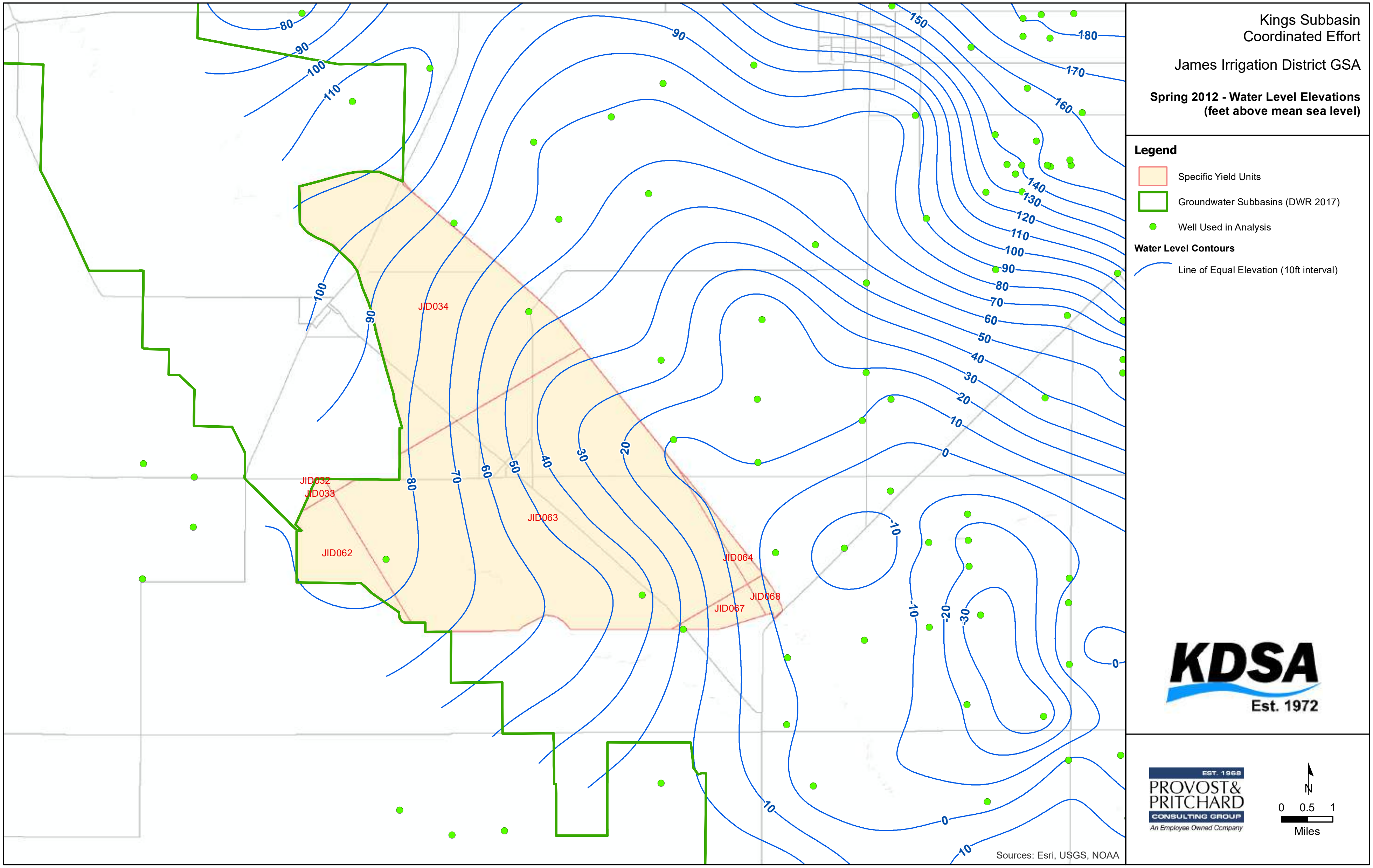

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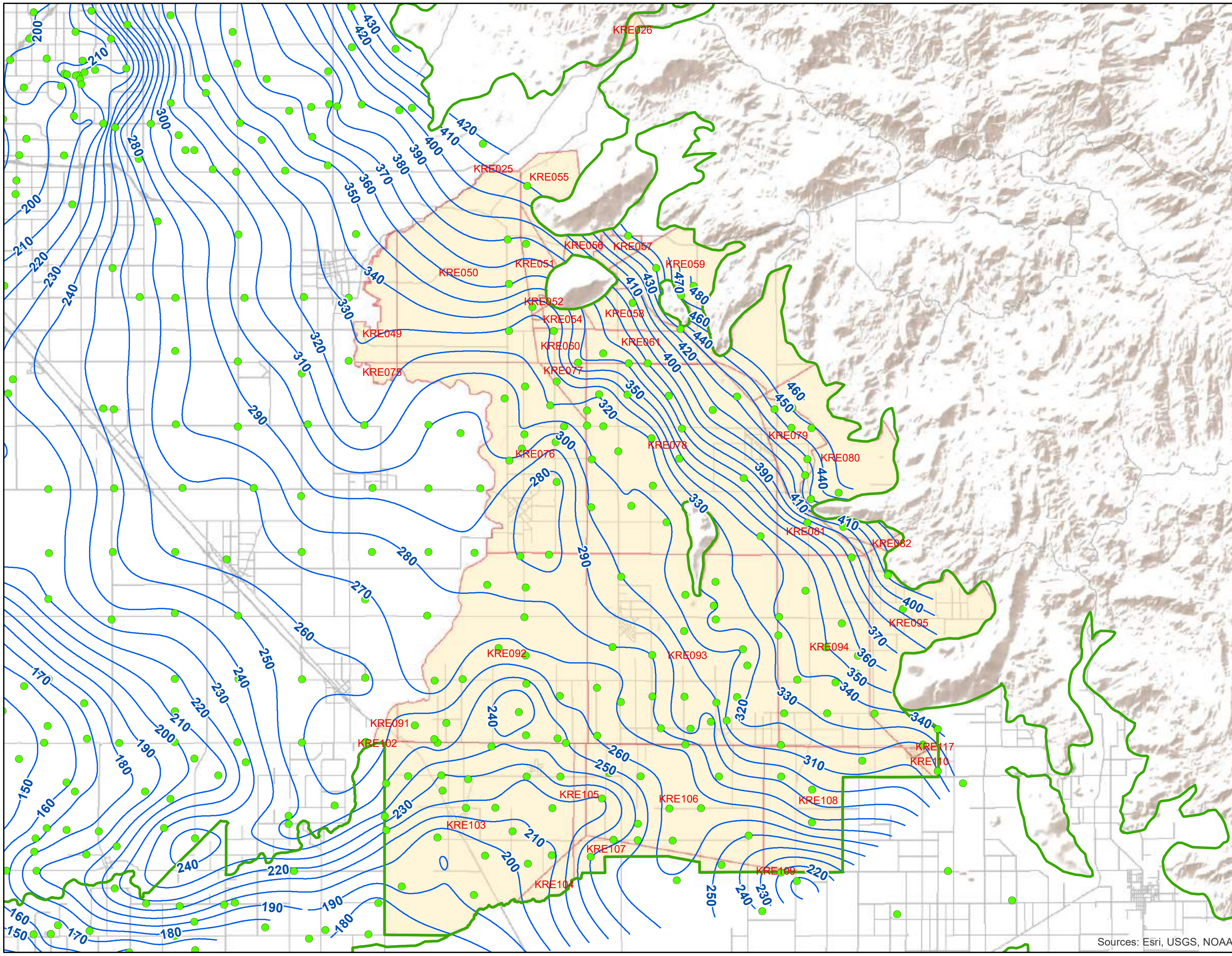
Kings Subbasin
Coordinated Effort

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)

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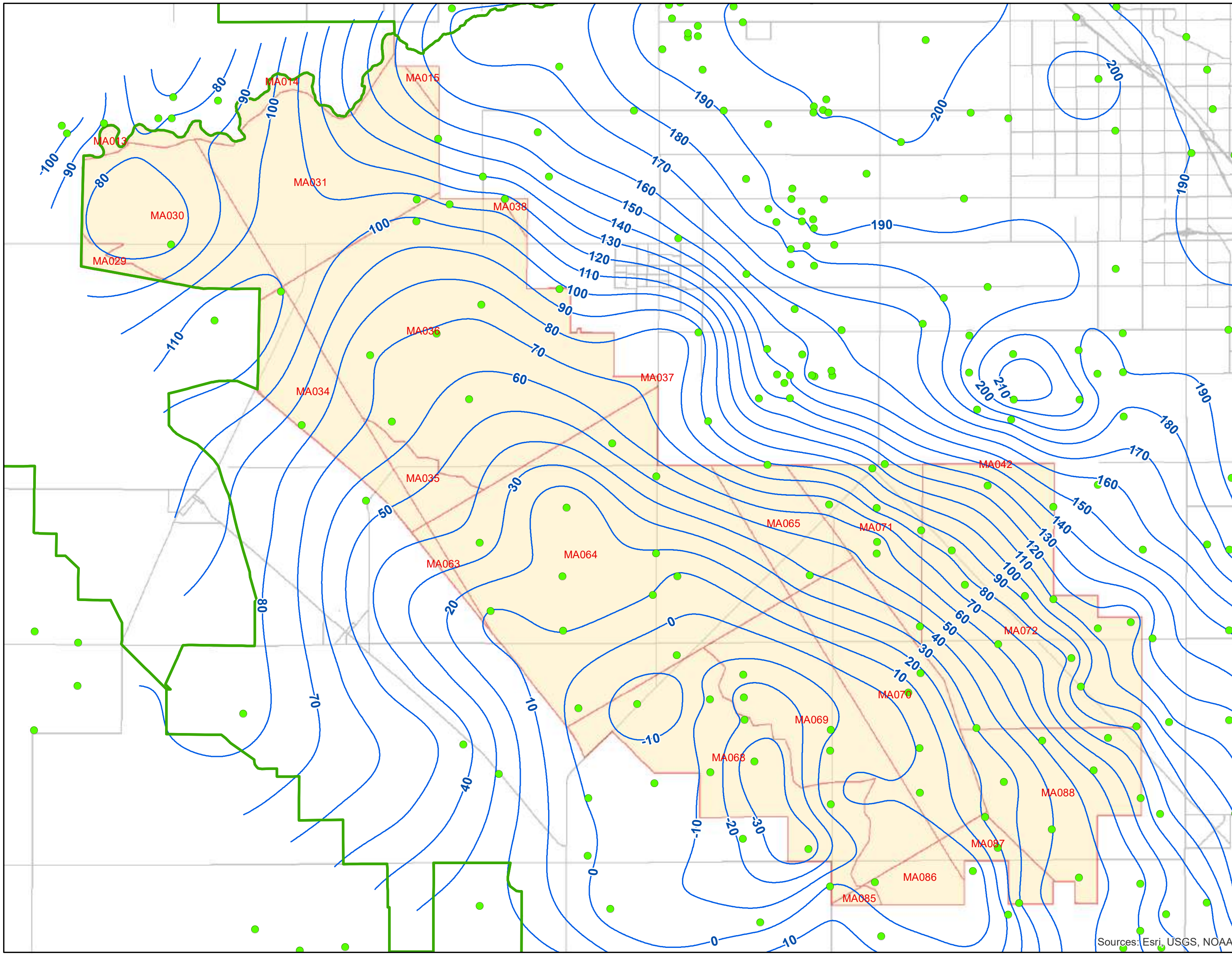

Kings Subbasin
Coordinated Effort

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 Est. 1972

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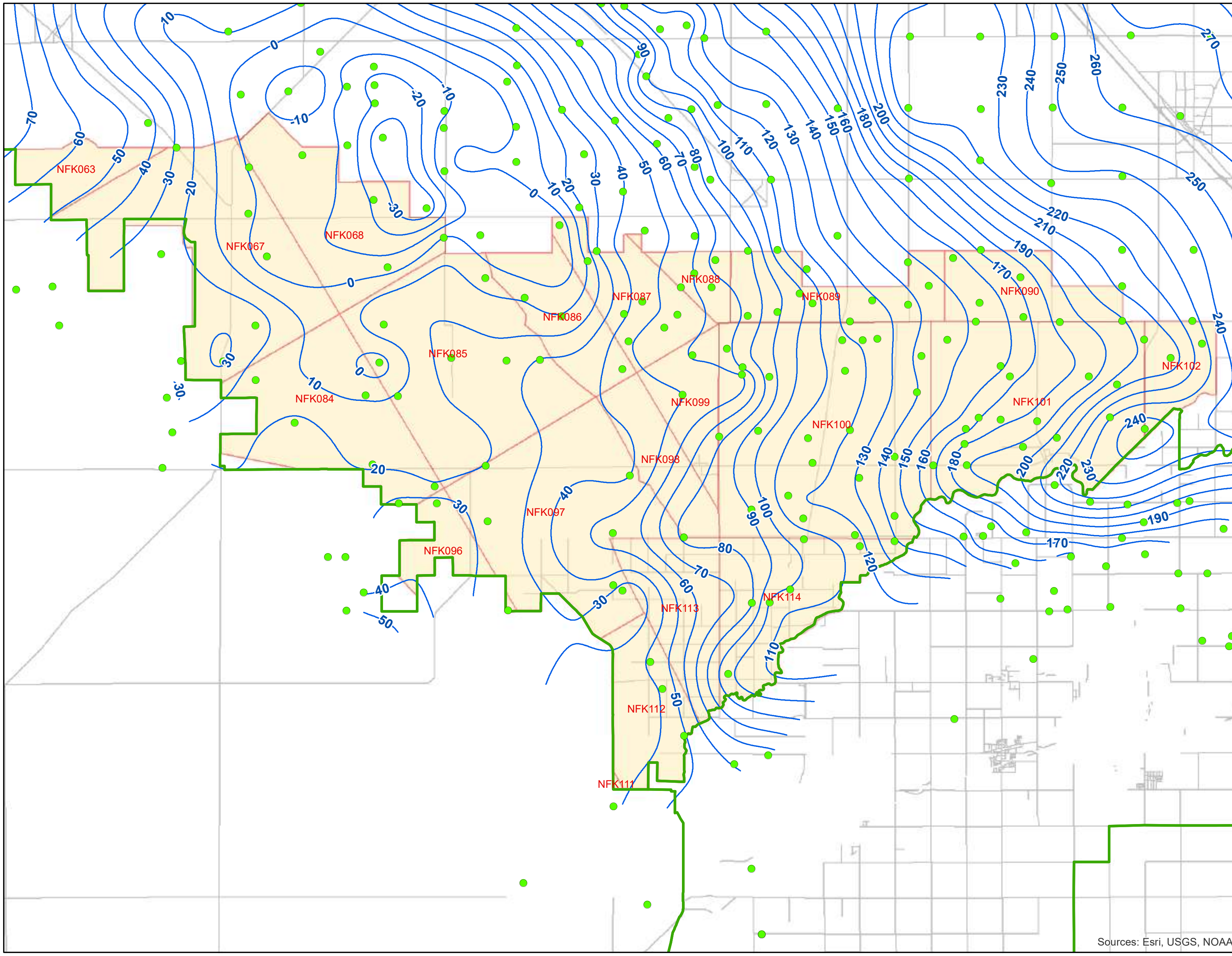

Kings Subbasin
Coordinated Effort

North Fork Kings GSA

Spring 2012 - Water Level Elevations
(feet above mean sea level)

Legend

Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

KDSA Est. 1972

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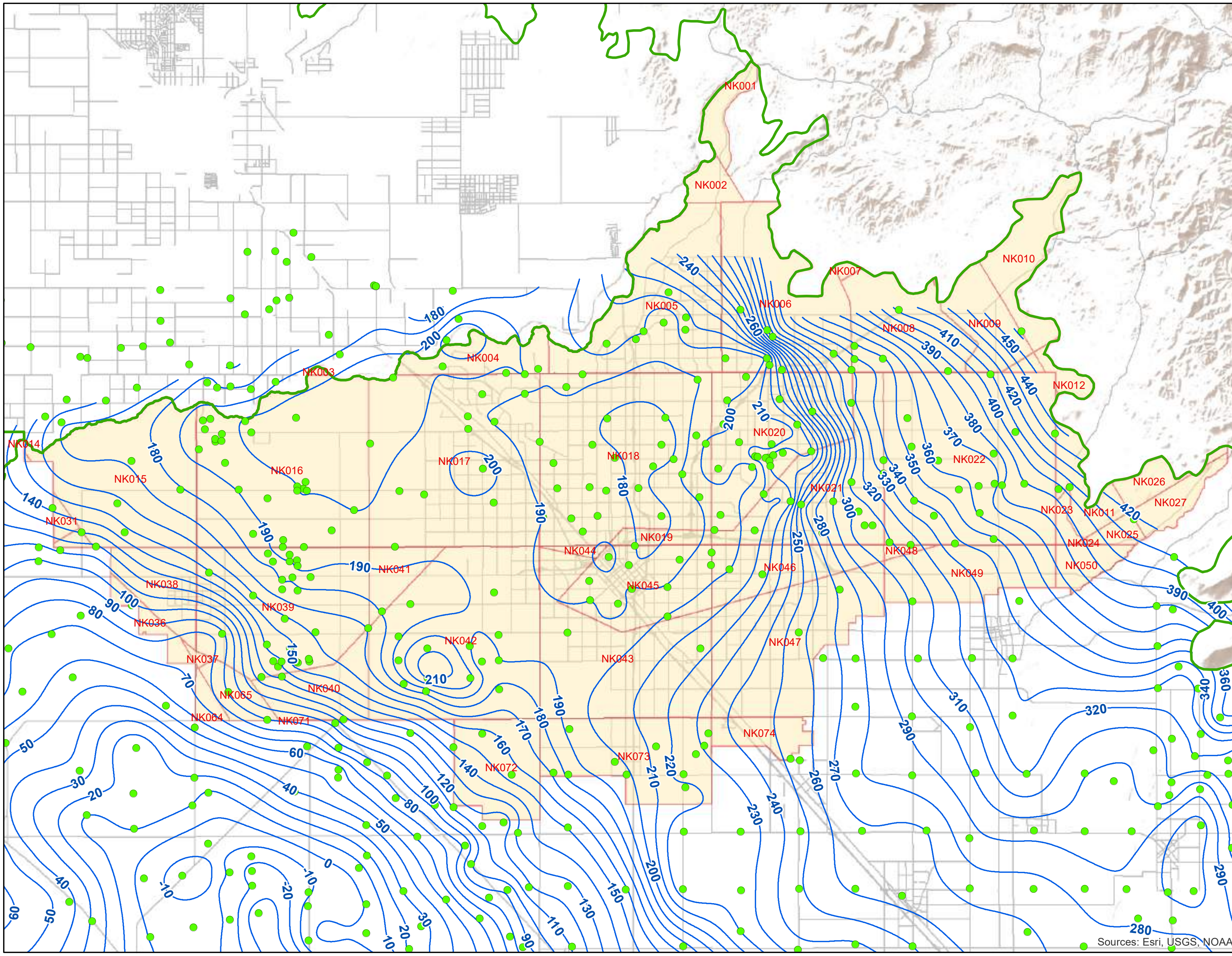
Kings Subbasin
Coordinated Effort

North Kings GSA

Spring 2012 - Water Level Elevations
(feet above mean sea level)



Legend

- Specific Yield Units
- Groundwater Subbasins (DWR 2017)
- Well Used in Analysis

Water Level Contours

- Line of Equal Elevation (10ft interval)

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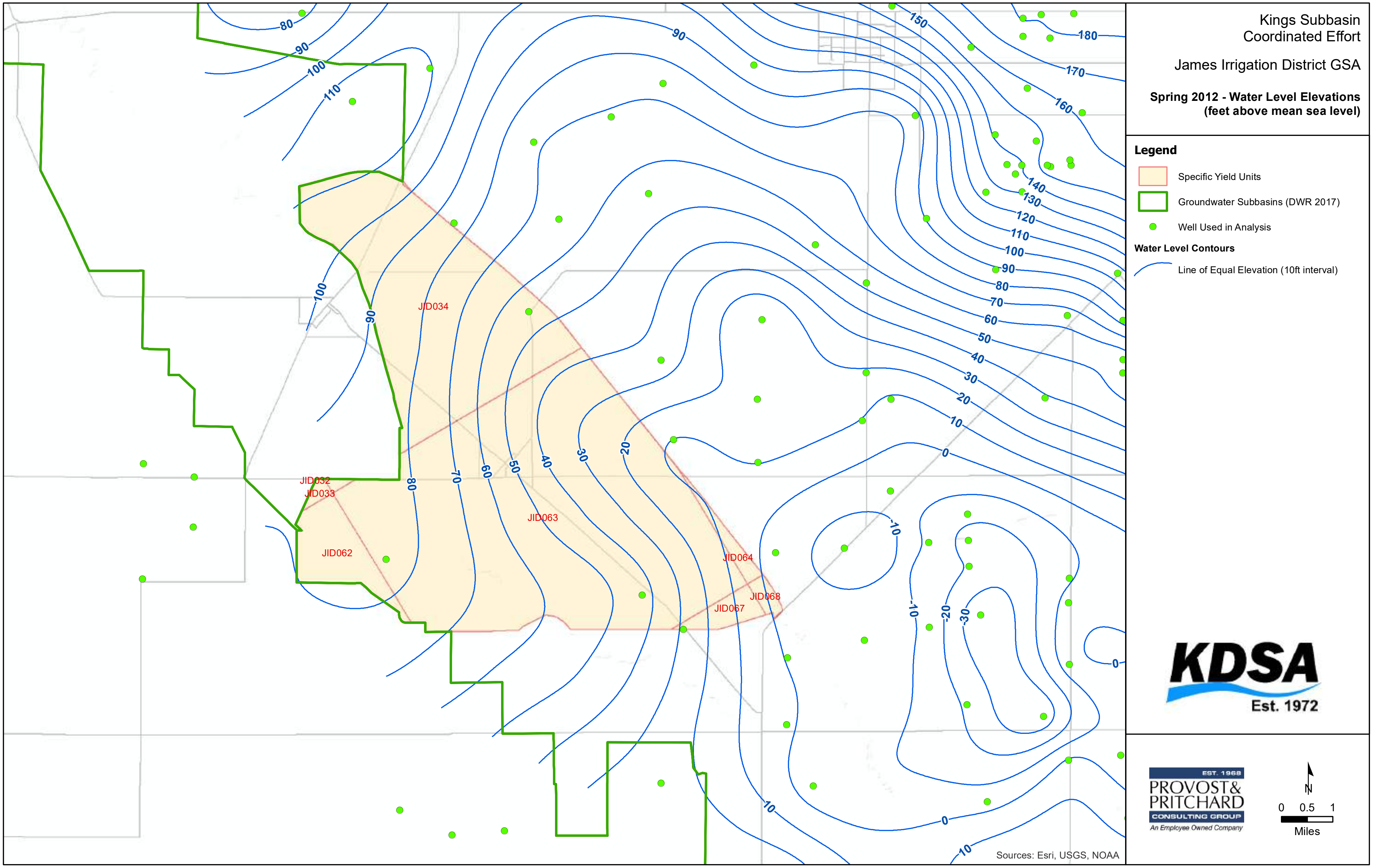

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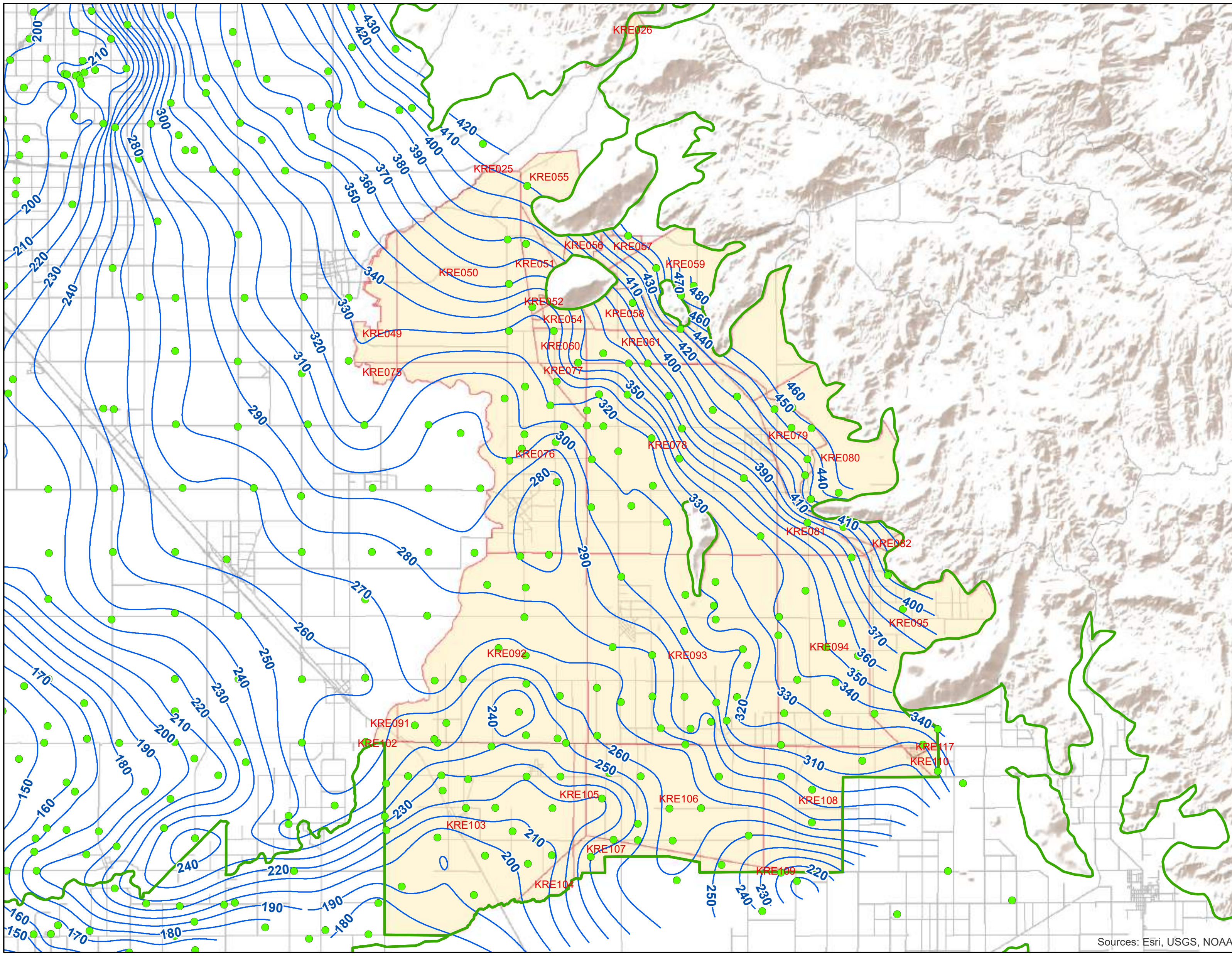

Kings Subbasin
Coordinated Effort

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)

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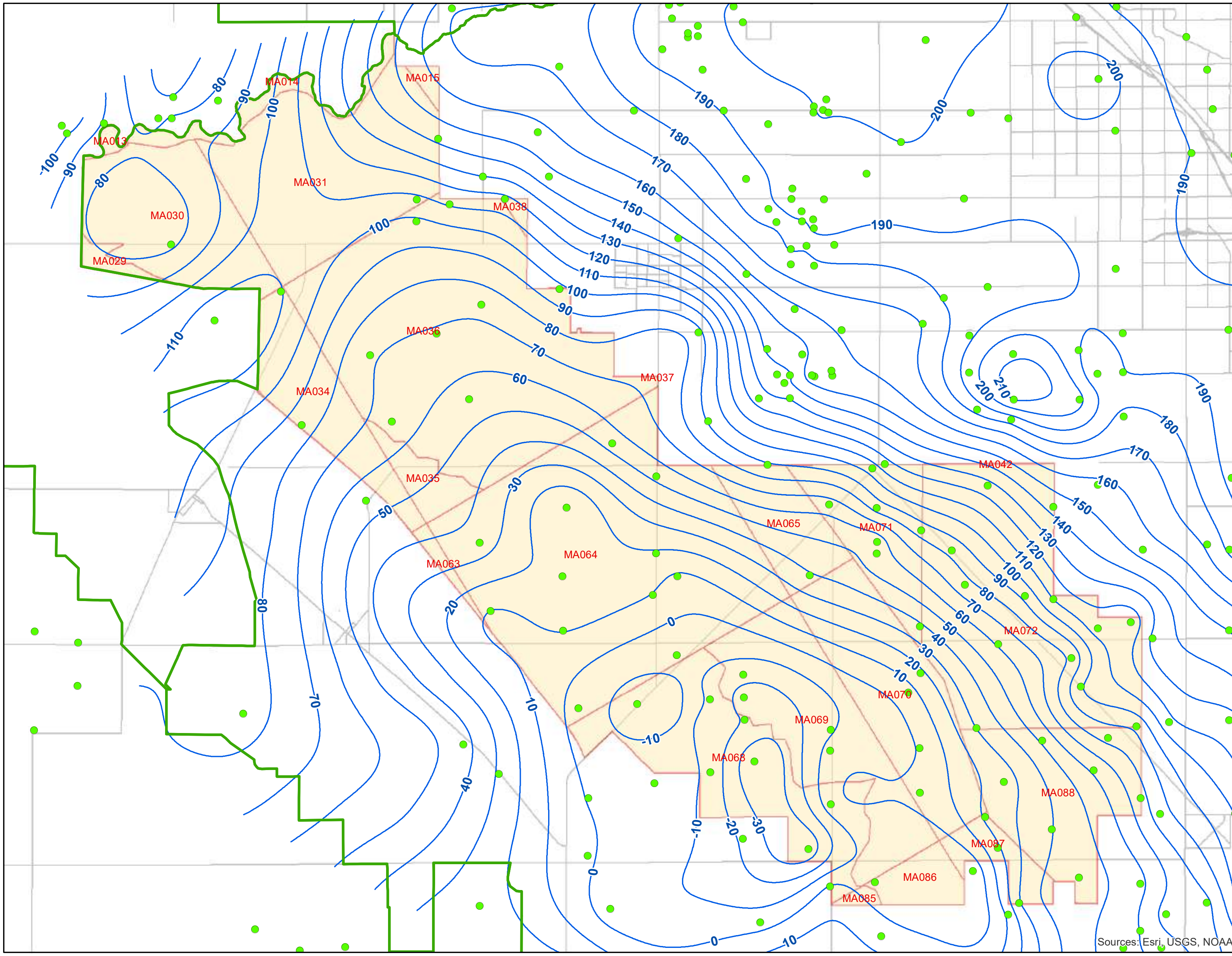

Kings Subbasin
Coordinated Effort

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)

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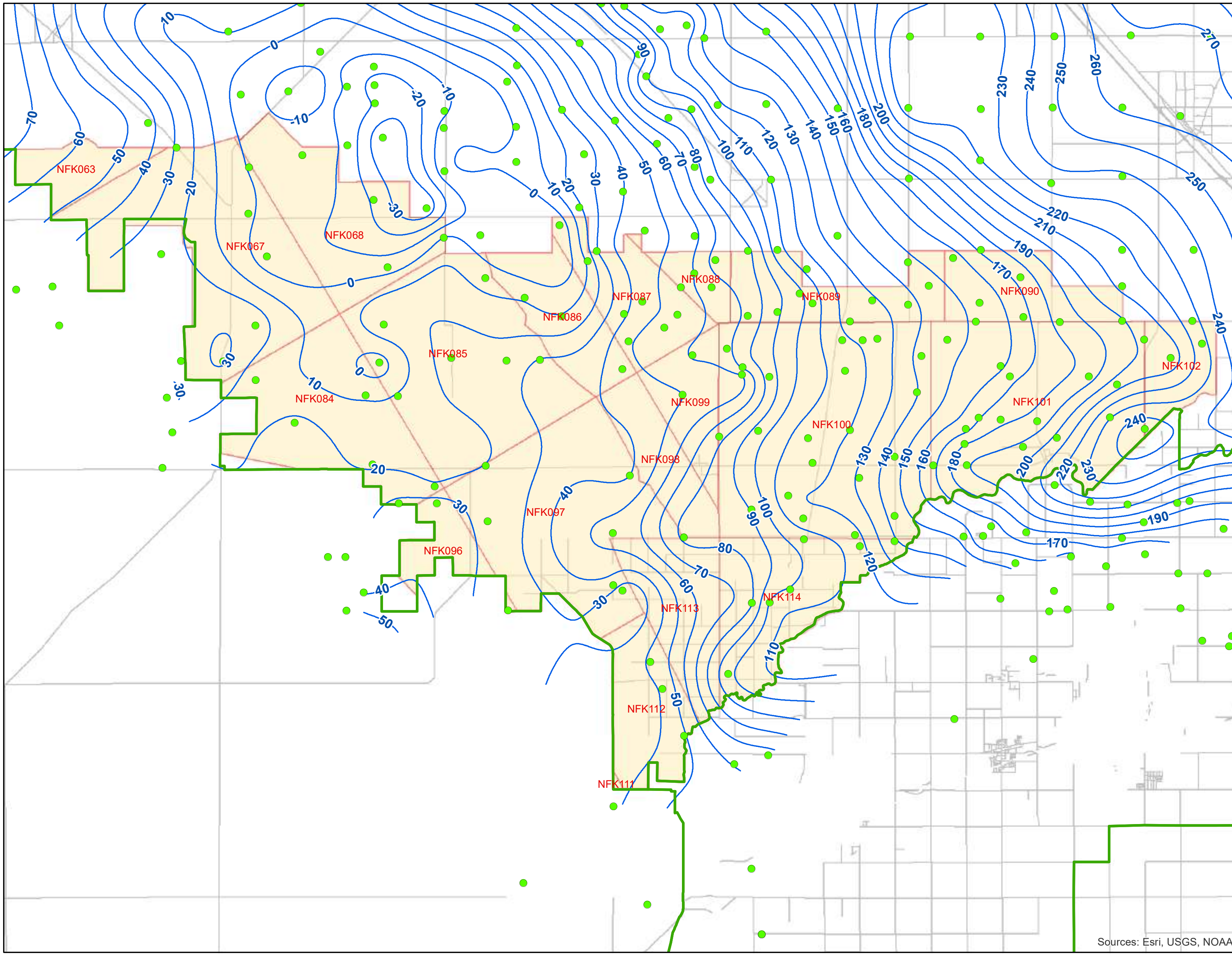

Kings Subbasin Coordinated Effort

North Fork Kings GSA

Spring 2012 - Water Level Elevations (feet above mean sea level)

Legend

Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

KDSA Est. 1972

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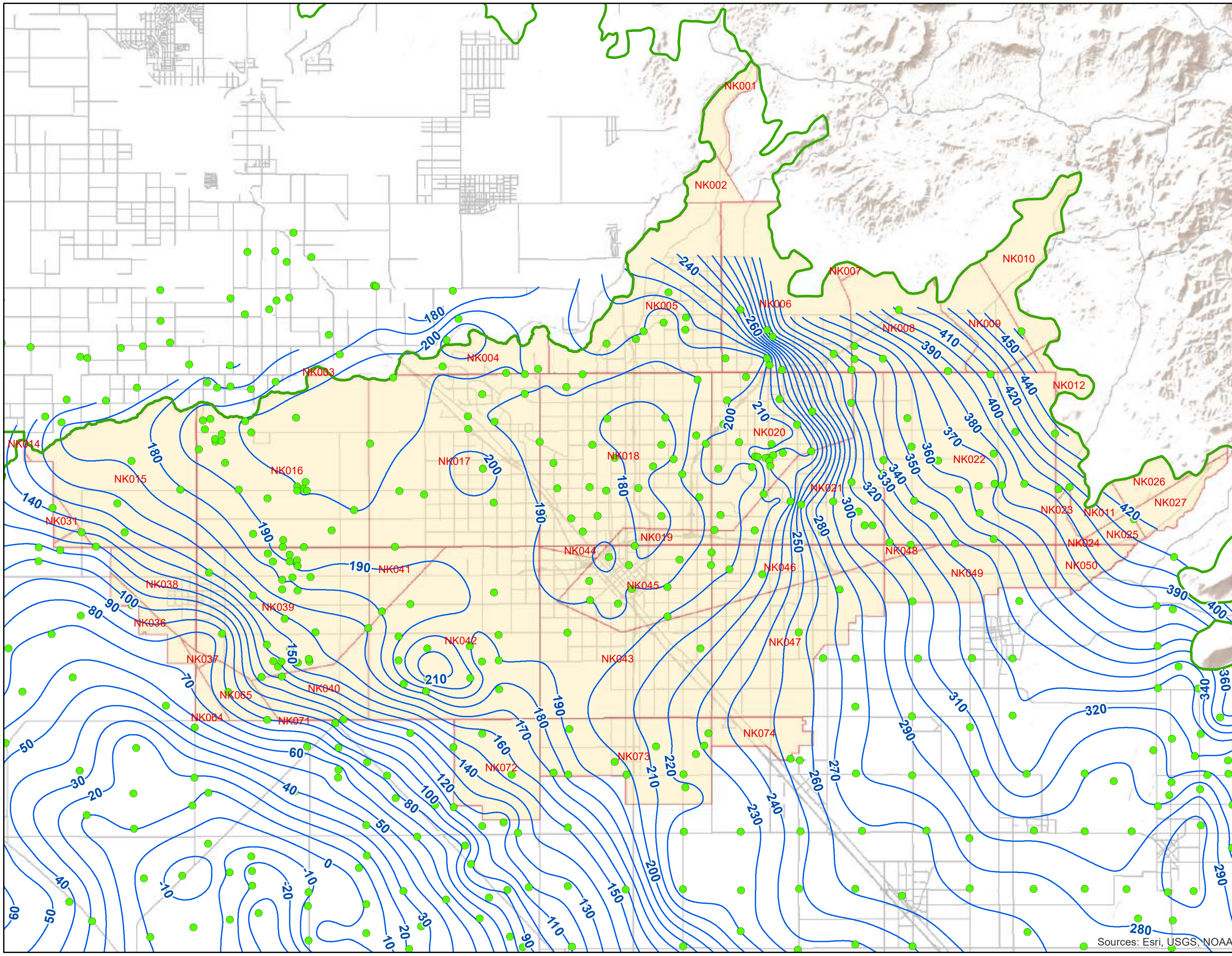

Kings Subbasin
Coordinated Effort

North Kings GSA

Spring 2012 - Water Level Elevations
(feet above mean sea level)

Legend

Specific Yield Units

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

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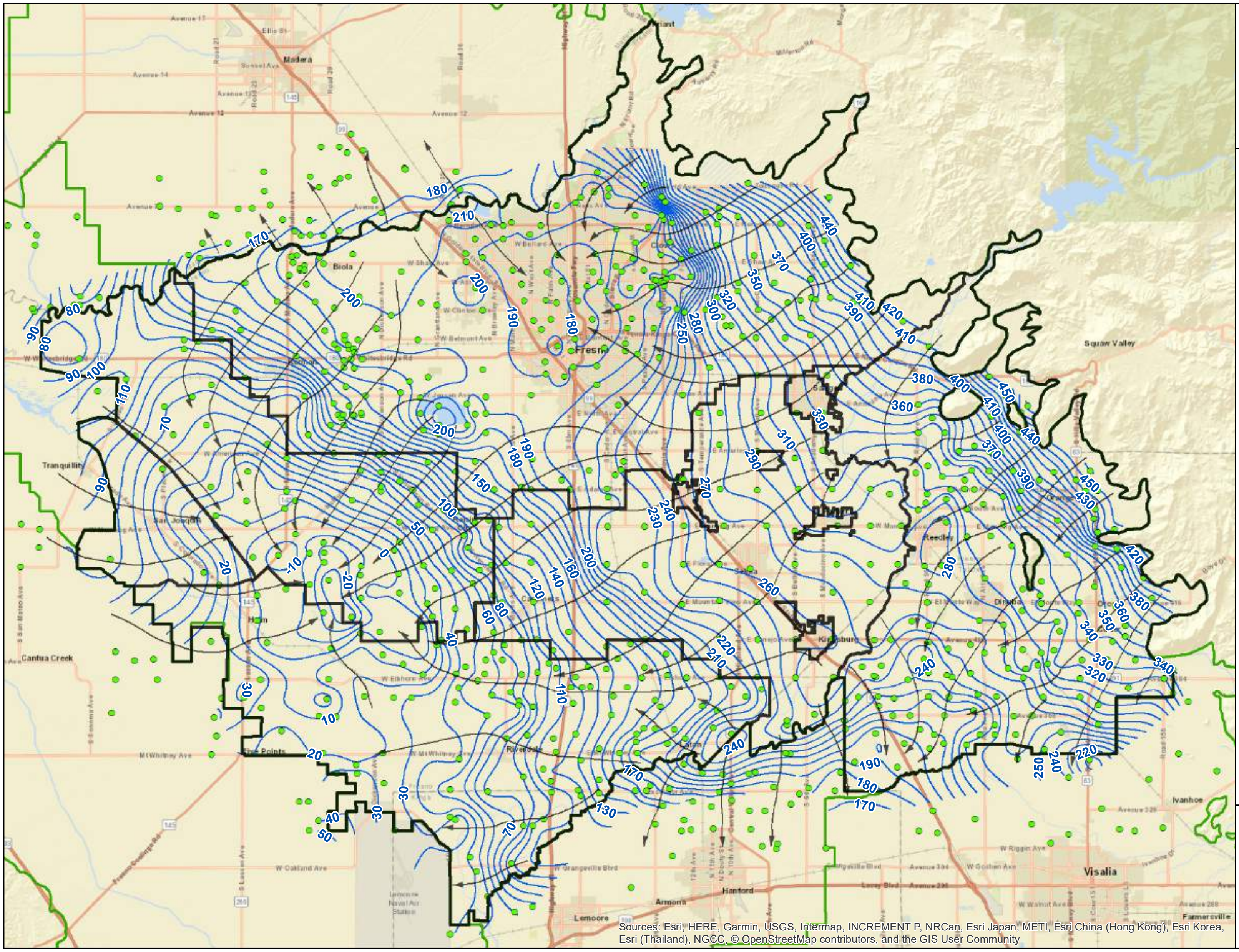

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2012 - Water Level Elevations
(feet above mean sea level)

Legend

Kings Coordinated Effort GSAs

Groundwater Subbasins (DWR 2017)

Well Used in Analysis

Water Level Contours

Line of Equal Elevation (10ft interval)

Direction of Groundwater Flow

DRAFT

KDSA Est. 1972

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

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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

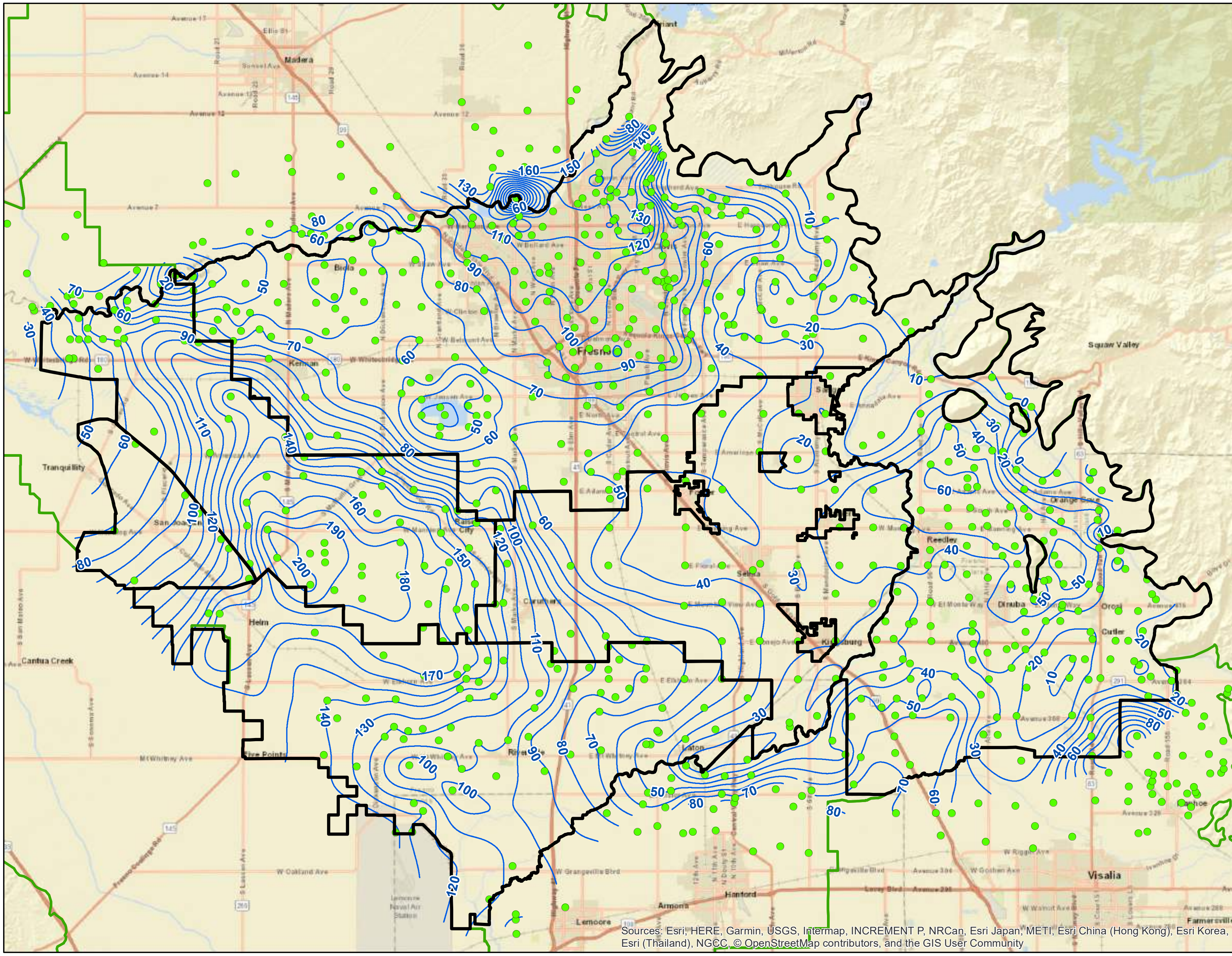
Attachment 3

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

N

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Miles

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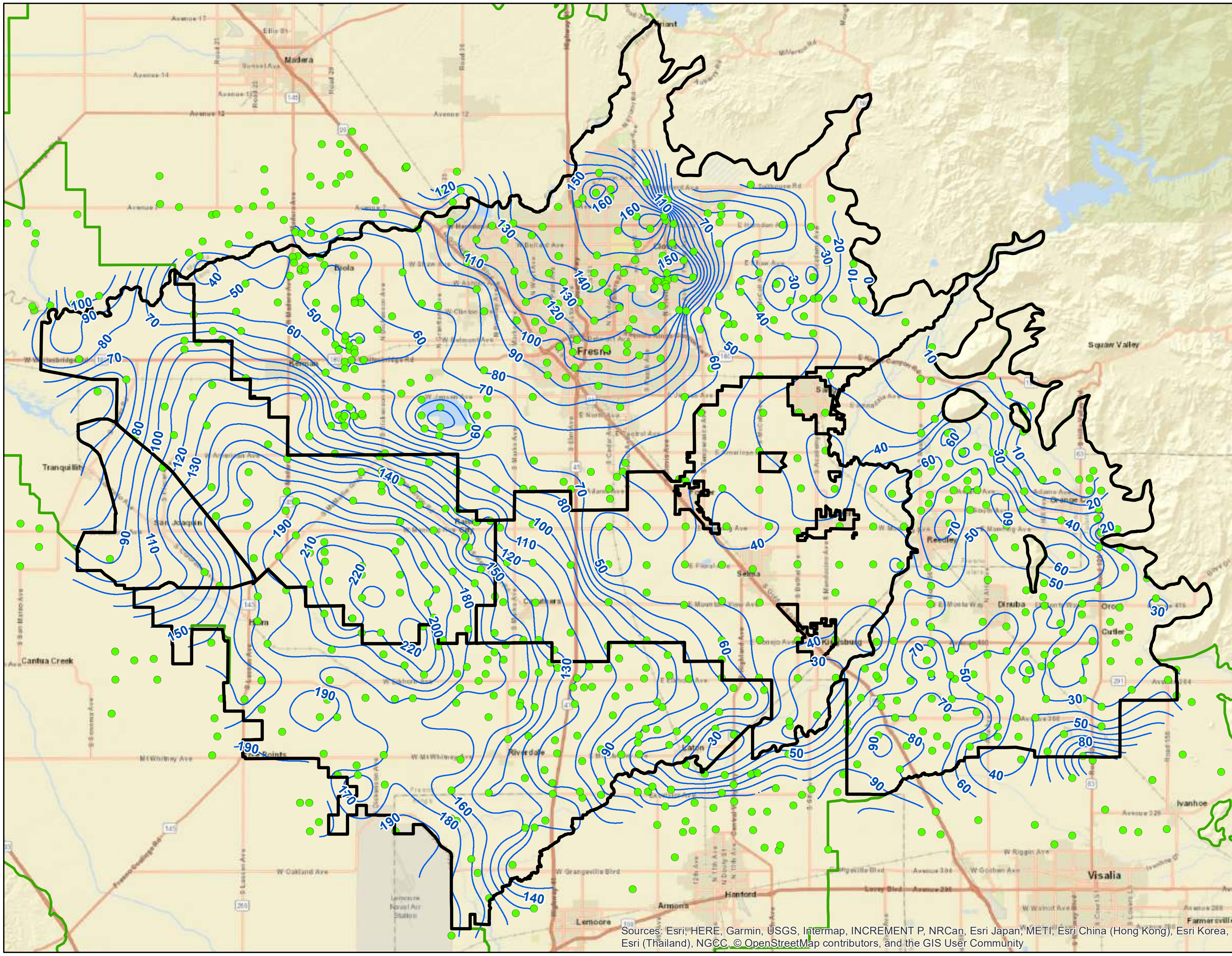
Kings Subbasin
Coordinated Effort

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

EST. 1968 PROVOST& PRITCHARD CONSULTING GROUP An Employee Owned Company

N

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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.

Flow Segments

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.

Hydraulic Gradient (I)

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.

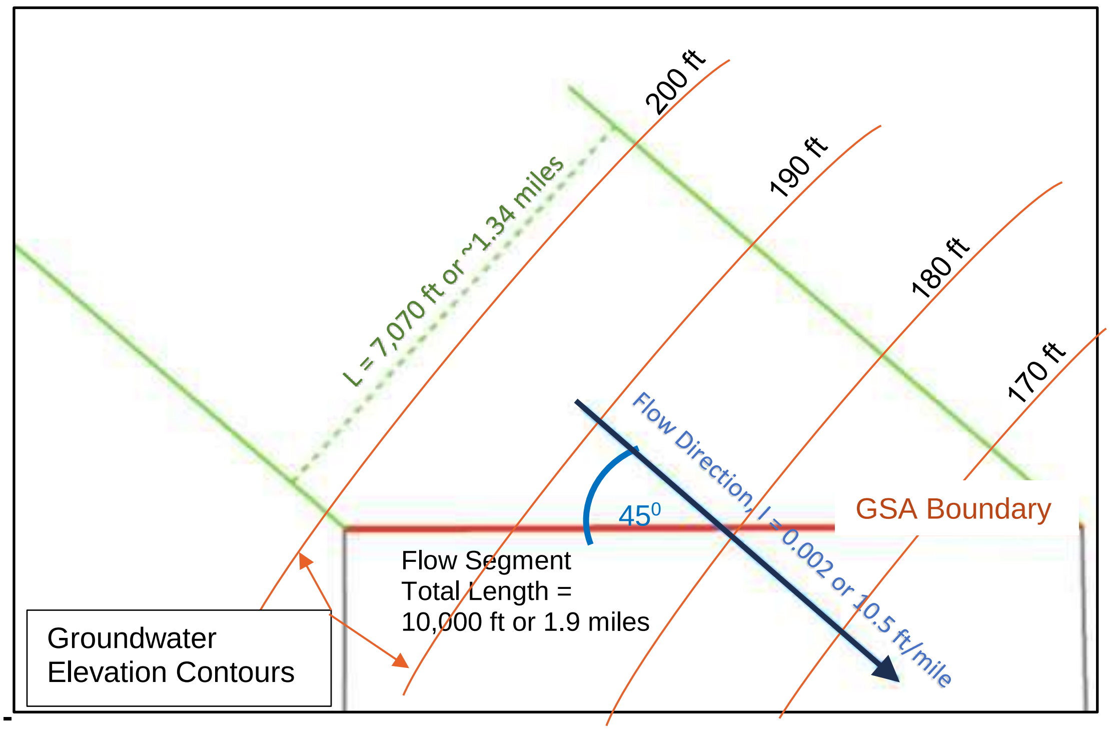
Flow Segment Length (L)

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 45º 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

$$\frac{1{,}125{,}600 \text{ gallons/day} \times 365 \text{ days/year}}{325{,}851 \text{ gallons/acre-foot}} = \mathbf{1{,}260\ AF/year}.$$

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.

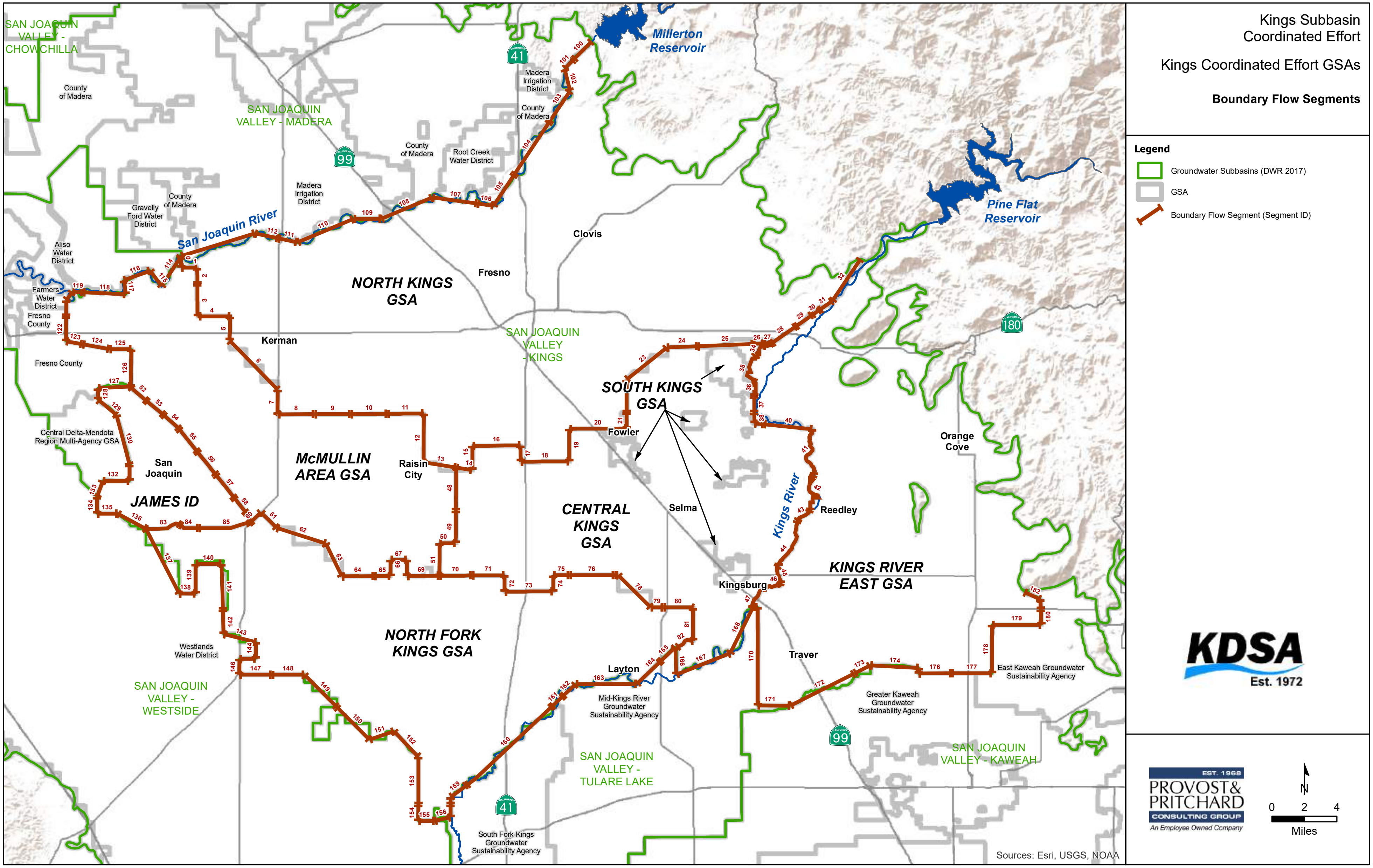
As well, Table 1 has estimates of internal and external flows between the Kings Subbasin and the neighboring basins for 1925 and the average from 1997 to 2012. Flows between South Kings GSA and Central Kings GSA were not estimated as work under this contract is being done for the six initial GSAs. The 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



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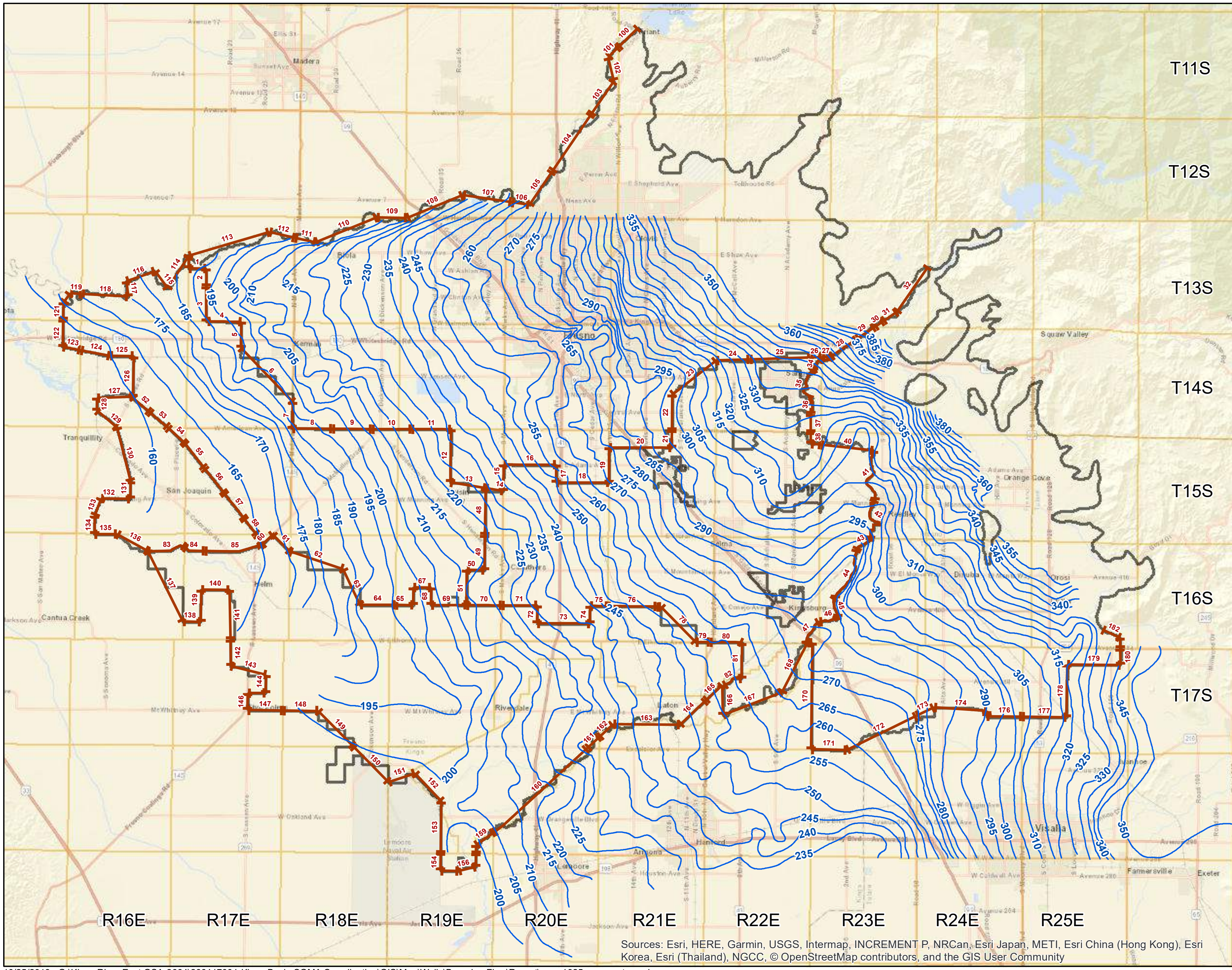
Attachment 2

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

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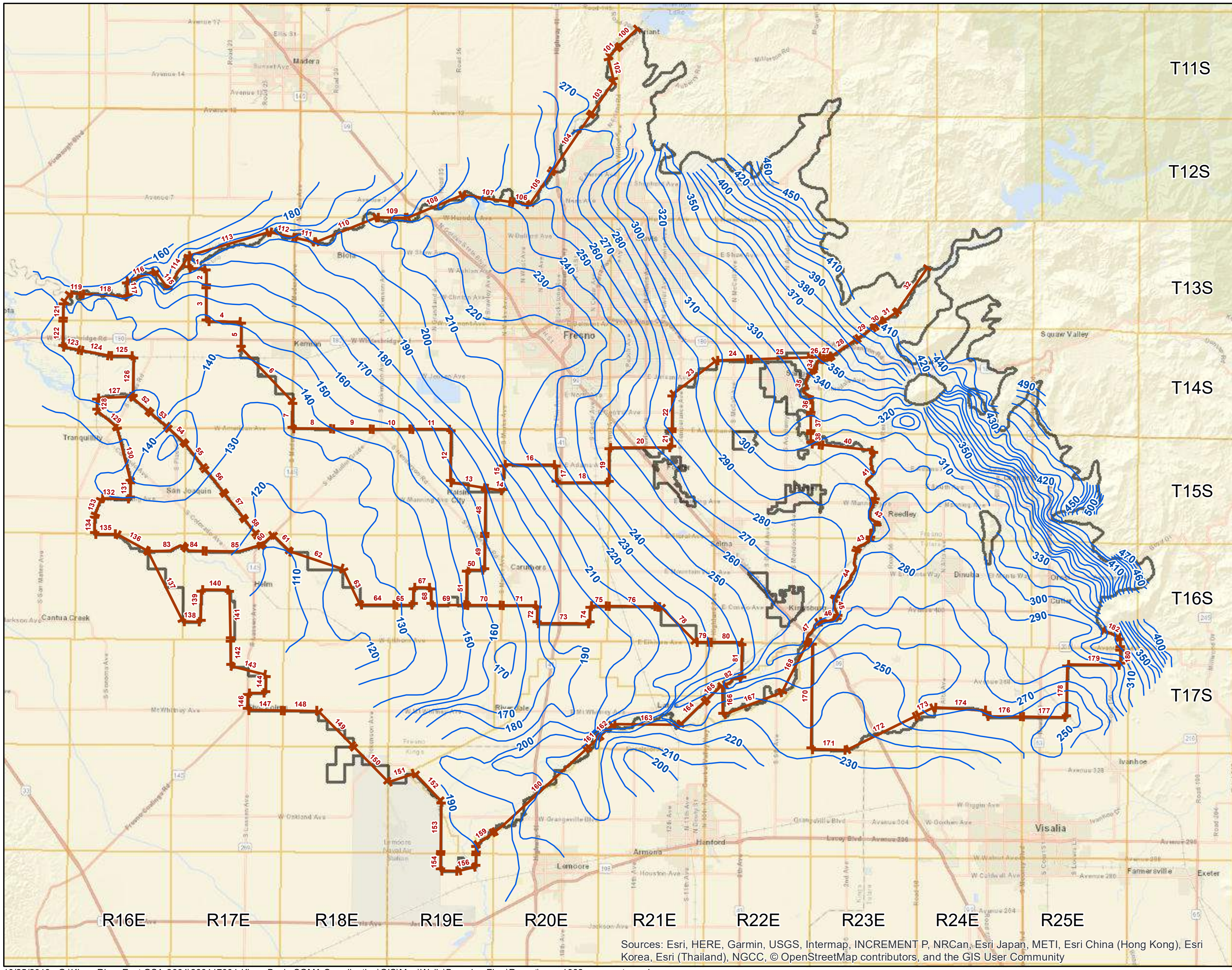

Kings Subbasin
Coordinated Effort

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*

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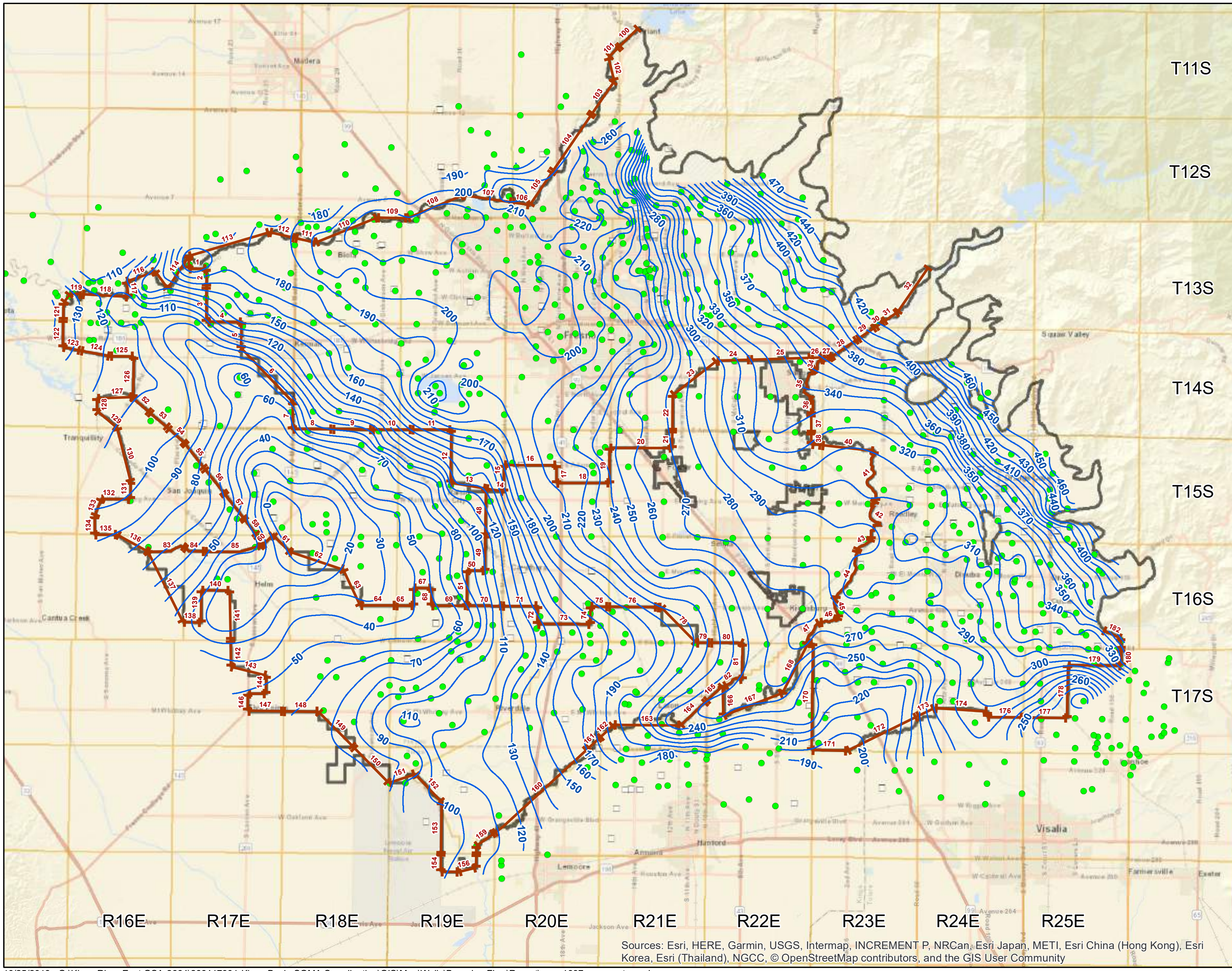

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Kings Subbasin Coordinated Effort

Kings Coordinated Effort GSAs

Spring 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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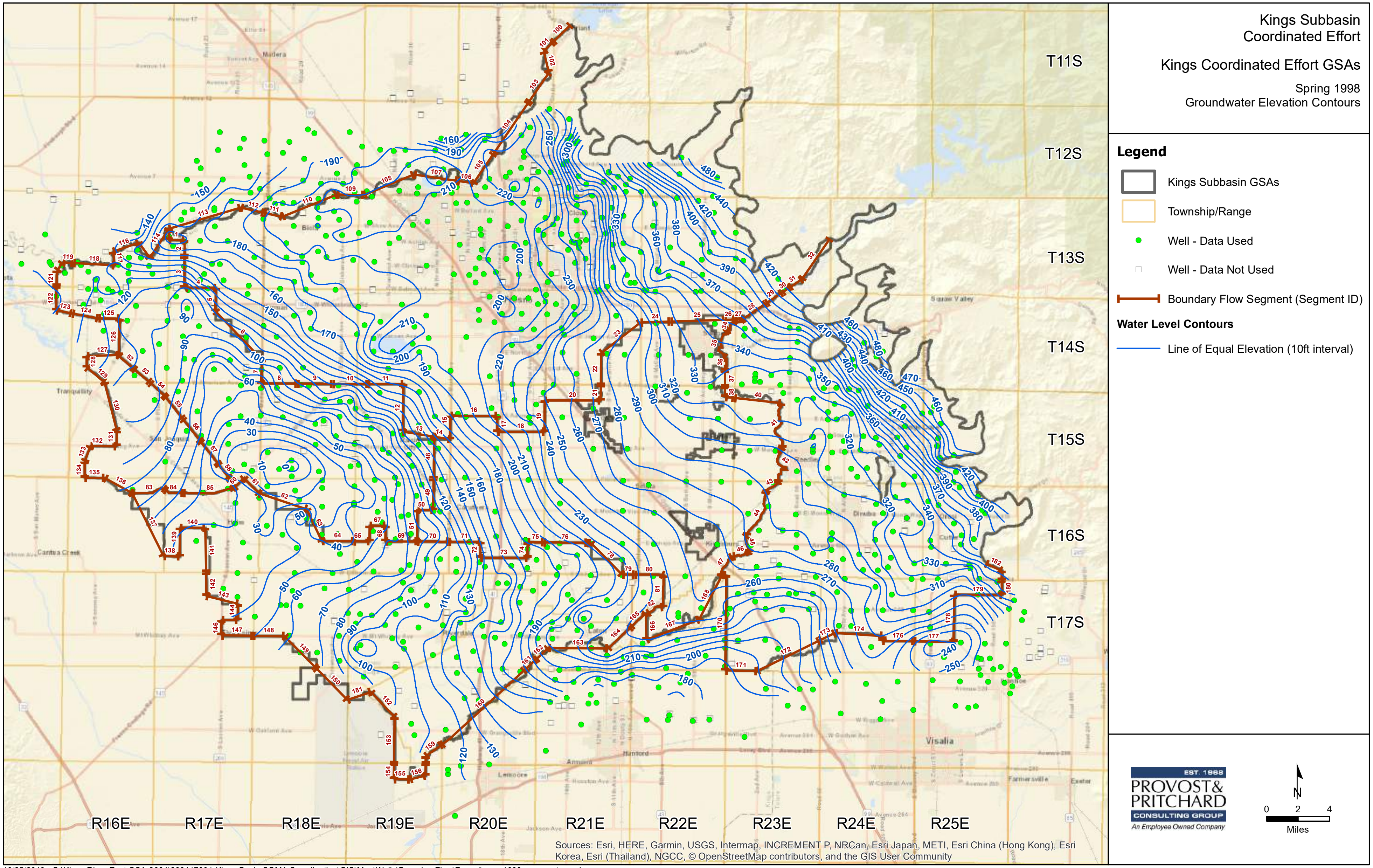

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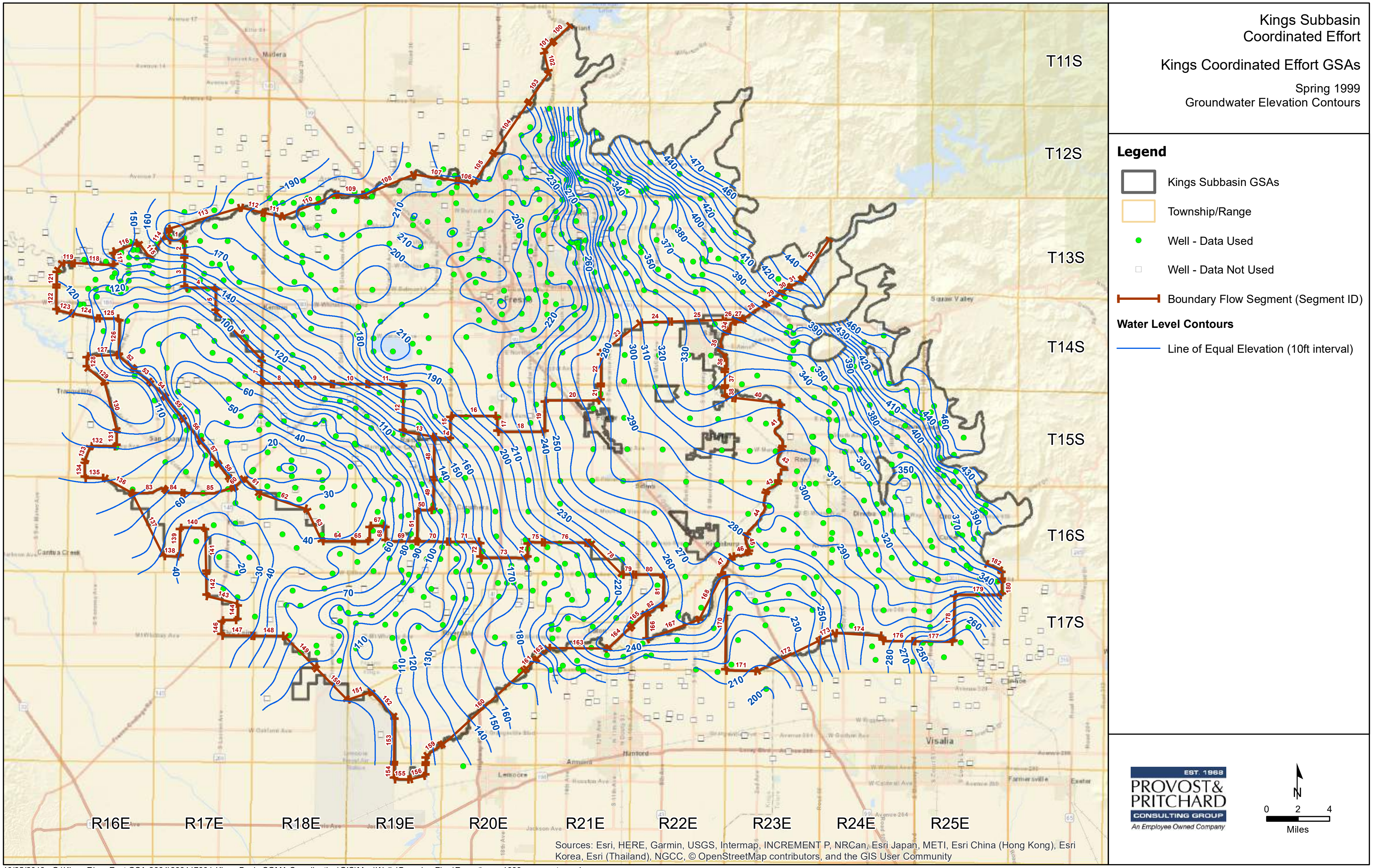

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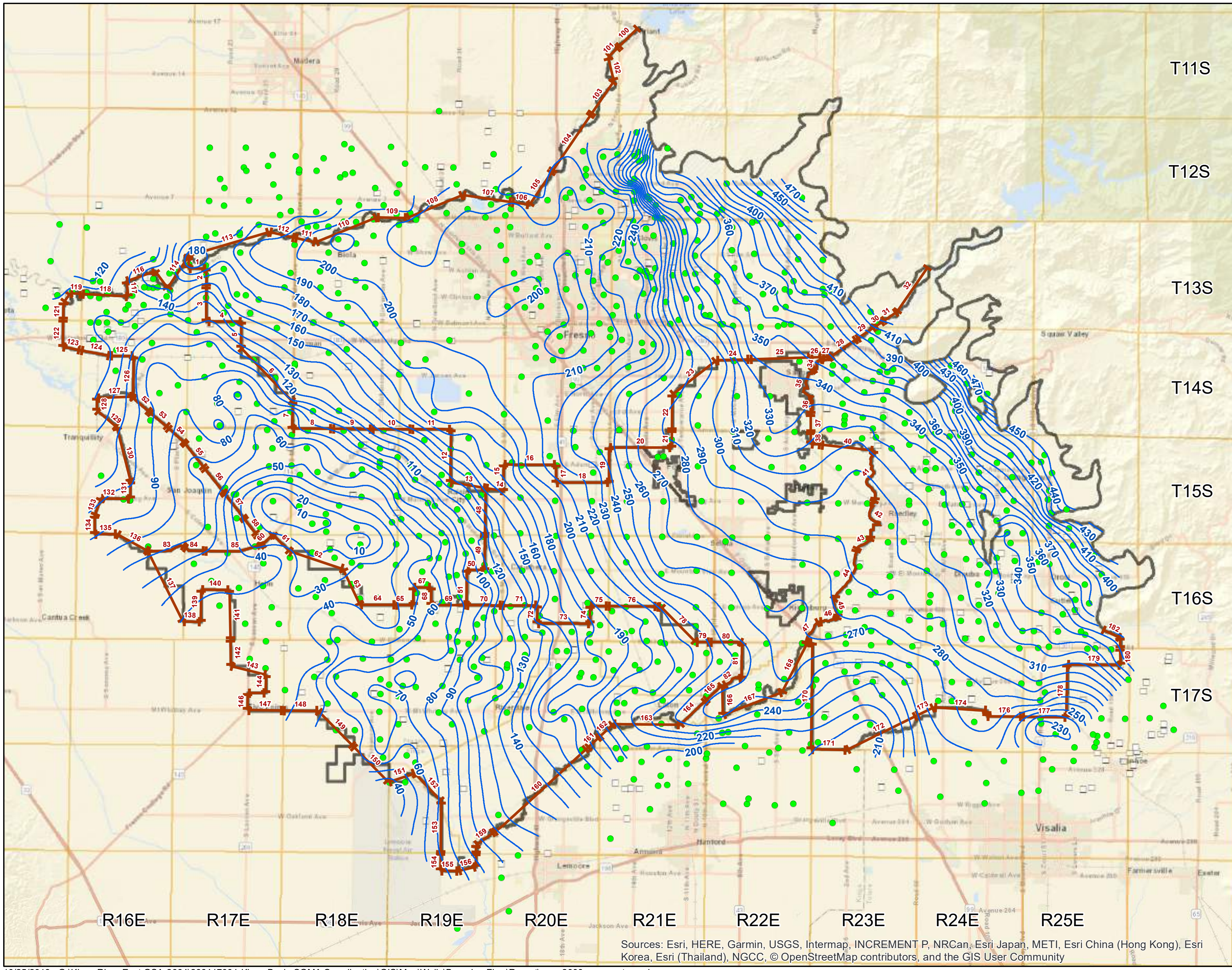

Kings Subbasin Coordinated Effort

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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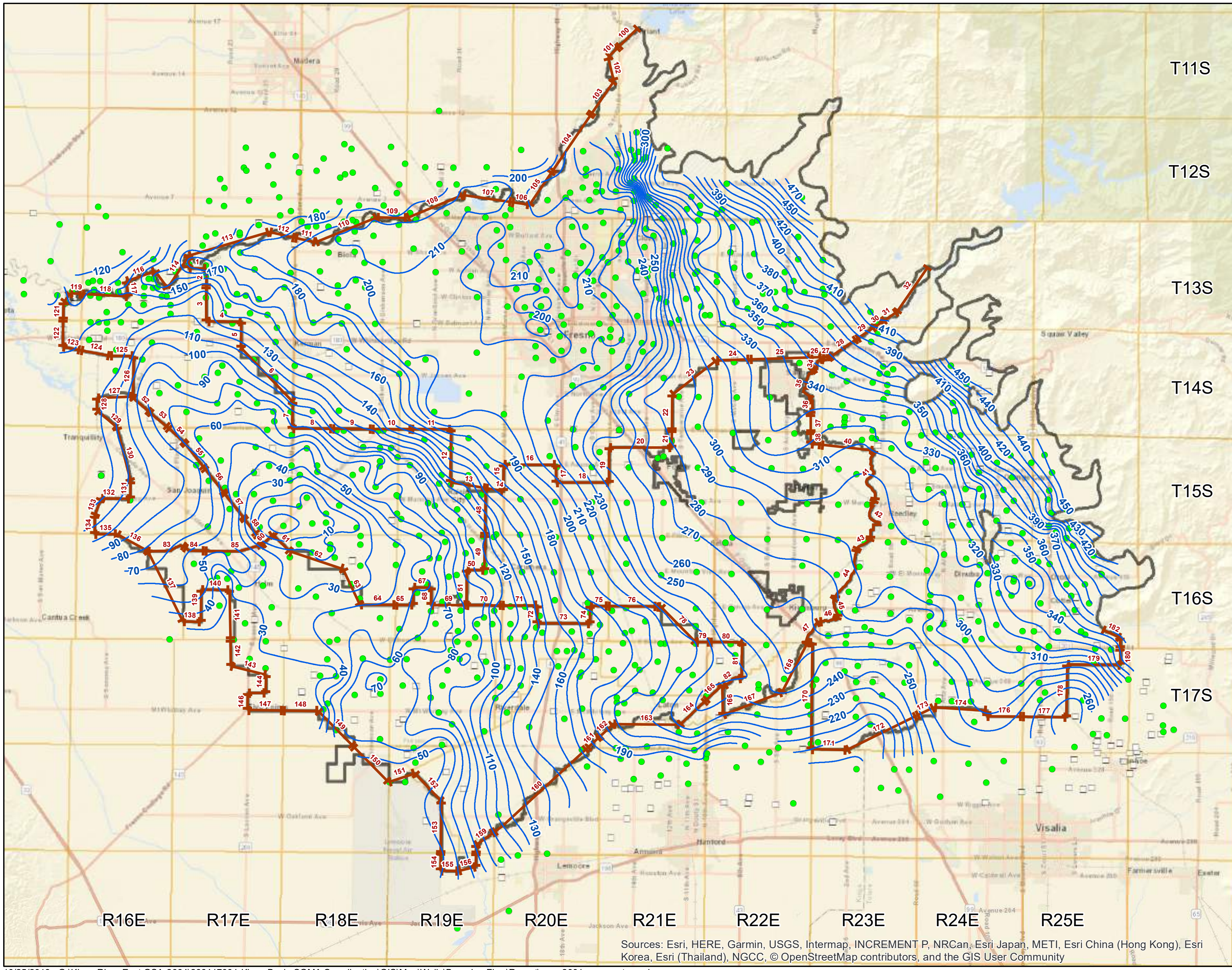
Kings Subbasin
Coordinated Effort

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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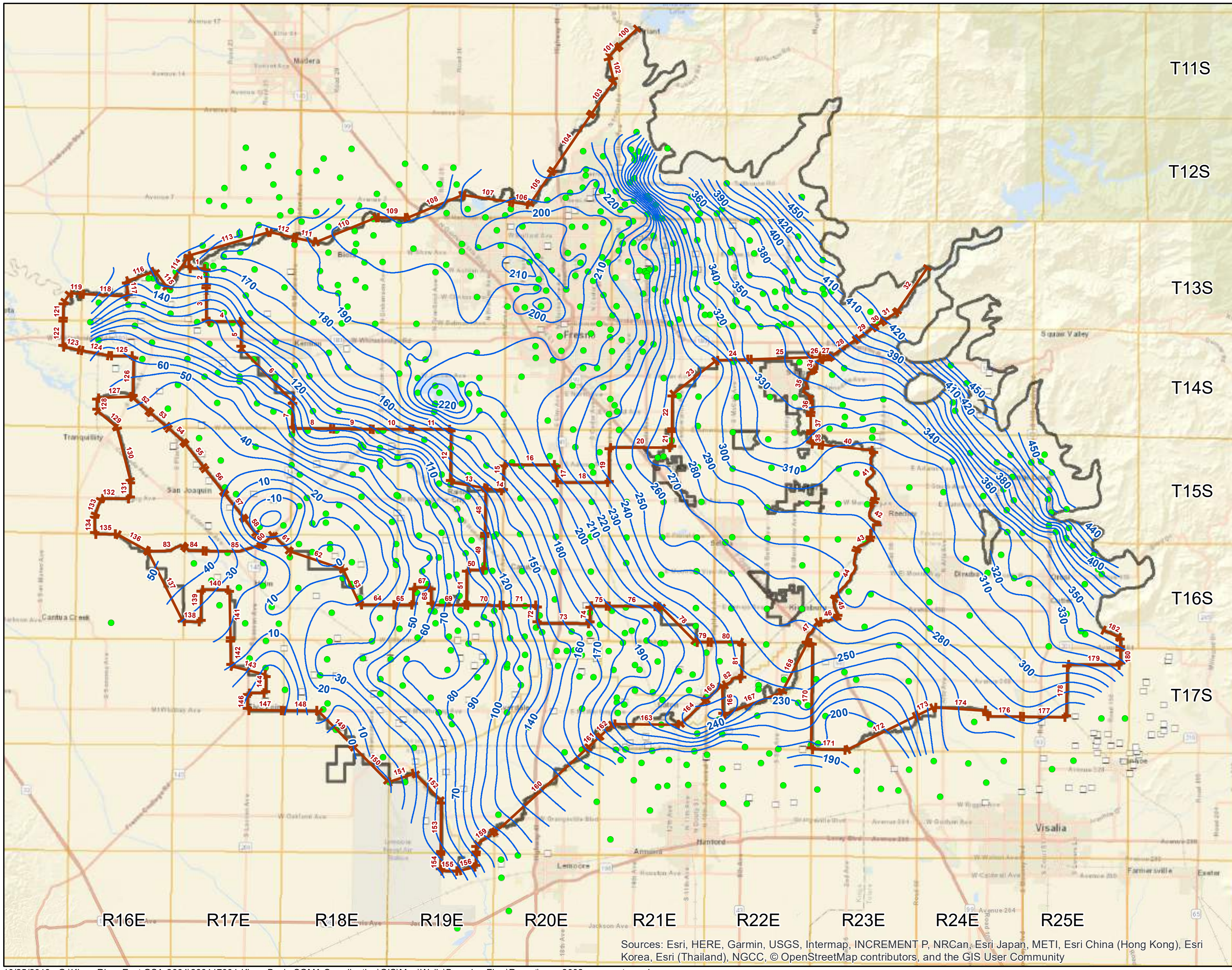
Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2002
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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Miles

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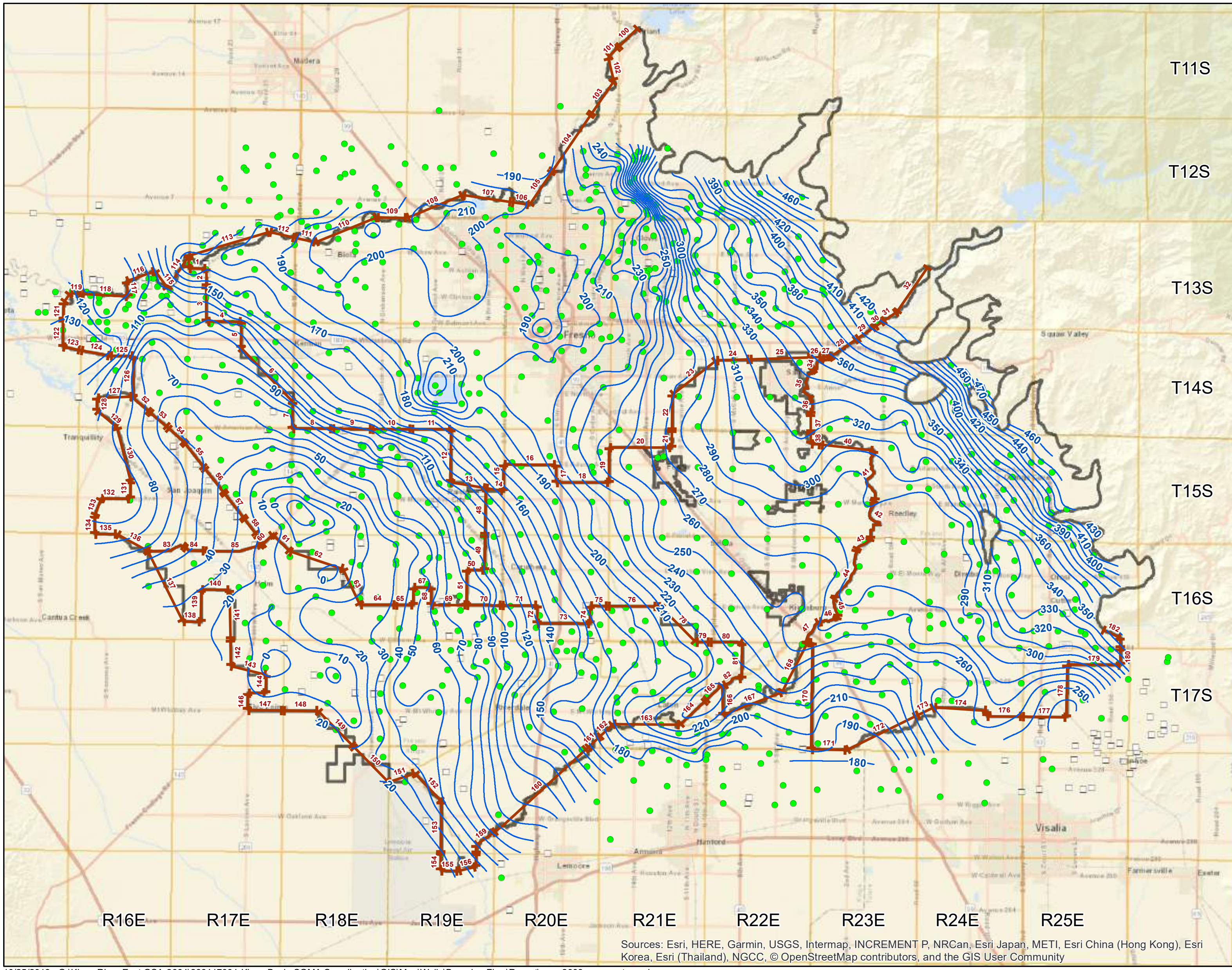
Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2003
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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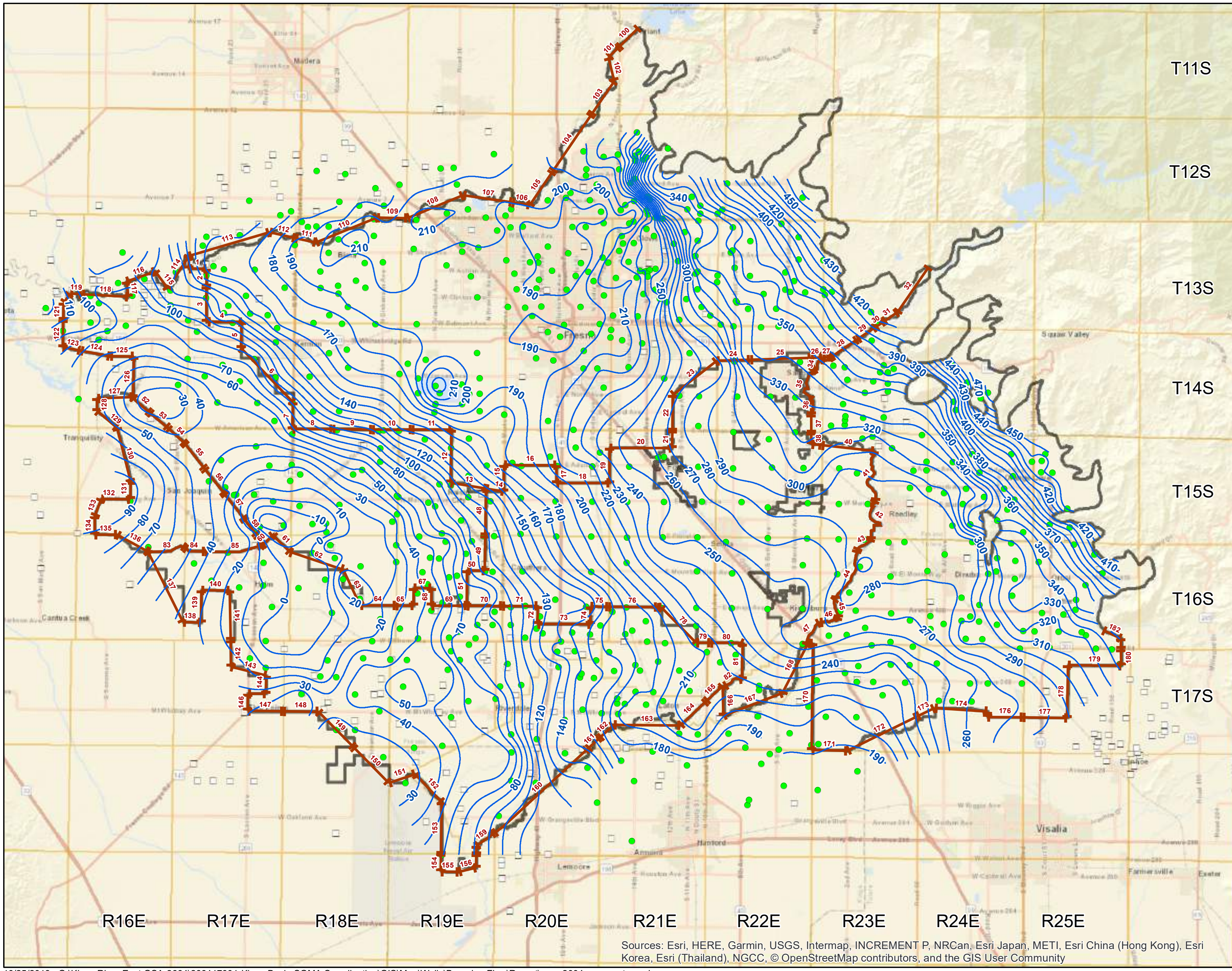

Kings Subbasin Coordinated Effort

Kings Coordinated Effort GSAs

Spring 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)

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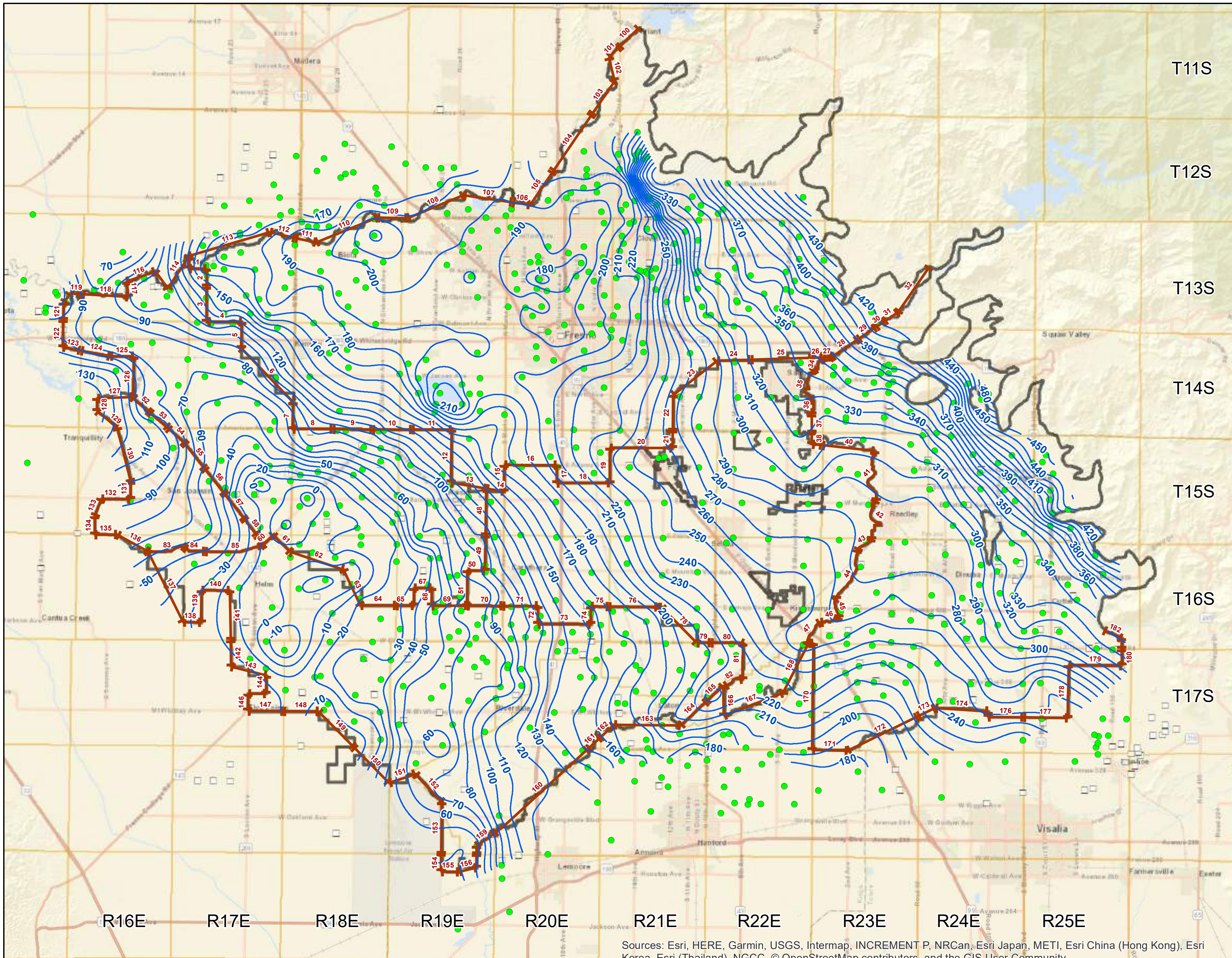
Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2005
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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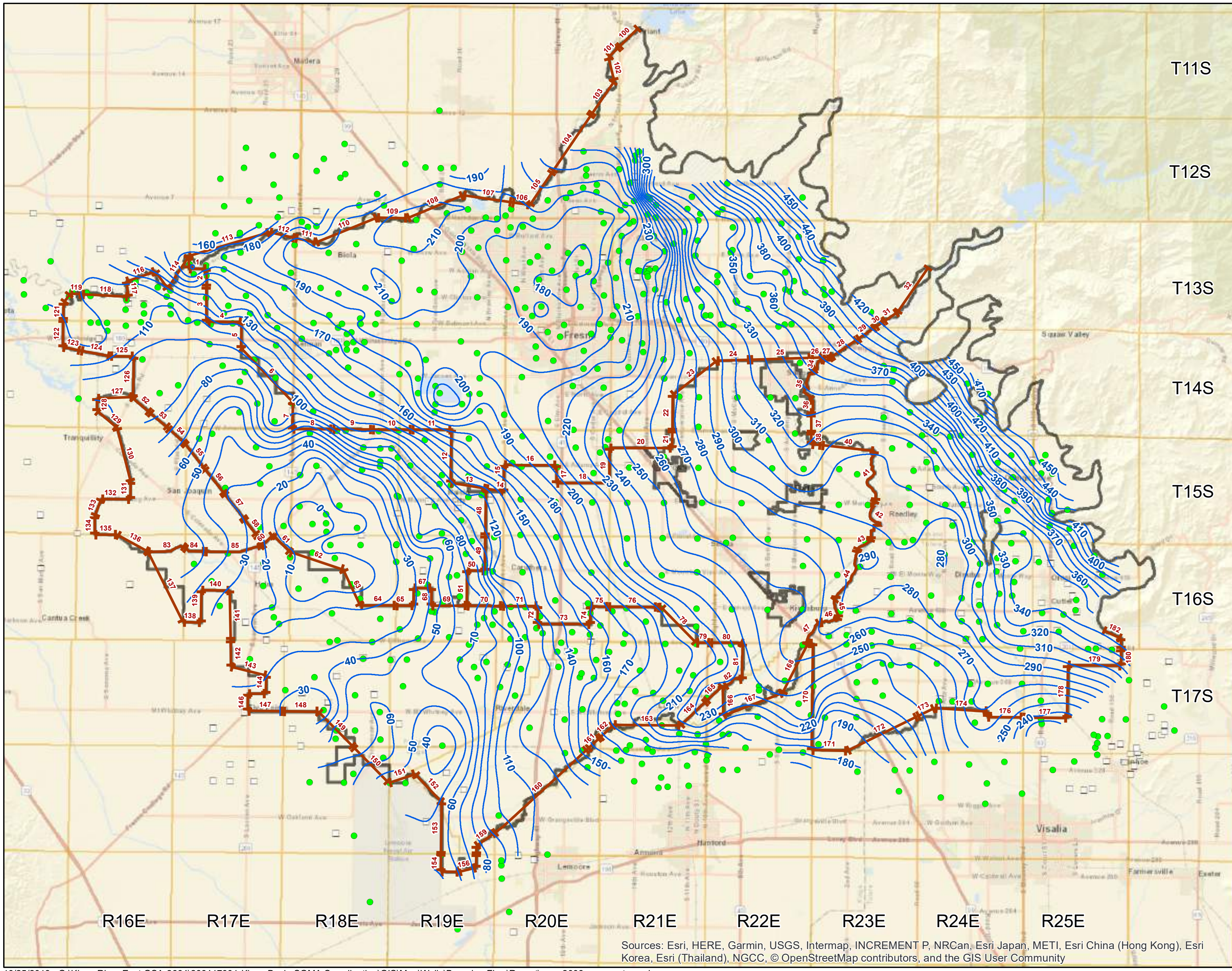

Kings Subbasin Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2006
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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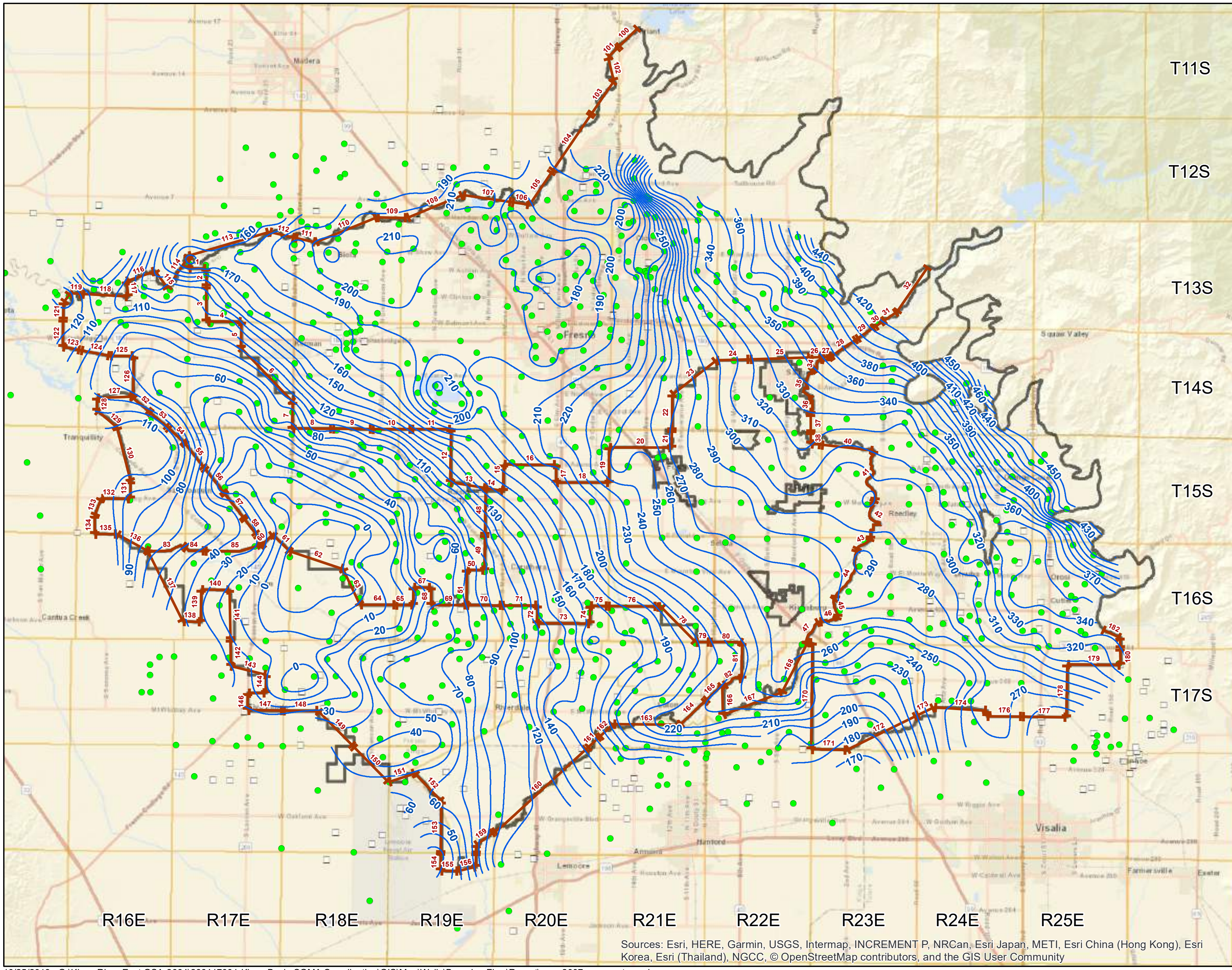

Kings Subbasin Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2007
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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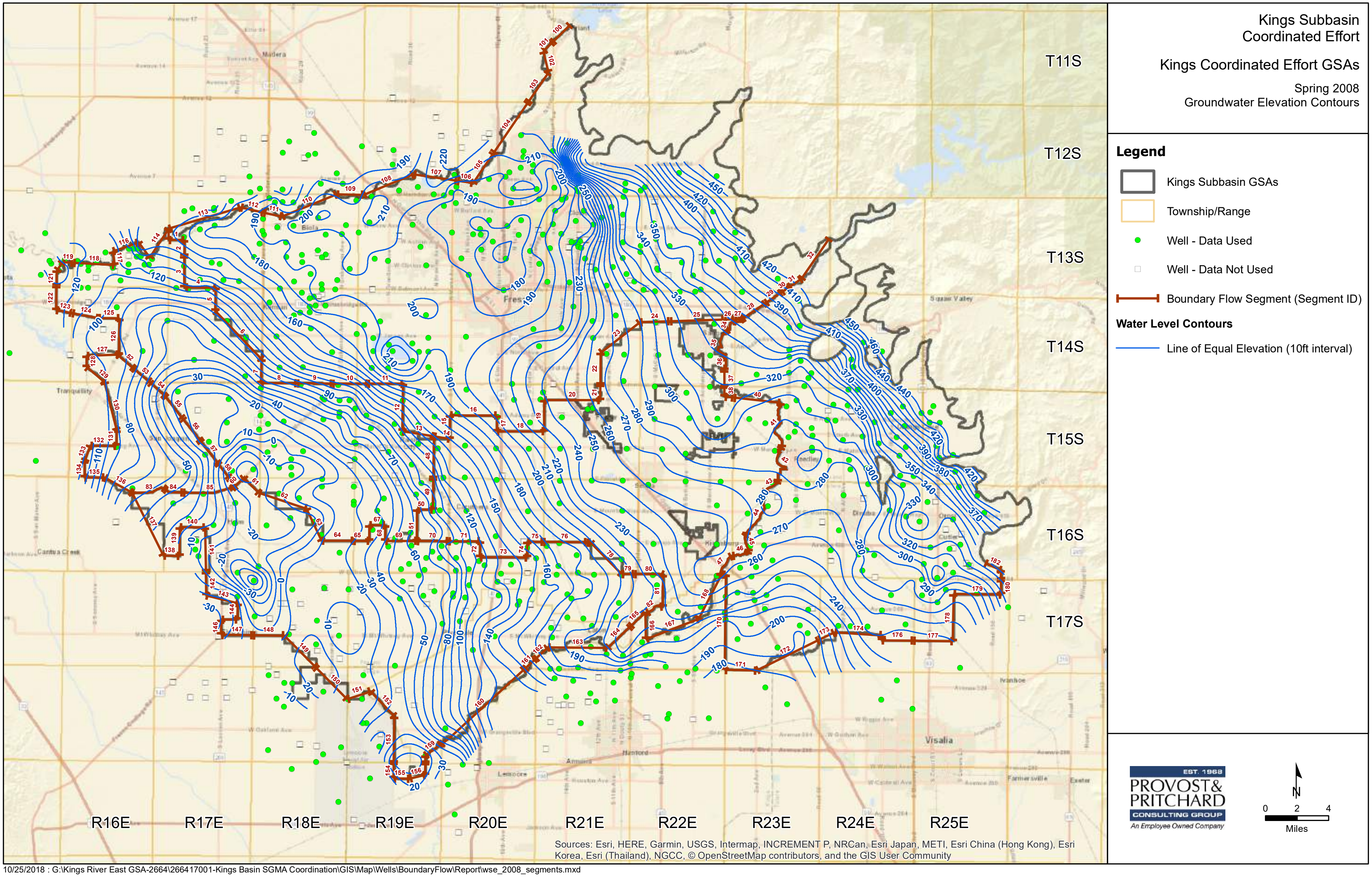
Kings Subbasin
Coordinated Effort
Kings Coordinated Effort GSAs
Spring 2008
Groundwater Elevation Contours
Legend
Kings Subbasin GSAs
Township/Range
Well - Data Used
Well - Data Not Used
Boundary Flow Segment (Segment ID)
Water Level Contours
Line of Equal Elevation (10ft interval)
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T14S
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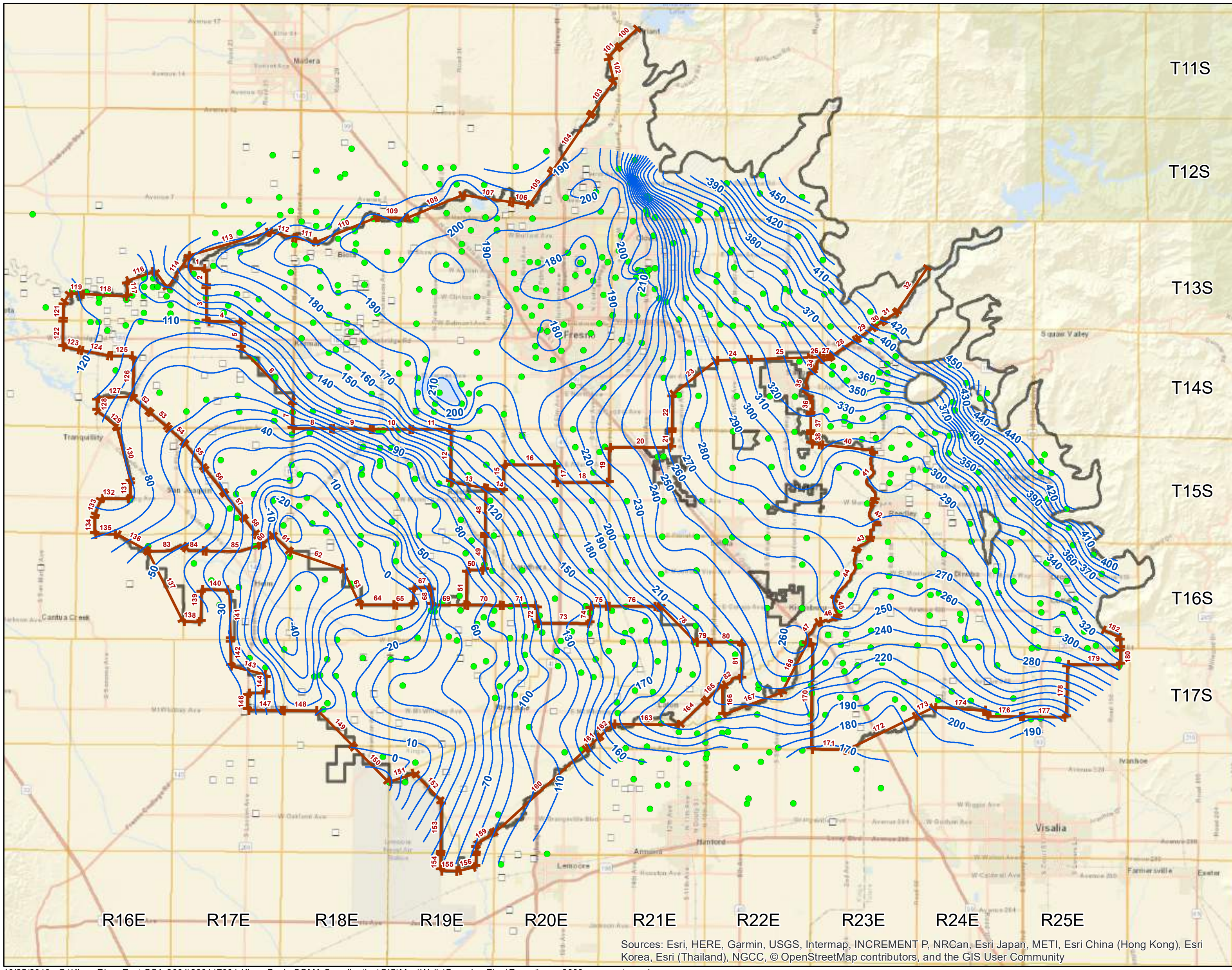

Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2009
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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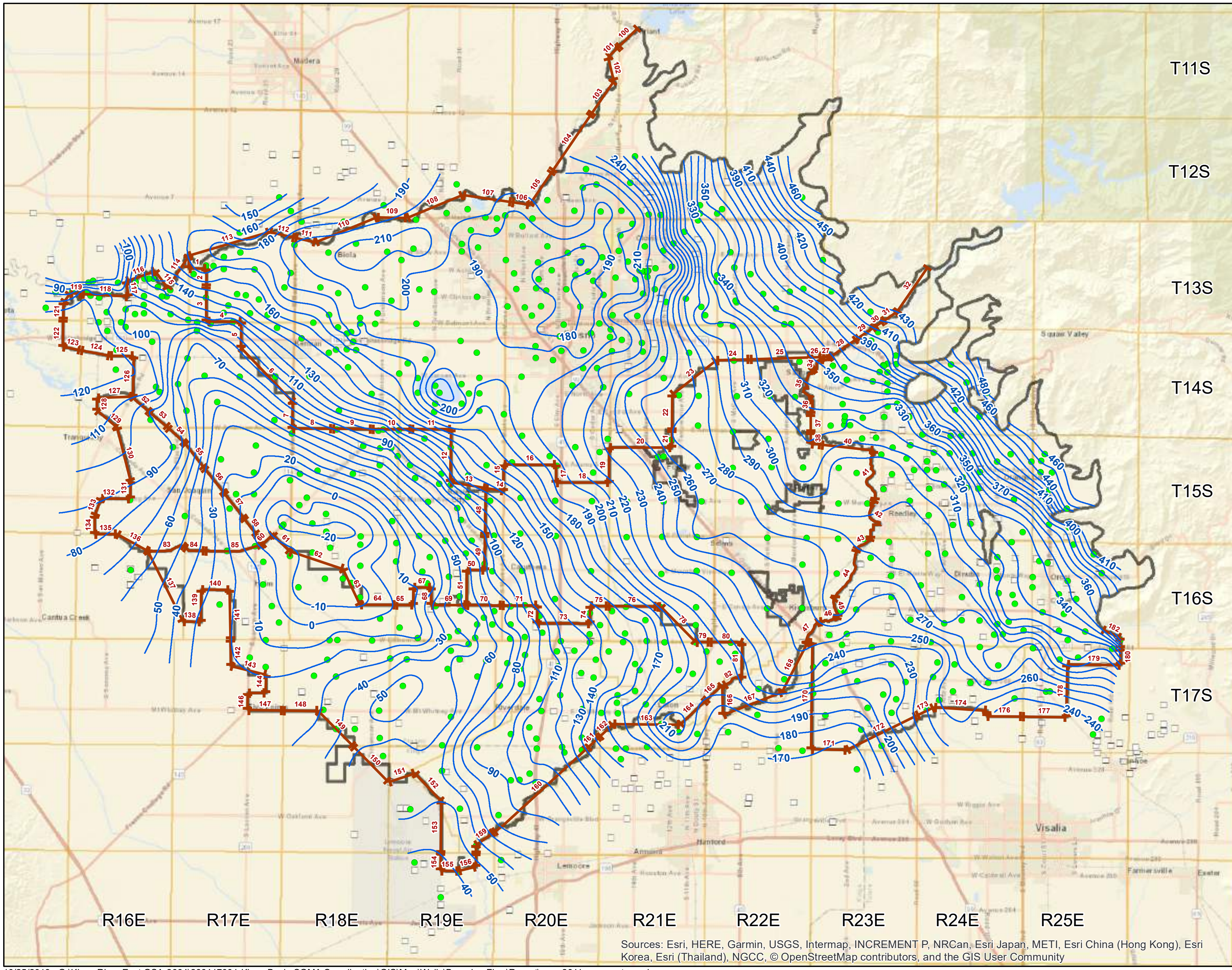
Kings Subbasin
Coordinated Effort

Kings Coordinated Effort GSAs

Spring 2011
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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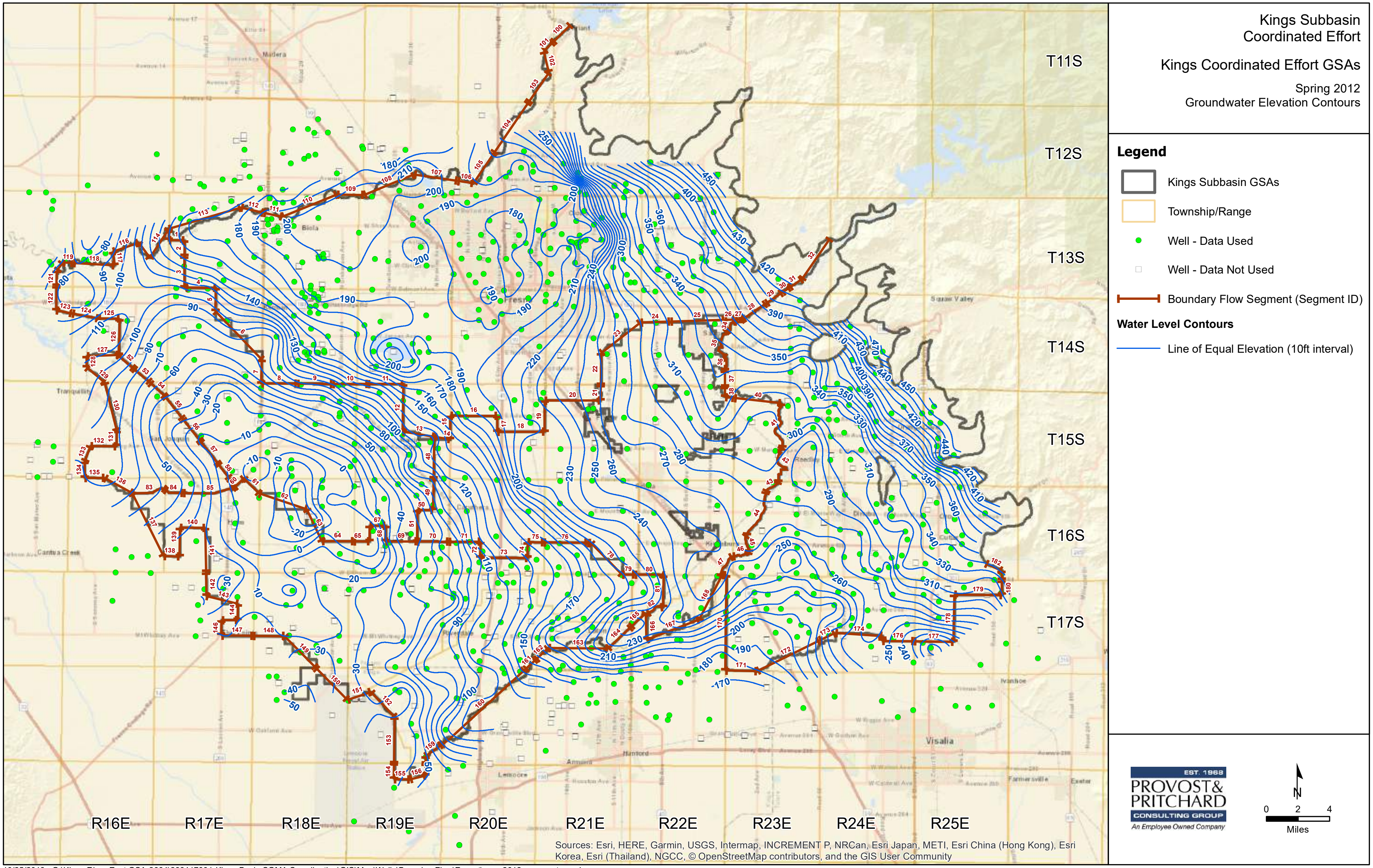

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Attachment 3
Estimated Flows
by Flow Segment

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

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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	0.0014	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

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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

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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 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

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 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

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, 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	0.0017	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

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therefore they are not adjusted for hydrologic base period years

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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.

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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 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

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)
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

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.

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	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	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°)	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	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.

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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 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°)	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
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 360^0)	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
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°)	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
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.

GSA	Neighboring GSA	1925 Internal	1925 External	1997 Internal	1997 External	1998 Internal	1998 External	1999 Internal	1999 External	2000 Internal	2000 External	2001 Internal	2001 External	2002 Internal	2002 External	2003 Internal	2003 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	-17,300	-300	-13,900	2,700
	McMullin	-4,400		-8,000		-7,400		-8,500		-8,500		-8,300		-8,000		-5,200	
	North Fork	-9,500		-15,800		-15,400		-15,600		-15,200		-14,200		-13,200		-8,700	
	Kings River East	0		0		0		0		0		0		0		0	
	North Kings	3,400		-3,100		2,700		-100		2,700		3,500		3,900		0	
	Mid Kings River GSA		-600		-500		-1,100		-1,100		800		1,200		-300		2,700
James		2,500	0	-16,400	4,500	-14,800	200	-45,300	-500	-9,800	11,300	-27,400	16,400	-2,900	0	-13,600	11,400
	McMullin	2,400		-10,100		-13,000		-42,200		-7,800		-24,400		-5,500		-9,600	
	North Fork	100		-6,300		-1,800		-3,100		-2,000		-3,000		2,600		-4,000	
	Fresno County		0		1,400		1,300		100		2,100		2,200		0		3,100
	CDMRMA		0		4,200		500		500		10,900		16,600		0		11,100
	Westlands WD		0		-1,100		-1,600		-1,100		-1,700		-2,400		0		-2,800
Kings River East		0	0	0	5,400	0	-1,600	0	-2,000	0	-2,300	0	-5,200	0	-2,400	0	-2,900
	Central/South Kings	0		0		0		0		0		0		0		0	
	North Kings	0		0		0		0		0		0		0		0	
	Mid Kings River GSA		0		7,800		1,200		4,900		2,800		1,200		700		1,800
	Greater Kaweah GSA		0		-700		-1,600		-4,600		-4,900		-5,300		-2,400		-4,700
	East Kaweah GSA		0		-1,700		-1,200		-2,300		-200		-1,100		-700		0
McMullin		16,600	-300	92,000	5,300	89,600	6,400	113,000	6,400	79,100	8,700	103,300	10,100	81,700	-2,500	83,600	1,800
	North Kings	18,800		69,000		54,300		53,600		56,000		61,100		57,600		65,400	
	Central/South Kings	4,400		8,000		7,400		8,500		8,500		8,300		8,000		5,200	
	North Fork	-4,200		4,900		14,900		8,700		6,800		9,500		10,600		3,400	
	James	-2,400		10,100		13,000		42,200		7,800		24,400		5,500		9,600	
	Aliso WD		0		0		0		0		0		0		0		0
	Farmers WD		0		1,400		1,100		0		-500		1,400		0		0
	Frenso County		-300		3,900		5,300		6,400		9,200		8,700		-2,500		1,800
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	0	-4,300	9,300	-6,000
	Central/South Kings	9,500		15,800		15,400		15,600		15,200		14,200		13,200		8,700	
	McMullin	4,200		-4,900		-14,900		-8,700		-6,800		-9,500		-10,600		-3,400	
	James	-100		6,300		1,800		3,100		2,000		3,000		-2,600		4,000	
	Westlands WD		0		-1,600		-2,700		1,900		-11,600		-11,100		-9,000		-4,100
	South Fork Kings GSA		0		300		0		0		-400		0		-700		-500
	Mid Kings River GSA		500		2,500		600		1,000		2,600		100		5,400		-1,400
North Kings		-22,200	0	-65,900	0	-57,000	0	-53,500	0	-58,700	0	-64,600	0	-61,500	0	-65,400	0
	Kings River East	0		0		0		0		0		0		0		0	
	McMullin	-18,800		-69,000		-54,300		-53,600		-56,000		-61,100		-57,600		-65,400	
	Central/South Kings	-3,400		3,100		-2,700		100		-2,700		-3,500		-3,900		0	
	Madera County		0		0		0		0		0		0		0		0
	Root Creek WD		0		0		0		0		0		0		0		0
	Madera ID		0		0		0		0		0		0		0		0

GSA	Neighboring GSA	2004 Internal	2004 External	2005 Internal	2005 External	2006 Internal	2006 External	2007 Internal	2007 External	2008 Internal	2008 External	2009 Internal	2009 External	2011 Internal	2011 External	2012 Internal	2012 External	Average 97-12 Internal	Average 97-12 External
Central/South Kings		-7,500	700	-20,000	2,200	-21,400	2,500	-23,500	-1,100	-17,900	-400	-15,900	-1,000	-21,900	-400	-34,800	2,300	-20,400	400
	McMullin	-4,800		-7,300		-7,000		-9,000		-8,700		-5,700		-8,100		-10,300		-7,700	
	North Fork	-6,100		-11,300		-17,400		-19,500		-15,100		-15,500		-19,700		-24,100		-15,100	
	Kings River East	0		0		0		0		0		0		0		0		0	
	North Kings	3,400		-1,400		3,000		5,000		5,900		5,300		5,900		-400		2,400	
	Mid Kings River GSA		700		2,200		2,500		-1,100		-400		-1,000		-400		2,300		400
James		-20,000	13,200	-30,400	6,100	-4,700	1,300	-39,800	600	-24,100	21,500	-20,600	12,000	-13,700	8,100	-4,300	8,600	-19,200	7,700
	McMullin	-17,800		-23,400		-4,300		-32,400		-19,600		-15,100		-13,700		-3,600		-16,200	
	North Fork	-2,200		-7,000		-400		-7,400		-4,500		-5,500		0		-700		-3,000	
	Fresno County		2,000		300		1,300		-4,700		-200		4,100		3,300		3,400		1,300
	CDMRMA		12,600		5,800		0		3,900		22,800		9,900		5,000		6,800		7,400
	Westlands WD		-1,400		0		0		1,400		-1,100		-2,000		-200		-1,600		-1,000
Kings River East		0	1,800	0	-7,500	0	-3,000	0	-1,700	0	-5,900	0	-2,600	0	-1,600	0	200	0	-2,100
	Central/South Kings	0		0		0		0		0		0		0		0		0	
	North Kings	0		0		0		0		0		0		0		0		0	
	Mid Kings River GSA		2,200		100		3,700		3,900		-600		6,800		1,700		1,200		2,600
	Greater Kaweah GSA		-1,000		-6,900		-6,500		-5,800		-5,300		-9,300		-3,400		-1,600		-4,300
	East Kaweah GSA		600		-700		-200		200		0		-100		100		600		-400
McMullin		89,100	200	95,300	33,700	79,700	-7,600	110,400	2,400	95,000	1,200	88,900	5,800	93,000	2,400	80,700	20,300	91,700	6,300
	North Kings	67,600		66,300		66,700		72,100		71,600		68,200		72,000		67,200		64,600	
	Central/South Kings	4,800		7,300		7,000		9,000		8,700		5,700		8,100		10,300		7,700	
	North Fork	-1,100		-1,700		1,700		-3,100		-4,900		-100		-800		-400		3,200	
	James	17,800		23,400		4,300		32,400		19,600		15,100		13,700		3,600		16,200	
	Aliso WD		0		0		0		0		0		0		0		0		0
	Farmers WD		1,700		2,000		-900		0		-600		100		-600		2,300		500
	Frenso County		-1,500		31,700		-6,700		2,400		1,800		5,700		3,000		18,000		5,800
North Fork Kings		9,400	-2,800	20,000	800	16,100	-3,100	30,000	18,900	24,500	19,700	21,100	13,300	20,500	-800	25,200	3,700	14,900	1,400
	Central/South Kings	6,100		11,300		17,400		19,500		15,100		15,500		19,700		24,100		15,100	
	McMullin	1,100		1,700		-1,700		3,100		4,900		100		800		400		-3,200	
	James	2,200		7,000		400		7,400		4,500		5,500		0		700		3,000	
	Westlands WD		-1,300		2,300		-3,000		17,100		16,600		12,800		1,600		4,300		800
	South Fork Kings GSA		0		100		-100		300		1,300		0		-400		600		0
	Mid Kings River GSA		-1,500		-1,600		0		1,500		1,800		500		-2,000		-1,200		600
North Kings		-71,000	0	-64,900	0	-69,700	0	-77,100	0	-77,500	0	-73,500	0	-77,900	0	-66,800	0	-67,000	0
	Kings River East	0		0		0		0		0		0		0		0		0	
	McMullin	-67,600		-66,300		-66,700		-72,100		-71,600		-68,200		-72,000		-67,200		-64,600	
	Central/South Kings	-3,400		1,400		-3,000		-5,000		-5,900		-5,300		-5,900		400		-2,400	
	Madera County		0		0		0		0		0		0		0		0		0
	Root Creek WD		0		0		0		0		0		0		0		0		0
	Madera ID		0		0		0		0		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

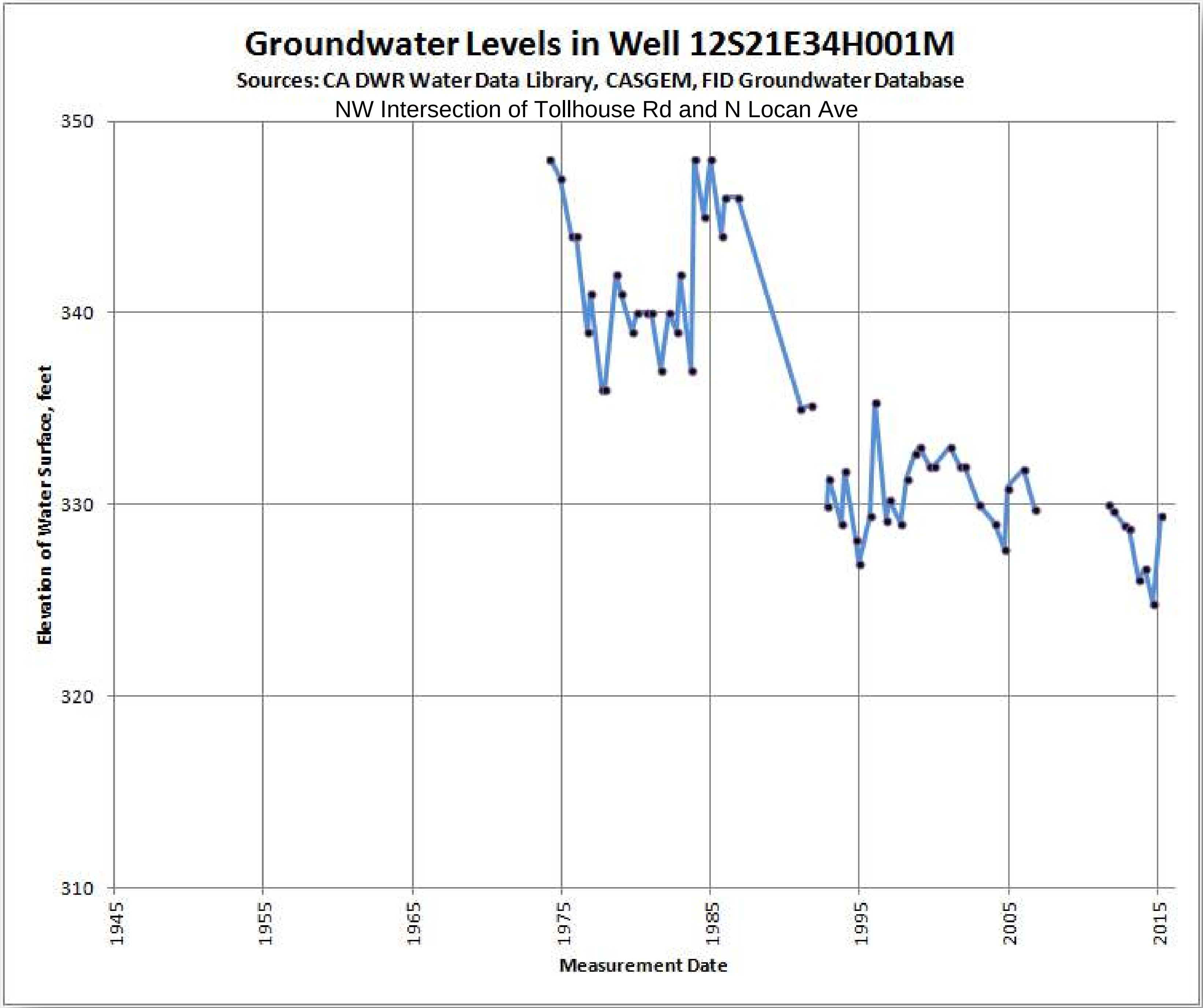
Alternatives Table

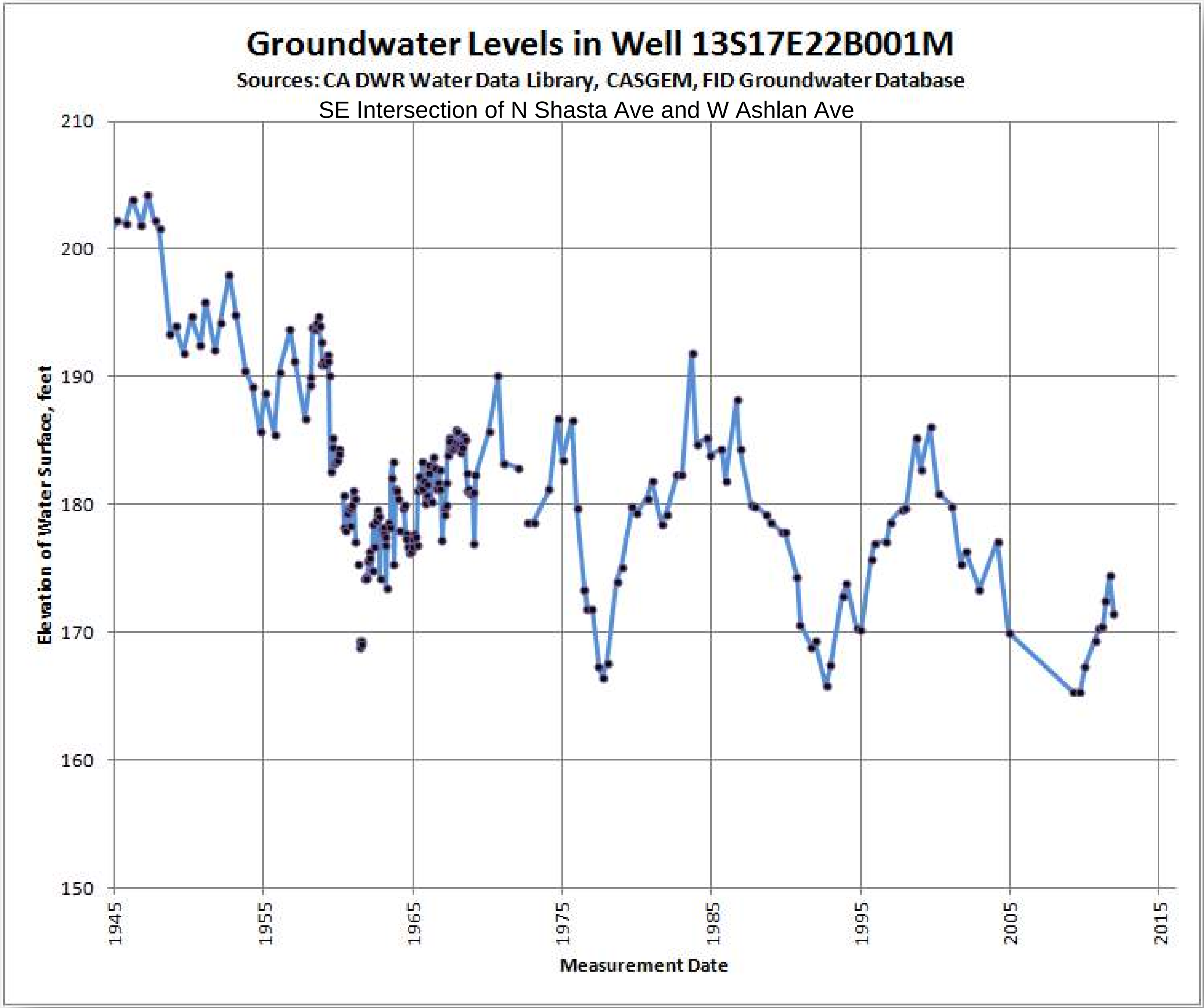
Kings Basin Methodology Alternatives for Proportionment of Storage Change
10/24/2018

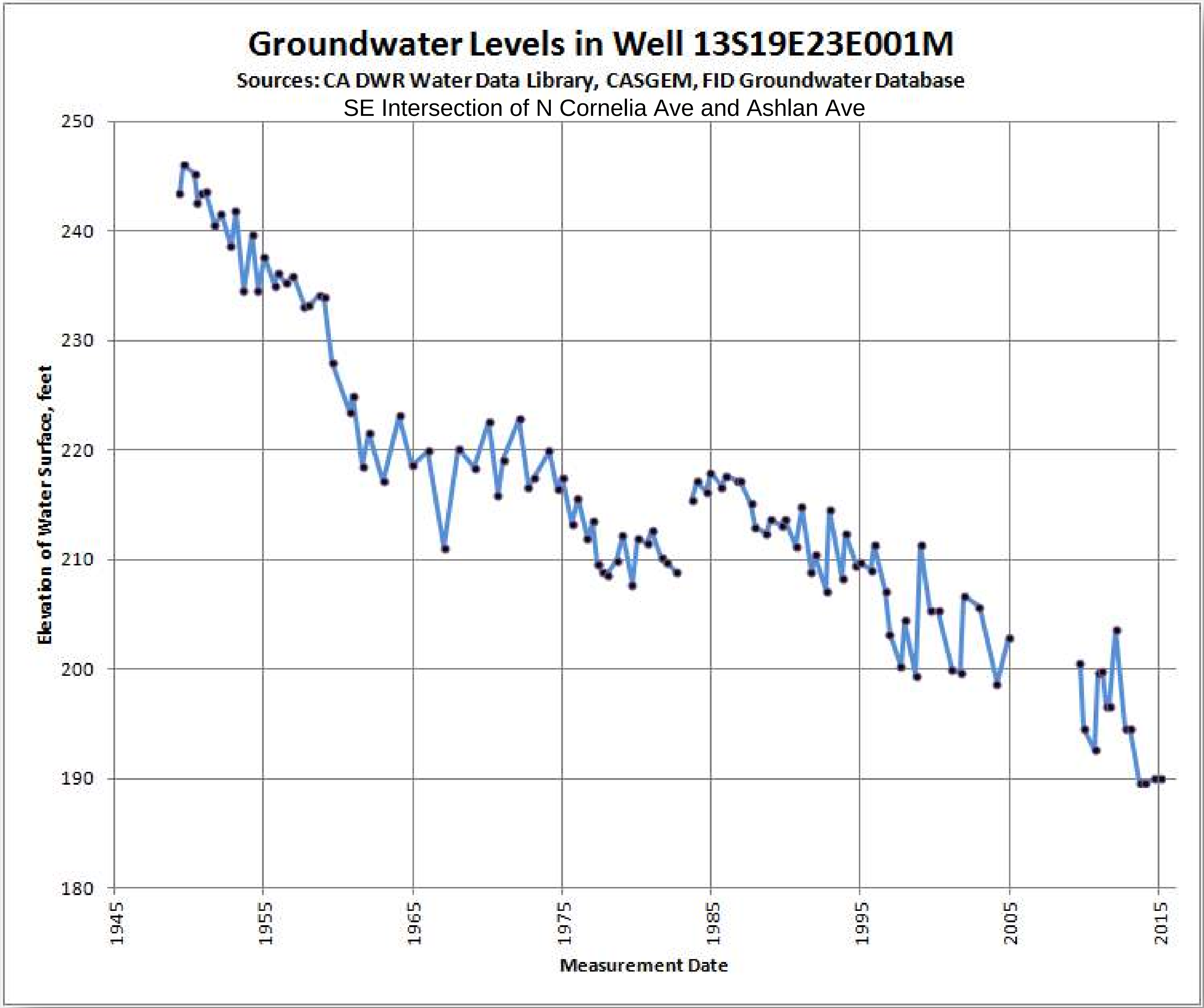
Column #	1	2	3	4	5	6	7
	Alt 1		**Alt 2**	**Alt 3**		**Alt 4**	
Methodology	**Equal Distribution**		**Storage Change Only**	**Storage Change +/- Recent Boundary Flows**		**Storage Change +/- Difference between Historic and Recent Boundary Flows**	
Column Calculation					3 - 4		3 - (4 - 6)
GSA	Acreage	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.

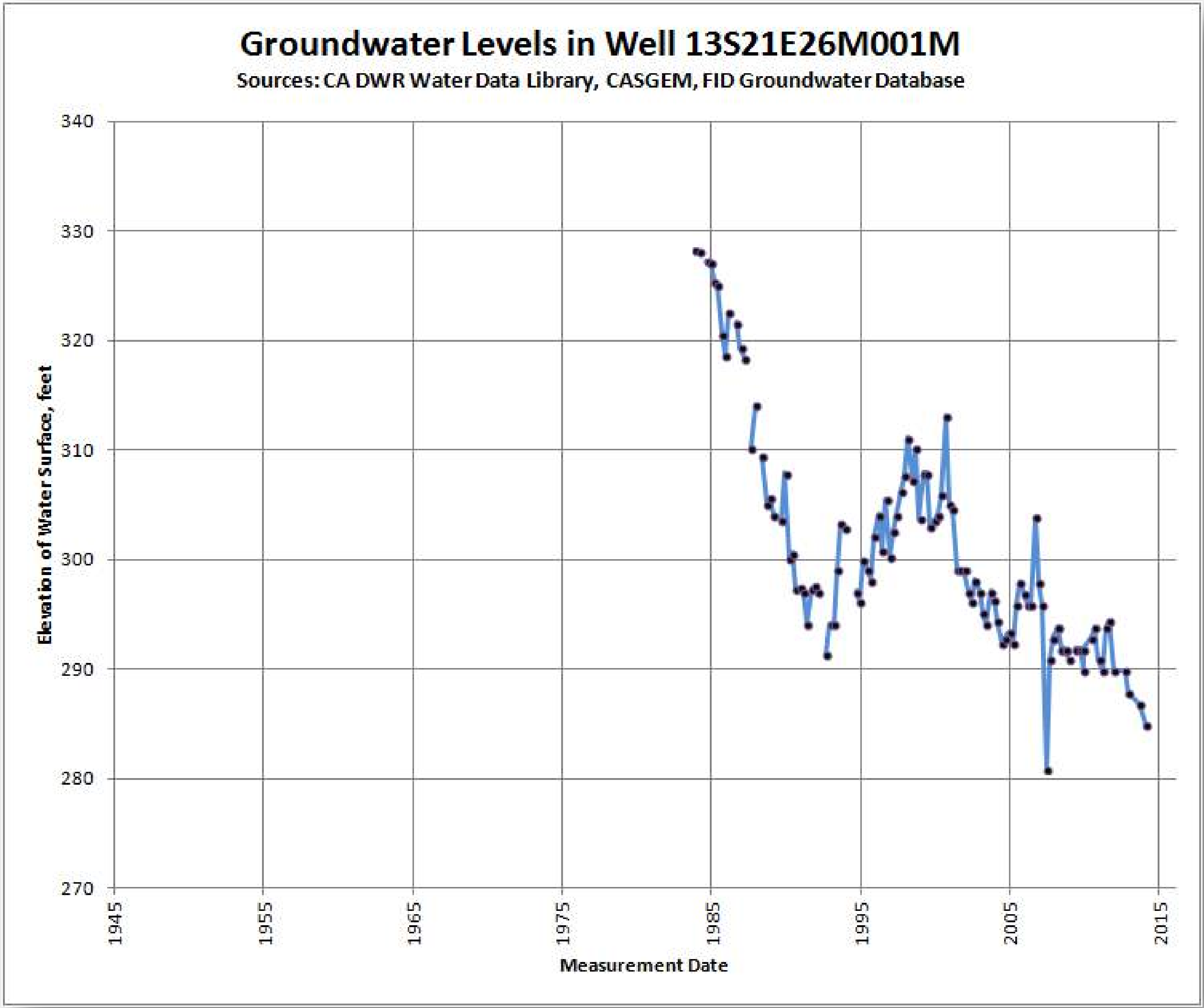
Appendix 3 B Hydrographs

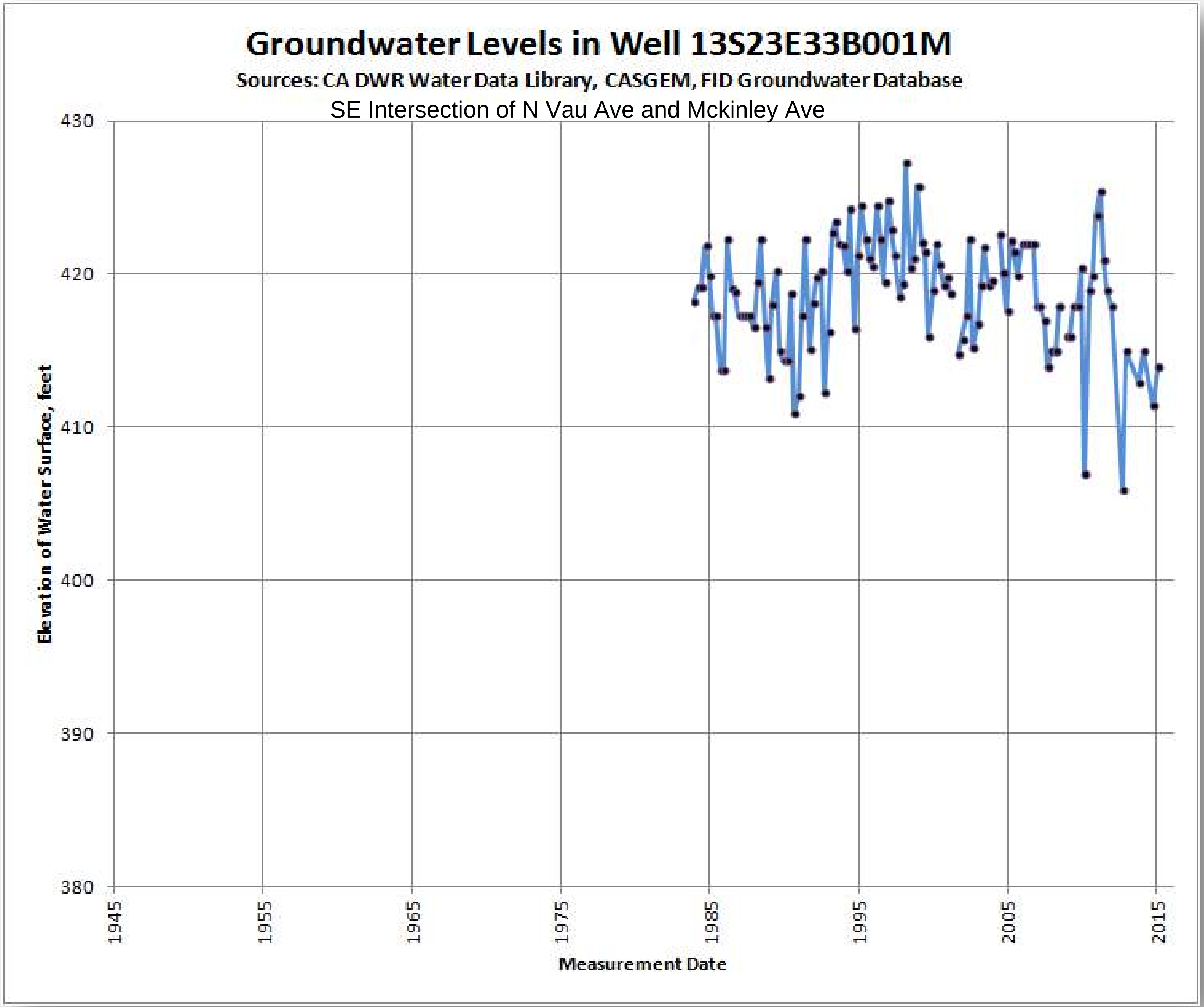

Groundwater Levels in Well 12S21E34H001M
Sources: CA DWR Water Data Library, CASGEM, FID Groundwater Database
NW Intersection of Tollhouse Rd and N Locan Ave
Elevation of Water Surface, feet
350
340
330
320
310
1945
1955
1965
1975
1985
1995
2005
2015
Measurement Date


Groundwater Levels in Well 13S17E22B001M
Sources: CA DWR Water Data Library, CASGEM, FID Groundwater Database
SE Intersection of N Shasta Ave and W Ashlan Ave
Elevation of Water Surface, feet
210
200
190
180
170
160
150
1945
1955
1965
1975
1985
1995
2005
2015
Measurement Date

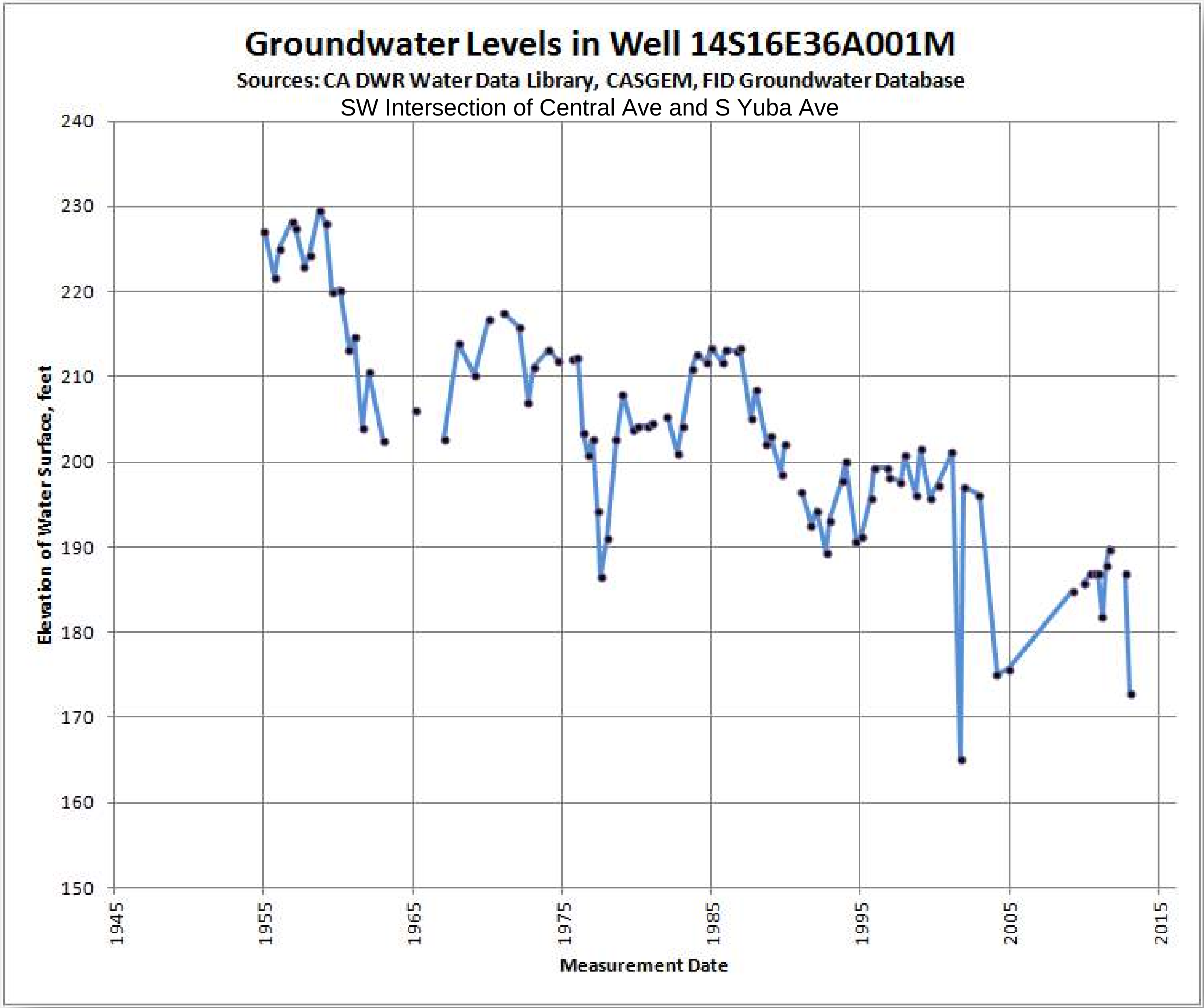


Groundwater Levels in Well 13S19E23E001M
Sources: CA DWR Water Data Library, CASGEM, FID Groundwater Database
SE Intersection of N Cornelia Ave and Ashlan Ave
Elevation of Water Surface, feet
250
240
230
220
210
200
190
180
1945
1955
1965
1975
1985
1995
2005
2015
Measurement Date

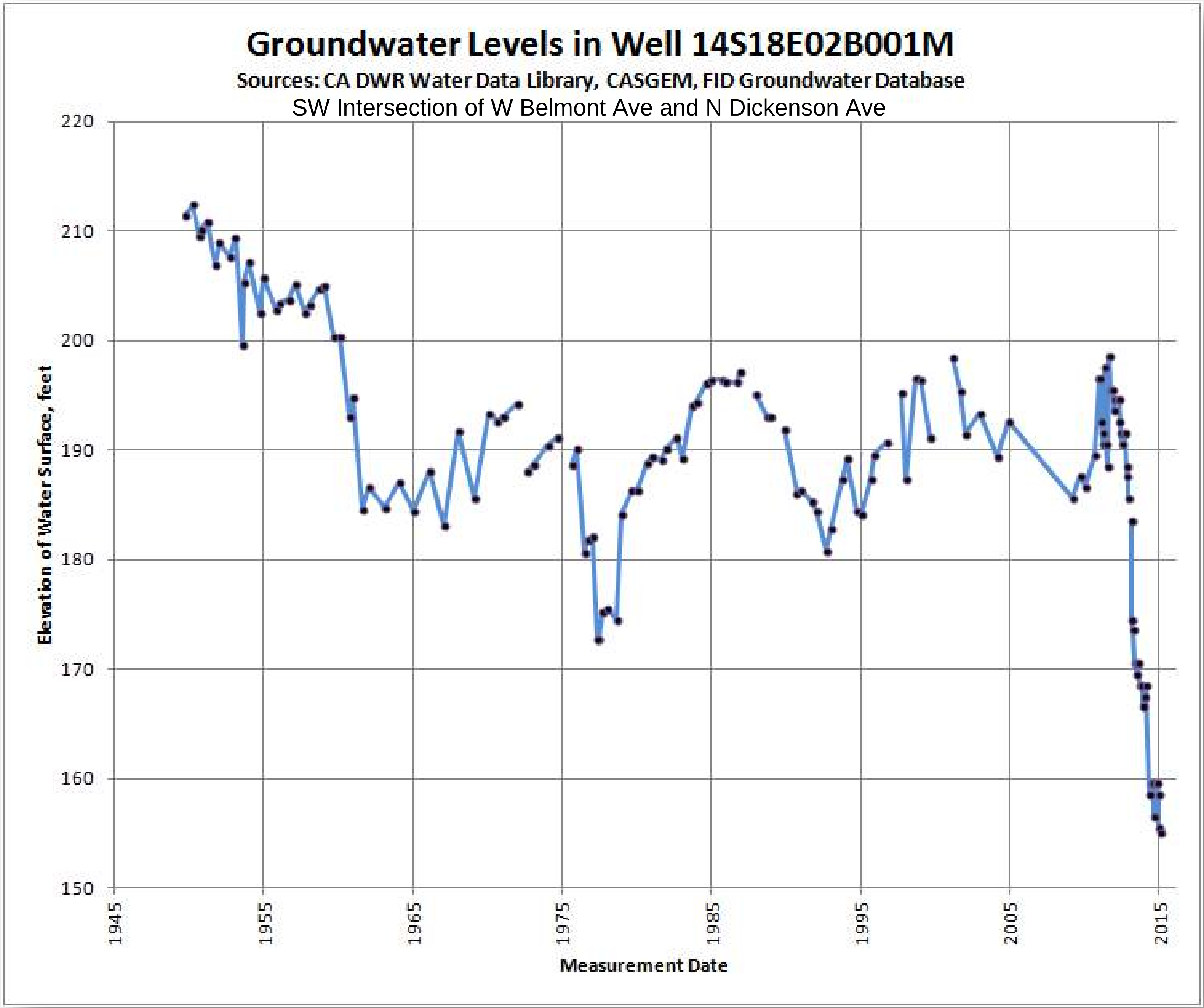

Groundwater Levels in Well 13S21E26M001M
Sources: CA DWR Water Data Library, CASGEM, FID Groundwater Database
Elevation of Water Surface, feet
340
330
320
310
300
290
280
270
1945
1955
1965
1975
1985
1995
2005
2015
Measurement Date



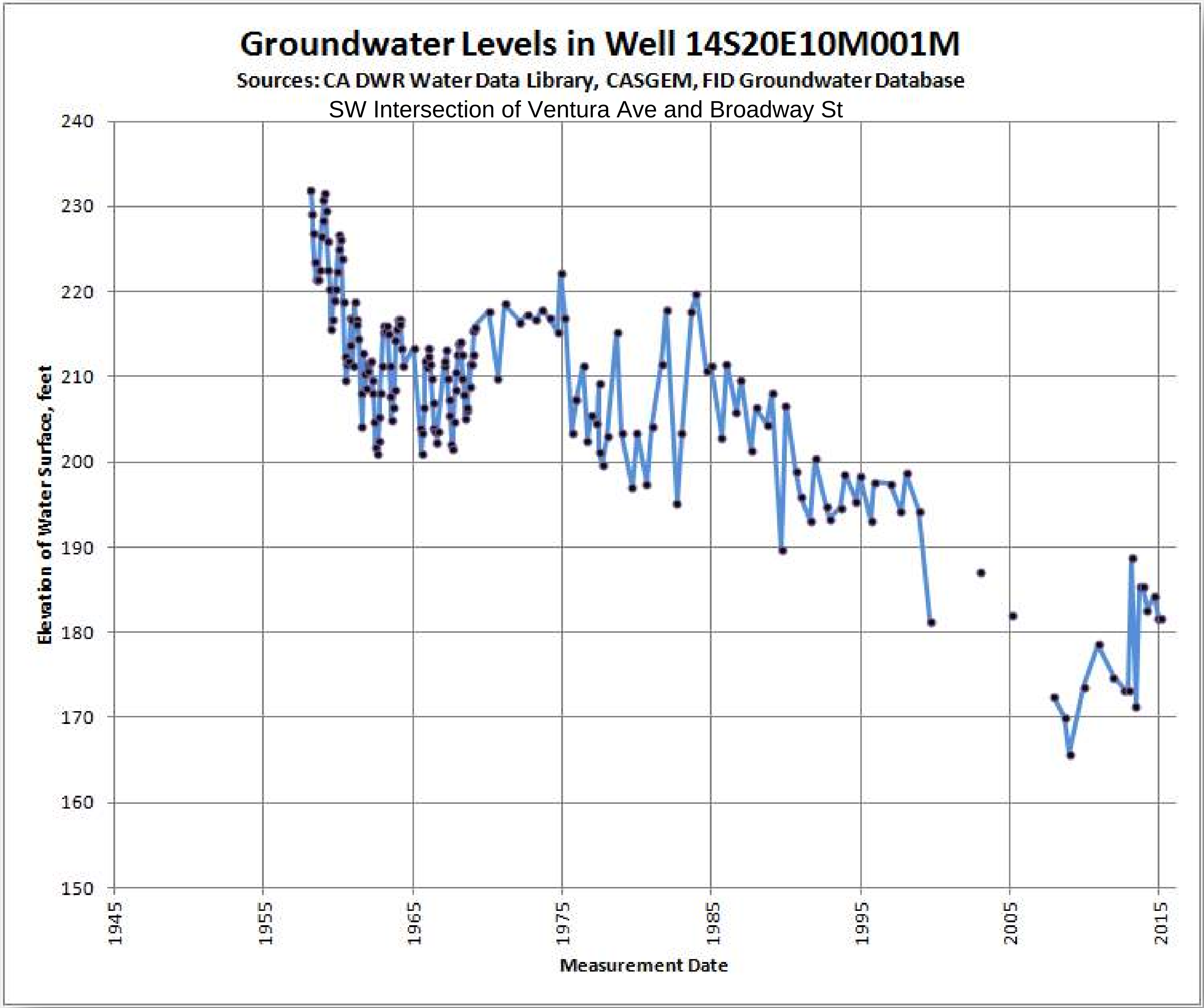
Groundwater Levels in Well 13S23E33B001M
Sources: CA DWR Water Data Library, CASGEM, FID Groundwater Database
SE Intersection of N Vau Ave and Mckinley Ave
430
420
410
400
390
380
Elevation of Water Surface, feet
1945
1955
1965
1975
1985
1995
2005
2015
Measurement Date

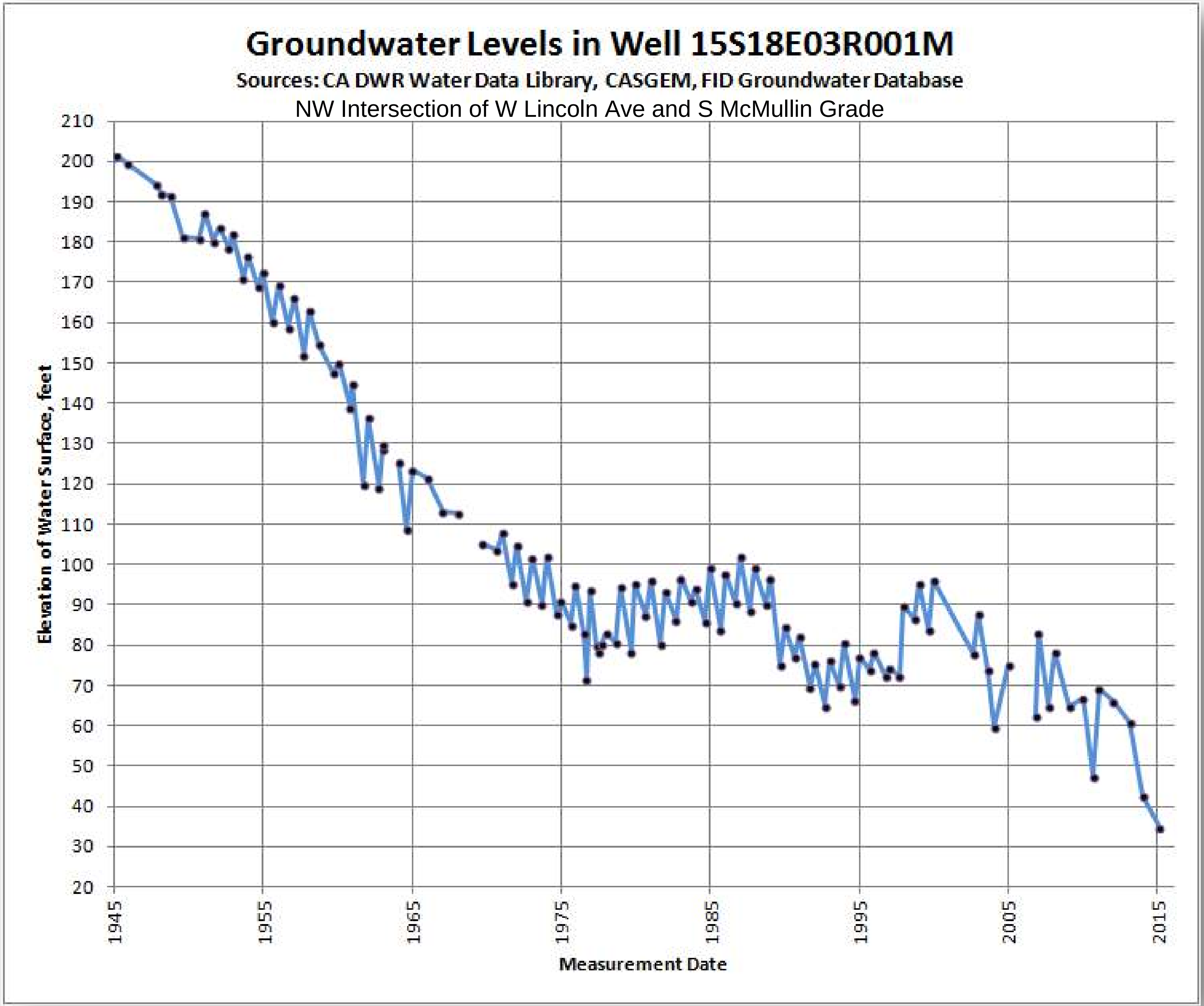


Groundwater Levels in Well 14S16E36A001M
Sources: CA DWR Water Data Library, CASGEM, FID Groundwater Database
SW Intersection of Central Ave and S Yuba Ave
Elevation of Water Surface, feet
240
230
220
210
200
190
180
170
160
150
1945
1955
1965
1975
1985
1995
2005
2015
Measurement Date

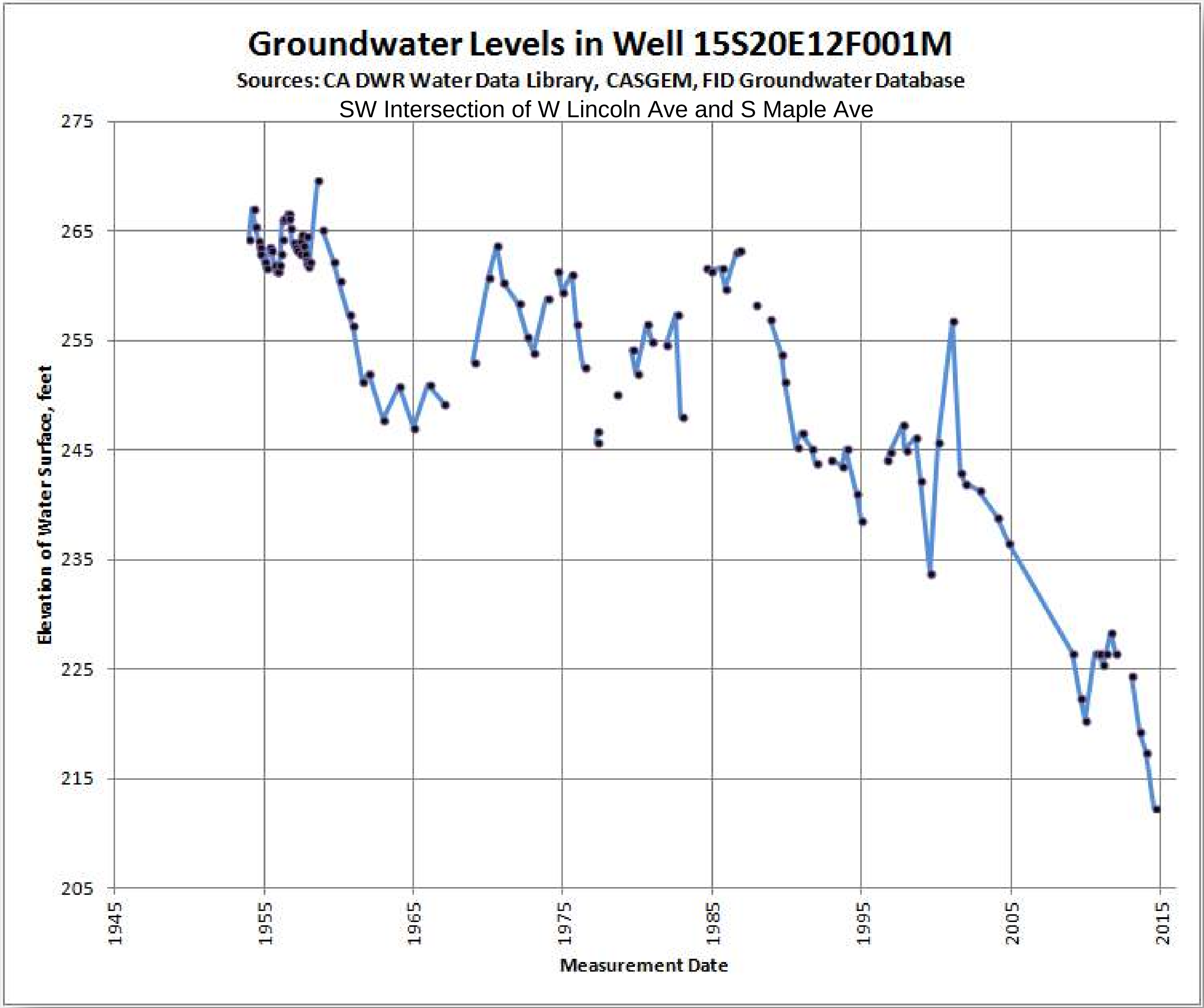


Groundwater Levels in Well 14S18E02B001M
Sources: CA DWR Water Data Library, CASGEM, FID Groundwater Database
SW Intersection of W Belmont Ave and N Dickenson Ave
Elevation of Water Surface, feet
220
210
200
190
180
170
160
150
1945
1955
1965
1975
1985
1995
2005
2015
Measurement Date

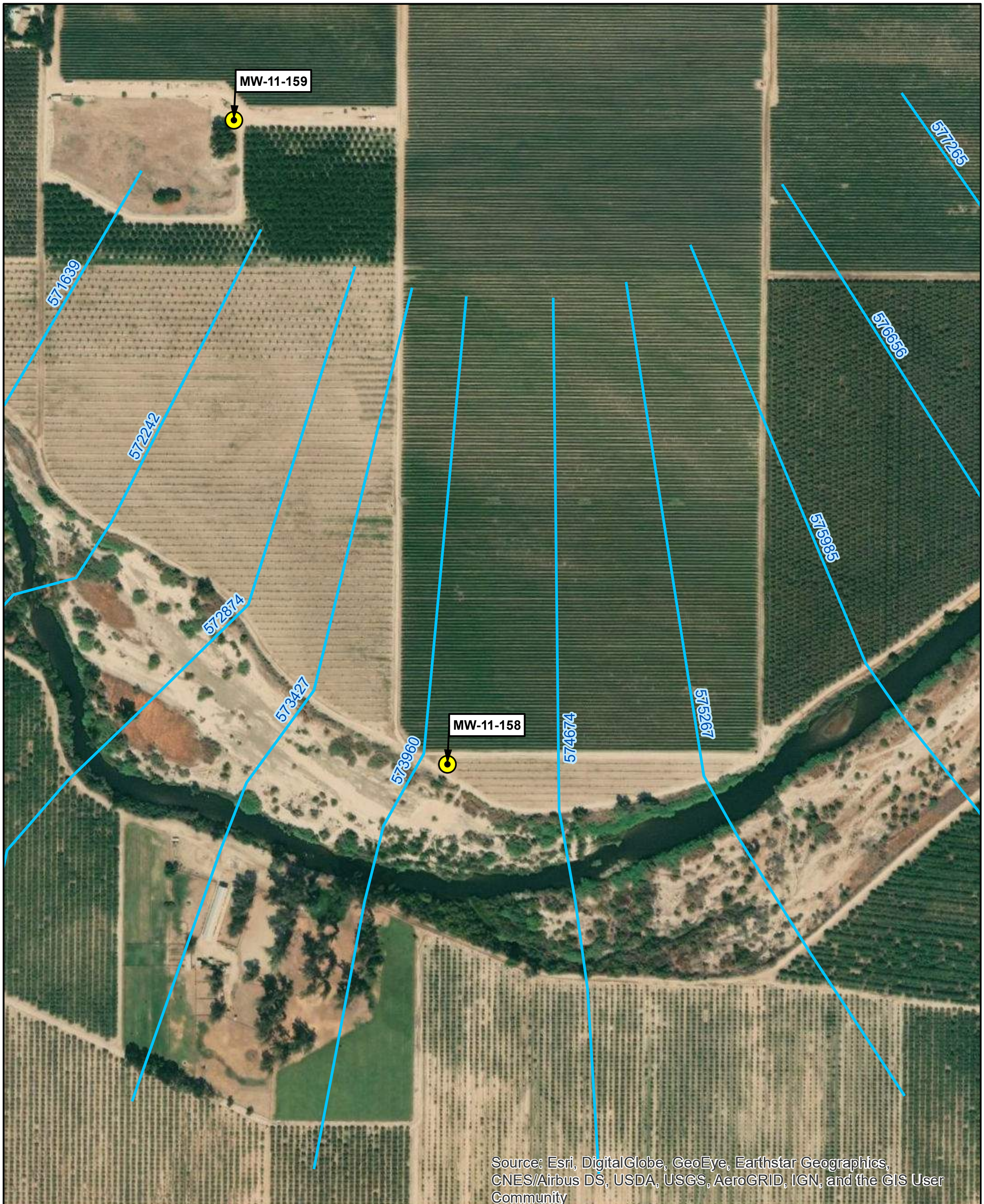

Groundwater Levels in Well 14S20E10M001M
Sources: CA DWR Water Data Library, CASGEM, FID Groundwater Database
SW Intersection of Ventura Ave and Broadway St
240
230
220
210
200
190
180
170
160
150
Elevation of Water Surface, feet
1945
1955
1965
1975
1985
1995
2005
2015
Measurement Date



Groundwater Levels in Well 15S18E03R001M
Sources: CA DWR Water Data Library, CASGEM, FID Groundwater Database
NW Intersection of W Lincoln Ave and S McMullin Grade
Elevation of Water Surface, feet
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
1945
1955
1965
1975
1985
1995
2005
2015
Measurement Date


Groundwater Levels in Well 15S20E12F001M
Sources: CA DWR Water Data Library, CASGEM, FID Groundwater Database
SW Intersection of W Lincoln Ave and S Maple Ave
Elevation of Water Surface, feet
275
265
255
245
235
225
215
205
1945
1955
1965
1975
1985
1995
2005
2015
Measurement Date

Appendix 3 C SJR Groundwater Information



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N
0 100 200
Feet

GW Monitoring Well

HECRAS Cross Section

SJRRP Cross Section and Monitoring Wells

Ave. 4 & Road 21 1/2 Group

8/9/2019 : G:\North Kings GSA-2643\264317001-Groundwater Sustainability Plan\GIS\Map\HCM\HECRAS.mxd

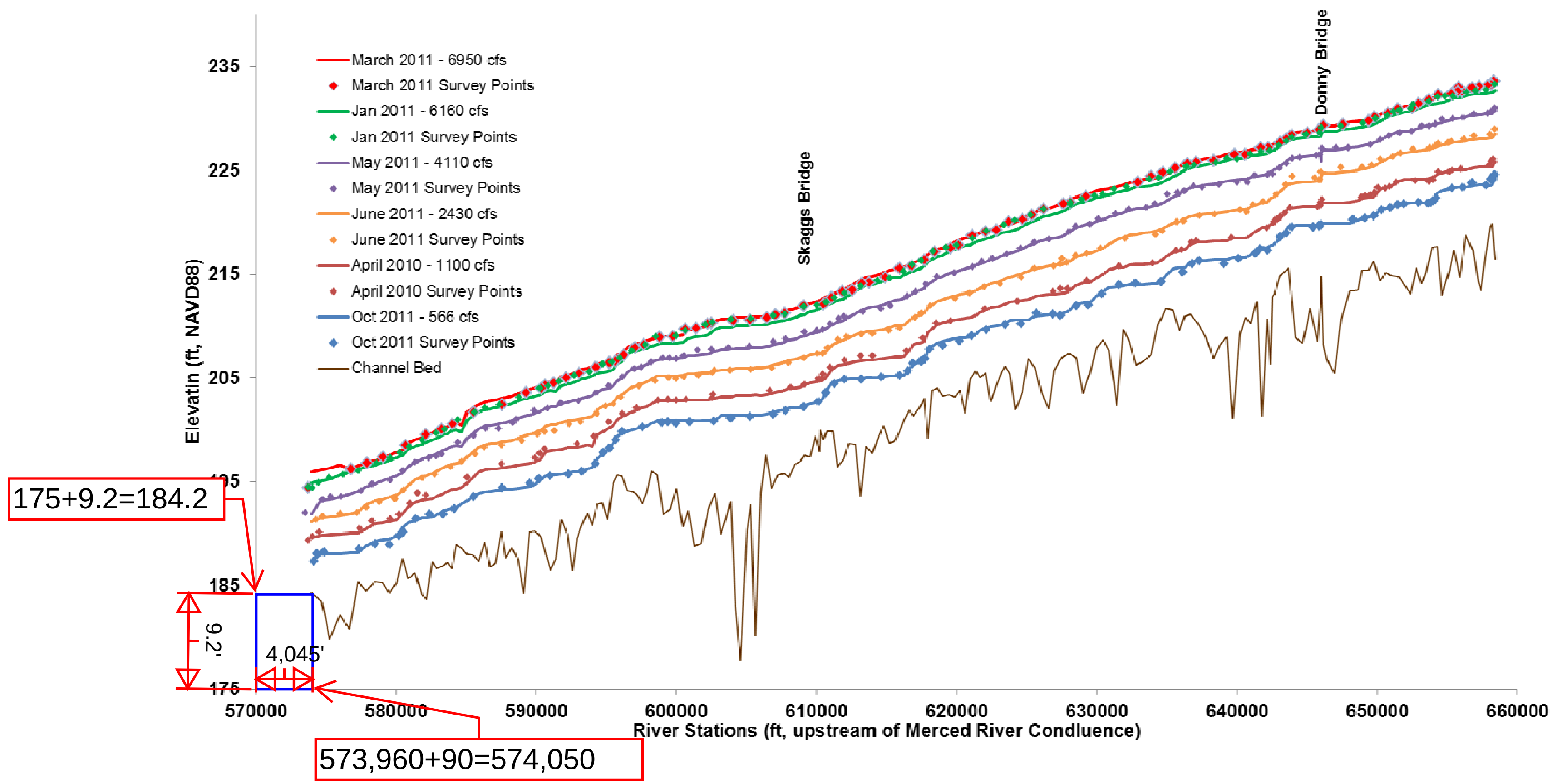
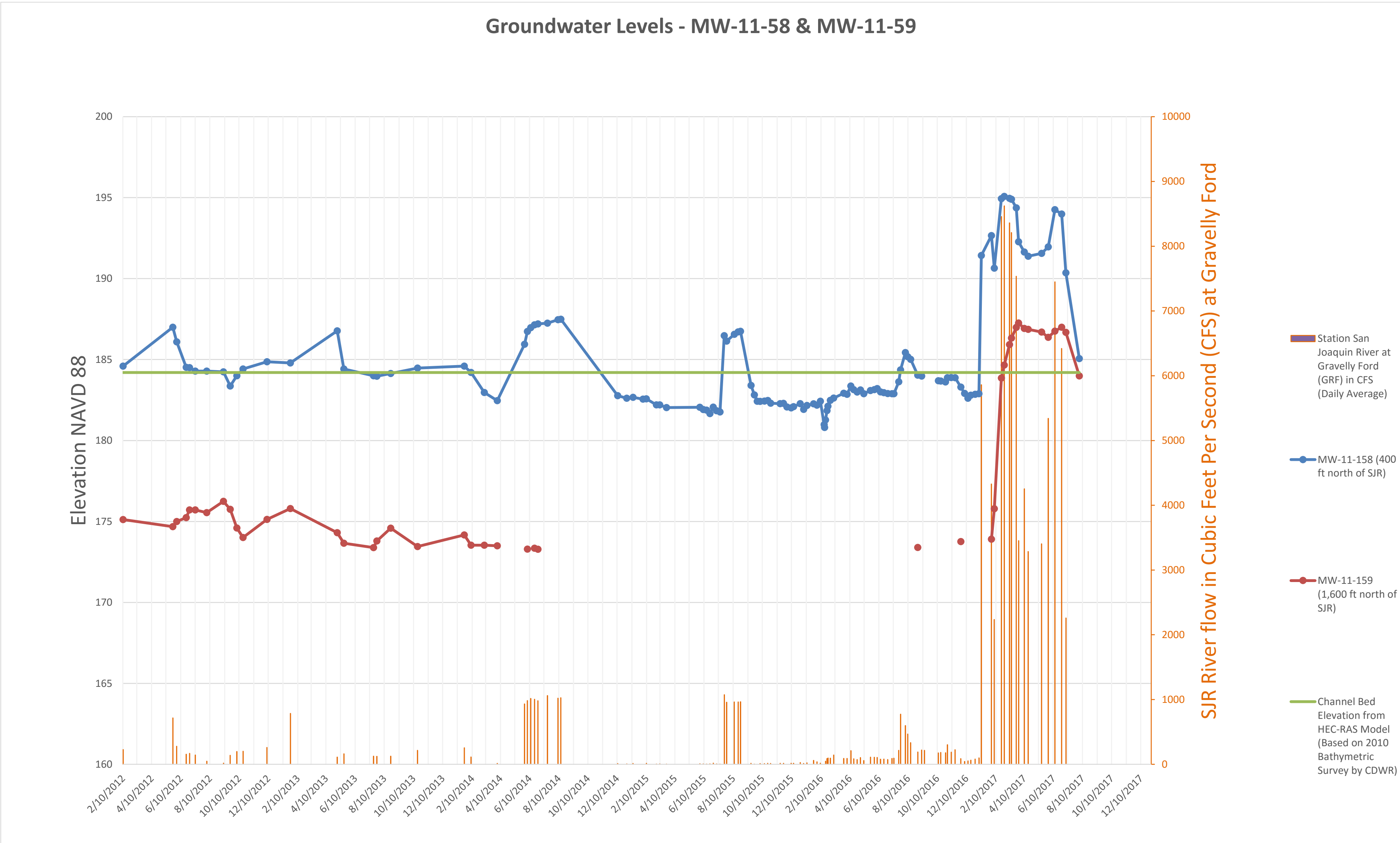
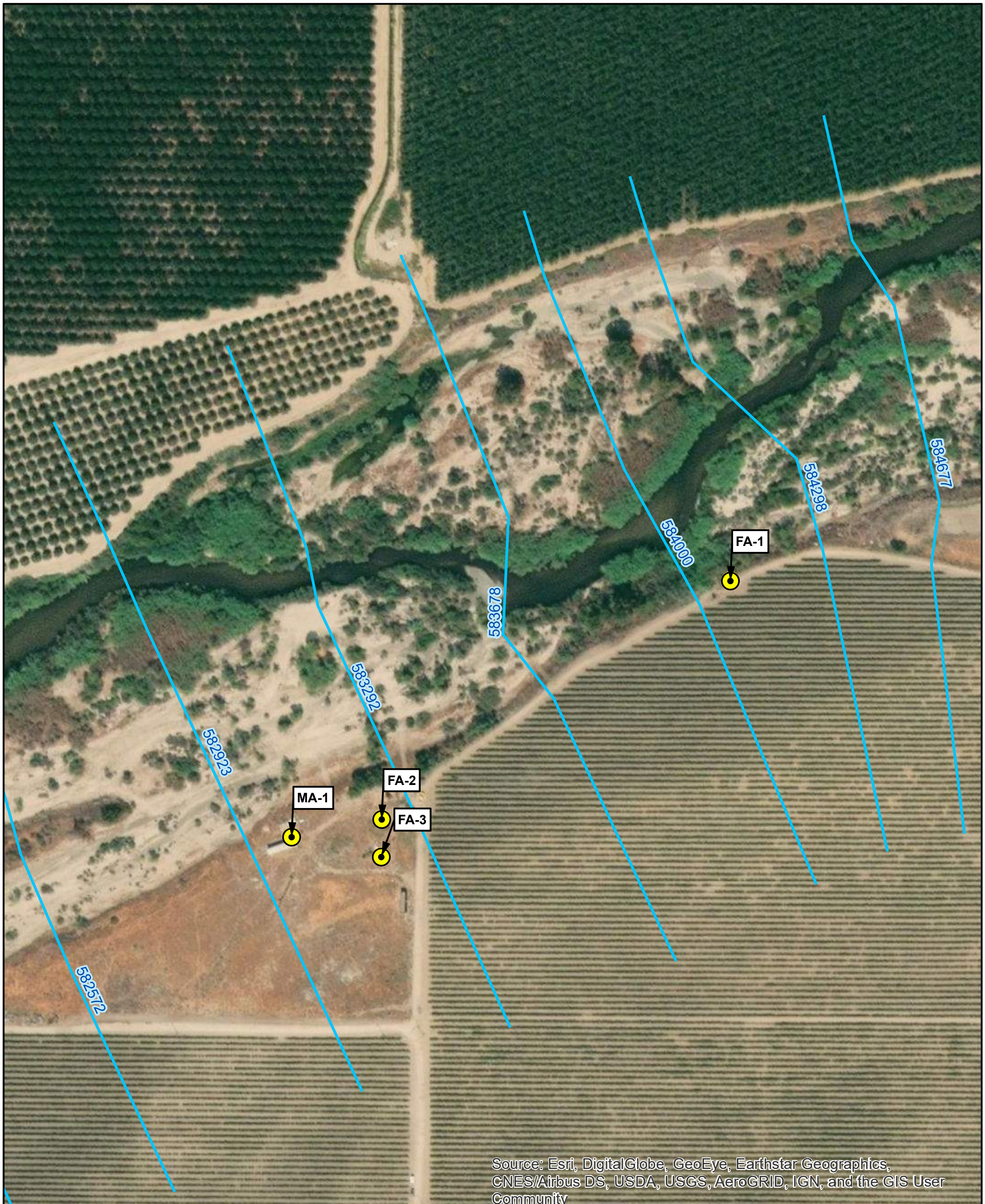


Figure 4.4. Computed (refined model) and surveyed water-surface elevations in Reach 1B for calibration flow events between 566 and 6,950 cfs.


Groundwater Levels - MW-11-58 & MW-11-59
Elevation NAVD 88
SJR River flow in Cubic Feet Per Second (CFS) at Gravelly Ford
200
195
190
185
180
175
170
165
160
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
2/10/2012
4/10/2012
6/10/2012
8/10/2012
10/10/2012
12/10/2012
2/10/2013
4/10/2013
6/10/2013
8/10/2013
10/10/2013
12/10/2013
2/10/2014
4/10/2014
6/10/2014
8/10/2014
10/10/2014
12/10/2014
2/10/2015
4/10/2015
6/10/2015
8/10/2015
10/10/2015
12/10/2015
2/10/2016
4/10/2016
6/10/2016
8/10/2016
10/10/2016
12/10/2016
2/10/2017
4/10/2017
6/10/2017
8/10/2017
10/10/2017
12/10/2017
Station San Joaquin River at Gravelly Ford (GRF) in CFS (Daily Average)
MW-11-158 (400 ft north of SJR)
MW-11-159 (1,600 ft north of SJR)
Channel Bed Elevation from HEC-RAS Model (Based on 2010 Bathymetric Survey by CDWR)



EST. 1968 PROVOST& PRITCHARD CONSULTING GROUP An Employee Owned Company

N

0 100 200 Feet

GW Monitoring Well

HECRAS Cross Section

SJRRP Cross Section and Monitoring Wells

Gravelly Ford Group

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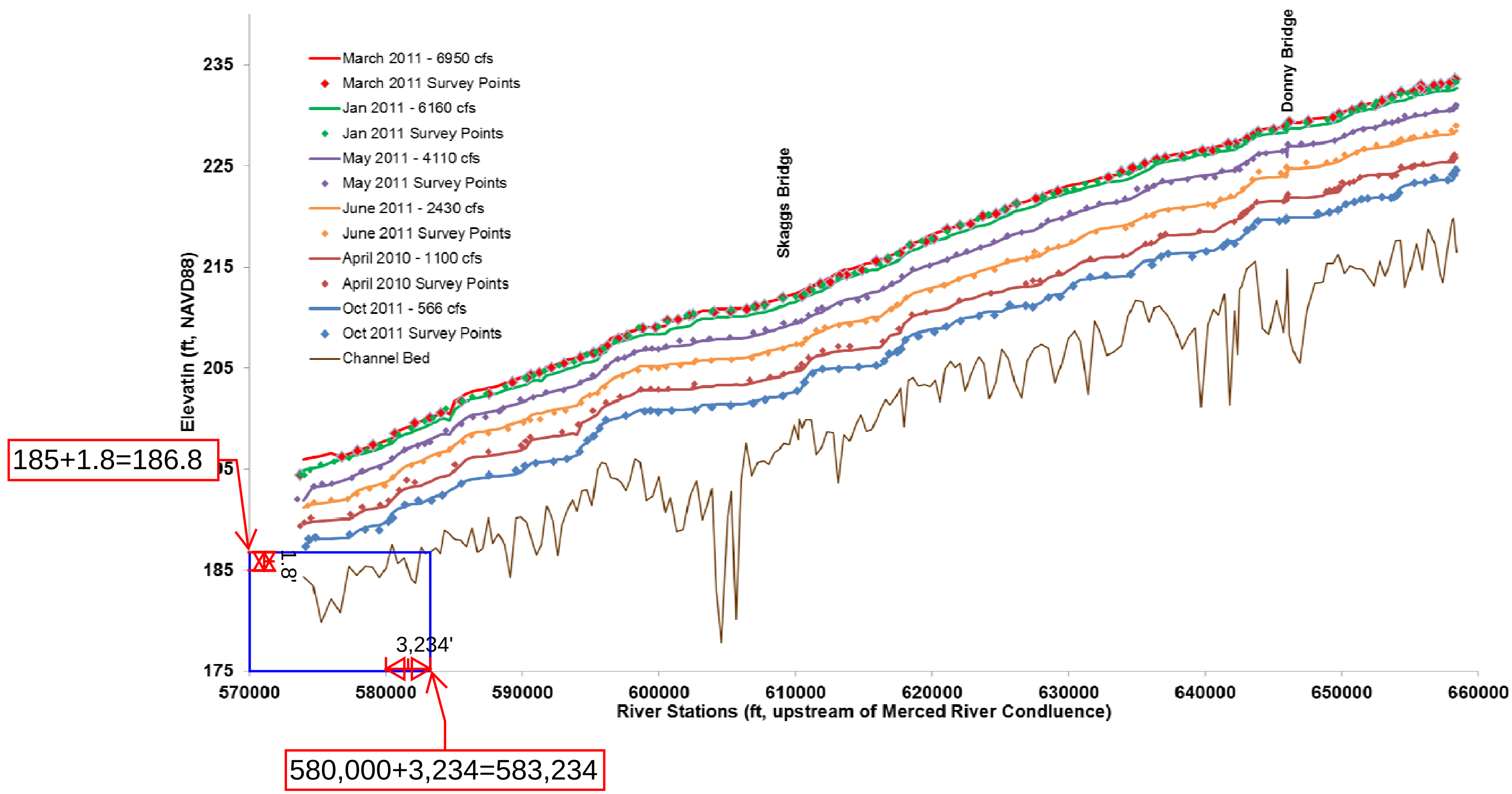
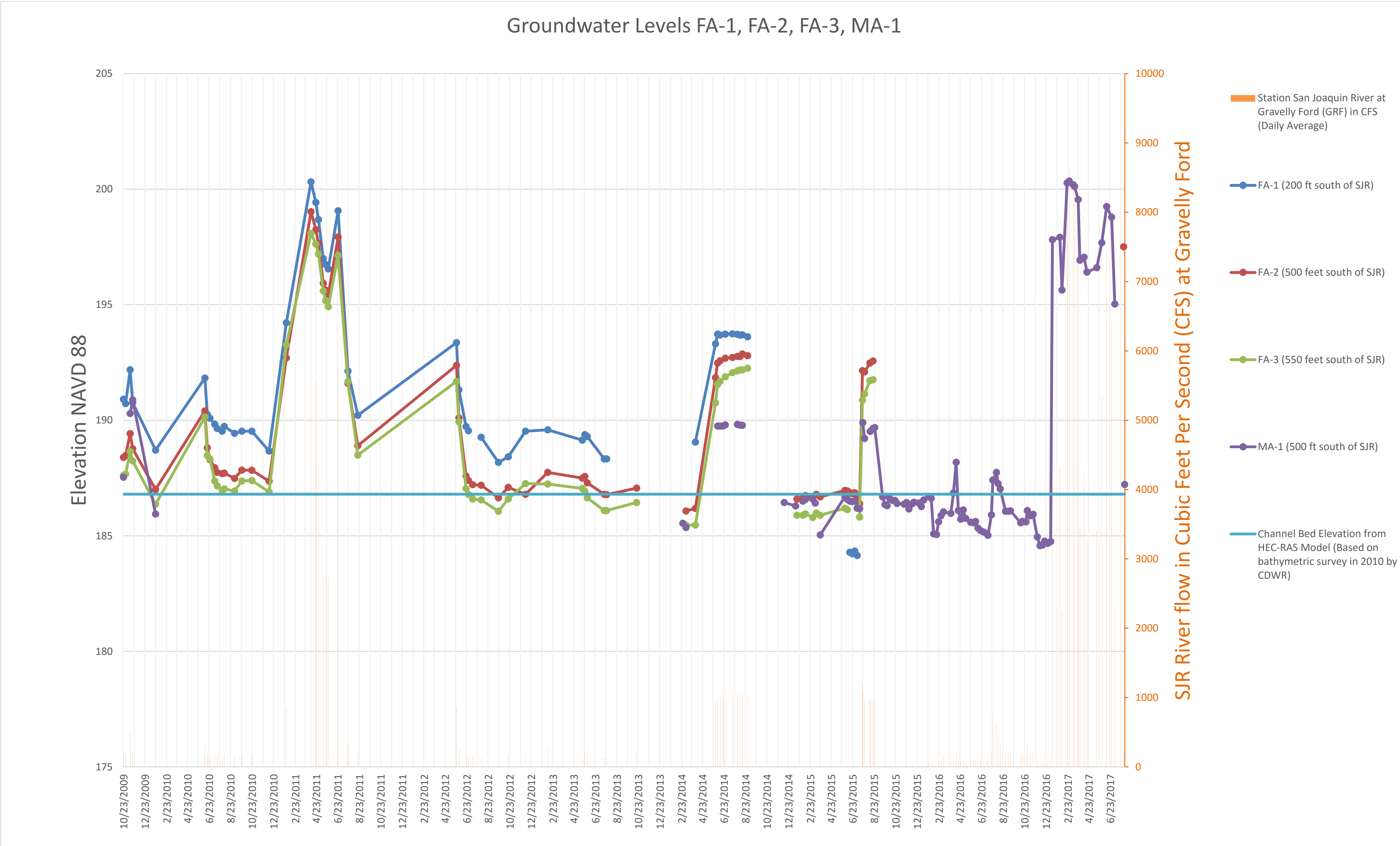


Figure 4.4. Computed (refined model) and surveyed water-surface elevations in Reach 1B for calibration flow events between 566 and 6,950 cfs.


Groundwater Levels FA-1, FA-2, FA-3, MA-1
Elevation NAVD 88
SJR River flow in Cubic Feet Per Second (CFS) at Gravelly Ford
205
200
195
190
185
180
175
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Station San Joaquin River at Gravelly Ford (GRF) in CFS (Daily Average)
FA-1 (200 ft south of SJR)
FA-2 (500 feet south of SJR)
FA-3 (550 feet south of SJR)
MA-1 (500 ft south of SJR)
Channel Bed Elevation from HEC-RAS Model (Based on bathymetric survey in 2010 by CDWR)
10/23/2009
12/23/2009
2/23/2010
4/23/2010
6/23/2010
8/23/2010
10/23/2010
12/23/2010
2/23/2011
4/23/2011
6/23/2011
8/23/2011
10/23/2011
12/23/2011
2/23/2012
4/23/2012
6/23/2012
8/23/2012
10/23/2012
12/23/2012
2/23/2013
4/23/2013
6/23/2013
8/23/2013
10/23/2013
12/23/2013
2/23/2014
4/23/2014
6/23/2014
8/23/2014
10/23/2014
12/23/2014
2/23/2015
4/23/2015
6/23/2015
8/23/2015
10/23/2015
12/23/2015
2/23/2016
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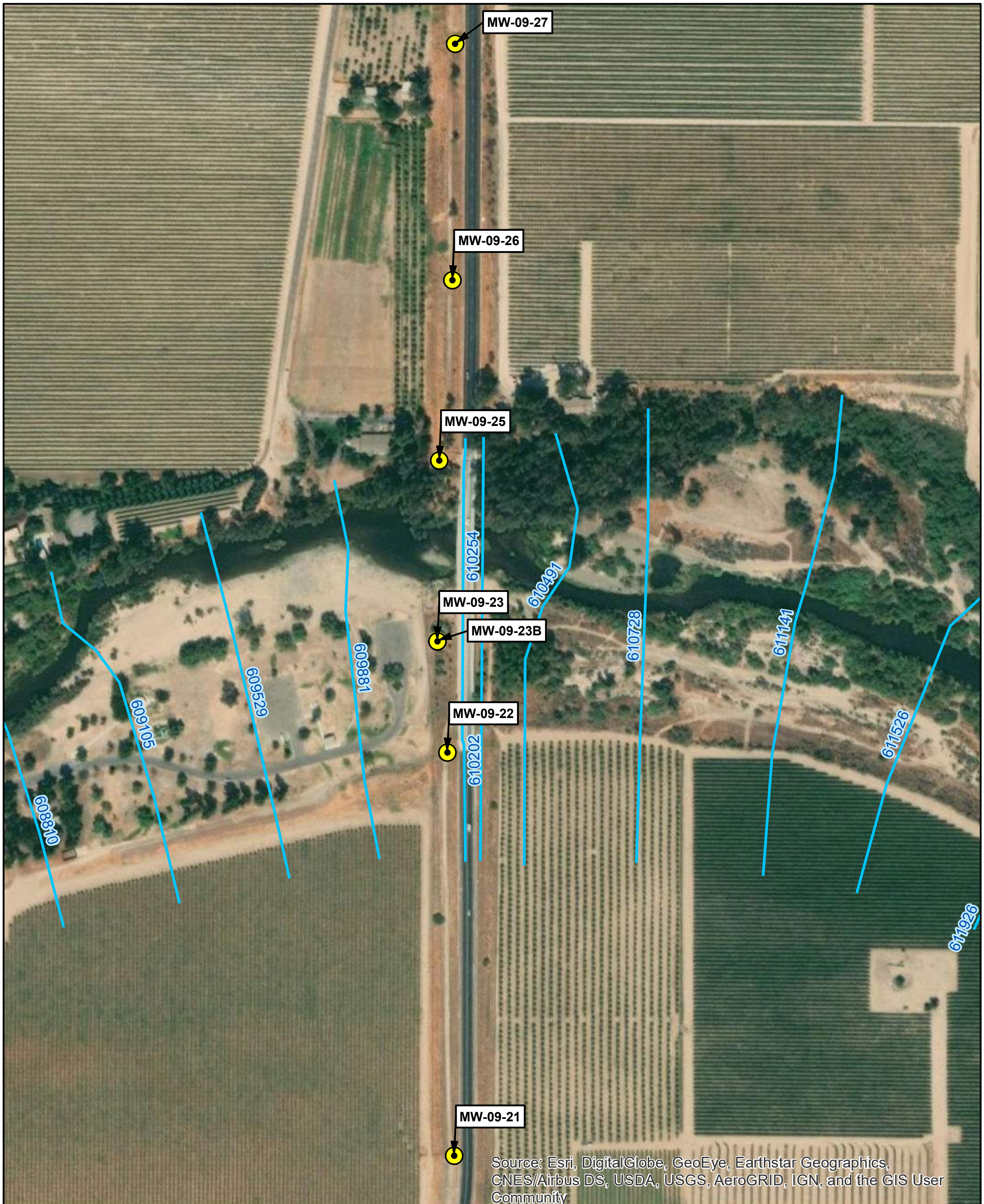
2/23/2017
4/23/2017
6/23/2017



EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
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N

0 100 200
Feet

GW Monitoring Well

HECRAS Cross Section

SJRRP Cross Section and Monitoring Wells

Highway 145 / Madera Ave. Group

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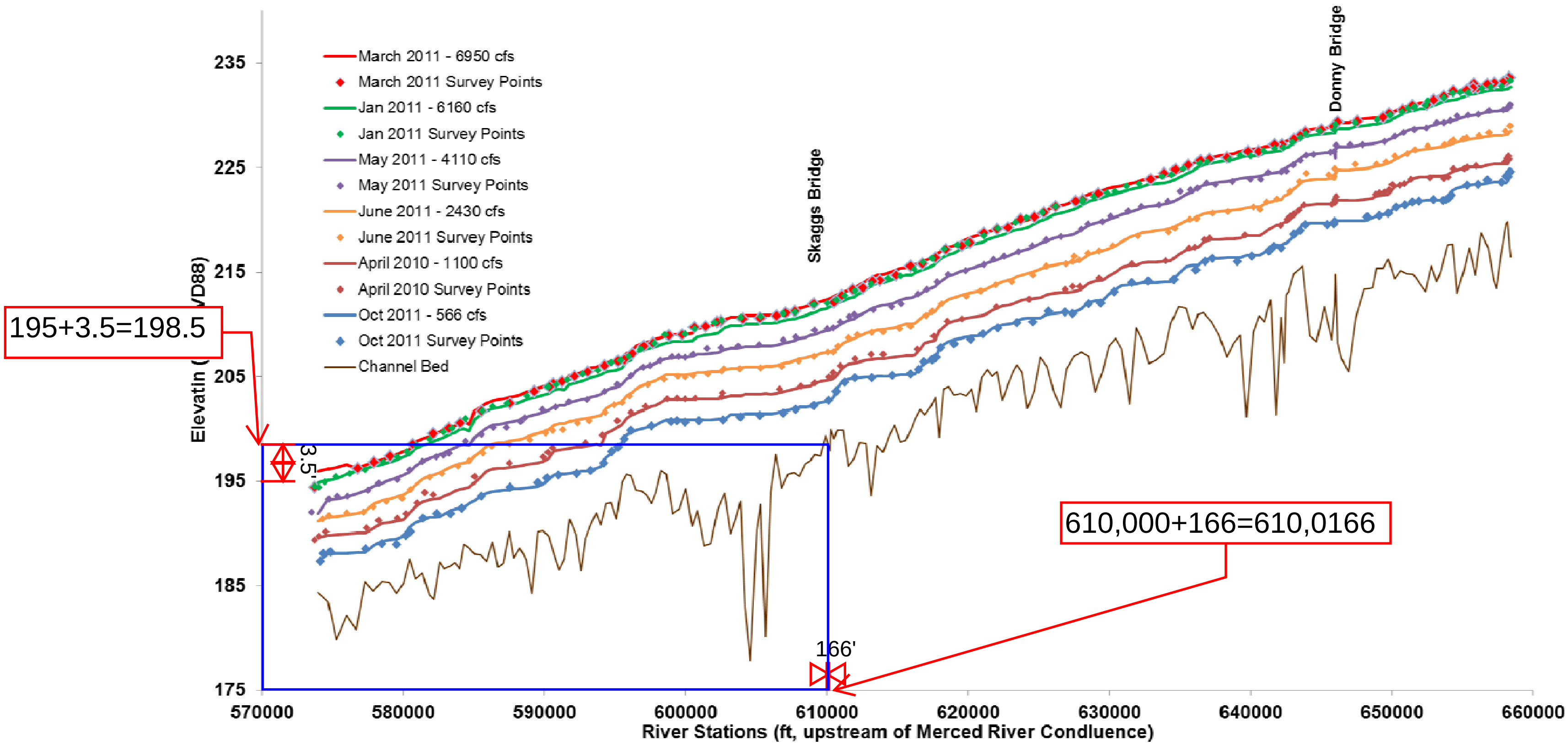
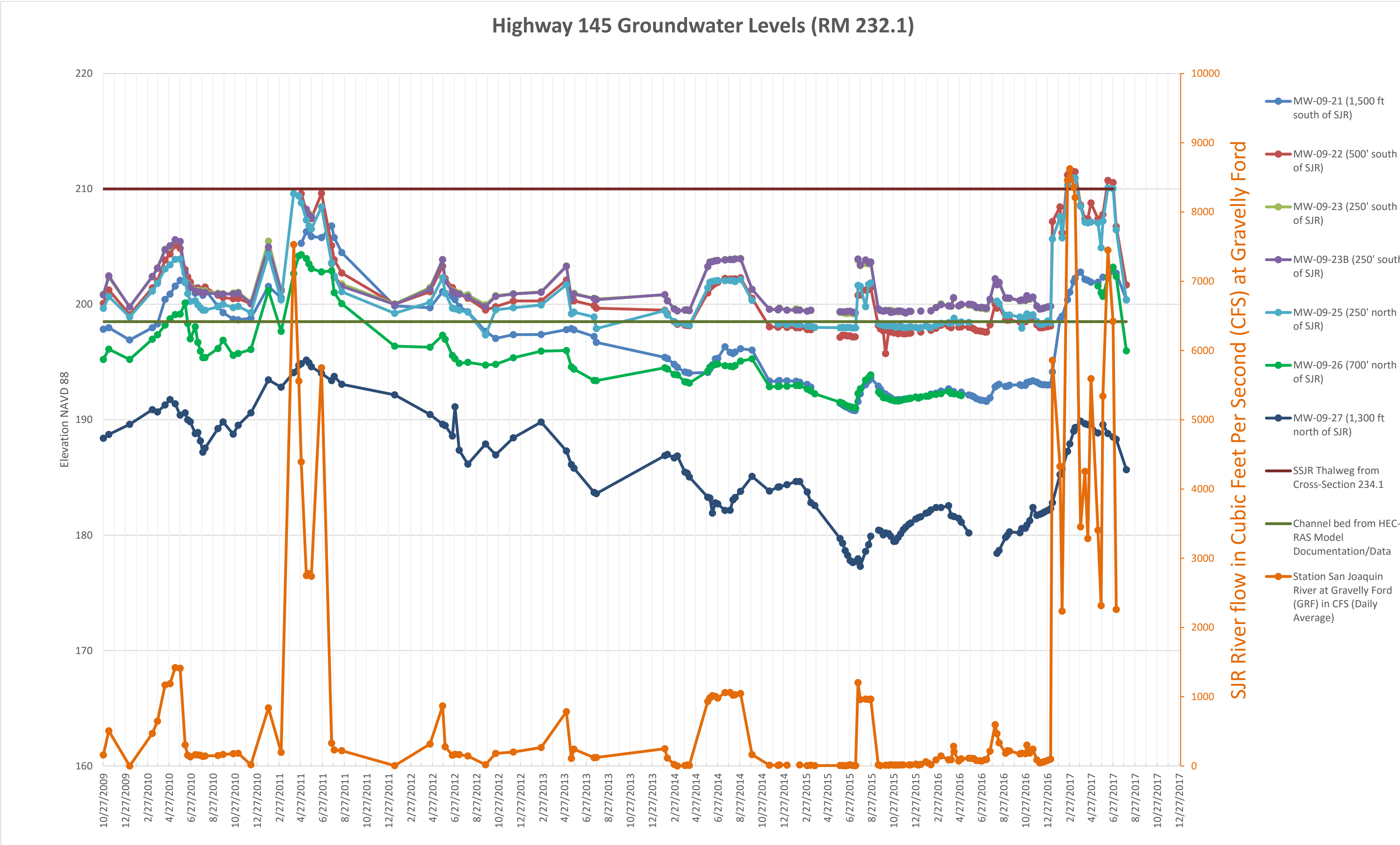
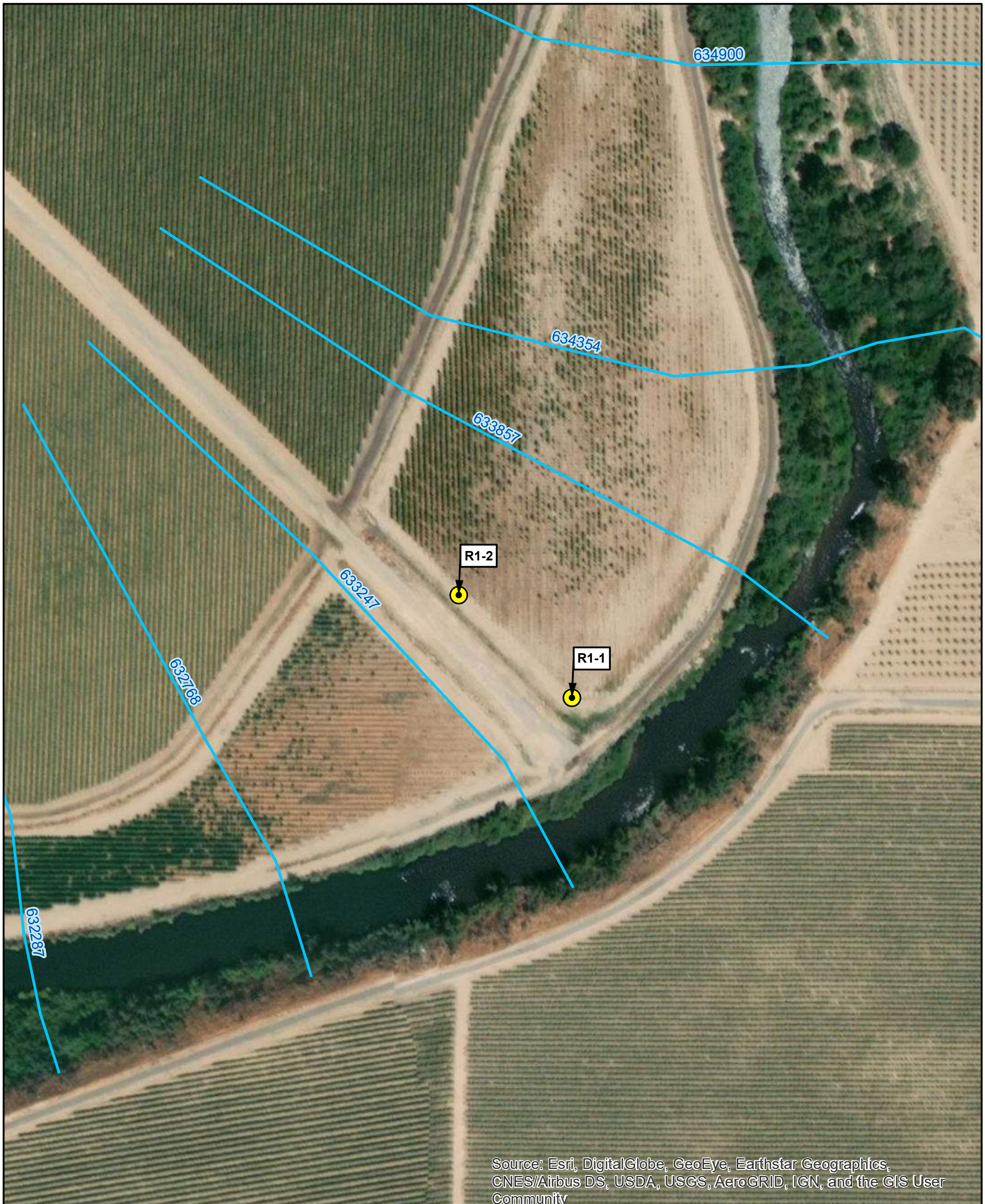


Figure 4.4. Computed (refined model) and surveyed water-surface elevations in Reach 1B for calibration flow events between 566 and 6,950 cfs.


Highway 145 Groundwater Levels (RM 232.1)
Elevation NAVD 88
SJR River flow in Cubic Feet Per Second (CFS) at Gravelly Ford
MW-09-21 (1,500 ft south of SJR)
MW-09-22 (500' south of SJR)
MW-09-23 (250' south of SJR)
MW-09-23B (250' south of SJR)
MW-09-25 (250' north of SJR)
MW-09-26 (700' north of SJR)
MW-09-27 (1,300 ft north of SJR)
SSJR Thalweg from Cross-Section 234.1
Channel bed from HEC-RAS Model Documentation/Data
Station San Joaquin River at Gravelly Ford (GRF) in CFS (Daily Average)



EST. 1968 PROVOST& PRITCHARD CONSULTING GROUP An Employee Owned Company

N

0 100 200 Feet

GW Monitoring Well

HECRAS Cross Section

SJRRP Cross Section and Monitoring Wells

Ave. 5 1/2 & Road 30 1/2 Group

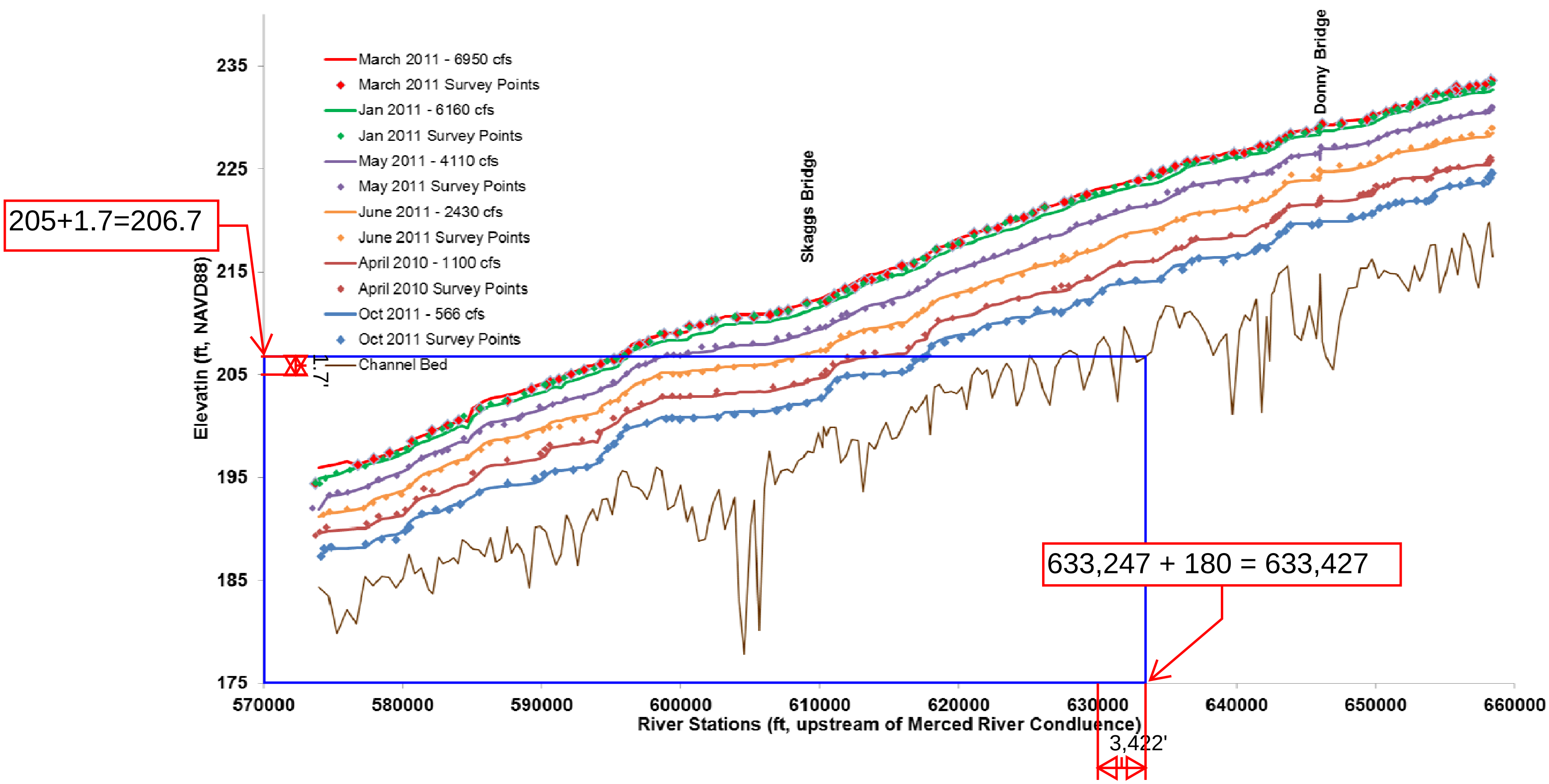
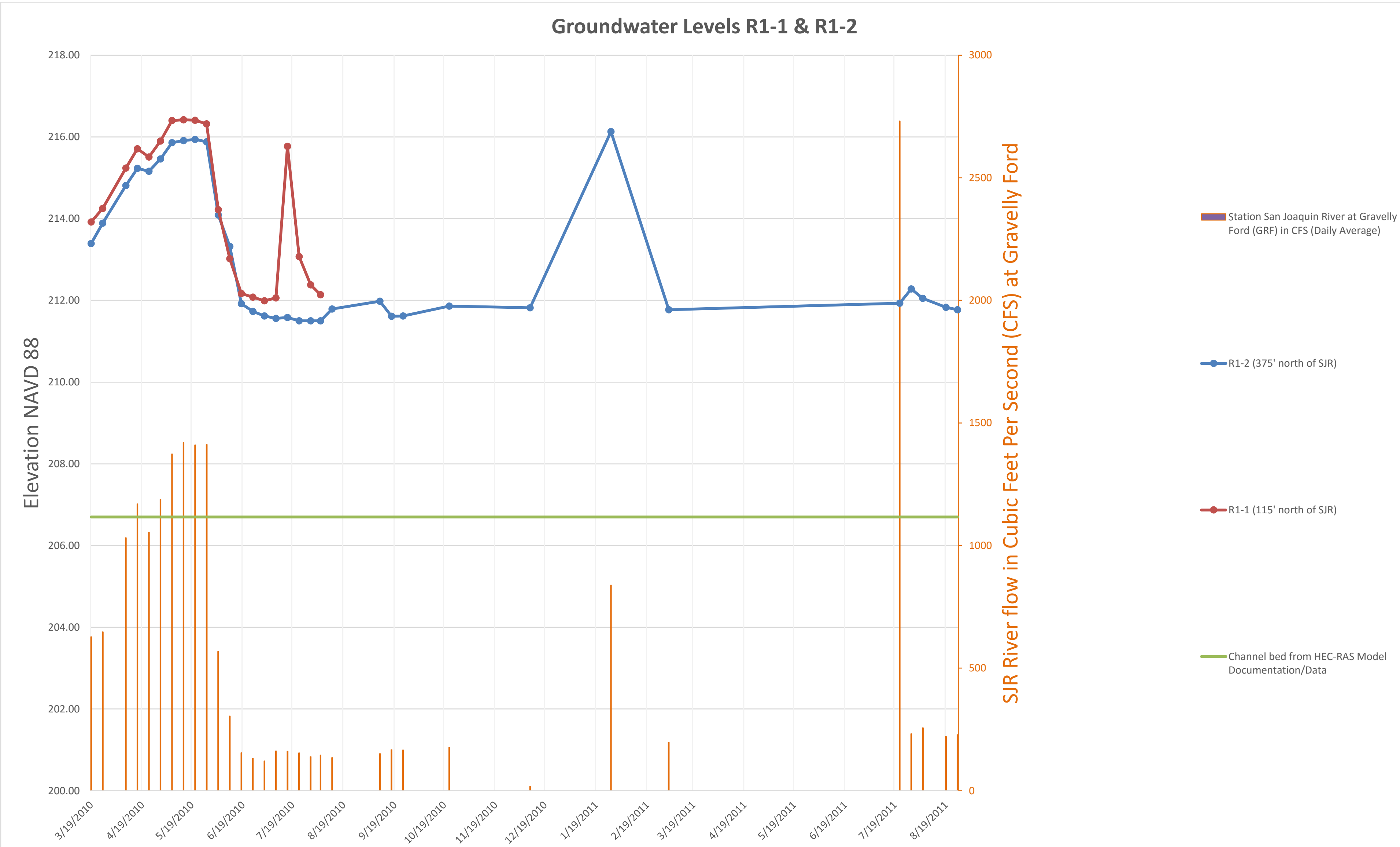
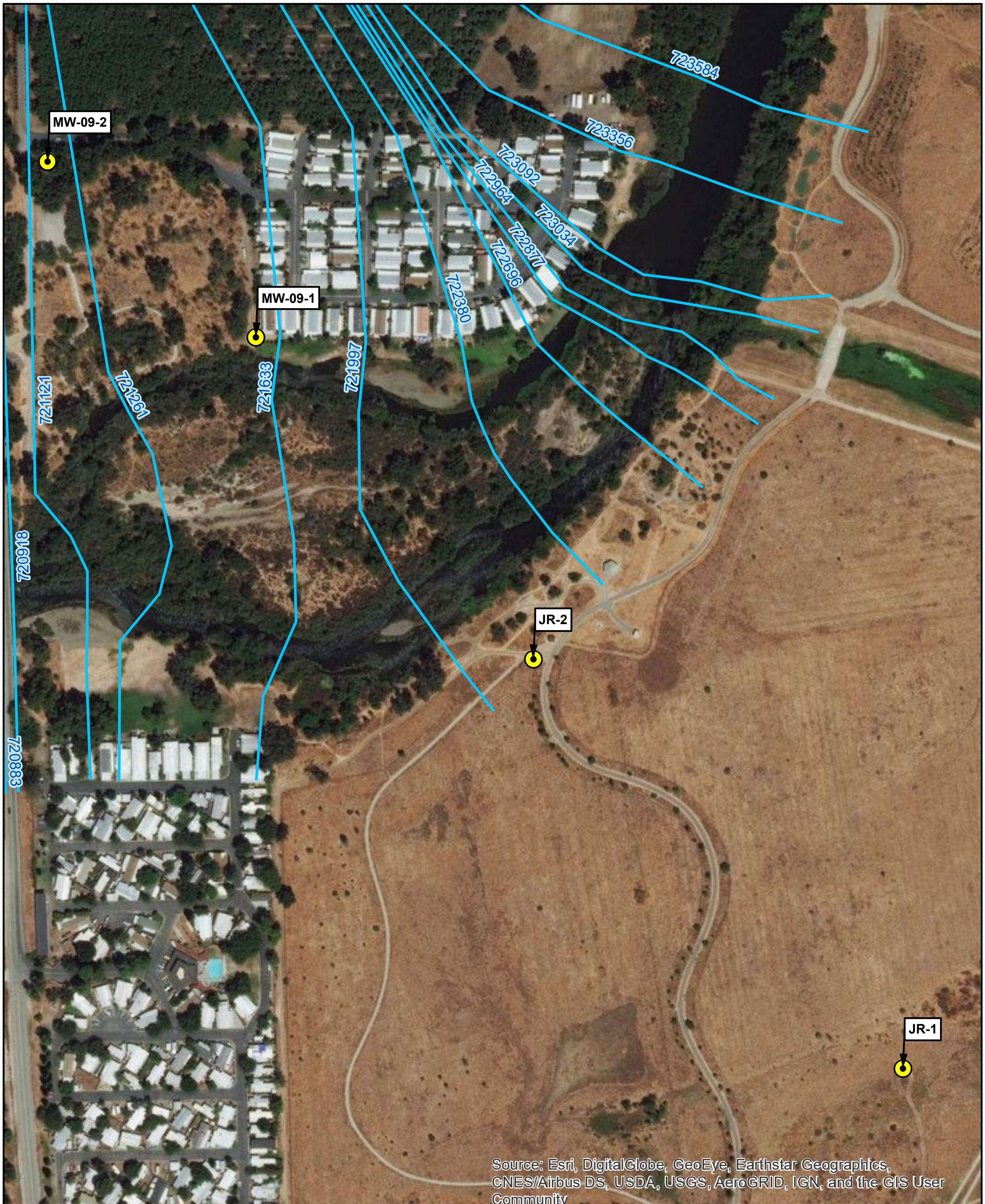


Figure 4.4. Computed (refined model) and surveyed water-surface elevations in Reach 1B for calibration flow events between 566 and 6,950 cfs.



Groundwater Levels R1-1 & R1-2
Elevation NAVD 88
218.00
216.00
214.00
212.00
210.00
208.00
206.00
204.00
202.00
200.00
SJR River flow in Cubic Feet Per Second (CFS) at Gravelly Ford
3000
2500
2000
1500
1000
500
0
3/19/2010
4/19/2010
5/19/2010
6/19/2010
7/19/2010
8/19/2010
9/19/2010
10/19/2010
11/19/2010
12/19/2010
1/19/2011
2/19/2011
3/19/2011
4/19/2011
5/19/2011
6/19/2011
7/19/2011
8/19/2011
Station San Joaquin River at Gravelly Ford (GRF) in CFS (Daily Average)
R1-2 (375' north of SJR)
R1-1 (115' north of SJR)
Channel bed from HEC-RAS Model Documentation/Data



PROVOST & PRITCHARD CONSULTING GROUP
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N
0 100 200
Feet

GW Monitoring Well
HECRAS Cross Section

SJRRP Cross Section and Monitoring Wells

Highway 41 Group

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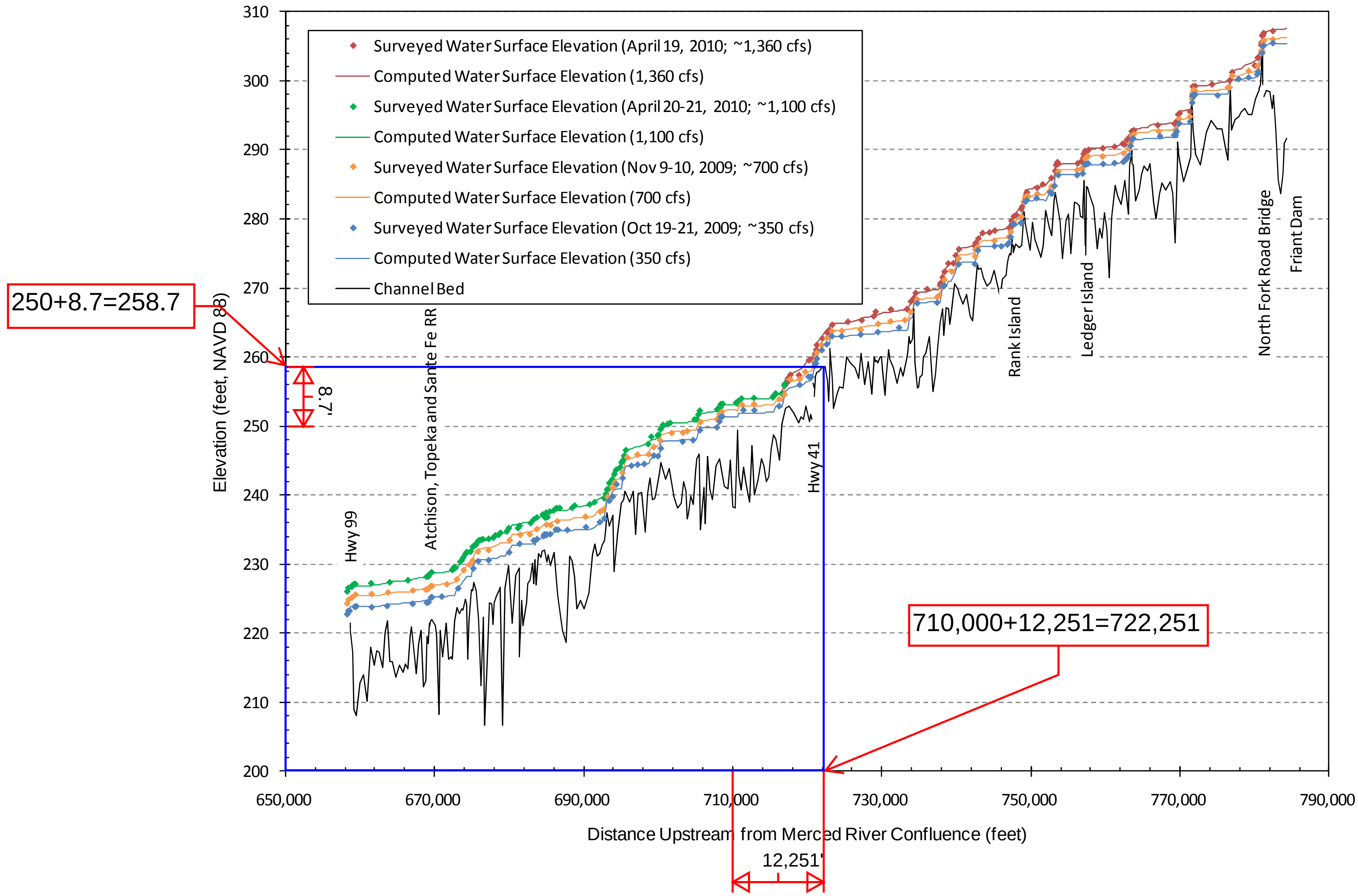
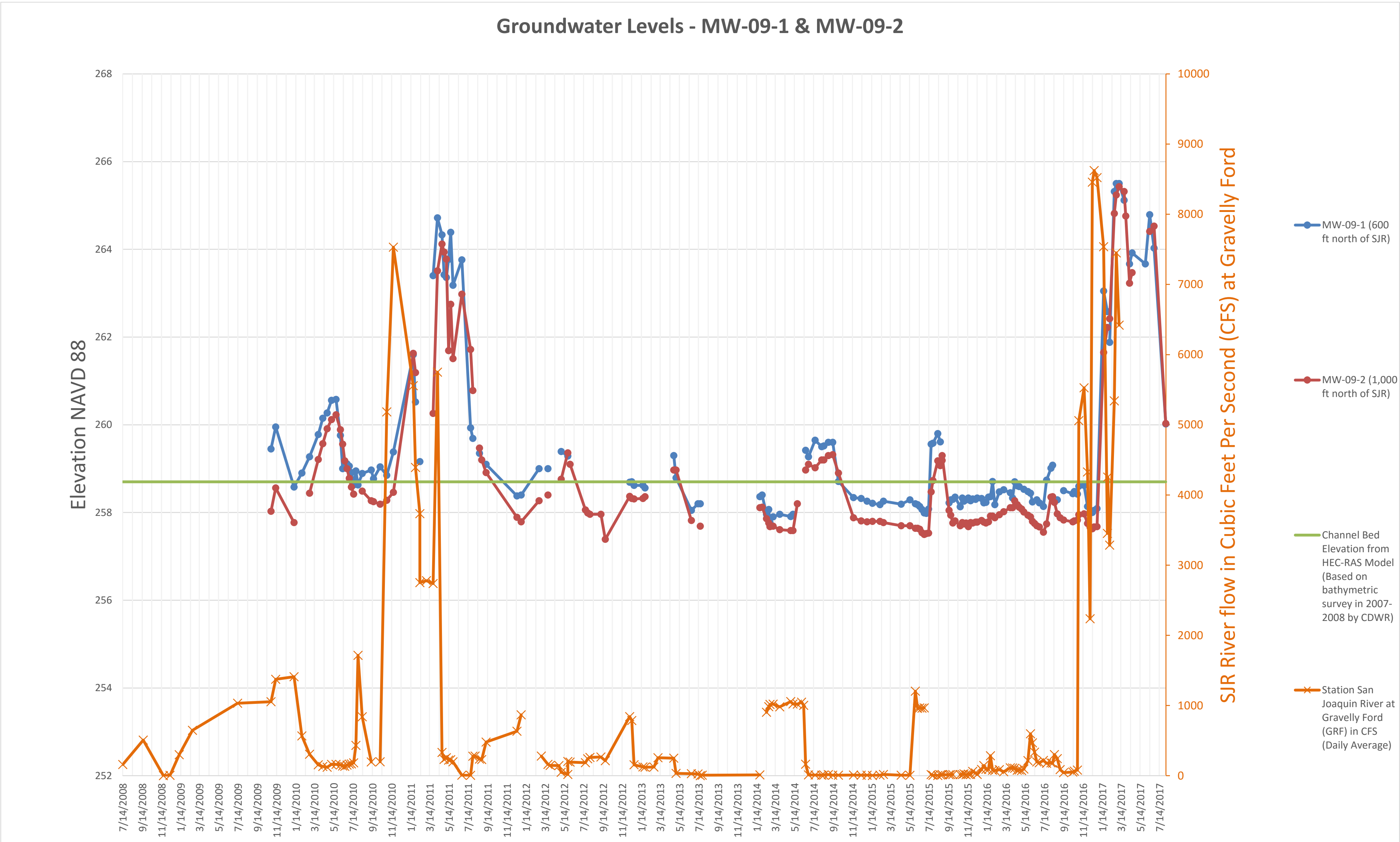


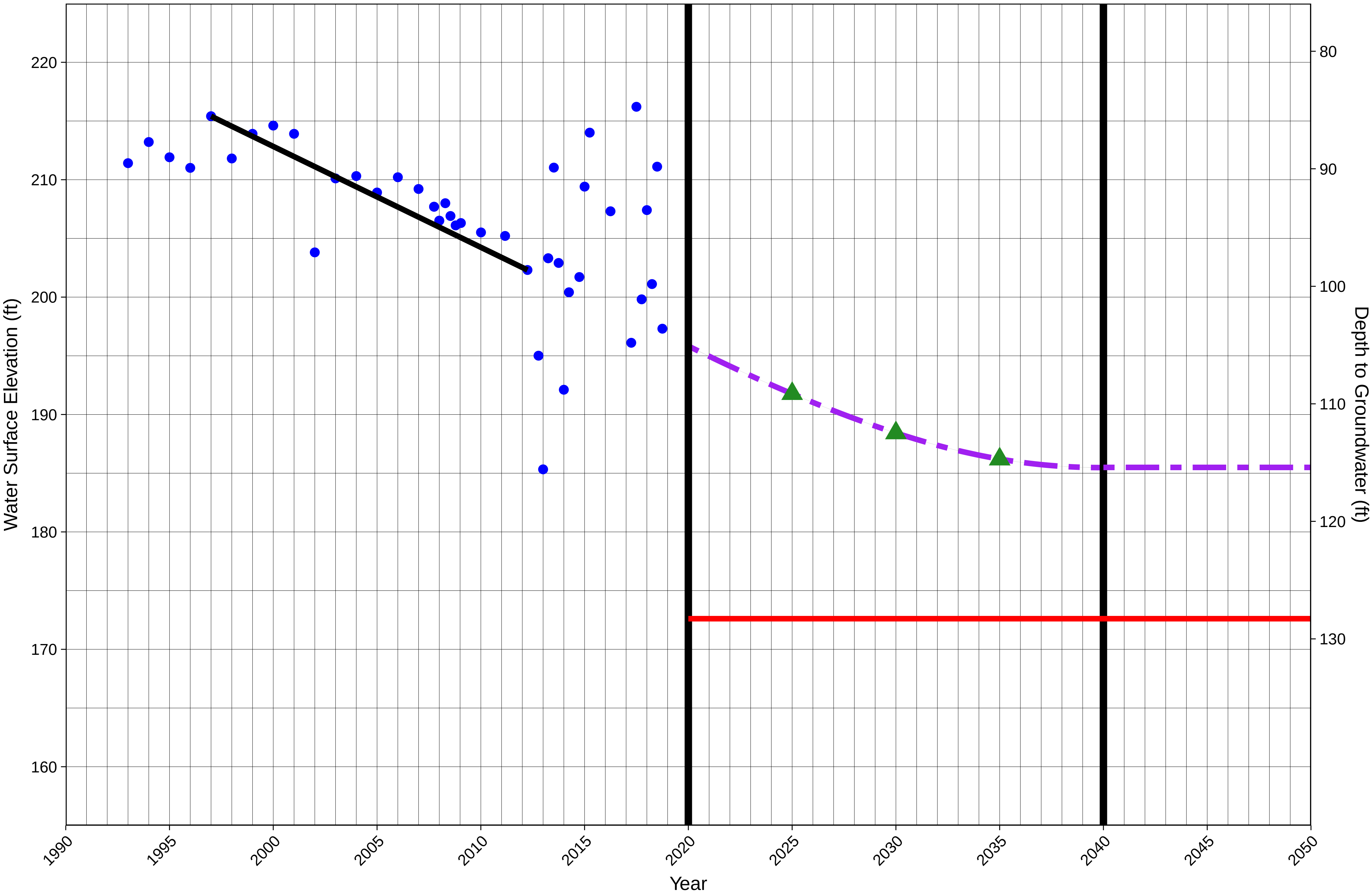
Figure 4.1. Computed (refined model) and measured water-surface profiles in Reach 1A at 350, 700, 1,100, and 1,360 cfs.


Groundwater Levels - MW-09-1 & MW-09-2
Elevation NAVD 88
SJR River flow in Cubic Feet Per Second (CFS) at Gravelly Ford
MW-09-1 (600 ft north of SJR)
MW-09-2 (1,000 ft north of SJR)
Channel Bed Elevation from HEC-RAS Model (Based on bathymetric survey in 2007-2008 by CDWR)
Station San Joaquin River at Gravelly Ford (GRF) in CFS (Daily Average)

Appendix 4 A Hydrographs

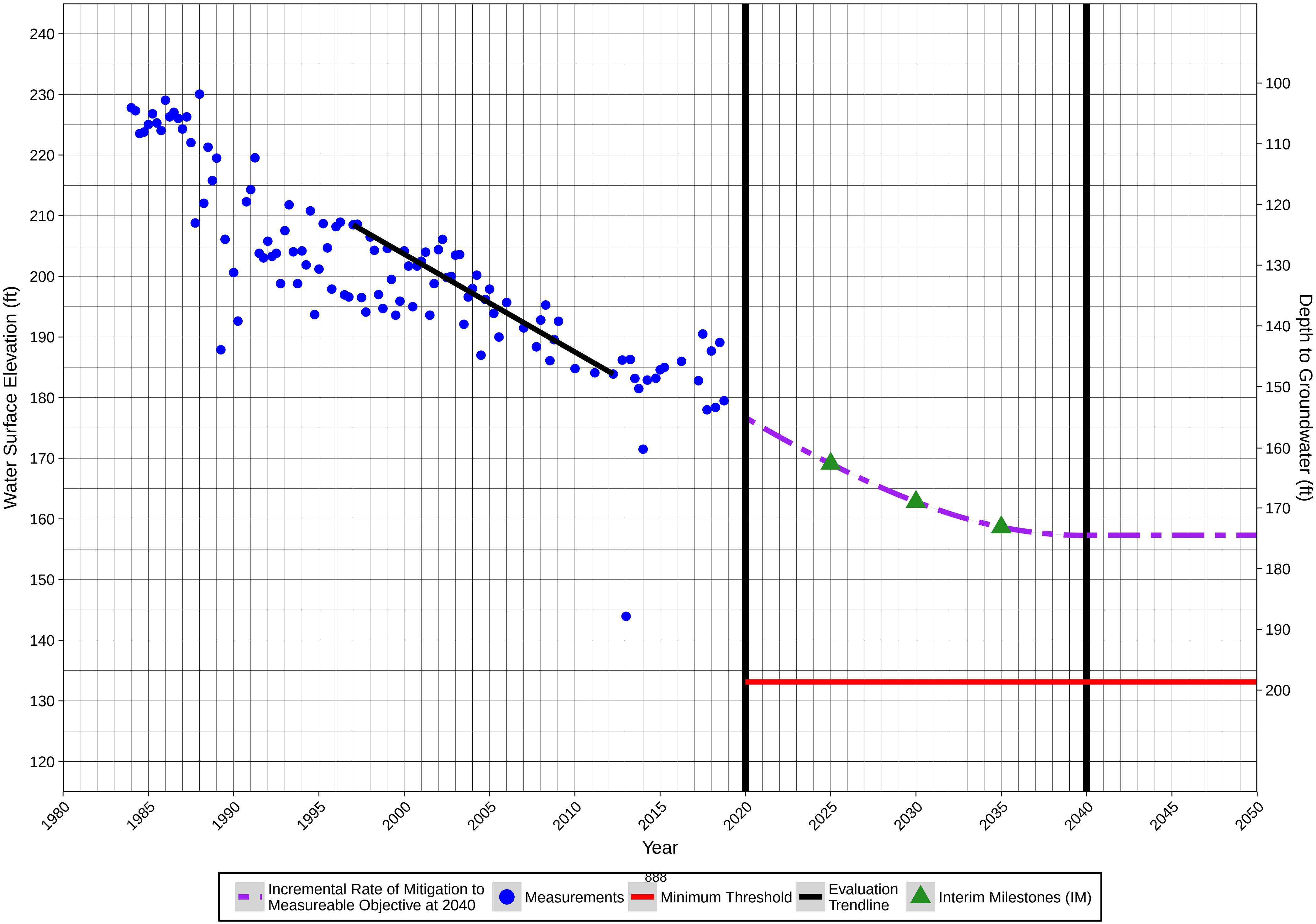
12S19E33P001MX

NW Intersection of W Spruce Ave and N Sandrini Ave
Ground Surface Elevation: 301 ft
North Kings GSA



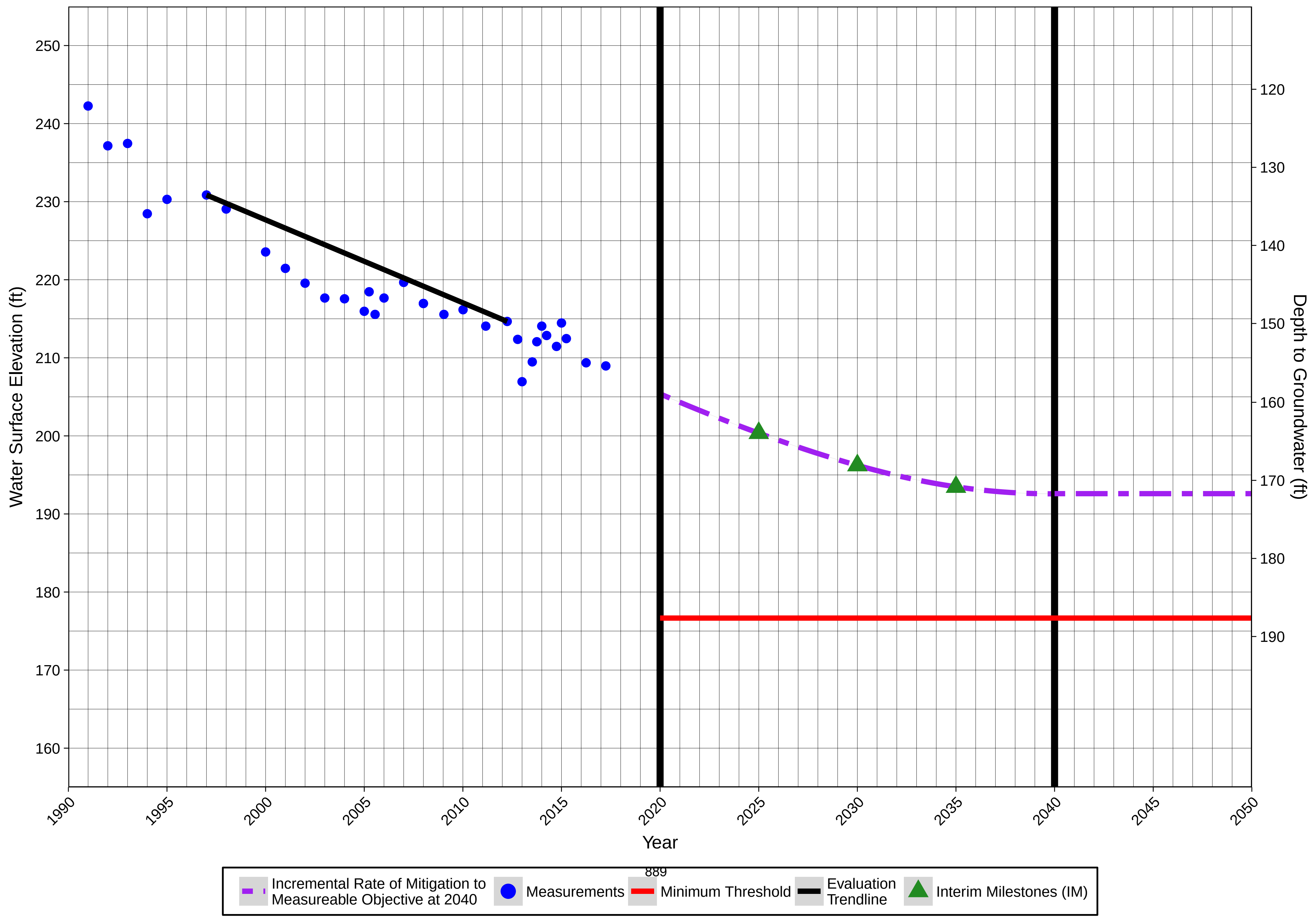
12S19E36J001MX

NW Intersection of W Alluvial Ave and N Van Ness Blvd
Ground Surface Elevation: 332 ft
North Kings GSA



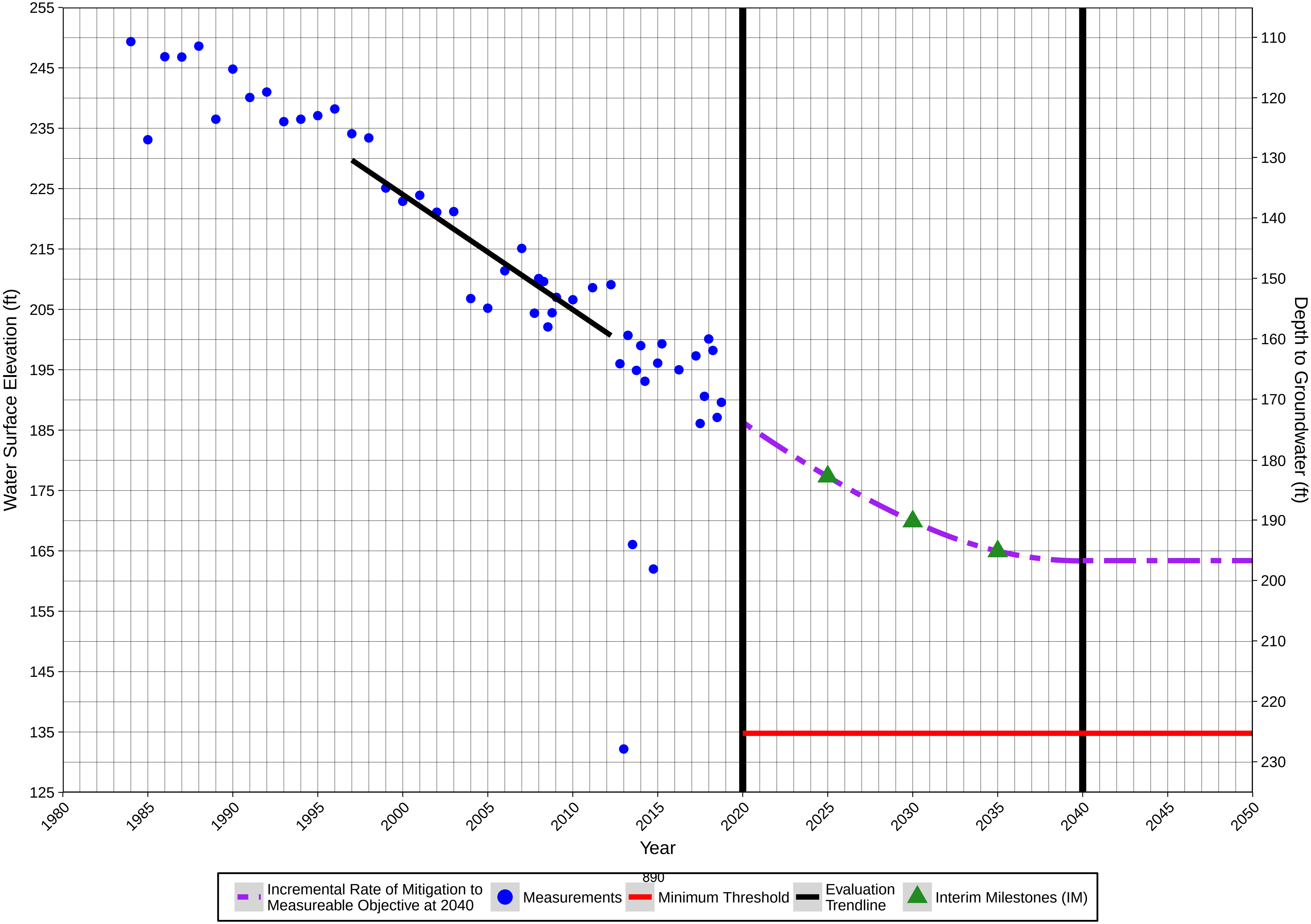
12S20E23D001MX

NE Intersection of Ft Washington Rd and E Champlain Dr
Ground Surface Elevation: 364 ft
North Kings GSA



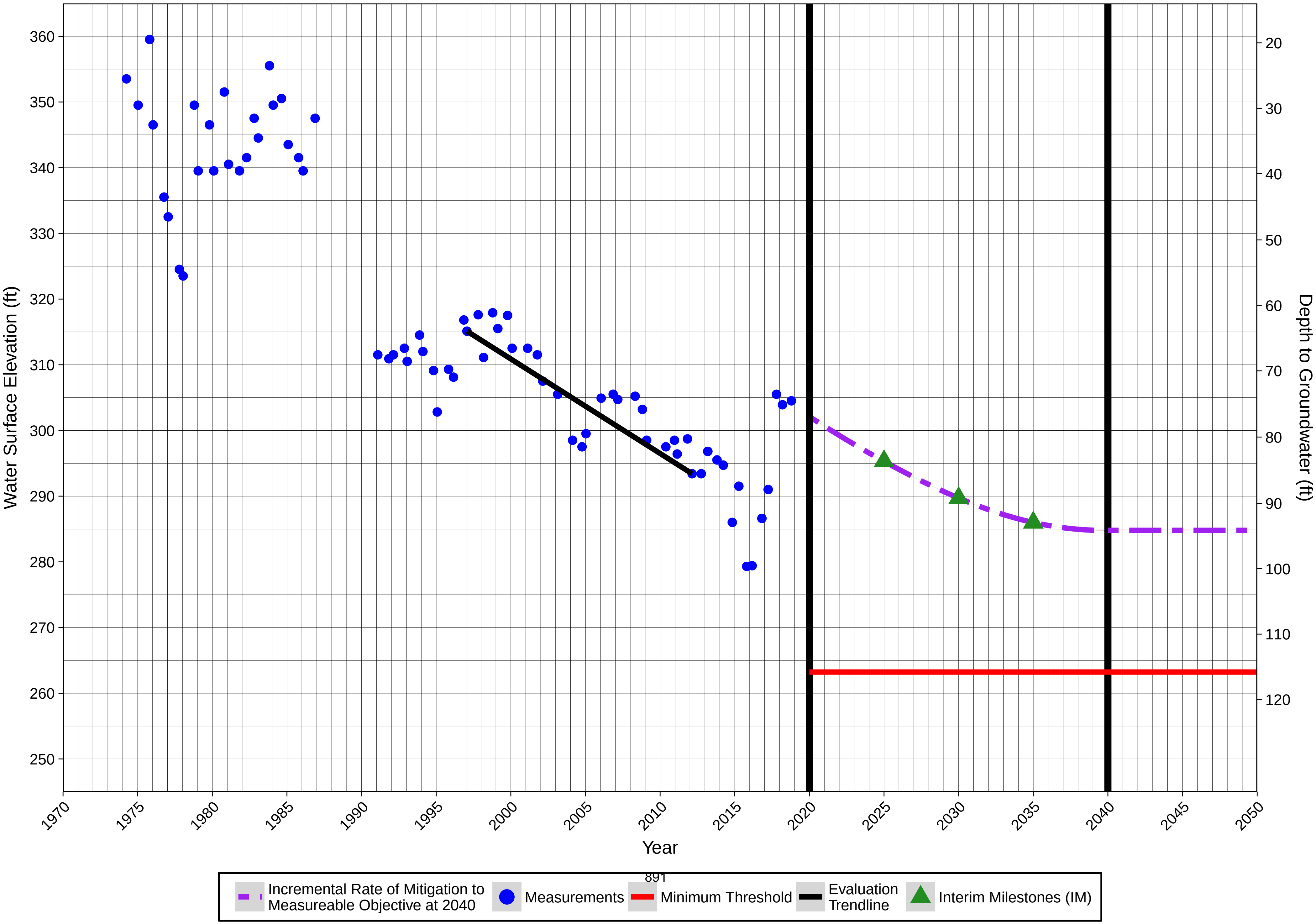
12S20E34K001MX

SE Intersection of E Alluvial Ave and N First St
Ground Surface Elevation: 360 ft
North Kings GSA



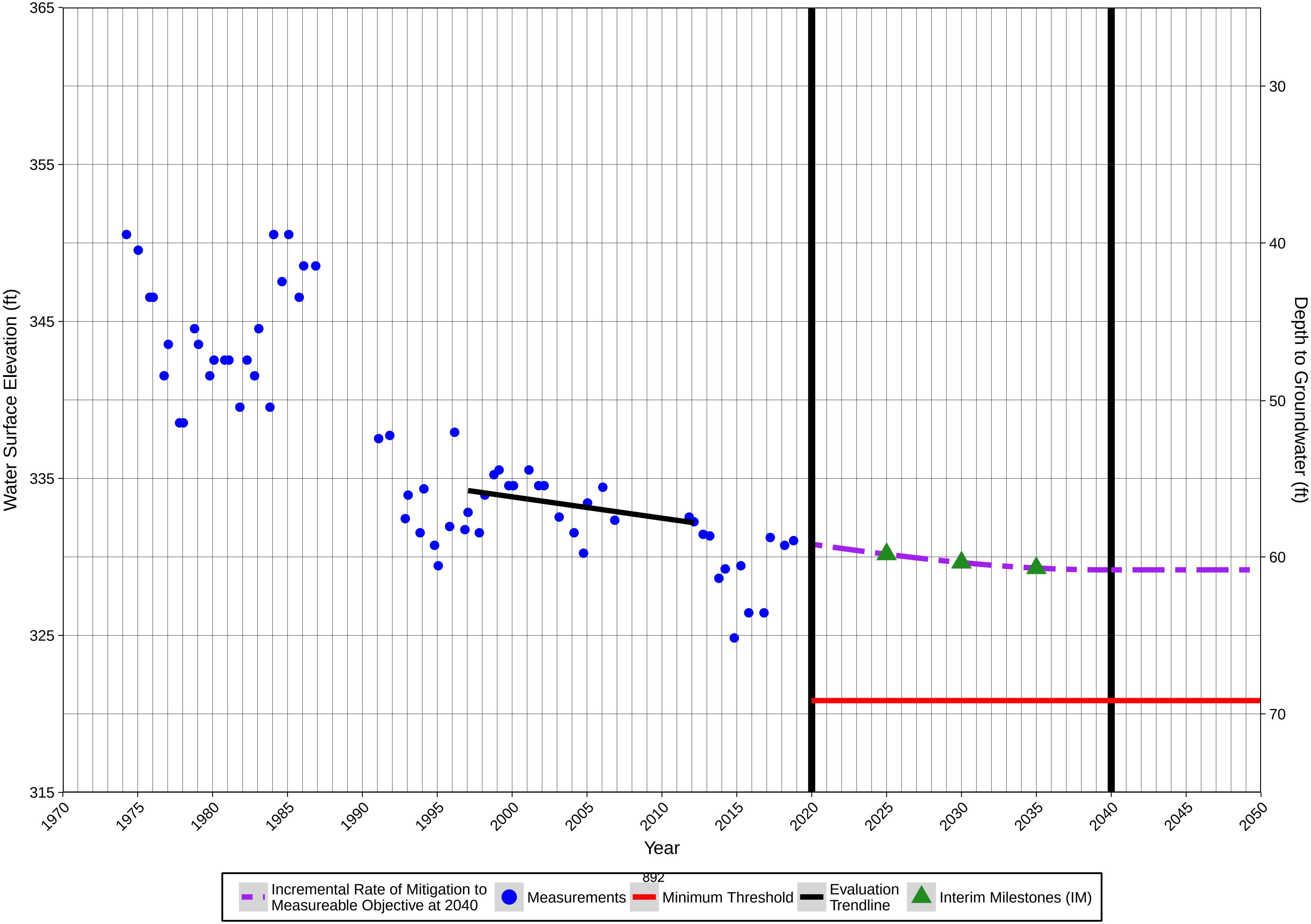
12S21E29K001M

SE Intersection of Teague Ave and N Clovis Ave
Ground Surface Elevation: 379 ft
North Kings GSA



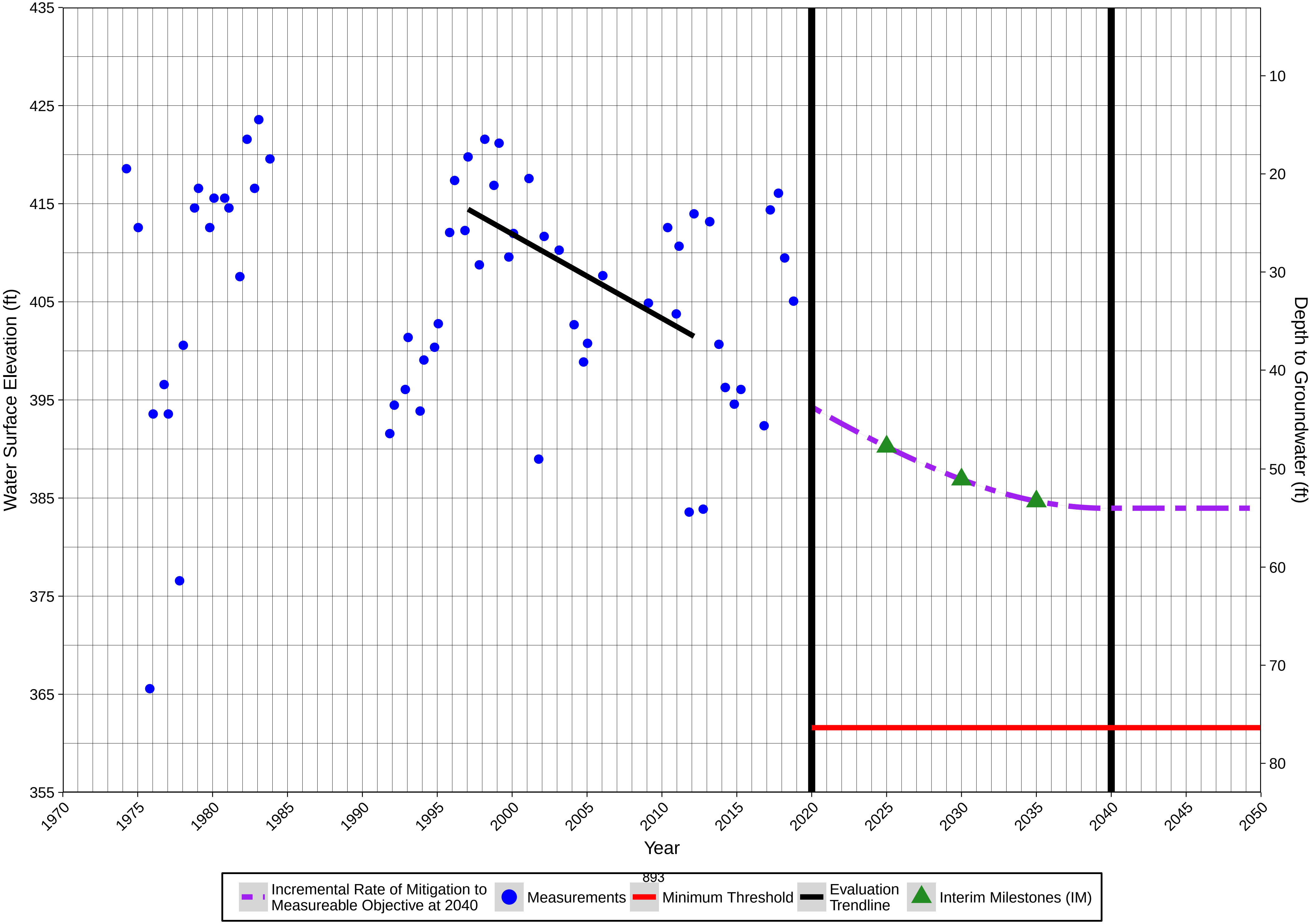
12S21E34H001M

NE Intersection of Hwy 168 and N Temperance Ave
Ground Surface Elevation: 390 ft
North Kings GSA



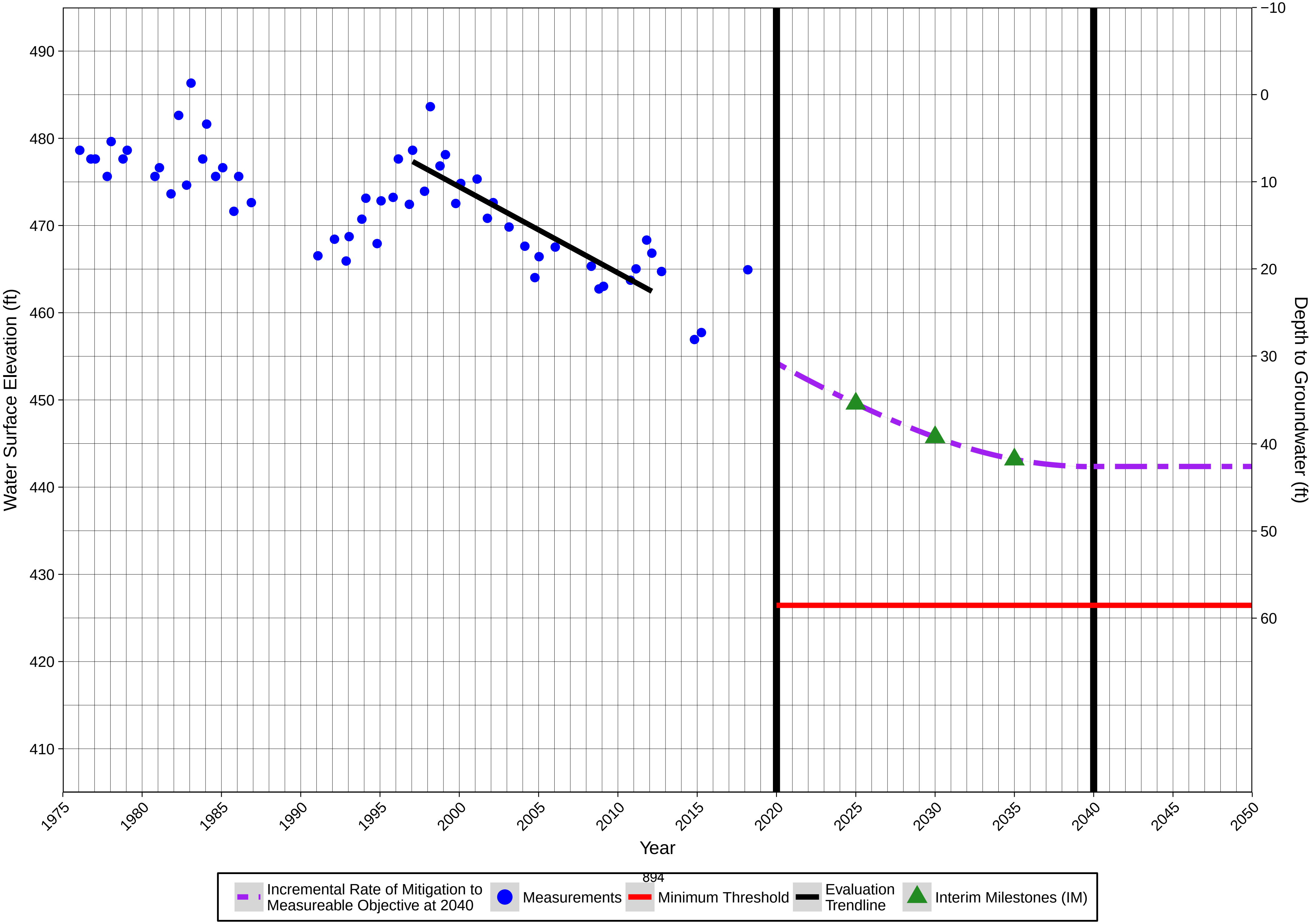
12S22E19N001M

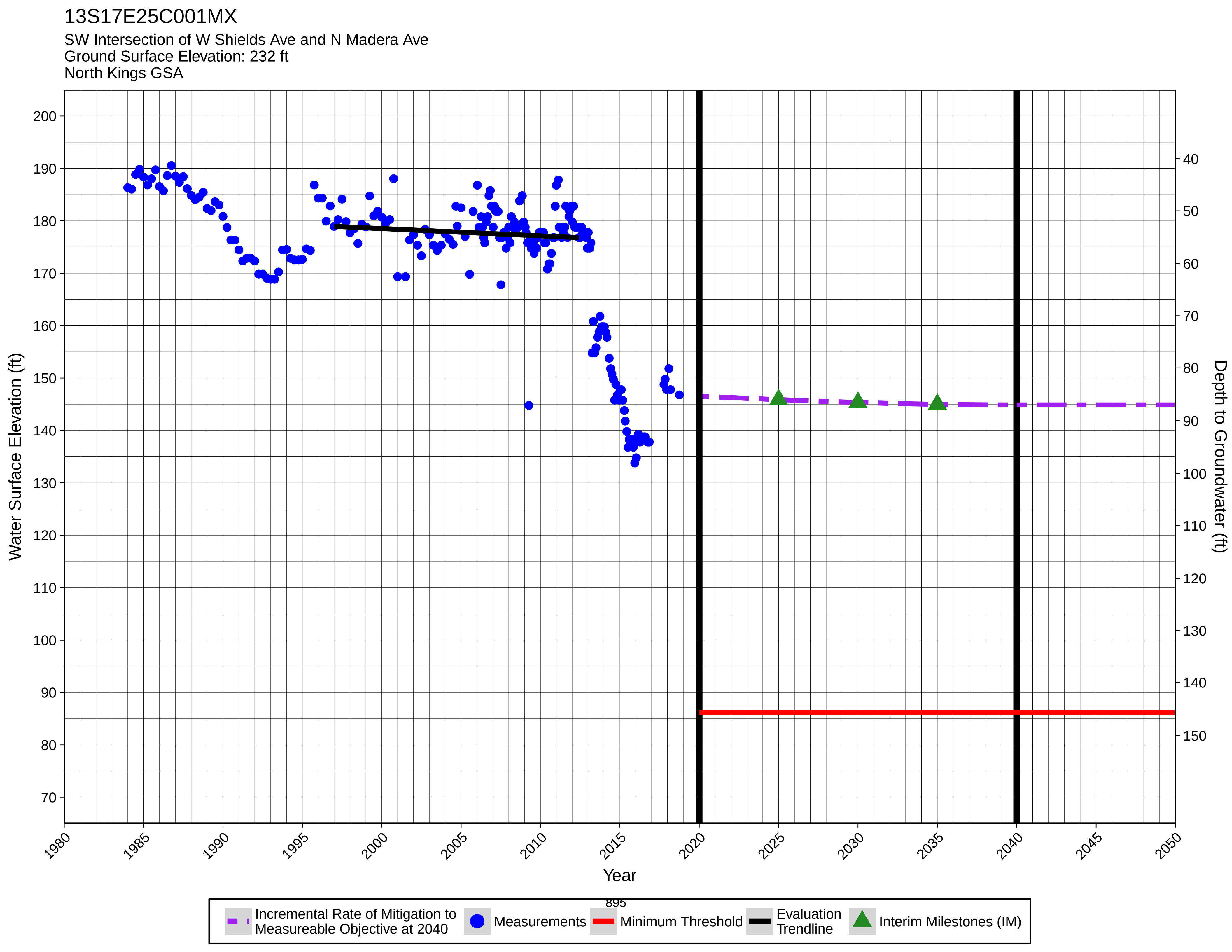
NE Intersection of Tollhouse Rd and N Thompson Ave
Ground Surface Elevation: 438 ft
North Kings GSA



12S22E26L001M

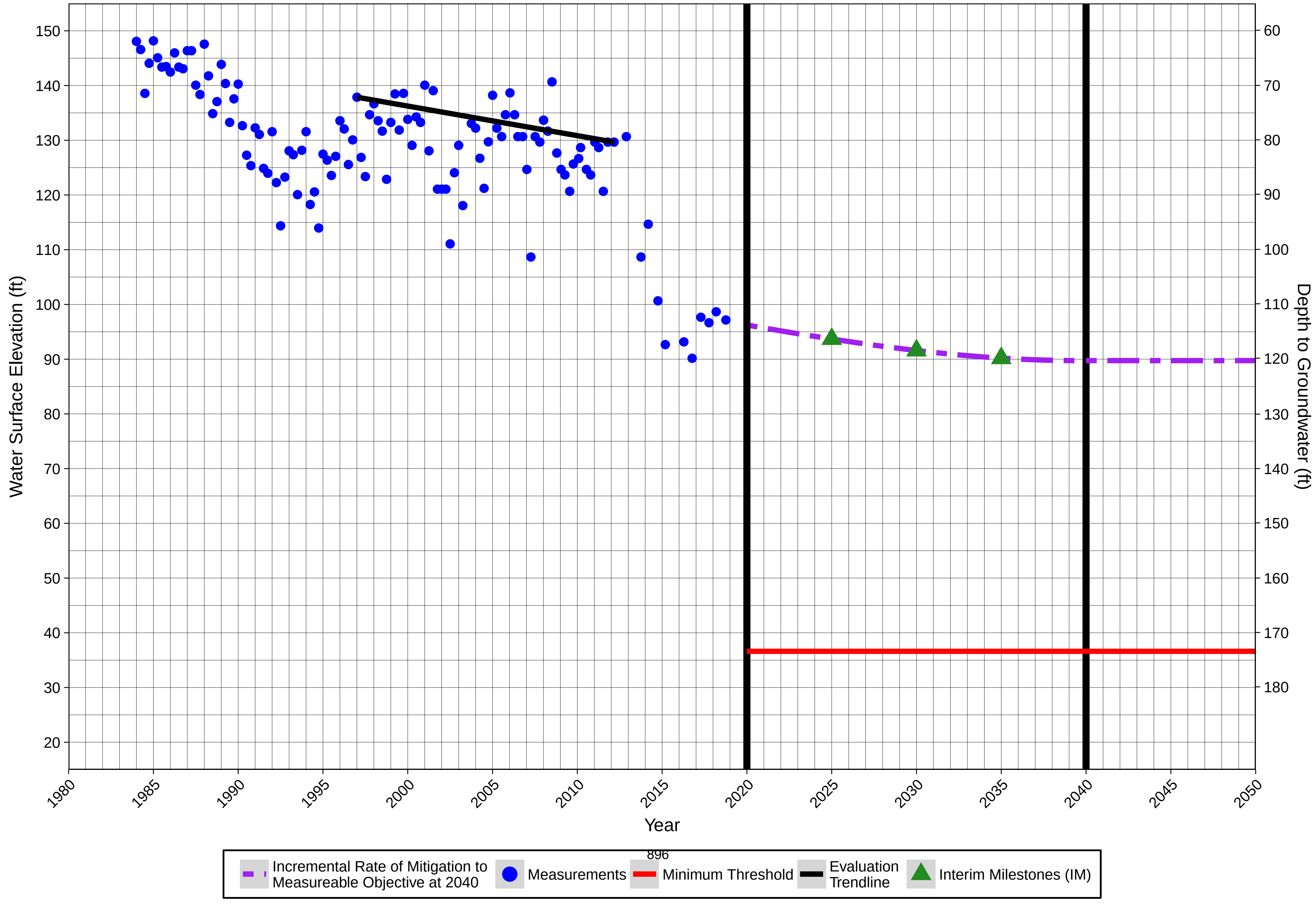
SW Intersection of E Teague Ave and N Madsen Ave
Ground Surface Elevation: 485 ft
North Kings GSA




13S17E25C001MX
SW Intersection of W Shields Ave and N Madera Ave
Ground Surface Elevation: 232 ft
North Kings GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
Incremental Rate of Mitigation to Measureable Objective at 2040
Measurements
Minimum Threshold
Evaluation Trendline
Interim Milestones (IM)

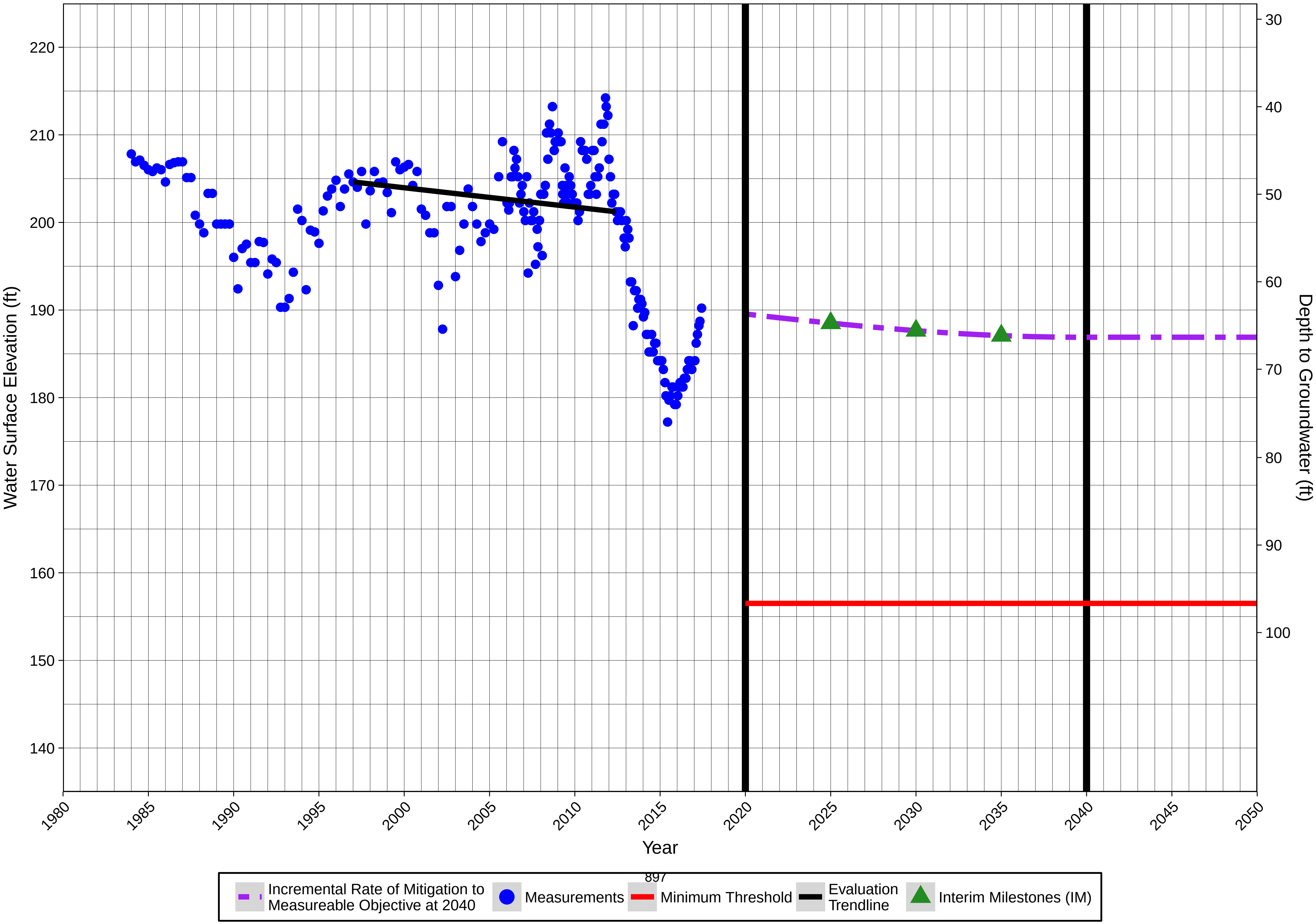
13S17E33M001MX

State Well ID: 13S17E32H001M
NW Intersection of W Olive Ave and N Lake Ave
Ground Surface Elevation: 210 ft
North Kings GSA



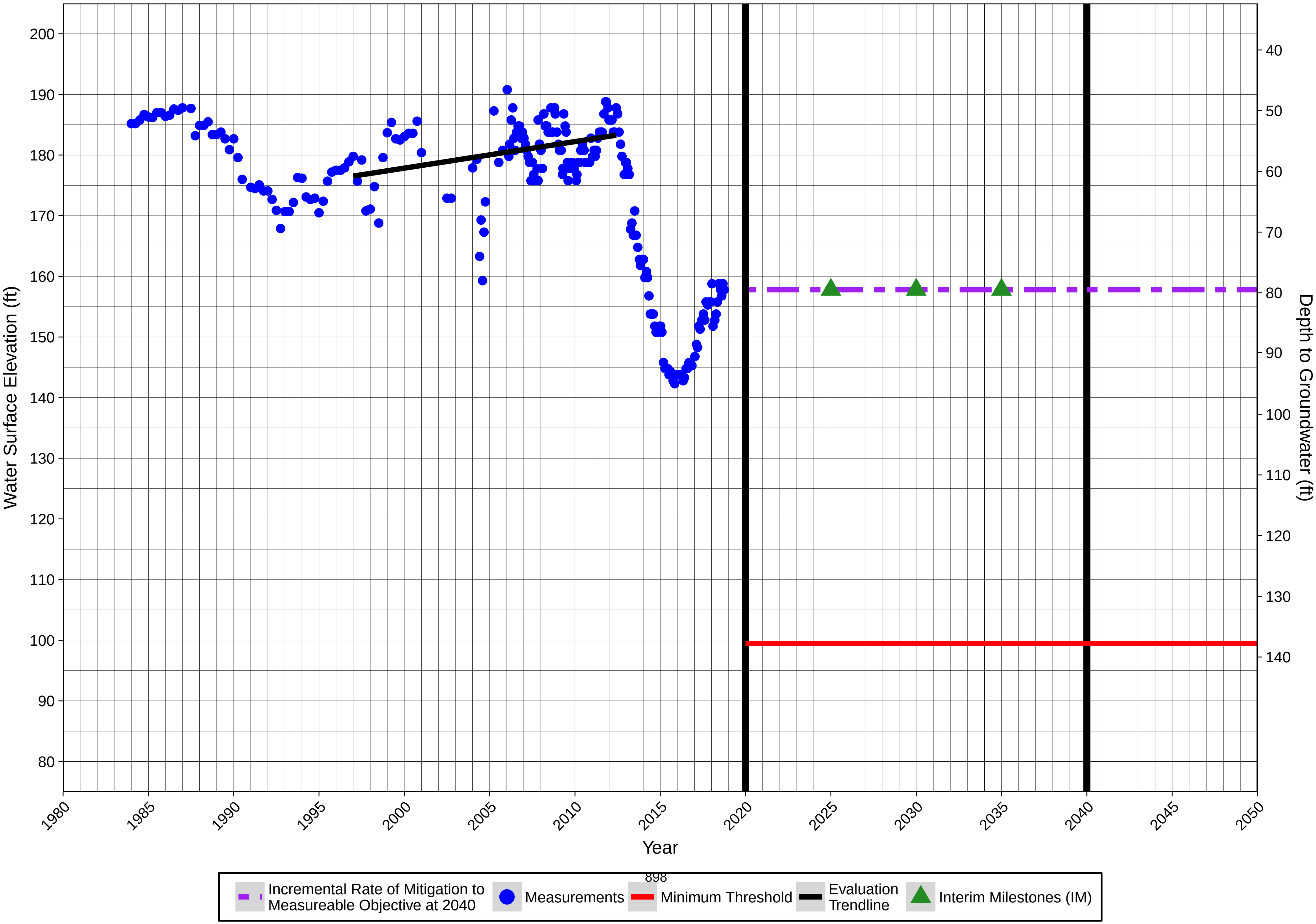
13S18E17A001MX

SW Intersection of W Shaw Ave and N Howard Ave
Ground Surface Elevation: 253 ft
North Kings GSA



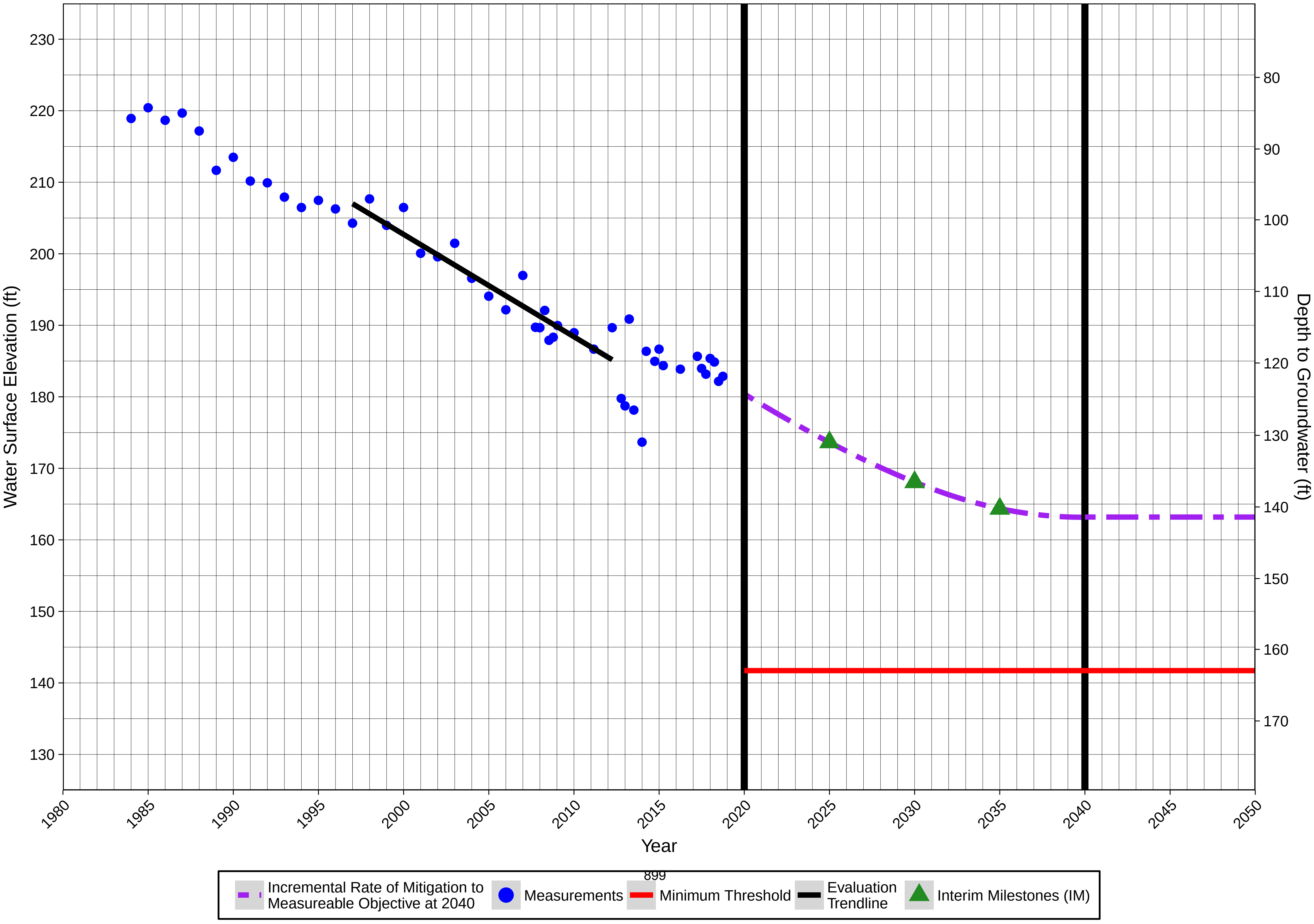
13S18E33M001MX

NW Intersection of W Belmont Ave and N Howard Ave
Ground Surface Elevation: 237 ft
North Kings GSA



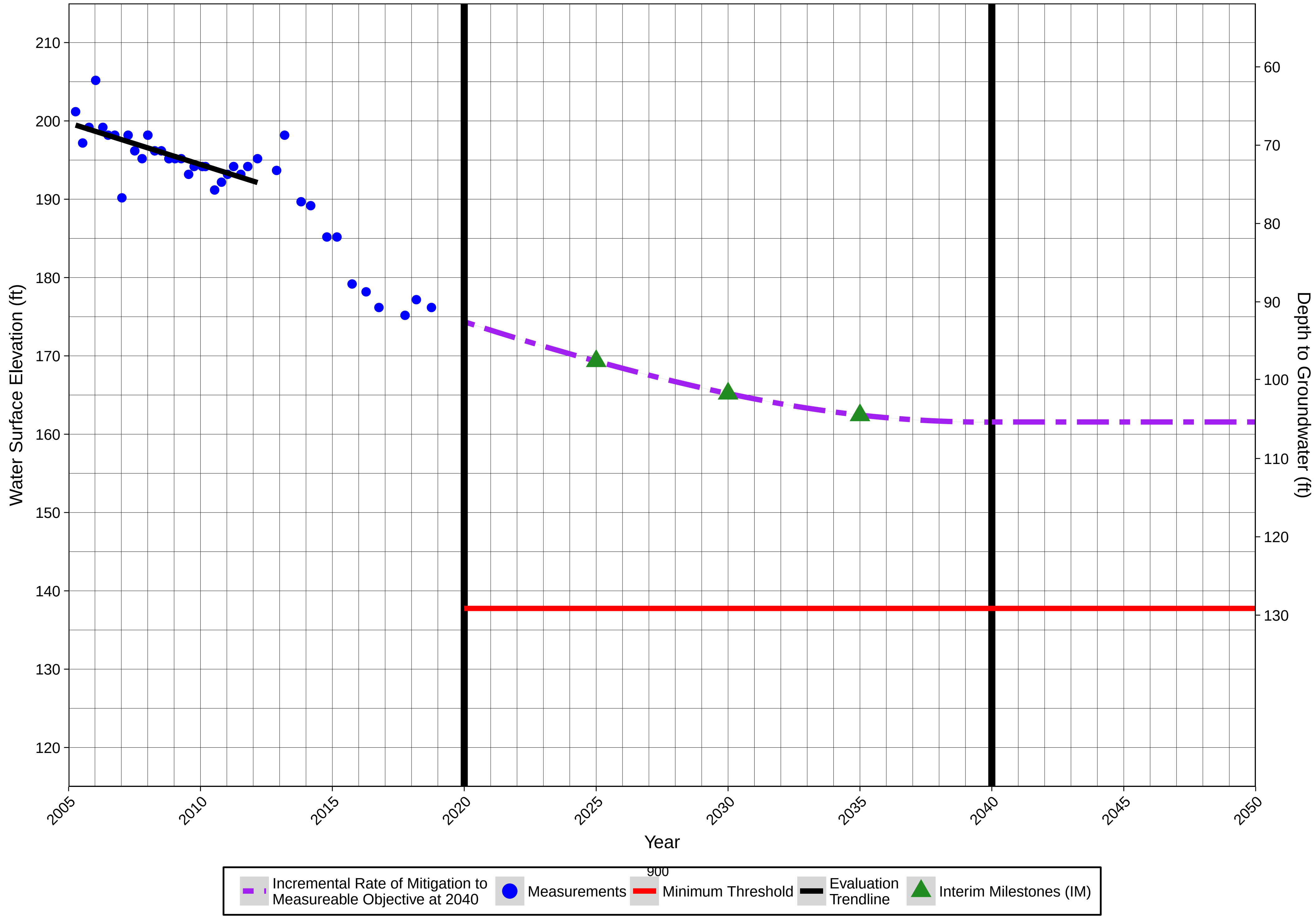
13S19E11L001MX

NE Intersection of N Gates Ave and N Blythe Ave
Ground Surface Elevation: 305 ft
North Kings GSA



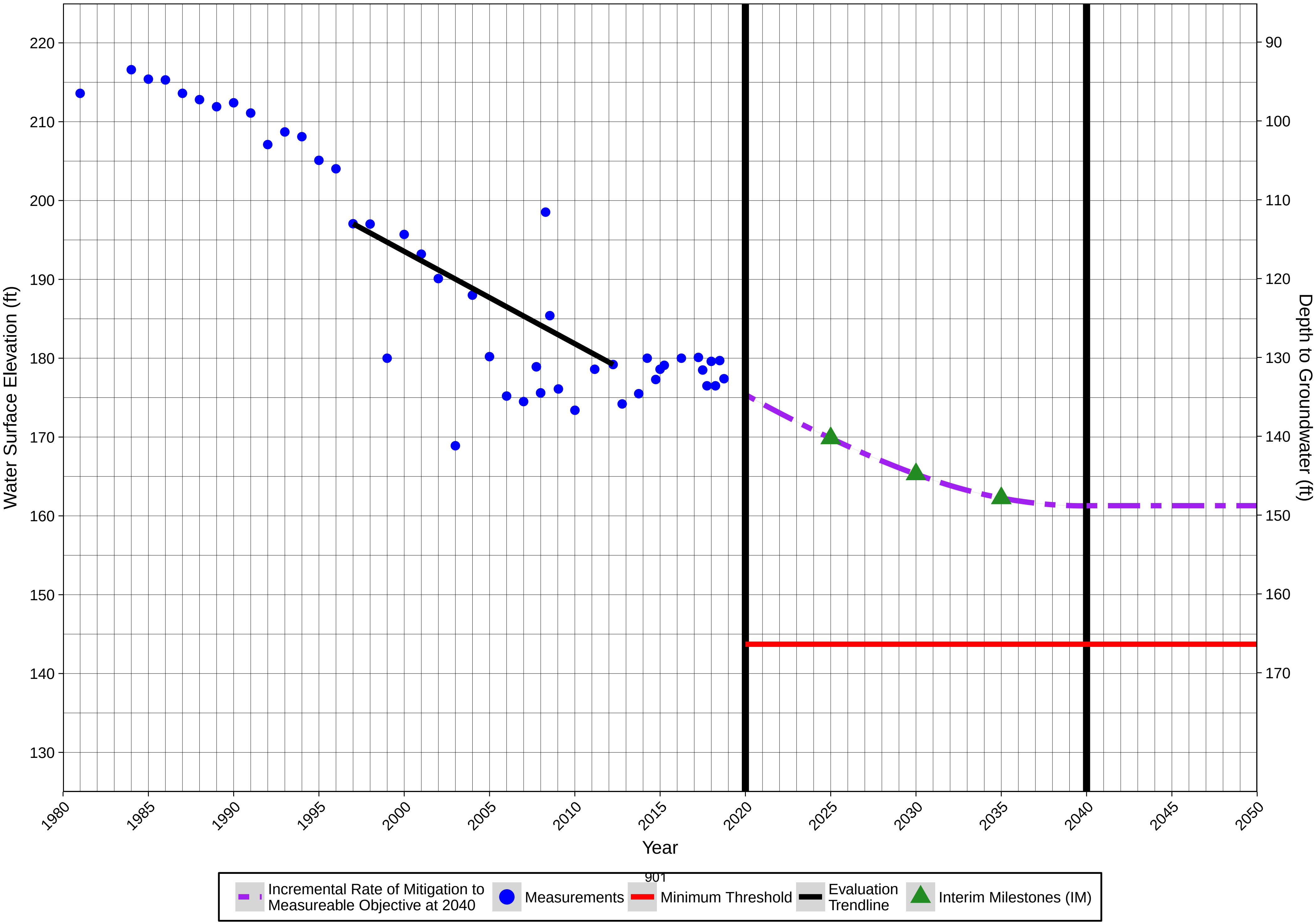
13S19E29A001MX

SW Intersection of W Shields Ave and N Grantland Ave
Ground Surface Elevation: 267 ft
North Kings GSA



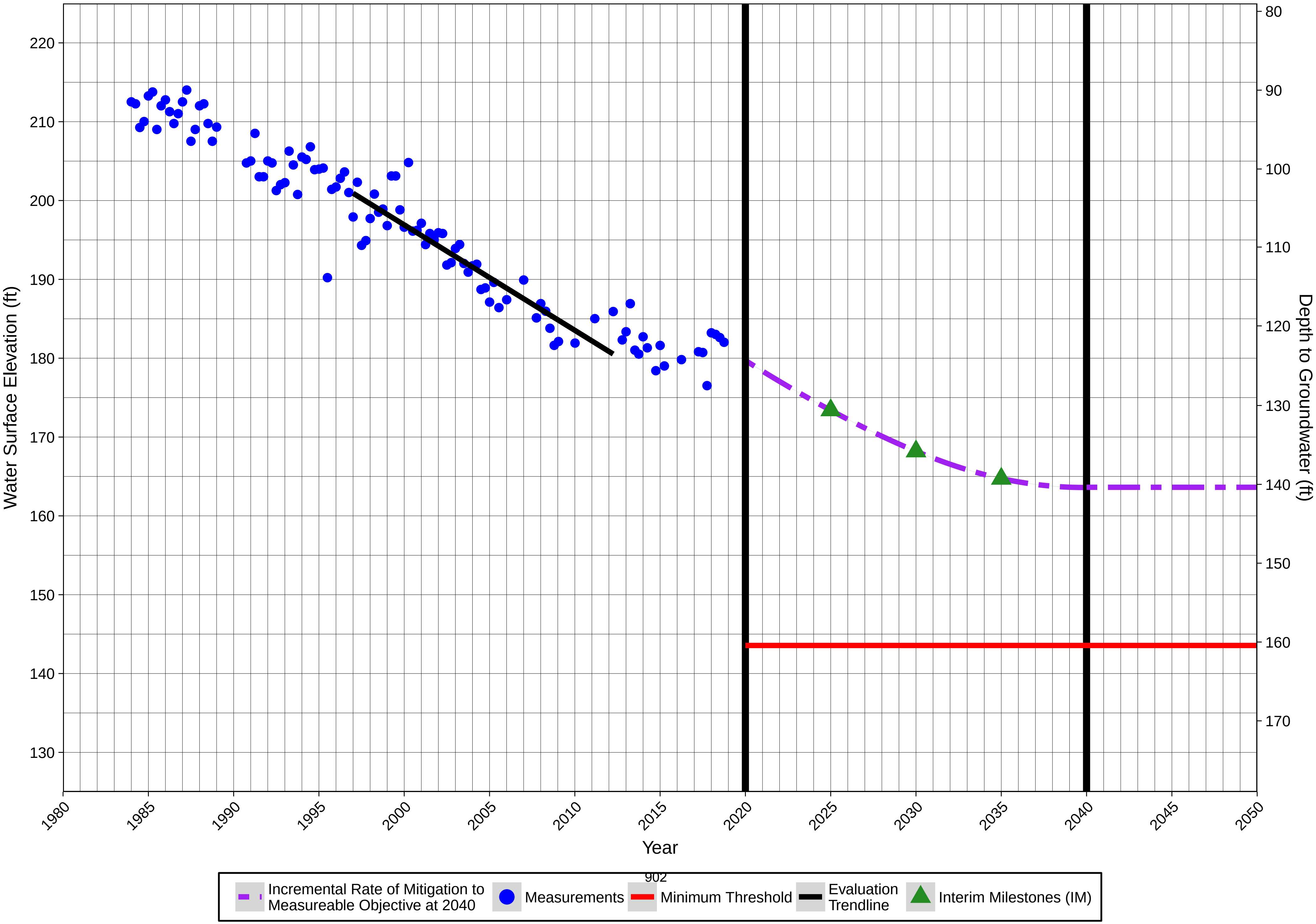
13S20E27C001MX

SW Intersection of E Shields Ave and N Fresno St
Ground Surface Elevation: 310 ft
North Kings GSA



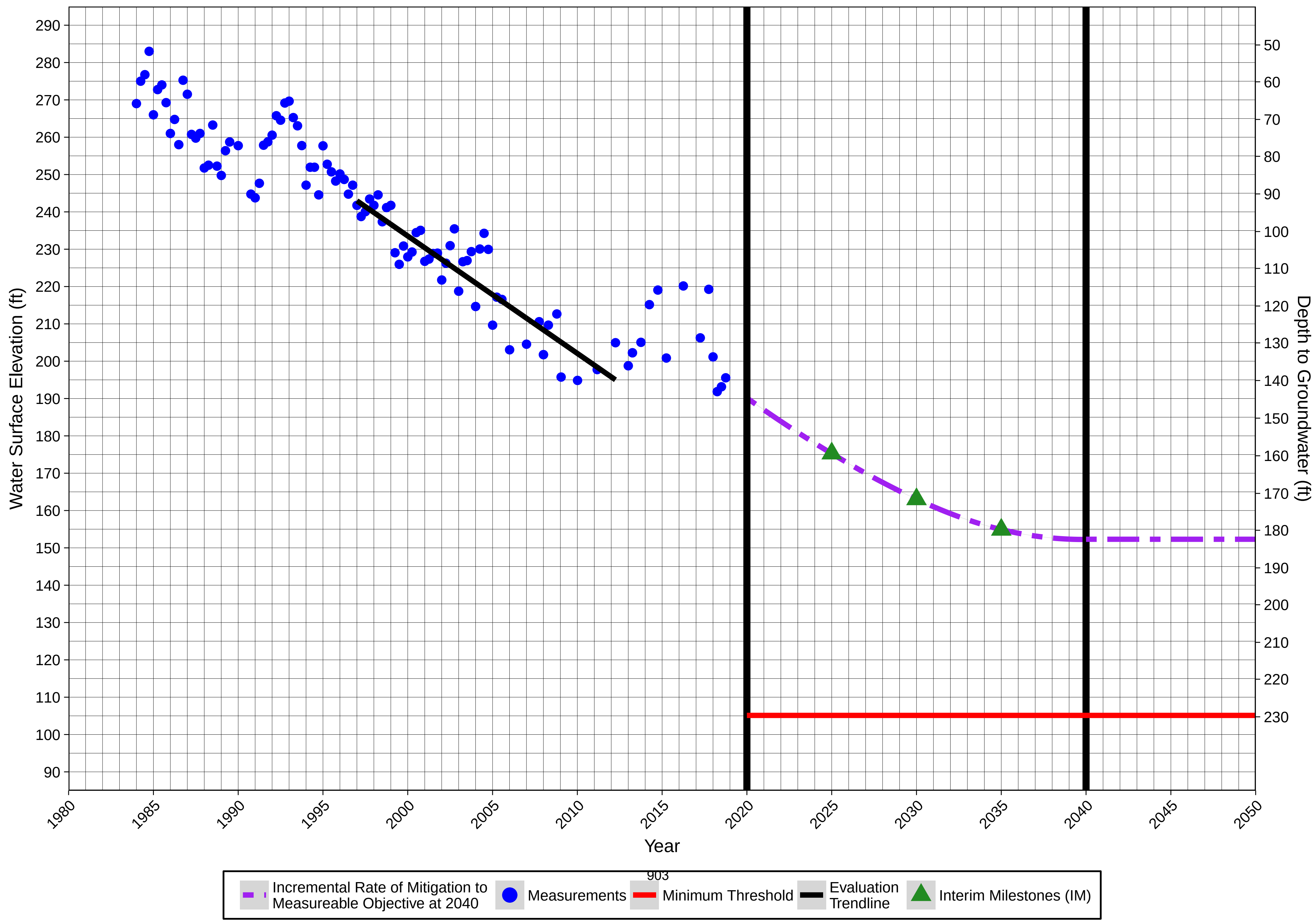
13S20E30B001MX

SE Intersection of W Shields Ave and N Hughes Ave
Ground Surface Elevation: 304 ft
North Kings GSA



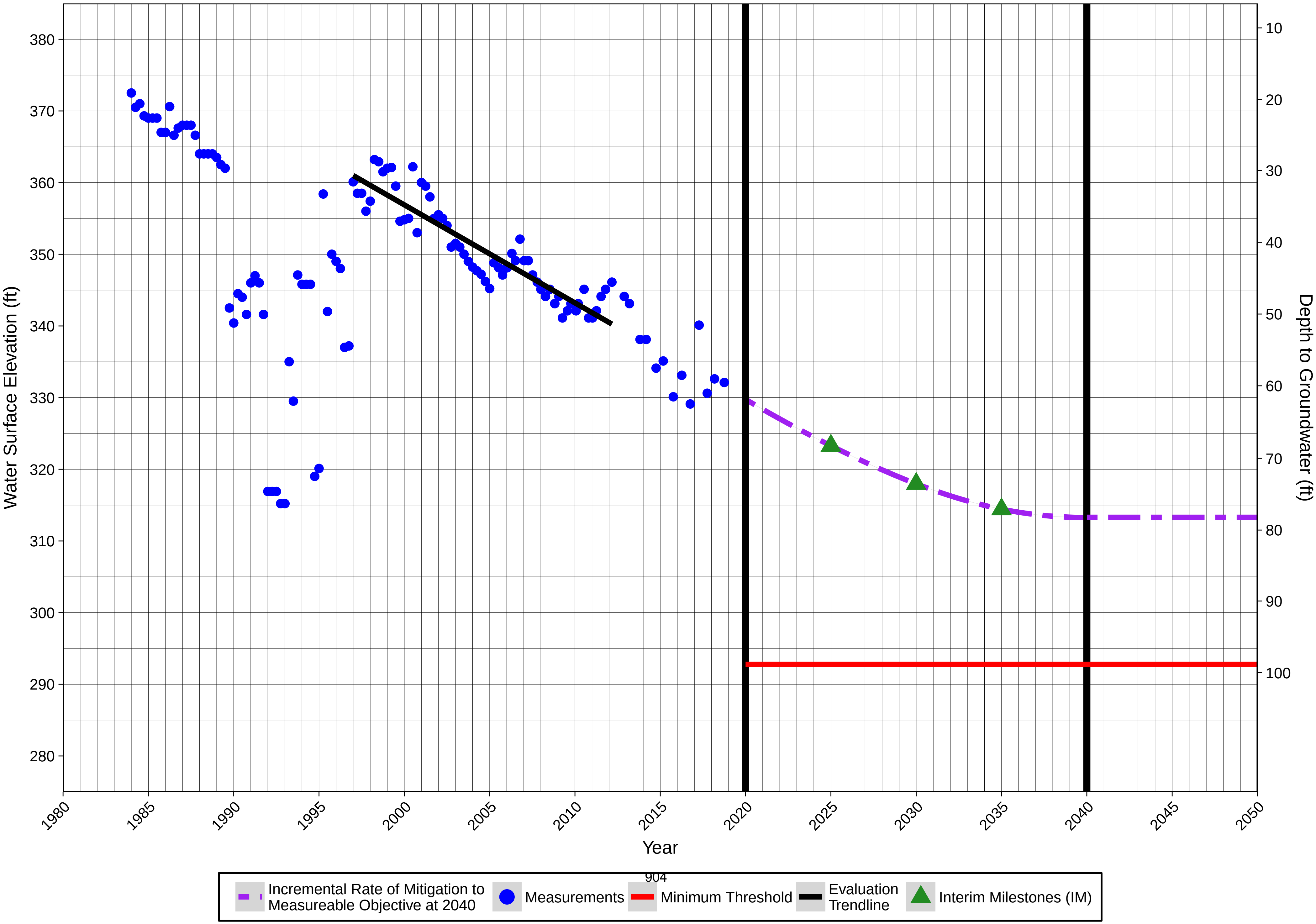
13S21E19E001MX

SW Intersection of N Chestnut Ave and N Winery Ave
Ground Surface Elevation: 335 ft
North Kings GSA



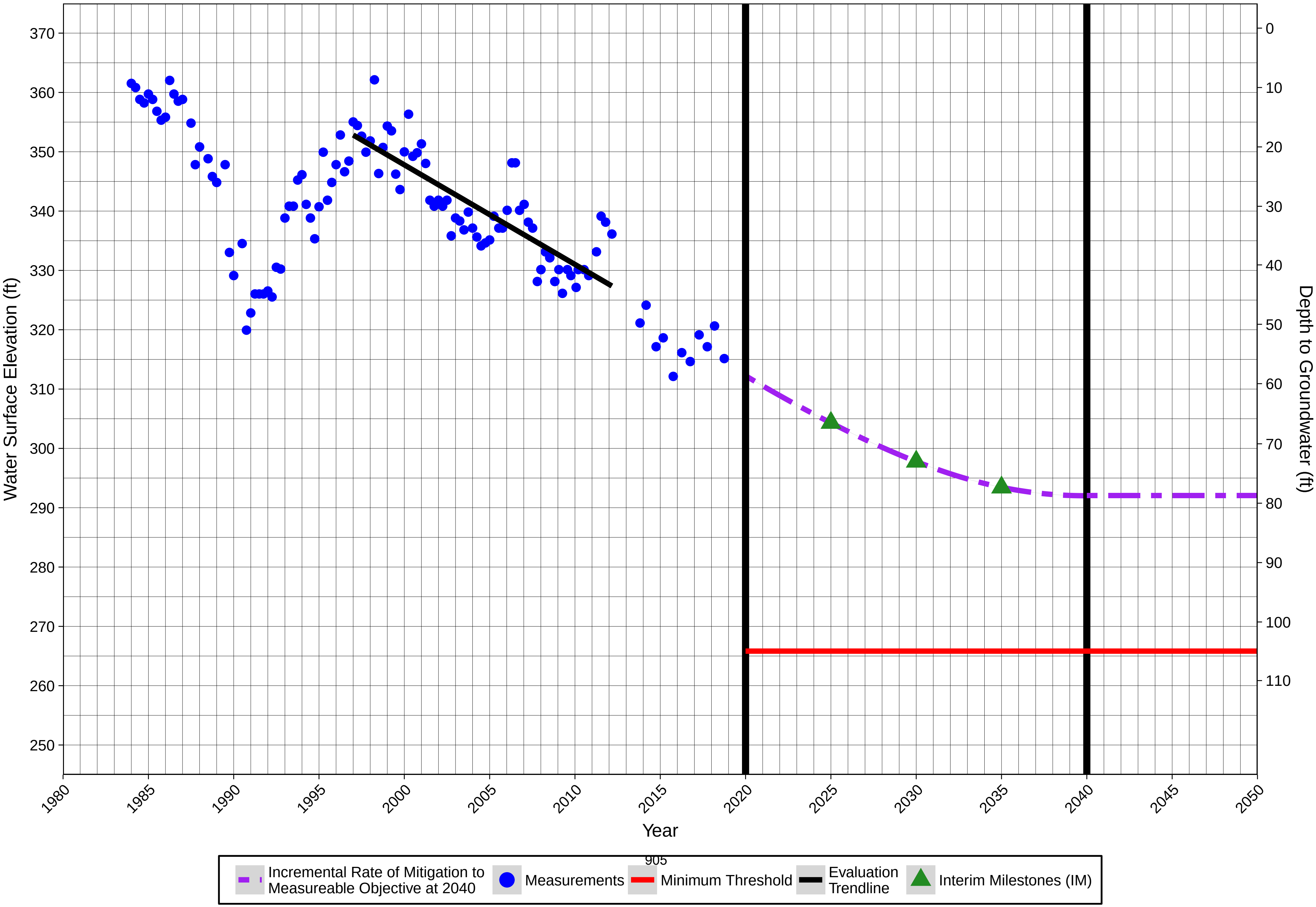
13S22E07R001MX

NW Intersection of E Shaw Ave and N McCall Ave
Ground Surface Elevation: 392 ft
North Kings GSA



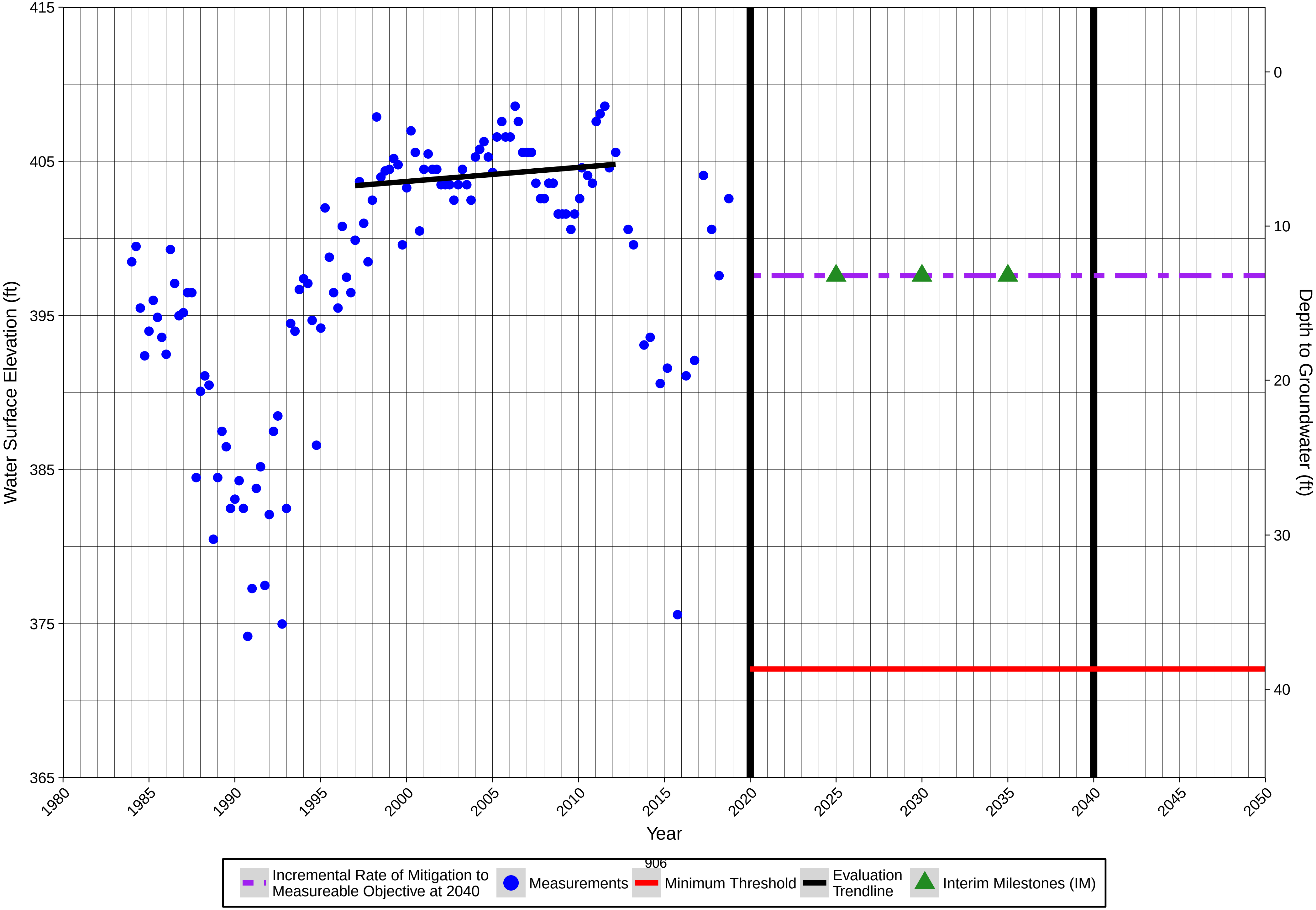
13S22E32A001MX

State Well ID: 13S22E32B001M
SW Intersection of E McKinley Ave and N Del Rey Ave
Ground Surface Elevation: 371 ft
North Kings GSA



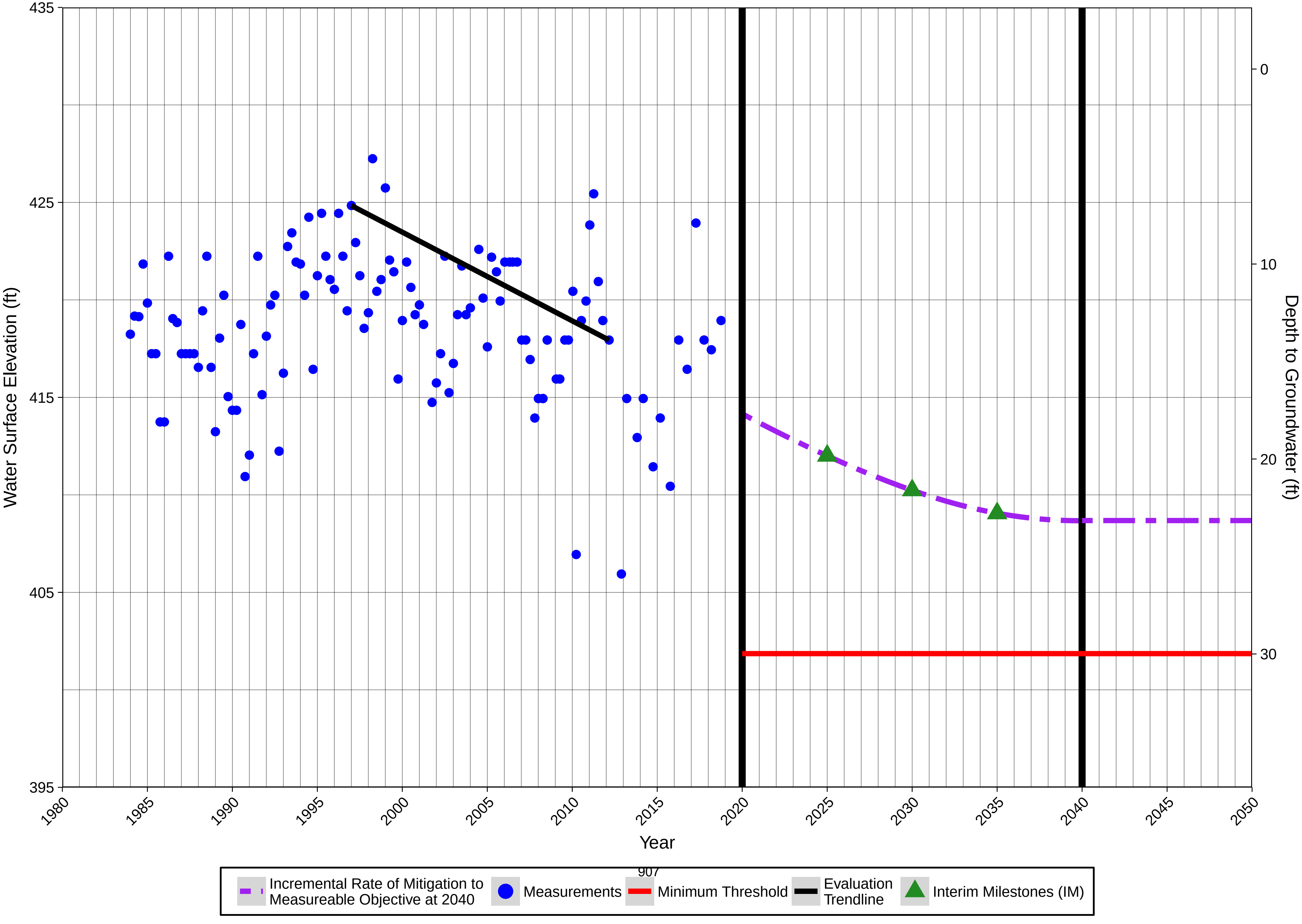
13S23E30B001MX

State Well ID: 13S23E30C001M
SW Intersection of E Shields Ave and N Riverbend Ave
Ground Surface Elevation: 411 ft
North Kings GSA



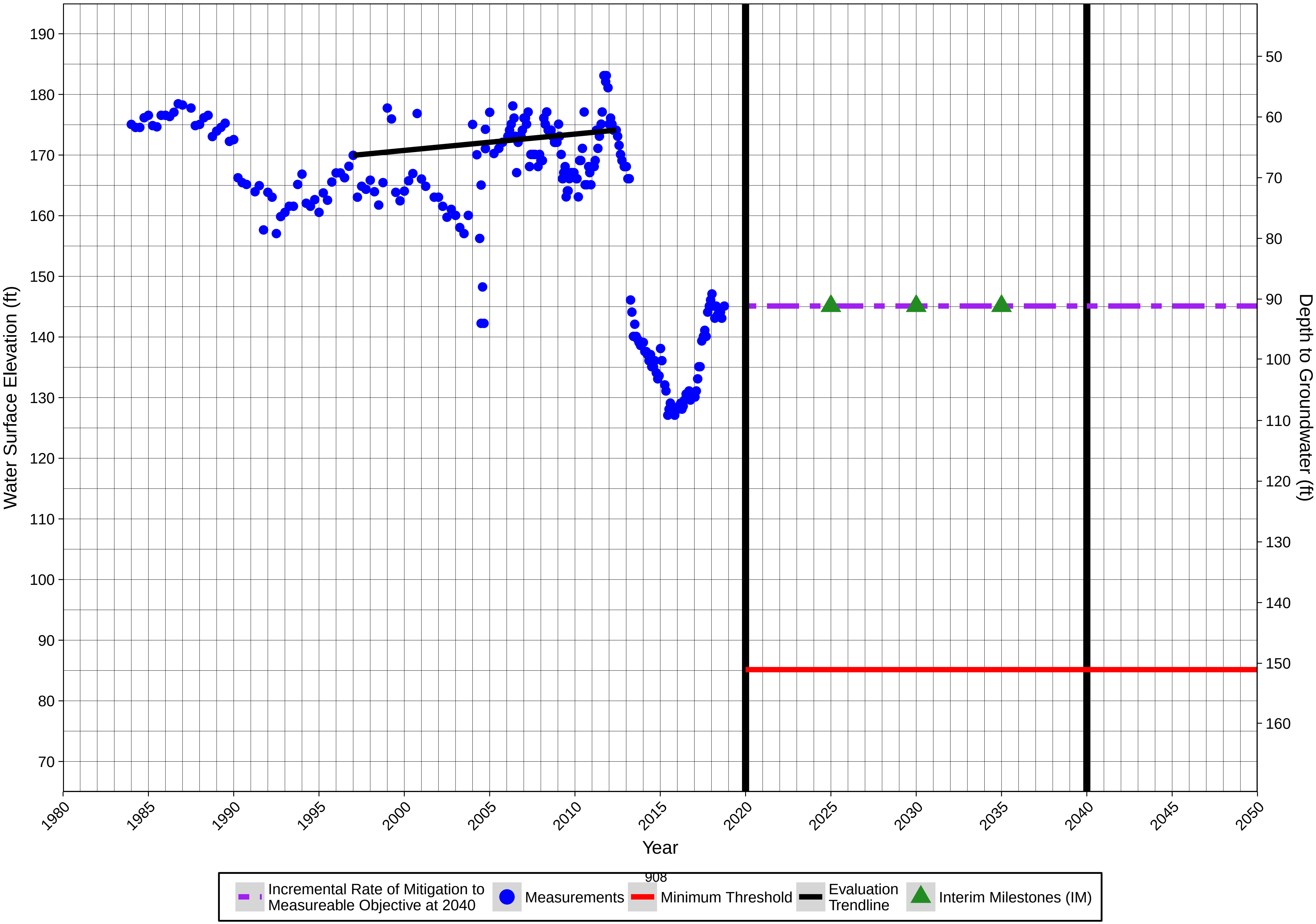
13S23E33B001MX

SW Intersection of E McKinley Ave and N Viau Ave
Ground Surface Elevation: 432 ft
North Kings GSA



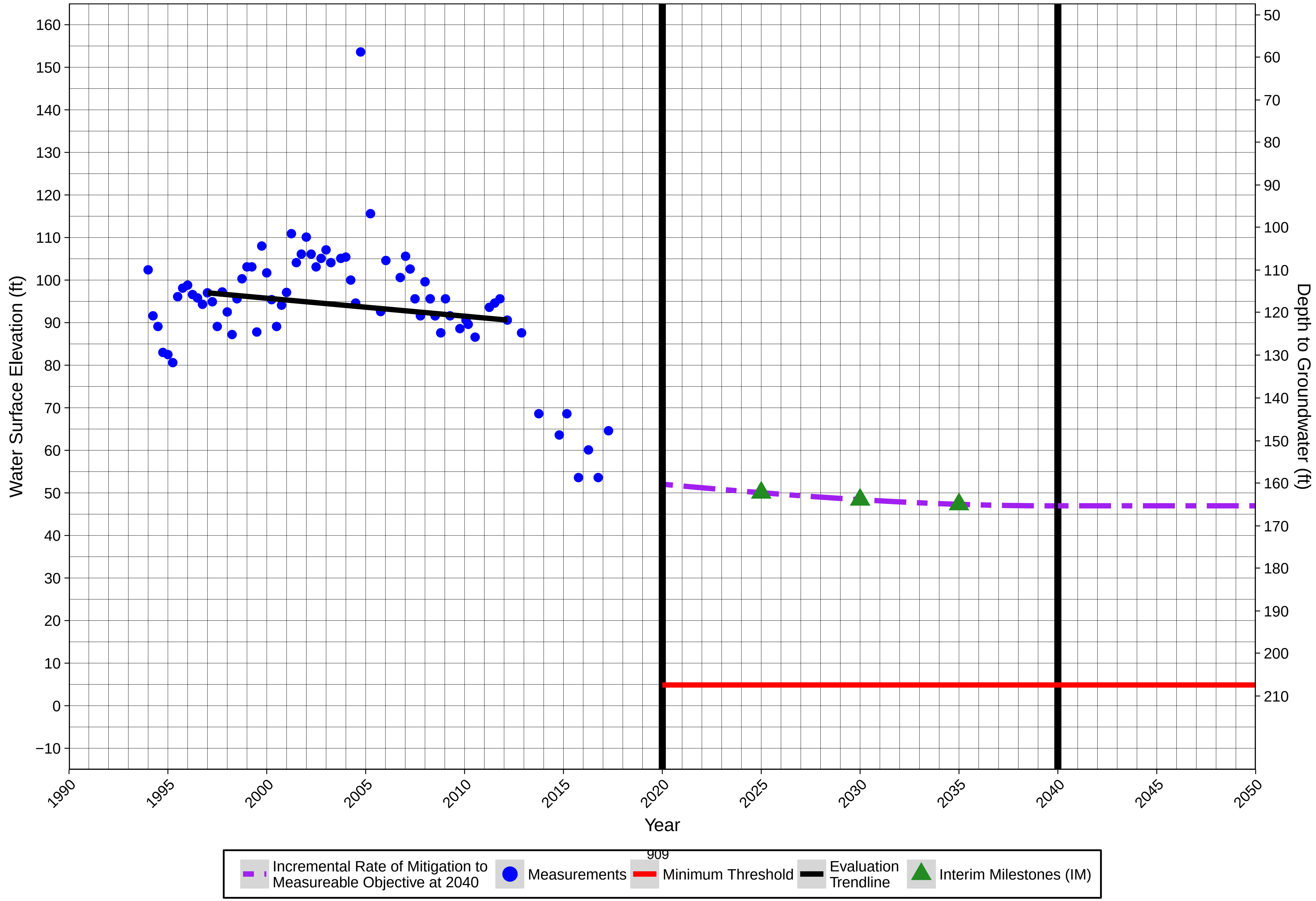
14S18E09H001MX

NW Intersection of W Kearney Blvd and S Bishop Ave
Ground Surface Elevation: 236 ft
North Kings GSA



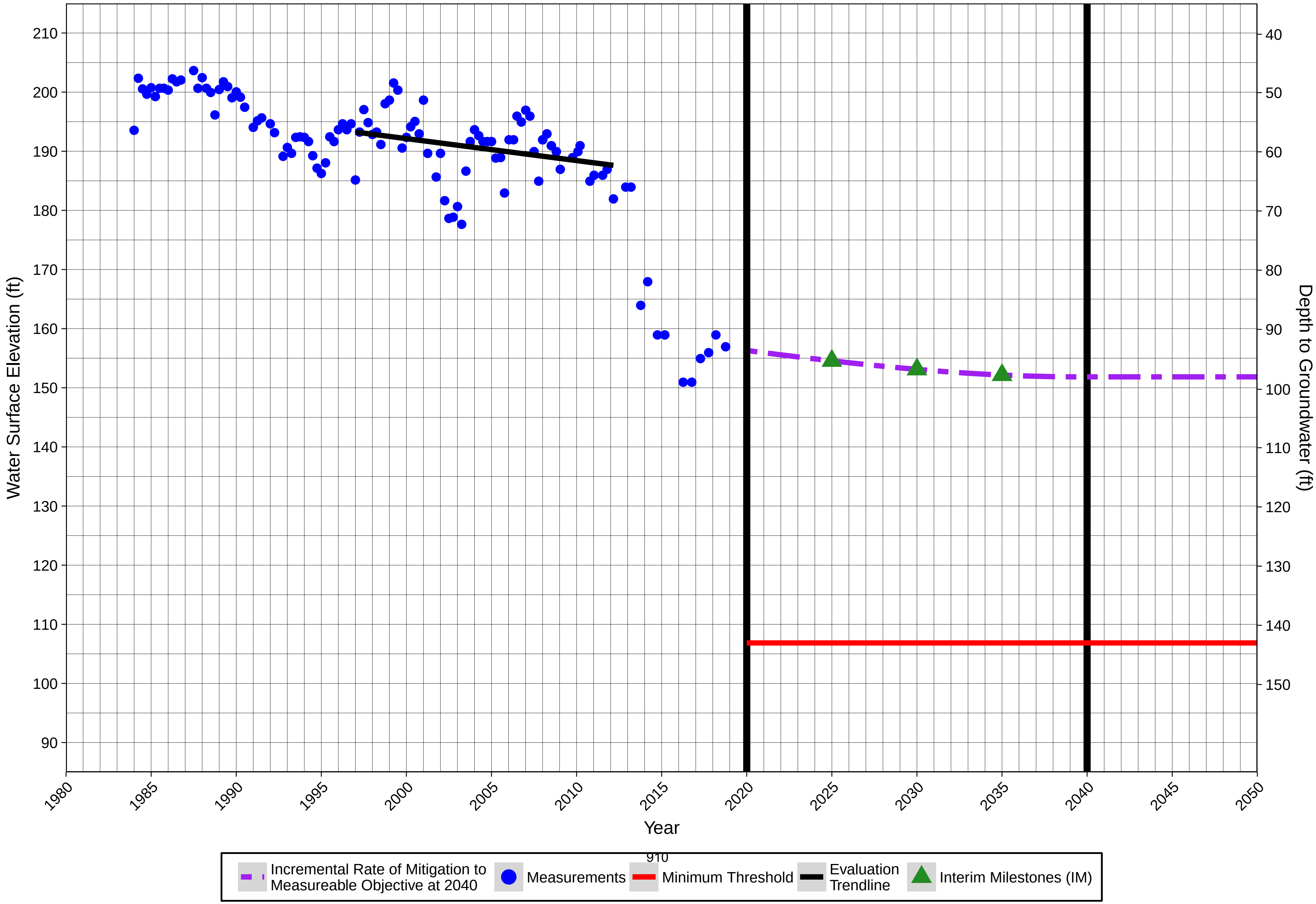
14S18E32D001MX

State Well ID: 14S18E32C001M
SE Intersection of W Central Ave and S Goldenrod Ave
Ground Surface Elevation: 212 ft
North Kings GSA



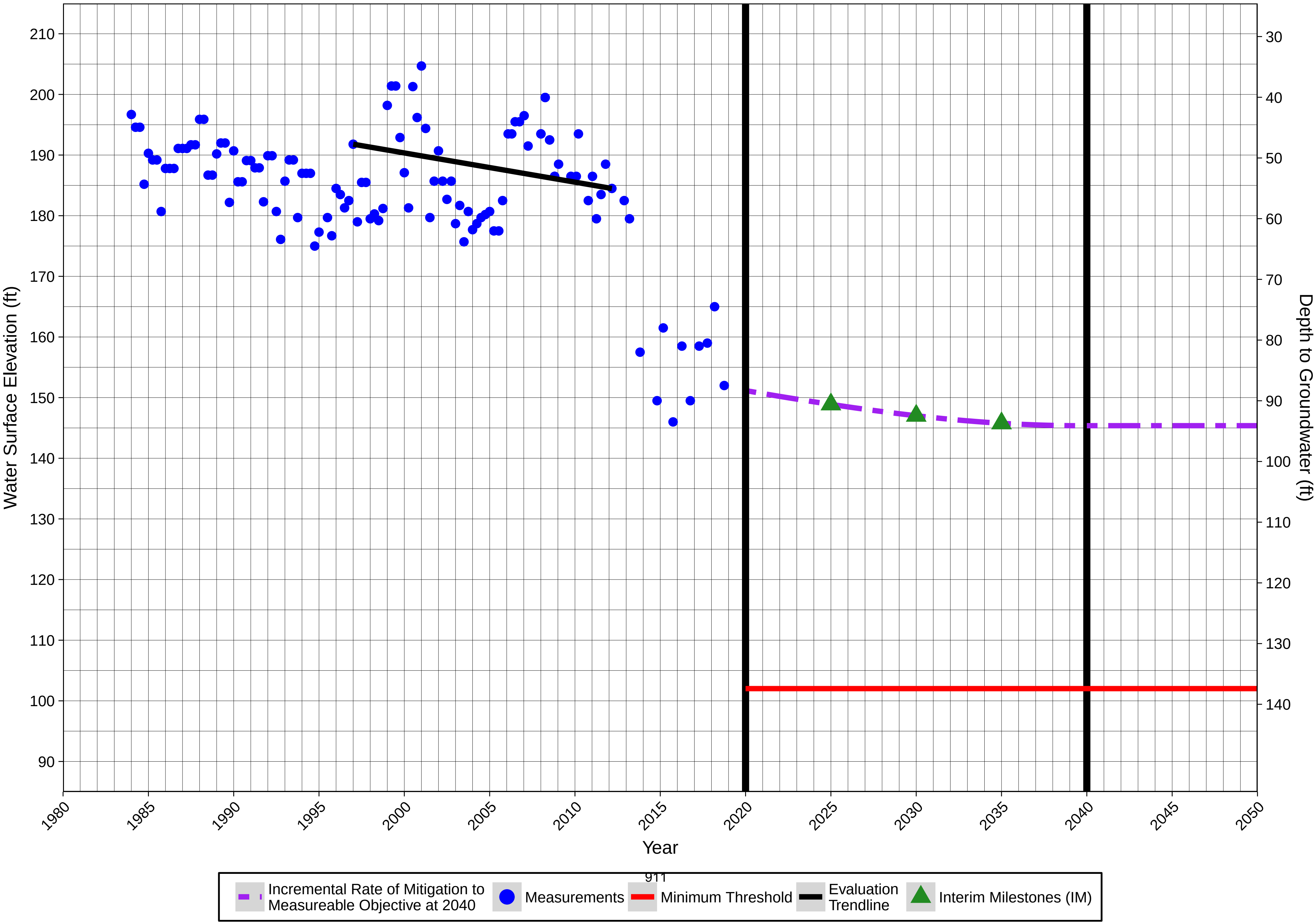
14S19E17C001MX

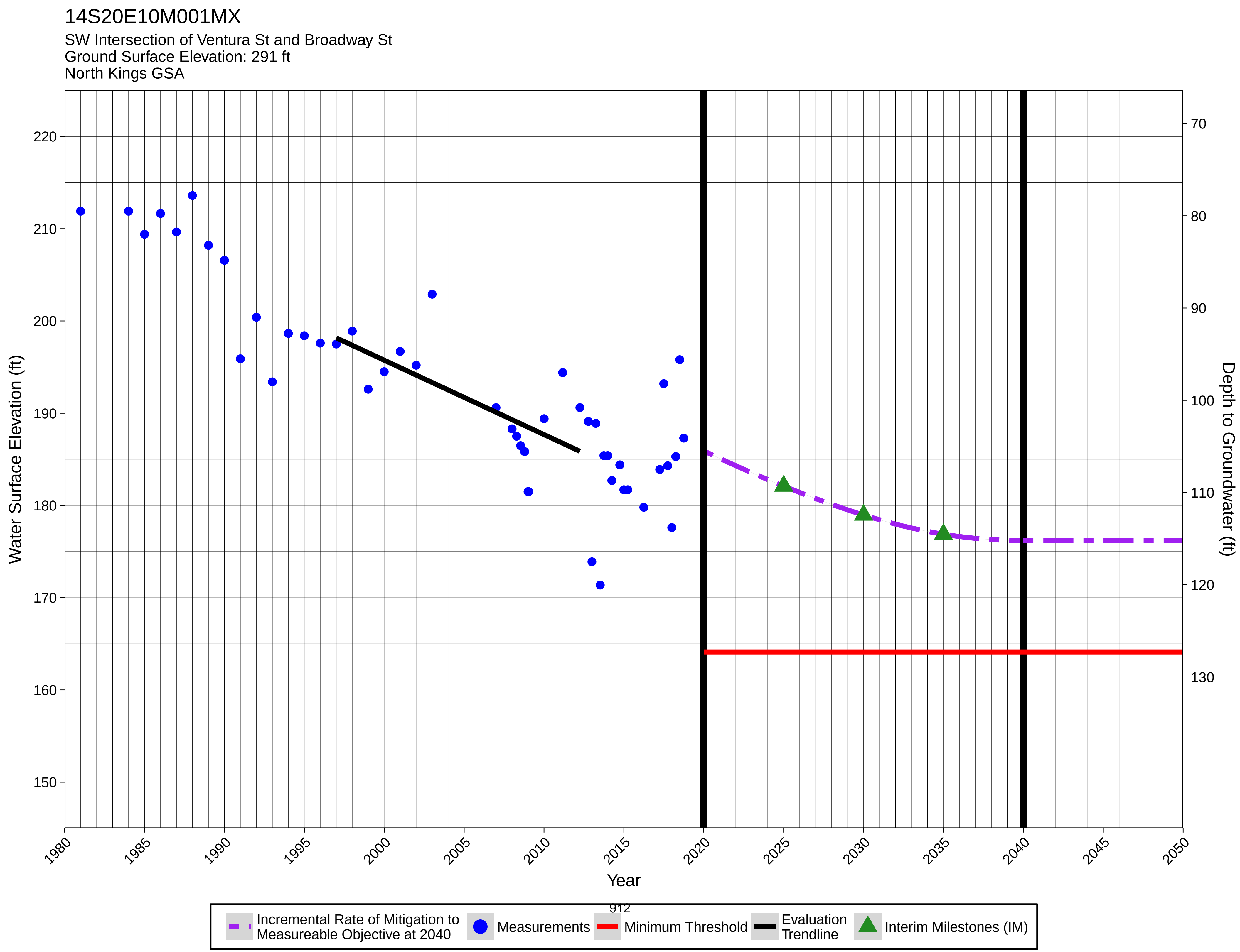
State Well ID: 14S19E17C003M
SW Intersection of W California Ave and S Garfield Ave
Ground Surface Elevation: 250 ft
North Kings GSA



14S19E33D001MX

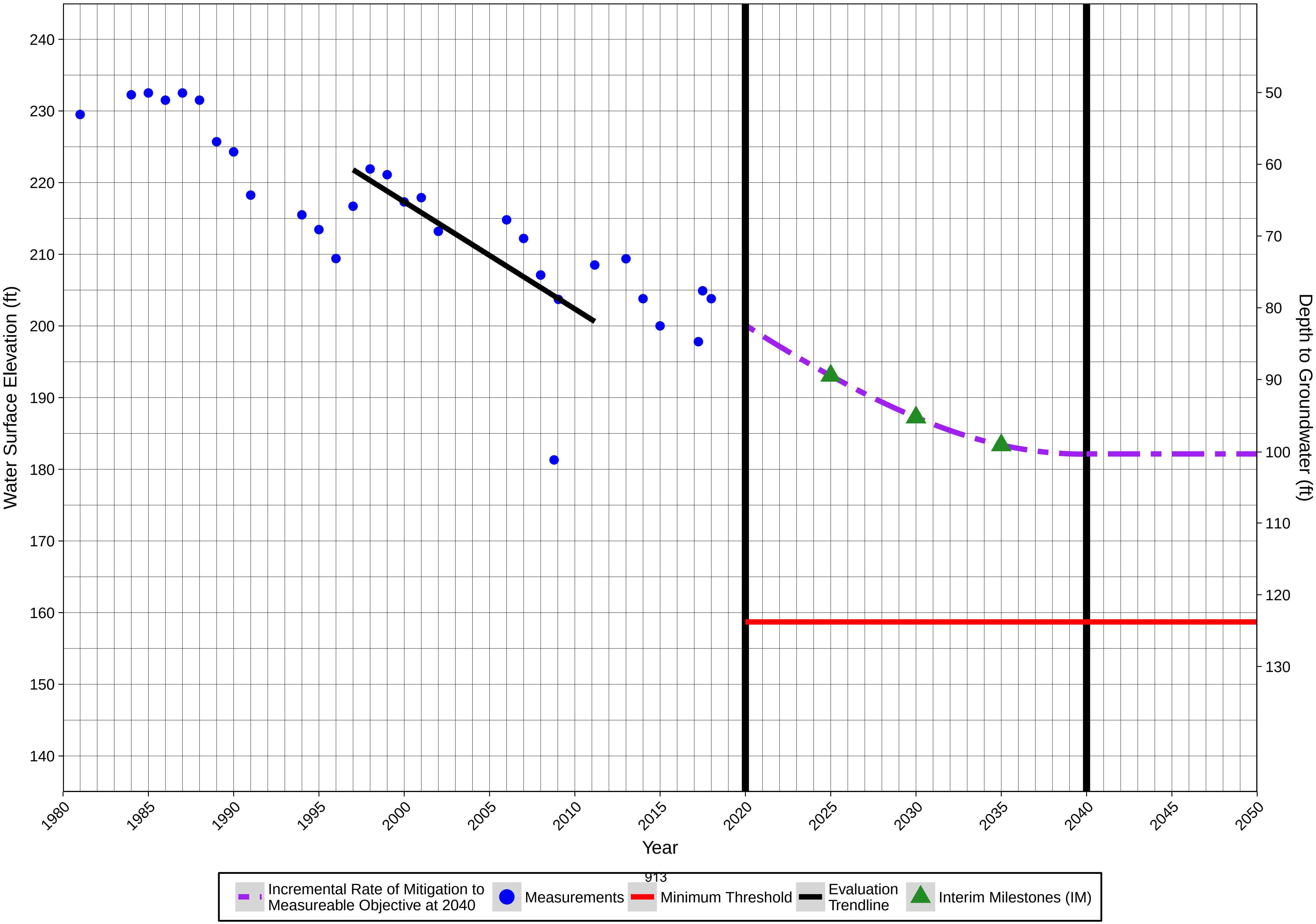
SE Intersection of W Central Ave and S Chateau Fresno Ave
Ground Surface Elevation: 239 ft
North Kings GSA




14S20E10M001MX
SW Intersection of Ventura St and Broadway St
Ground Surface Elevation: 291 ft
North Kings GSA
Water Surface Elevation (ft)
Depth to Groundwater (ft)
Year
Incremental Rate of Mitigation to Measureable Objective at 2040
Measurements
Minimum Threshold
Evaluation Trendline
Interim Milestones (IM)

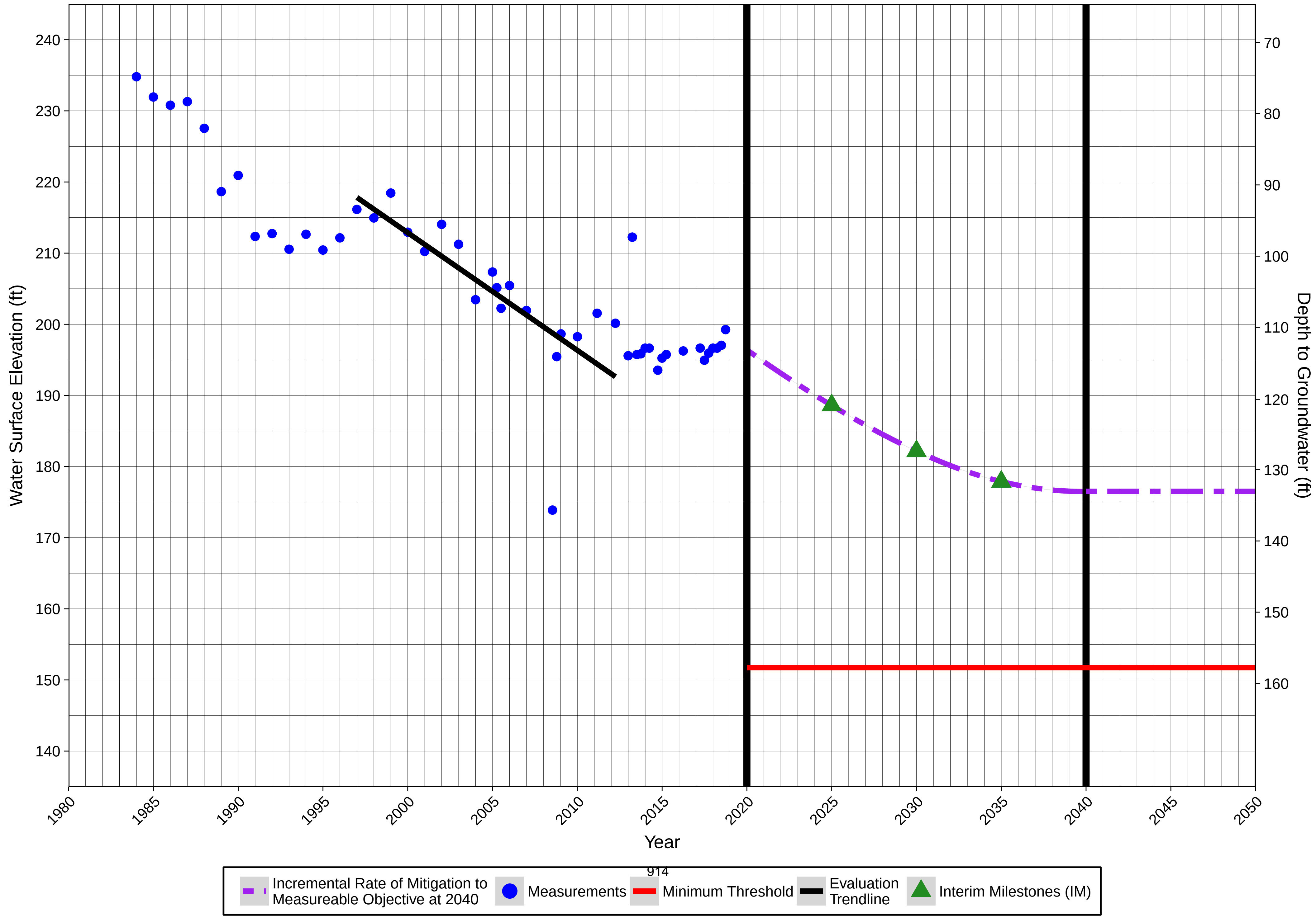
14S20E22J001MX

SW Intersection of E Annadale Ave and S East Avenue
Ground Surface Elevation: 283 ft
North Kings GSA



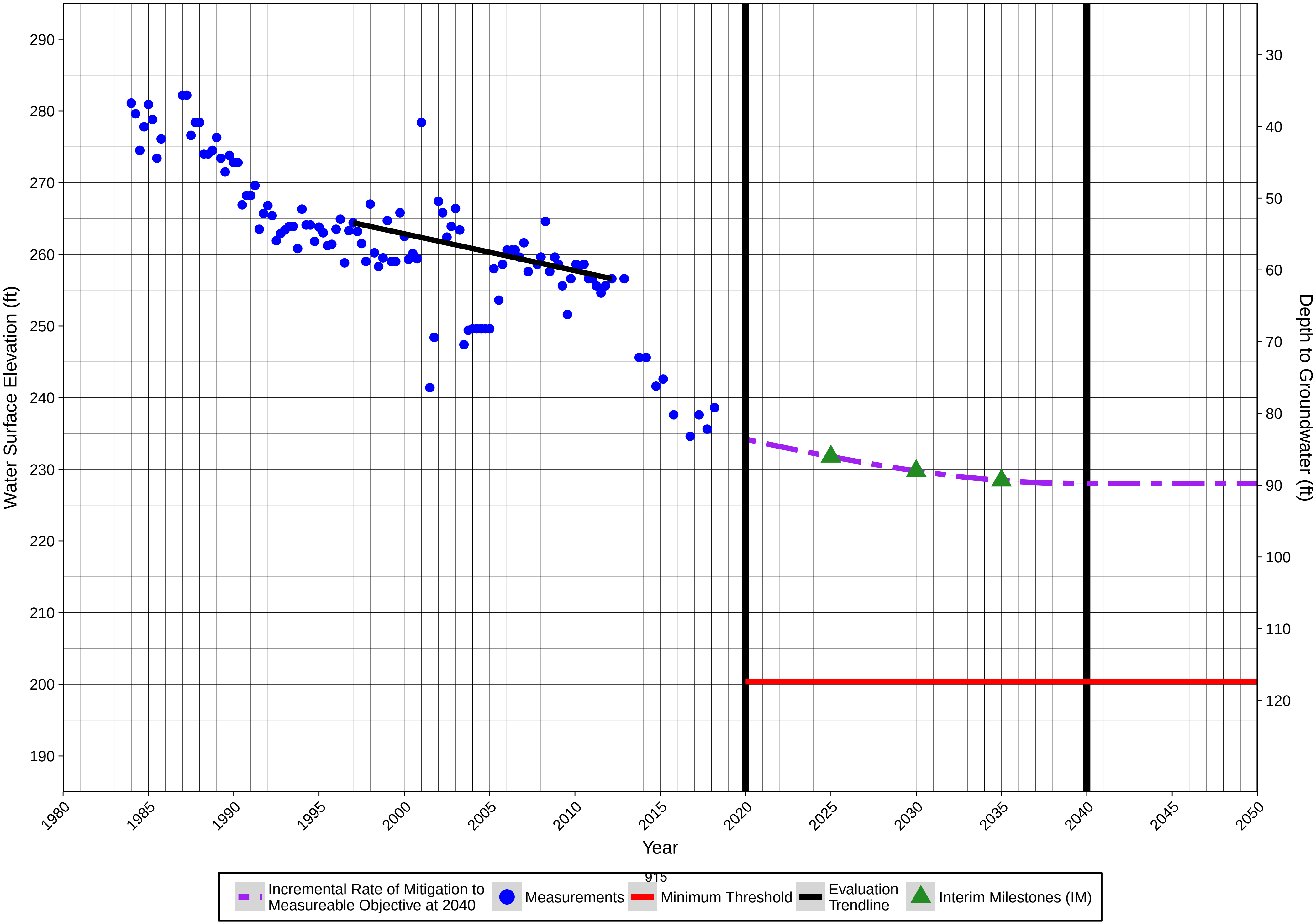
14S21E06Q001MX

NE Intersection of E Kings Canyon Rd and S Willow Ave
Ground Surface Elevation: 310 ft
North Kings GSA



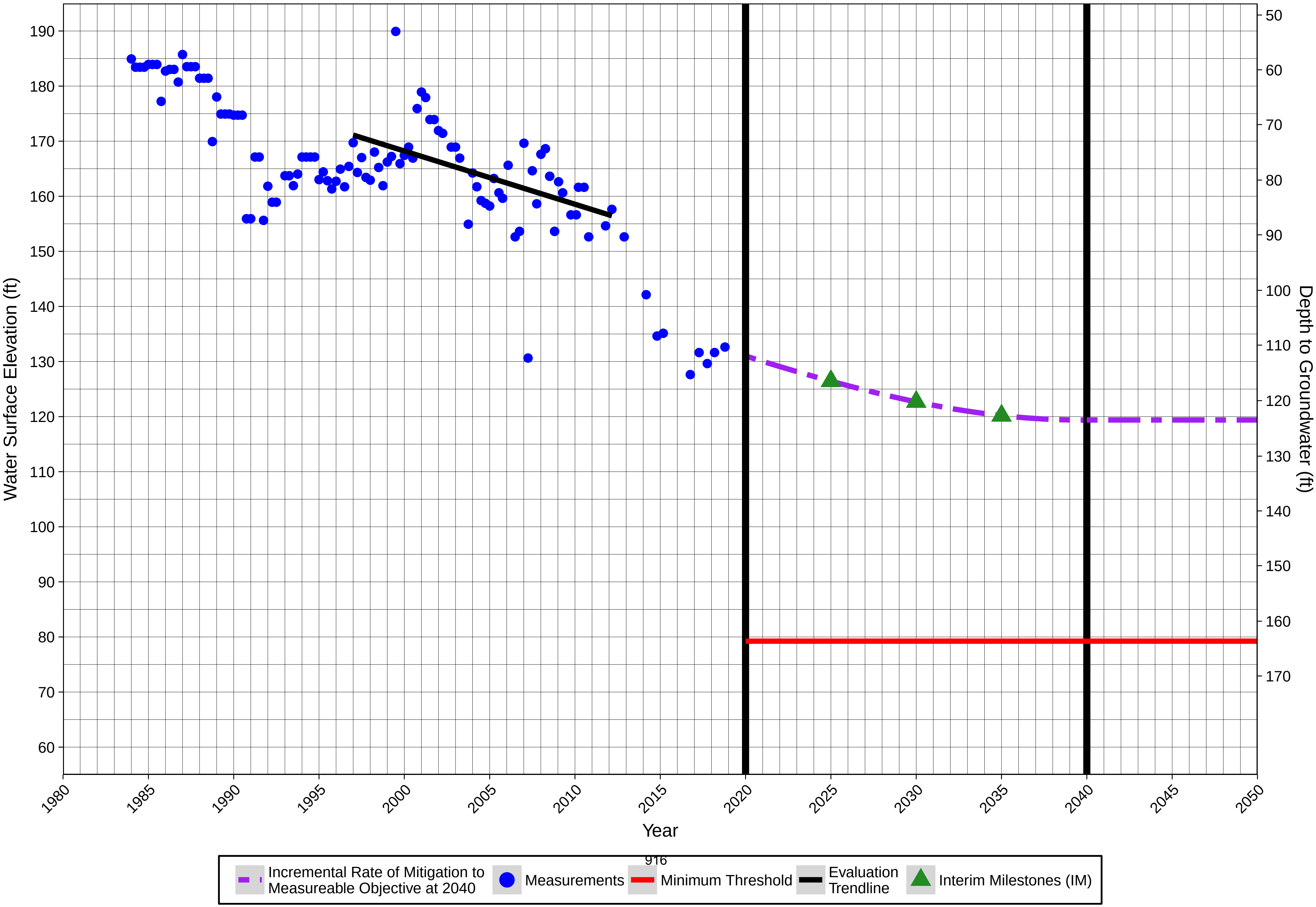
14S21E22D001MX

SE Intersection of E Jensen Ave and S Fowler Ave
Ground Surface Elevation: 318 ft
North Kings GSA



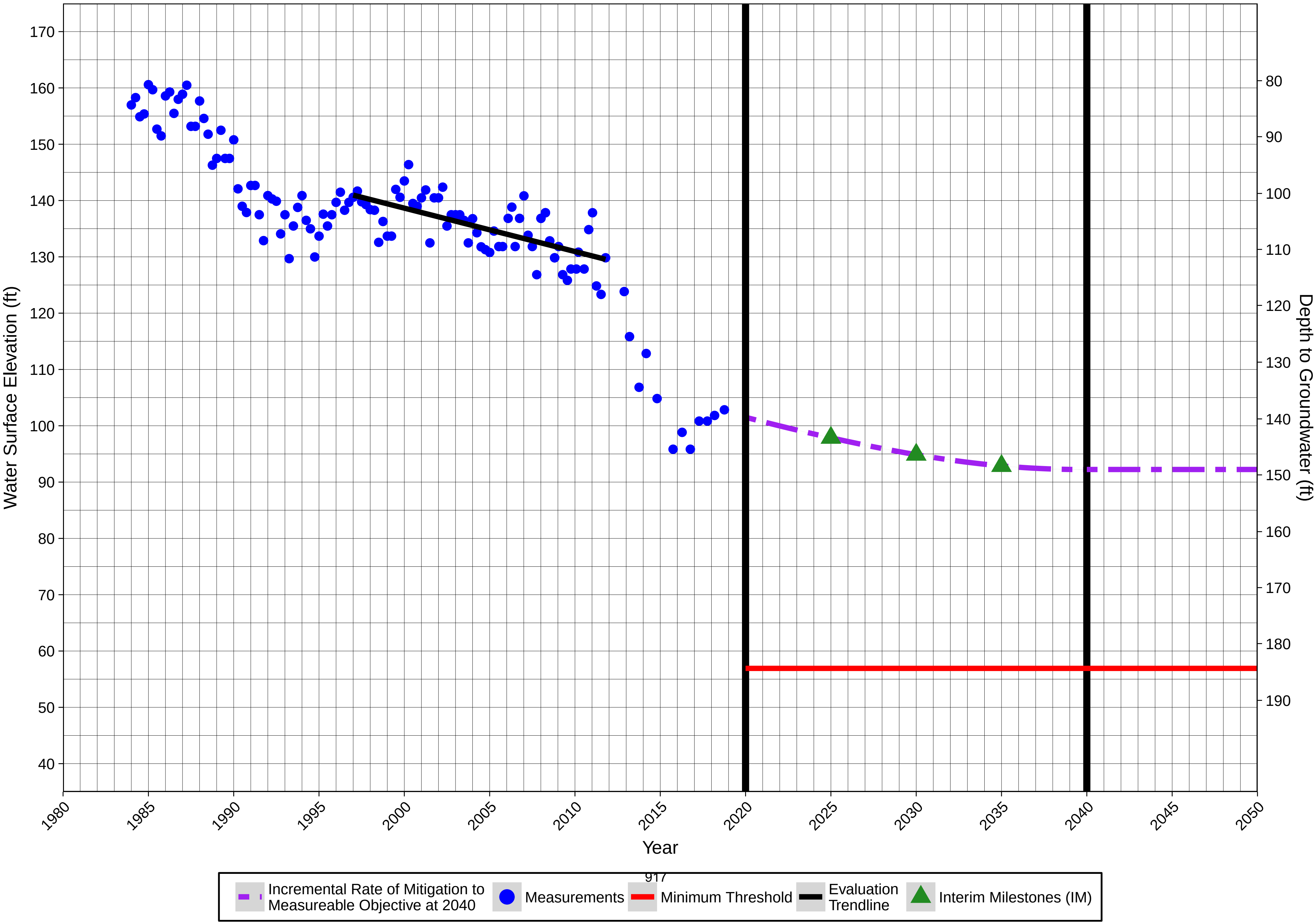
15S19E02M001MX

State Well ID: 15S19E03J001M
SW Intersection of W Jefferson Ave and S Cornelia Ave
Ground Surface Elevation: 243 ft
North Kings GSA



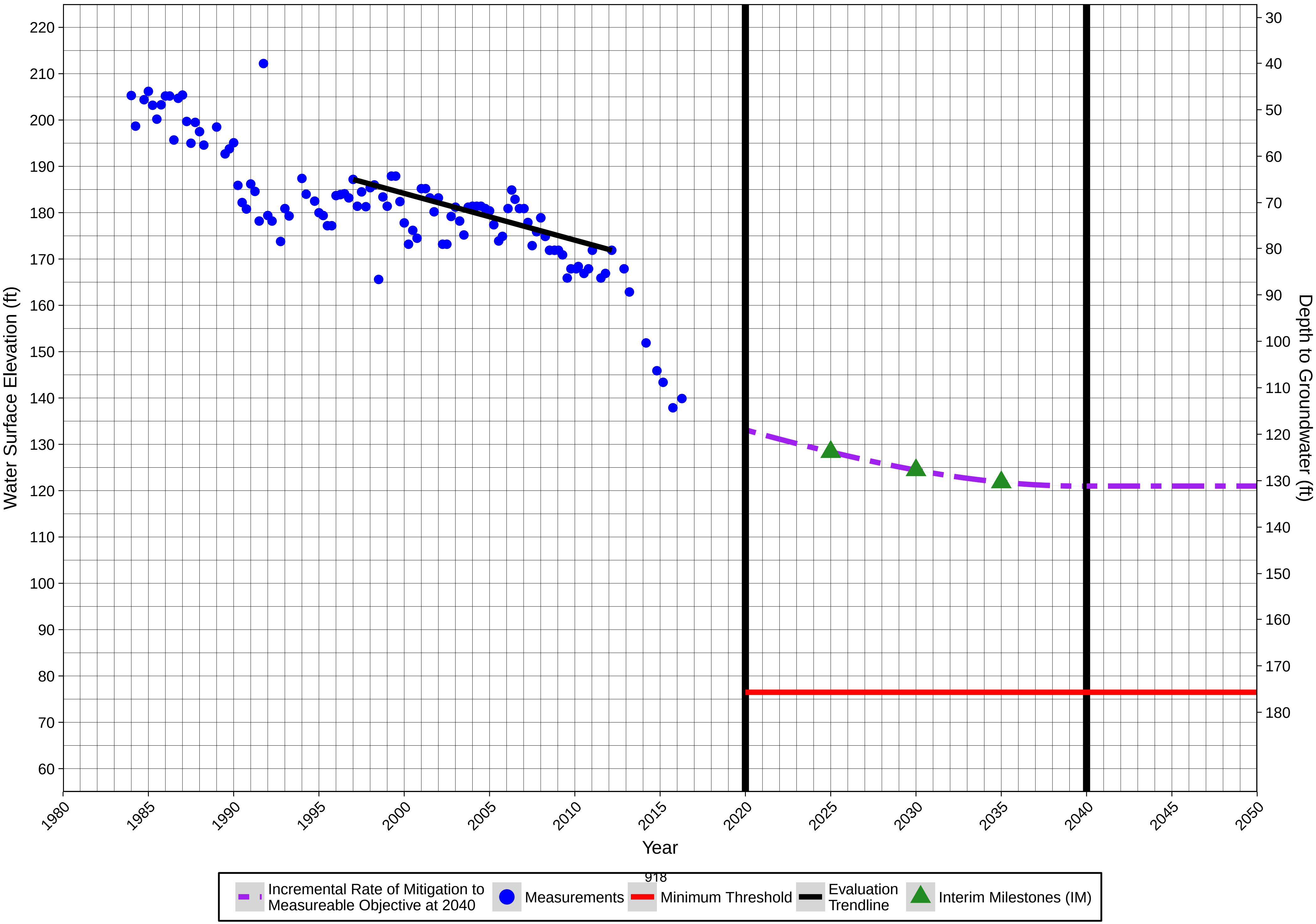
15S19E14M001MX

SE Intersection of W Sumner Ave and S Cornelia Ave
Ground Surface Elevation: 241 ft
North Kings GSA



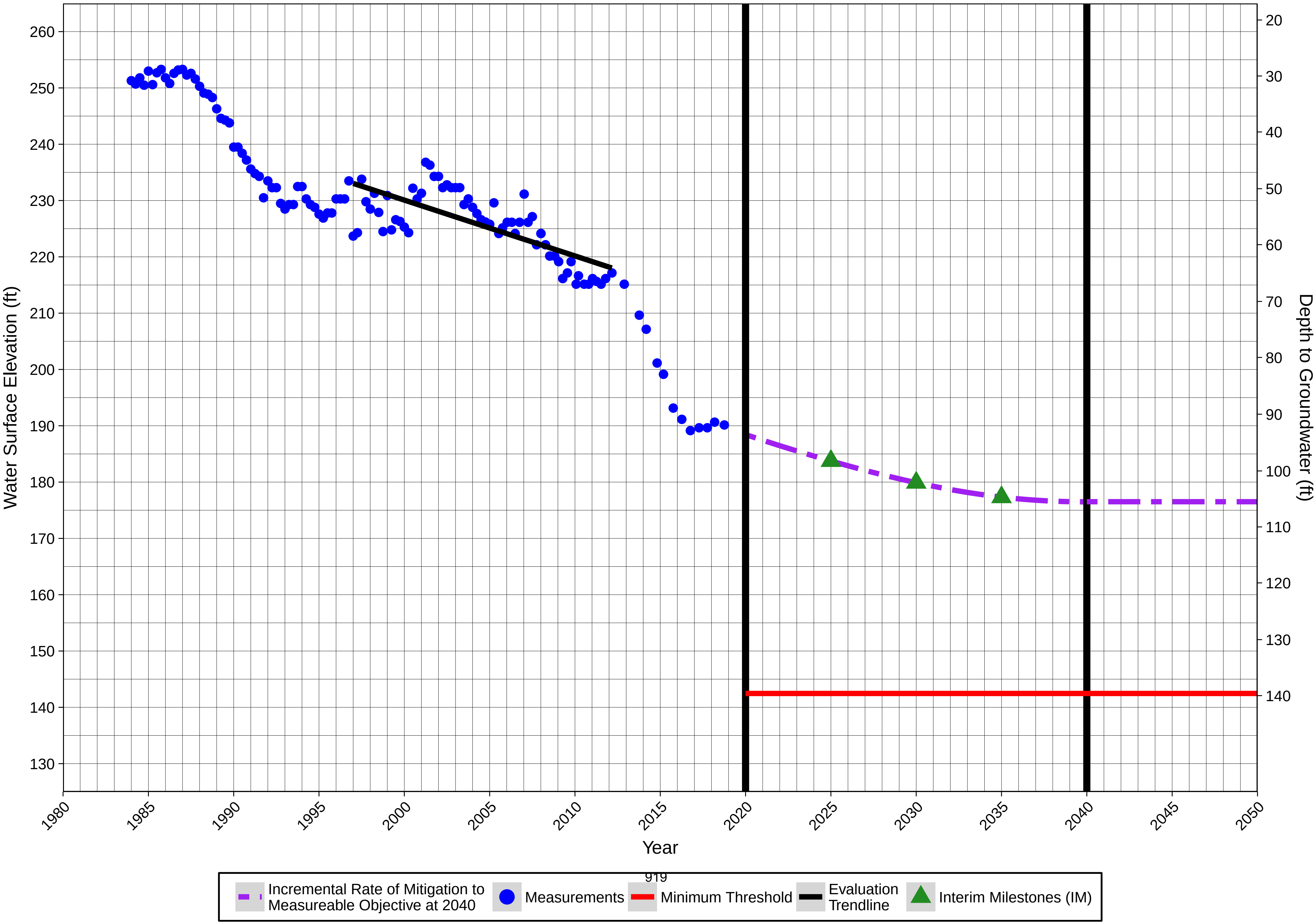
15S20E07Q001MX

NE Intersection of W Adams Ave and S Marks Ave
Ground Surface Elevation: 252 ft
North Kings GSA



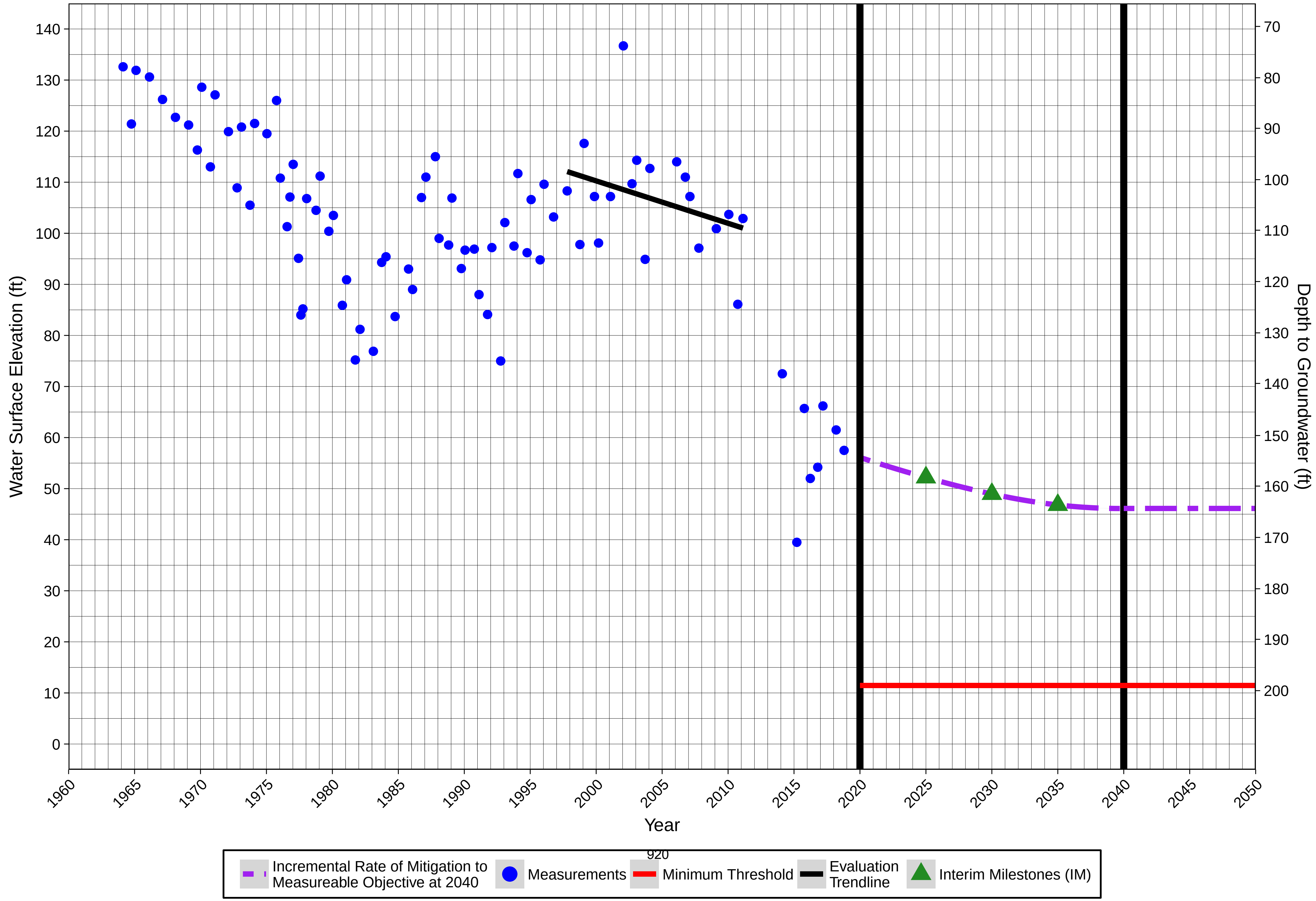
15S20E13E001MX

NE Intersection of E Sumner Ave and S Cedar Ave
Ground Surface Elevation: 282 ft
North Kings GSA



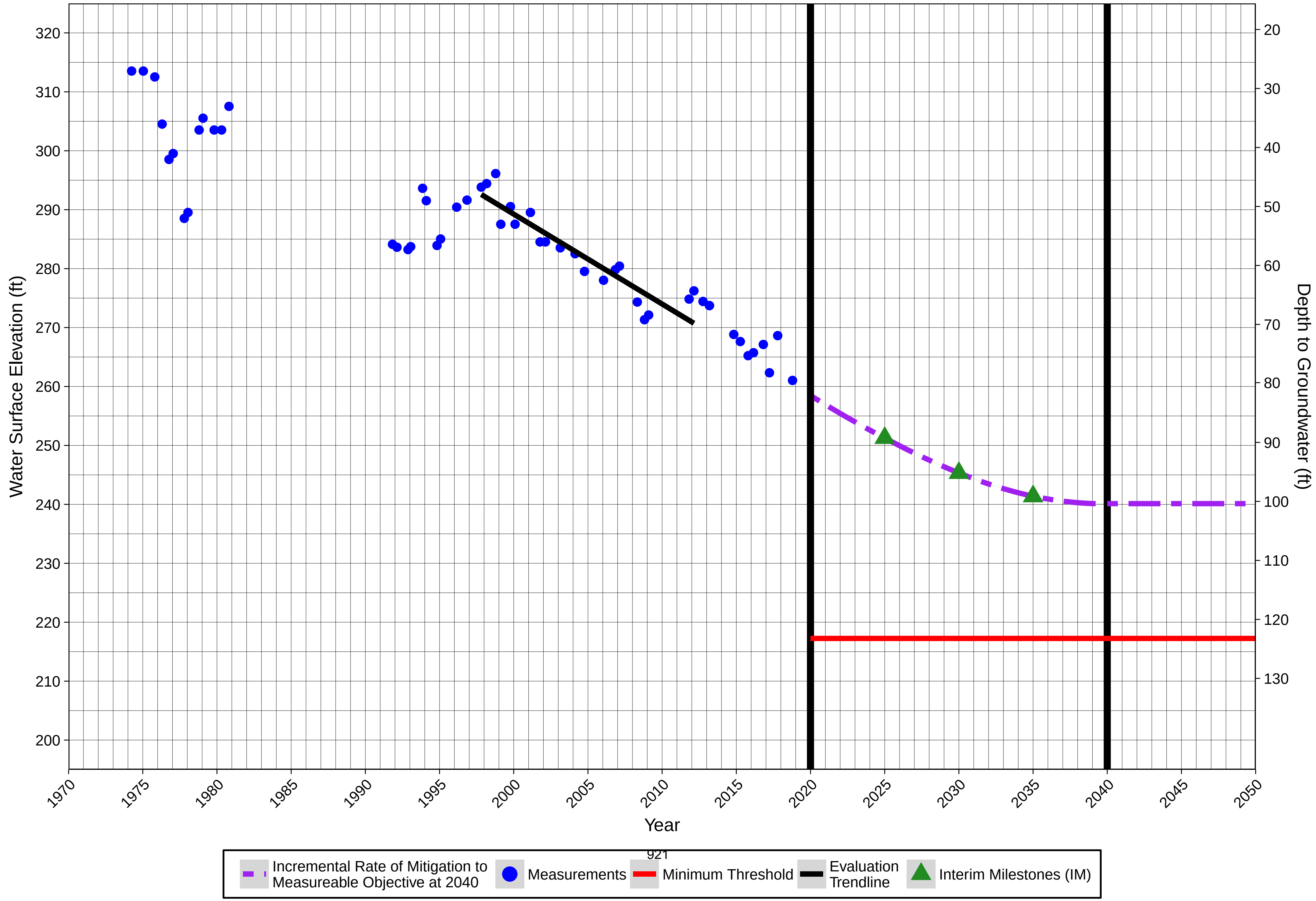
367113N1200785W001

State Well ID: 14S17E14J001M
SE Intersection of W Church Ave and S Siskiyou Ave
Ground Surface Elevation: 210 ft
North Kings GSA



367556N1196666W001

State Well ID: 13S21E34J002M
SW Intersection of E Olive Ave and N Temperance Ave
Ground Surface Elevation: 341 ft
North Kings GSA



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

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

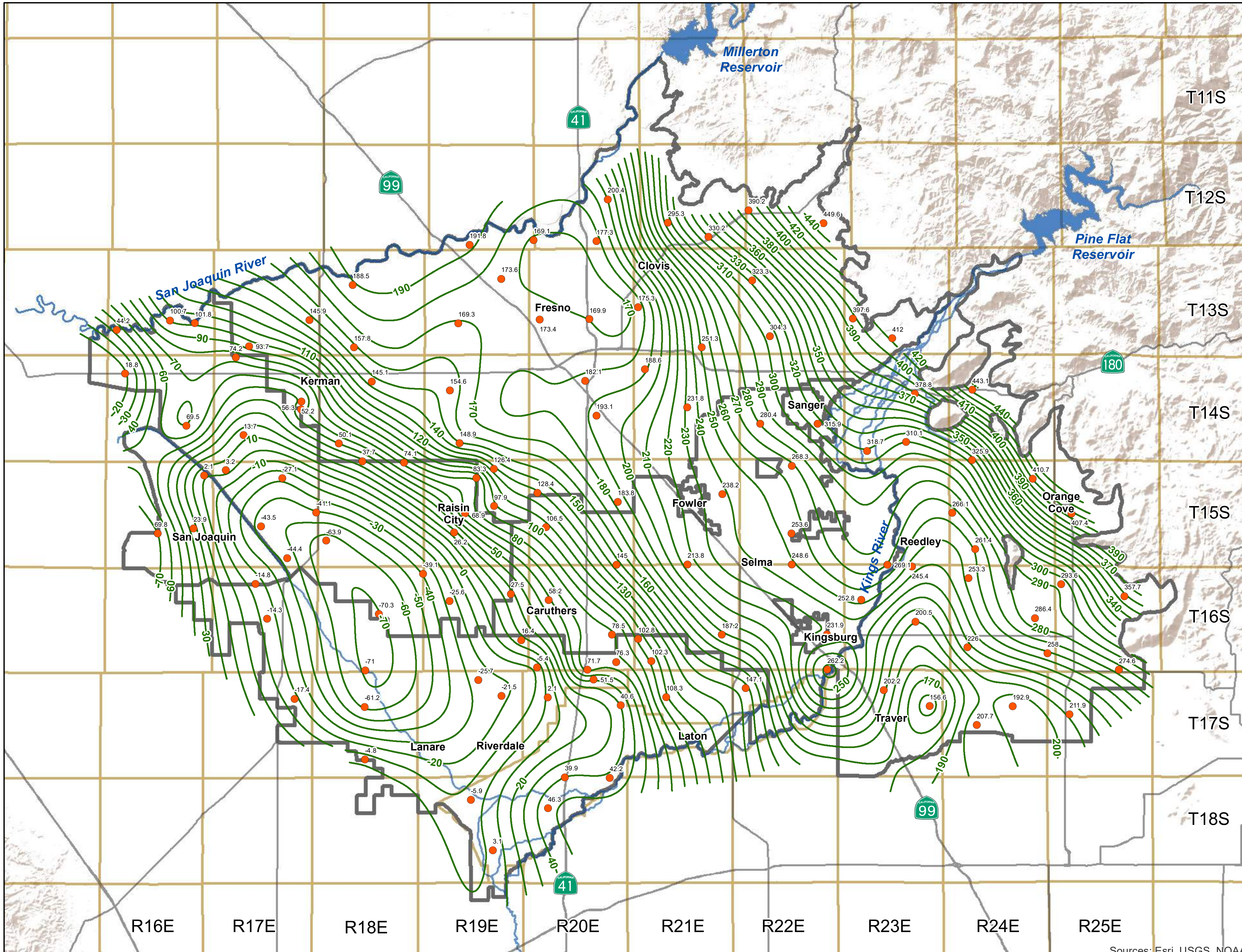
- USGS WSP 1469
- Page and LeBlanc 1969
- USGS PP 1401-D
- KRCD/AID
- KDSA
- USBR/OCID
- P&P
- Bedrock

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



Kings Subbasin Coordinated Effort

Interim Milestone 2025
Water Surface Elevation Contours

Legend

- Indicator Well
- WSE (Interim Milestone, ft)
- Kings Subbasin GSAs
- Township/Range
- Highway
- Waterways

EST. 1968
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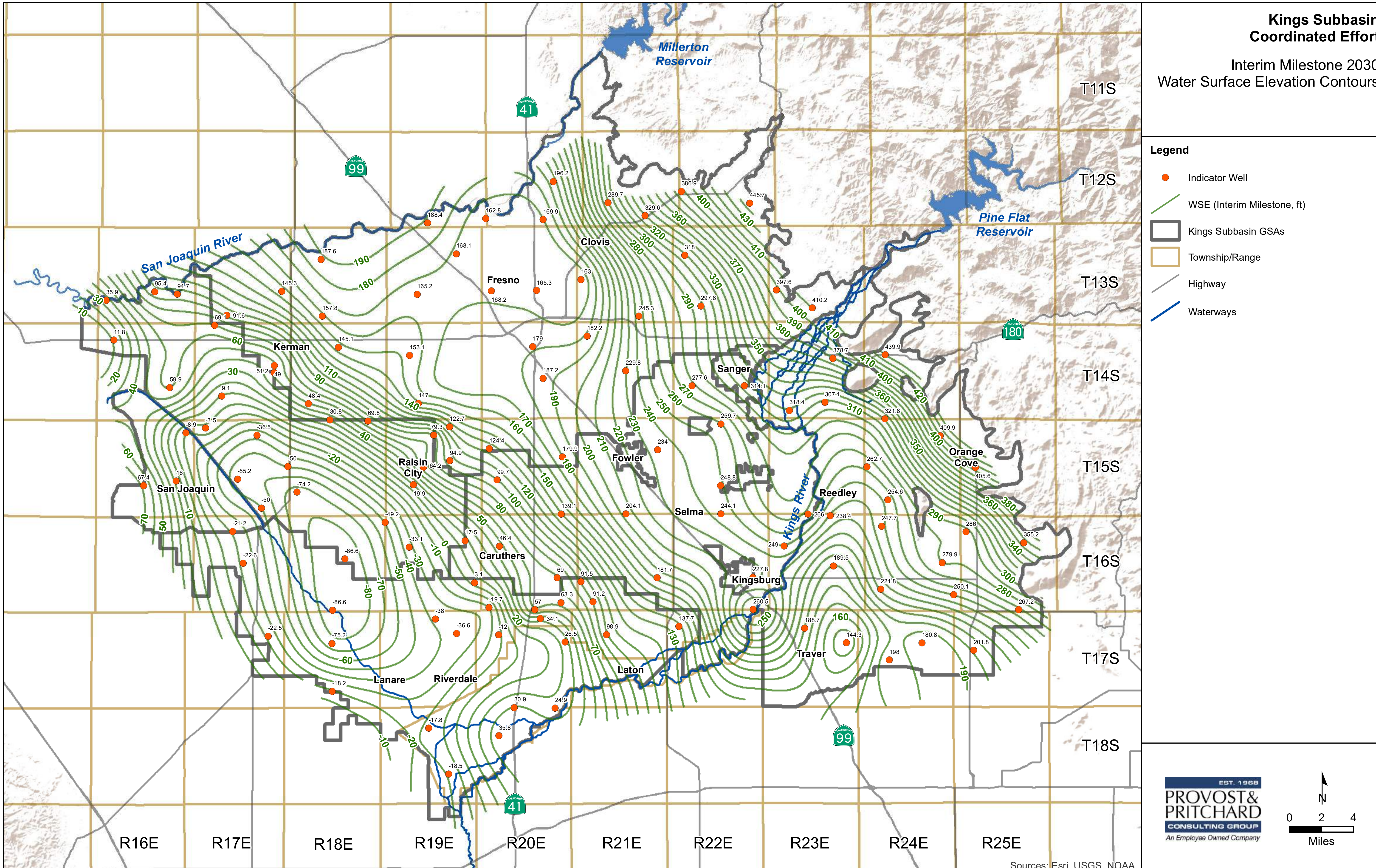
CONSULTING GROUP
An Employee Owned Company

N

0 2 4
Miles

1/9/2020 : G:\Kings River East GSA-2664\266417001-Kings Basin SGMA Coordination\GIS\Map\Wells\MonitorNetwork\MeasObjectives\InterimMilestones\IM2025_wse_contours_11x17.mxd



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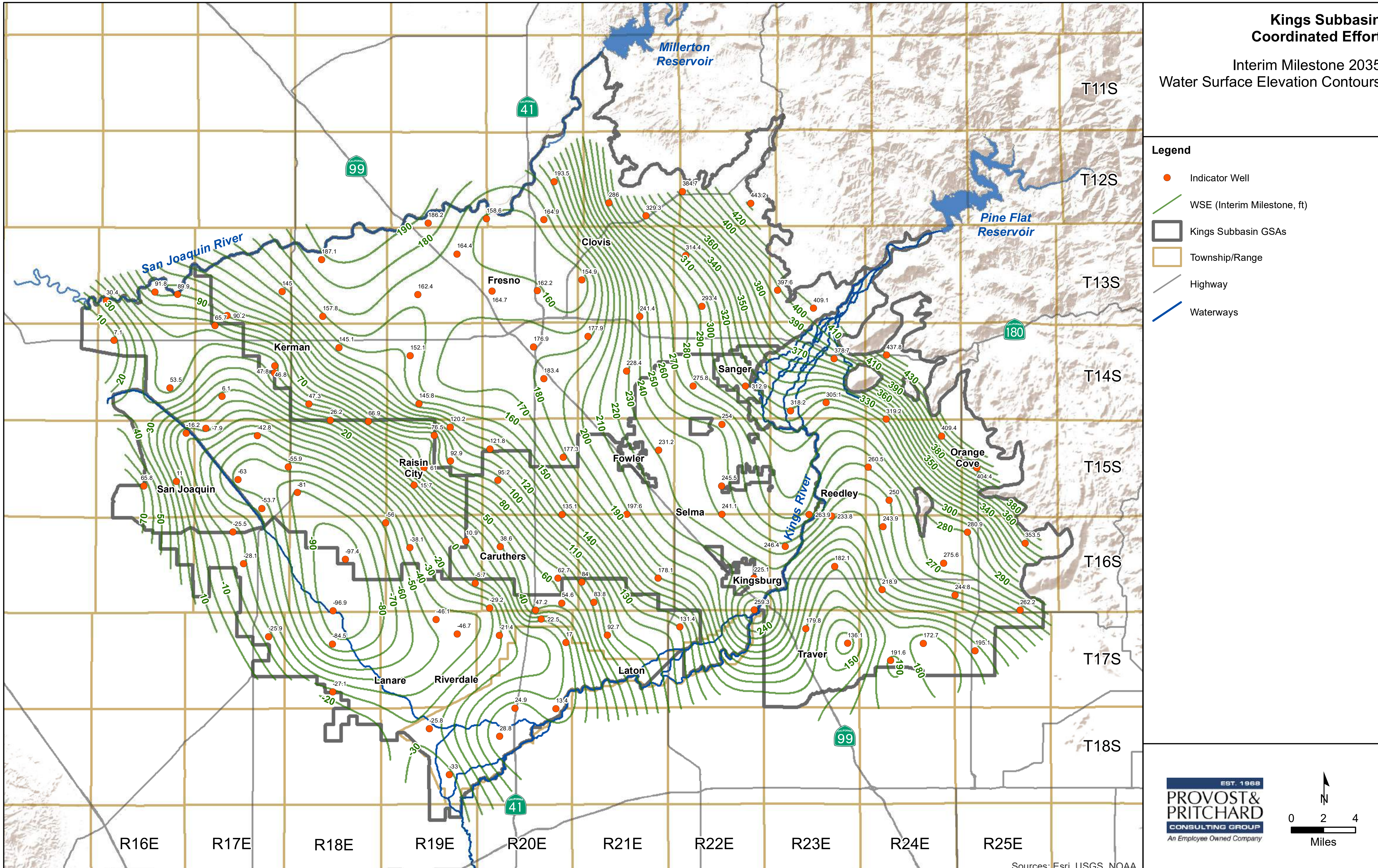

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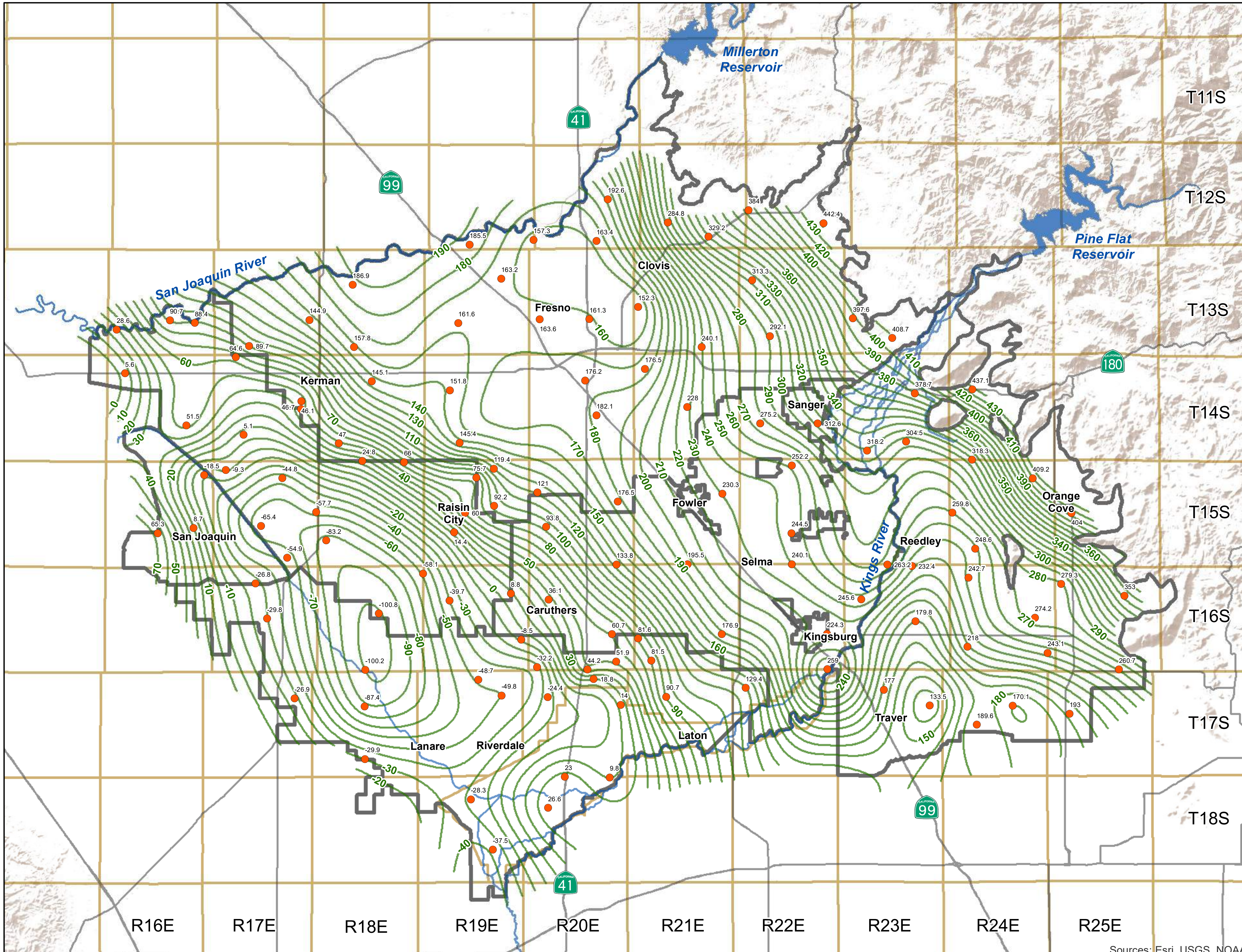

Kings Subbasin Coordinated Effort

Measureable Objective
Water Surface Elevation Contours

Legend

- Indicator Well
- WSE (Measureable Objective, ft)
- Kings Subbasin GSAs
- Township/Range
- Highway
- Waterways

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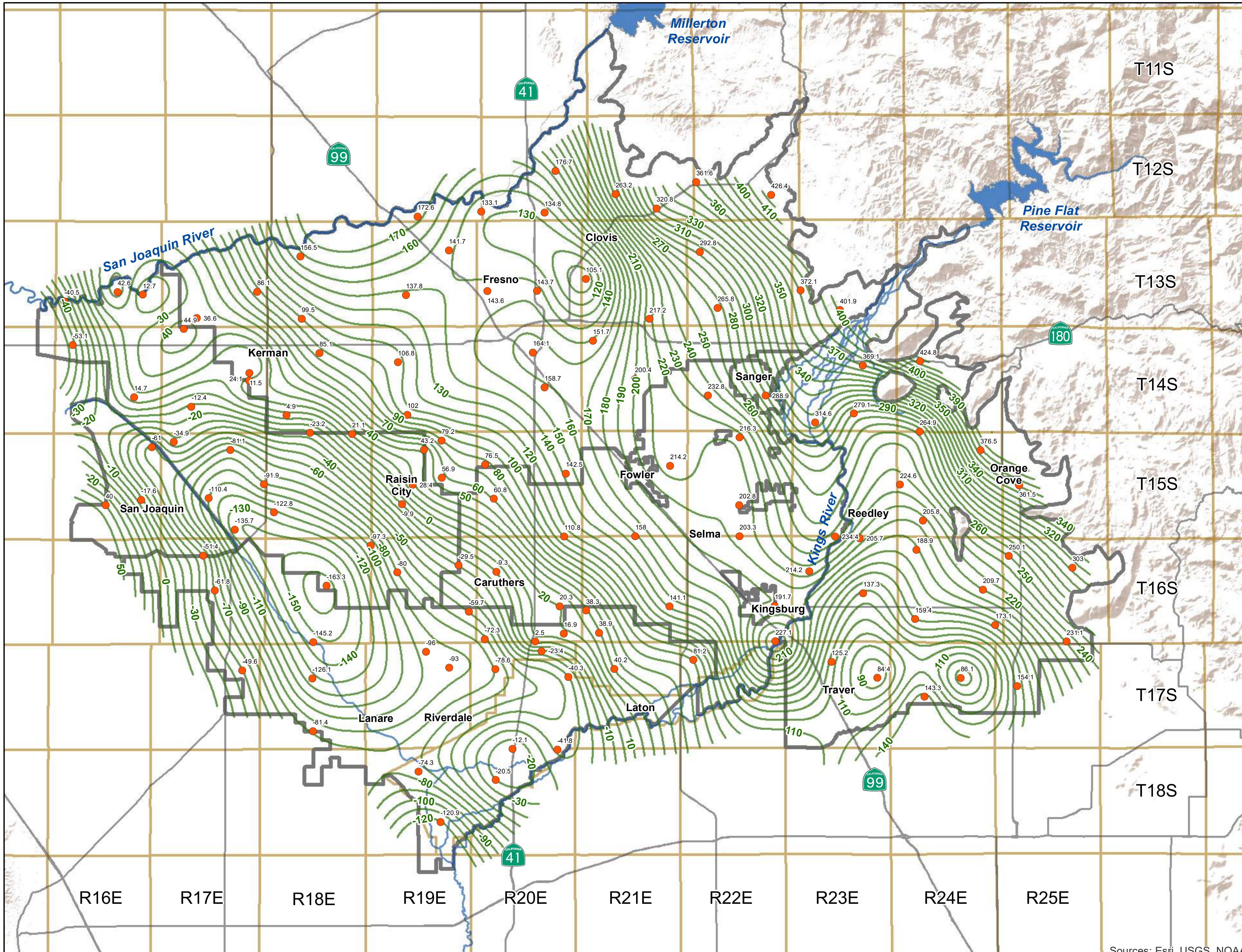
0 2 4
Miles

1/8/2020 : G:\Kings River East GSA-2664\266417001-Kings Basin SGMA Coordination\GIS\Map\Wells\MonitorNetwork\MeasObjectives\proposed_wells_MO_wse_contours_11x17.mxd



Kings Subbasin Coordinated Effort

Minimum Threshold Water Surface Elevation Contours

Legend

- Indicator Well
- WSE (Minimum Threshold, ft)
- Kings Subbasin GSAs
- Township/Range
- Highway
- Waterways

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N

0 2 4 Miles

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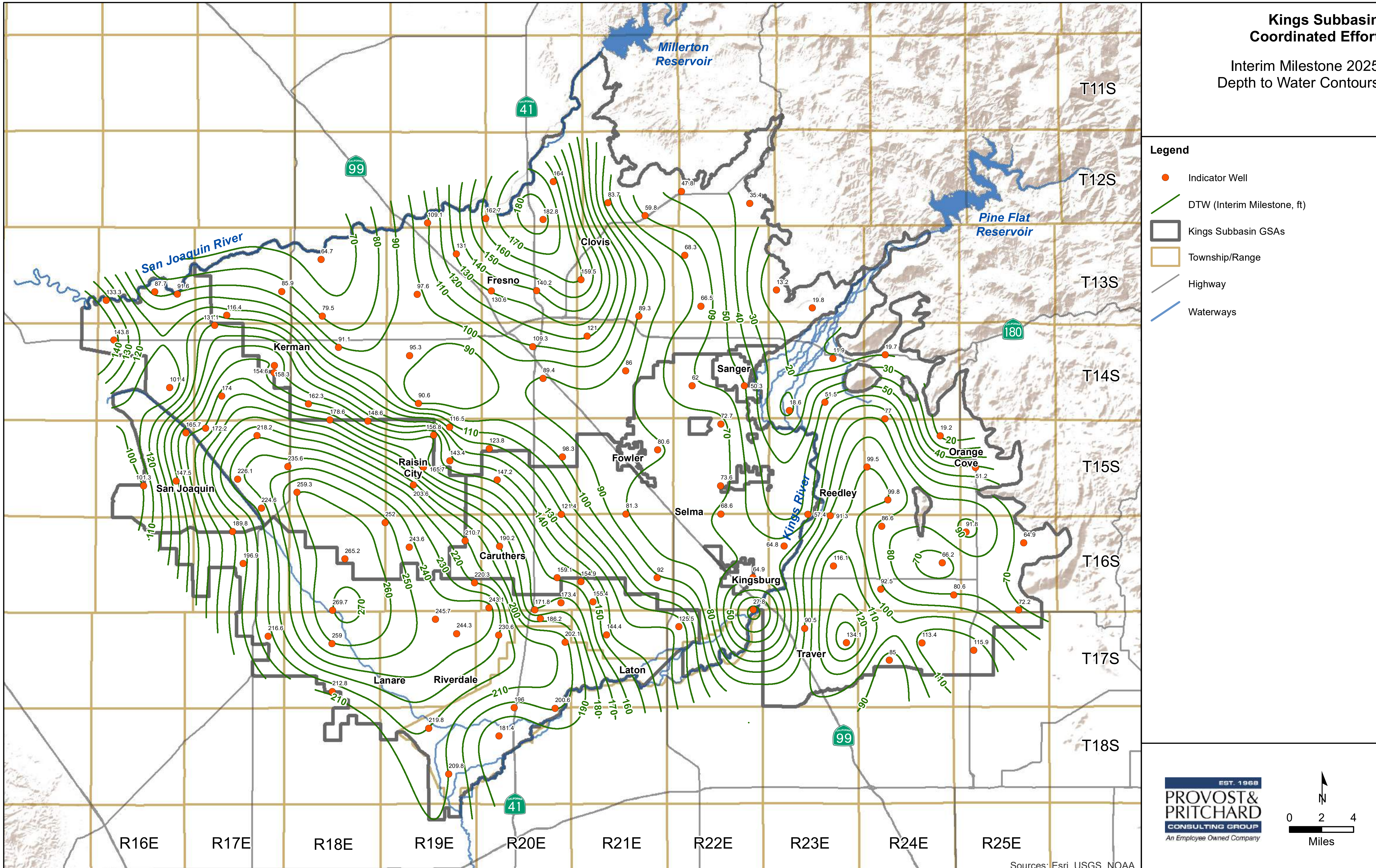

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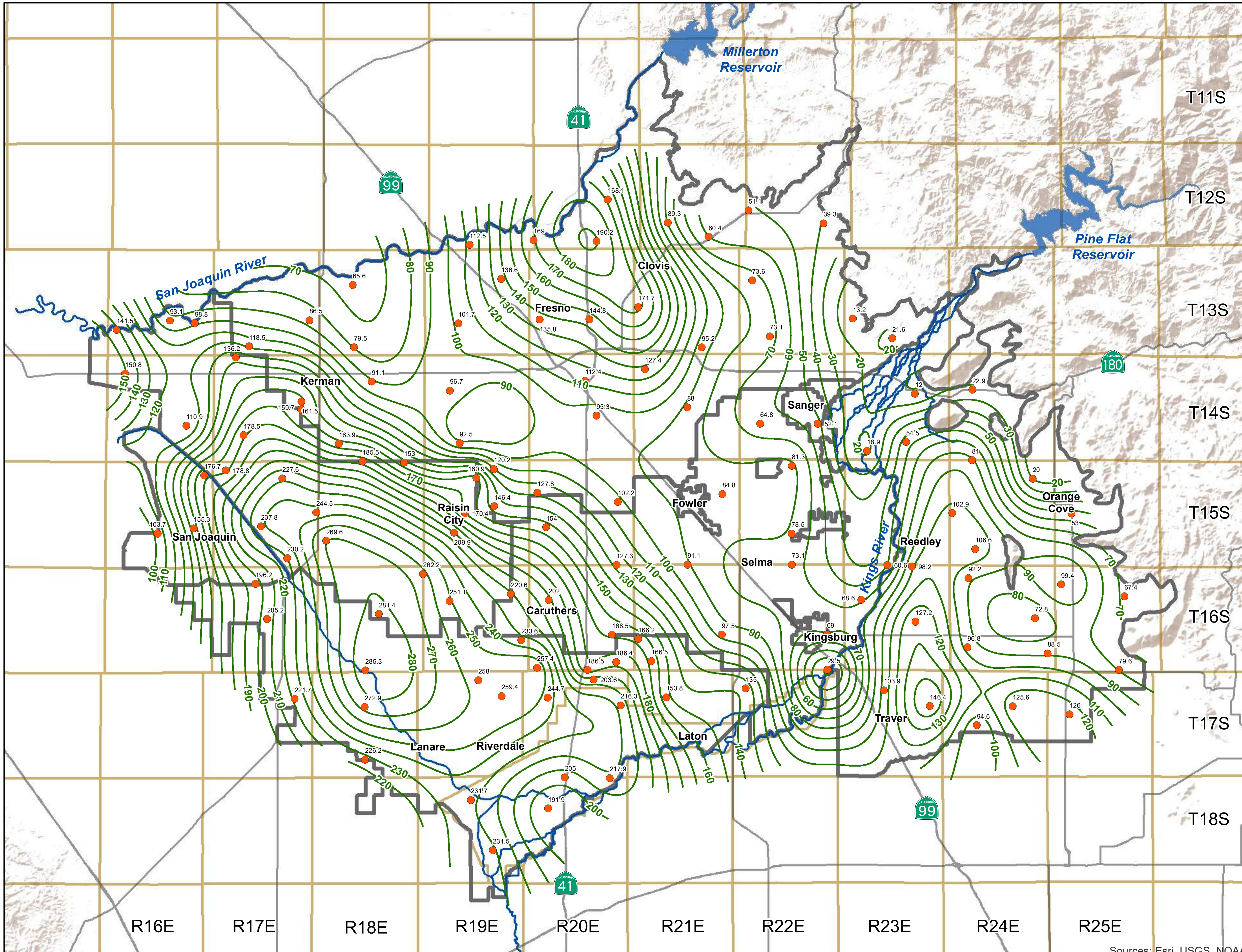
Kings Subbasin Coordinated Effort

Interim Milestone 2030
Depth to Water Contours



Legend

- Indicator Well
- DTW (Interim Milestone, ft)
- Kings Subbasin GSAs
- Township/Range
- Highway
- Waterways

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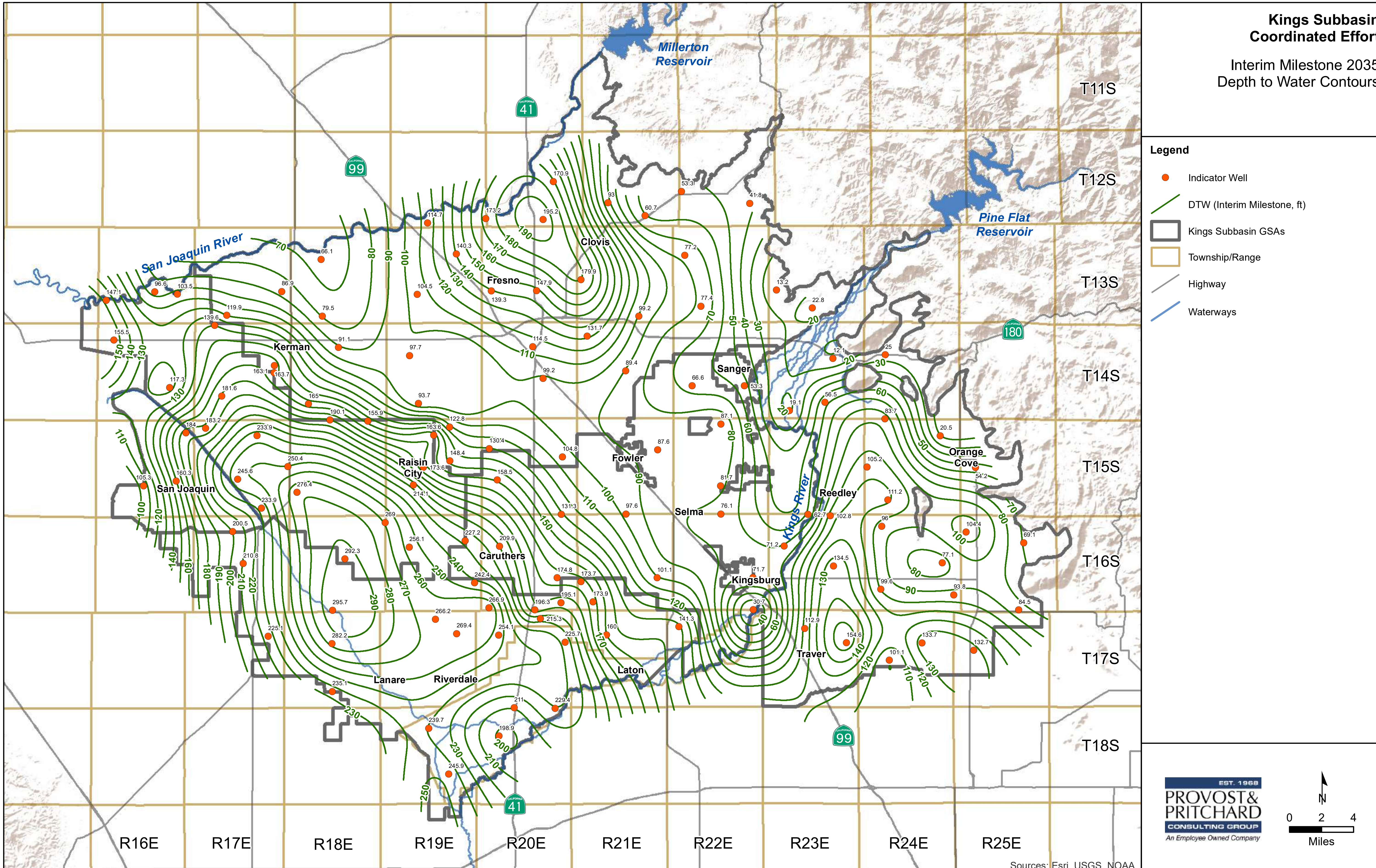
N
0 2 4
Miles

1/8/2020 : G:\Kings River East GSA-2664\266417001-Kings Basin SGMA Coordination\GIS\Map\Wells\MonitorNetwork\MeasObjectives\InterimMilestones\IM2030_dtw_contours_11x17.mxd



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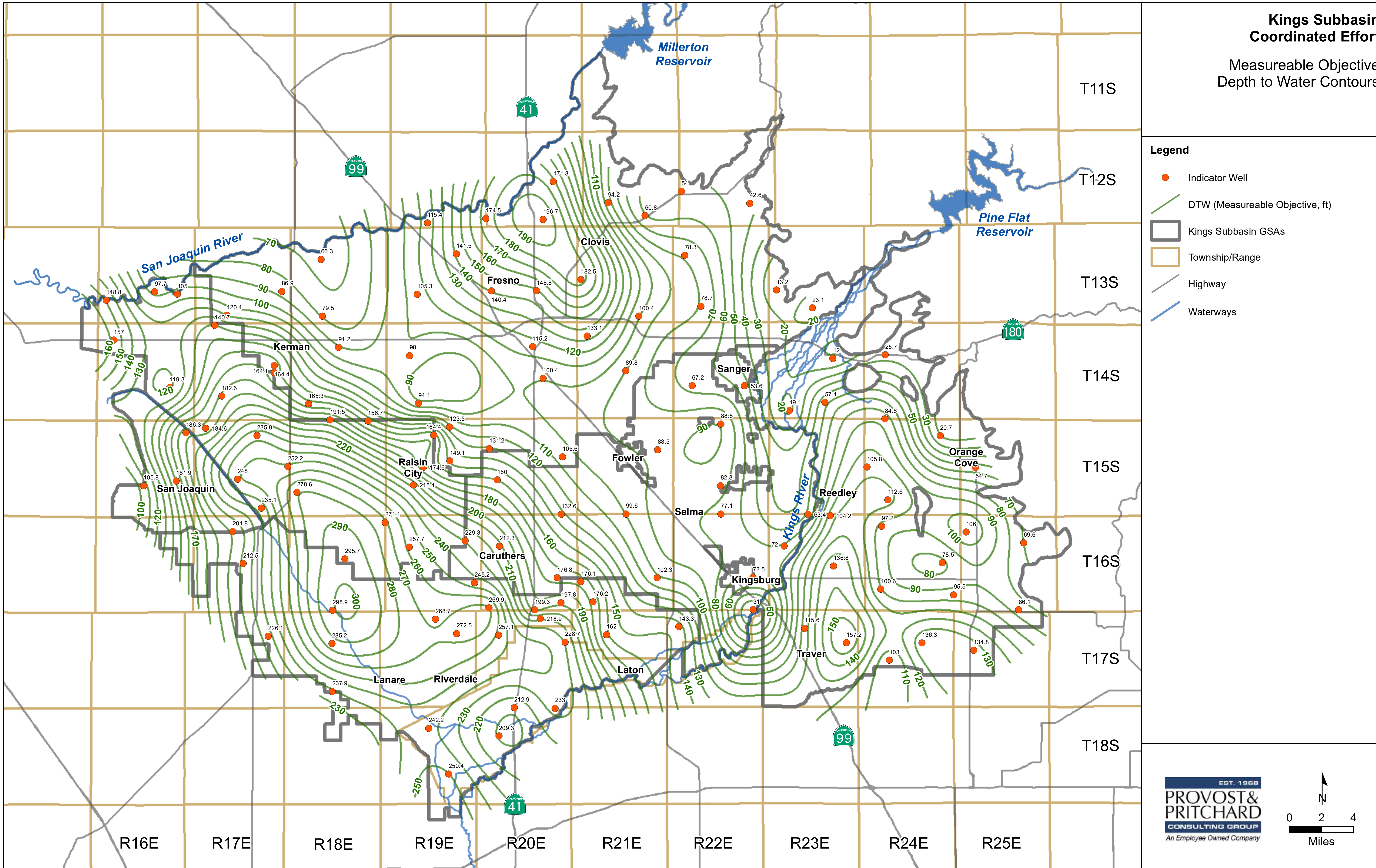

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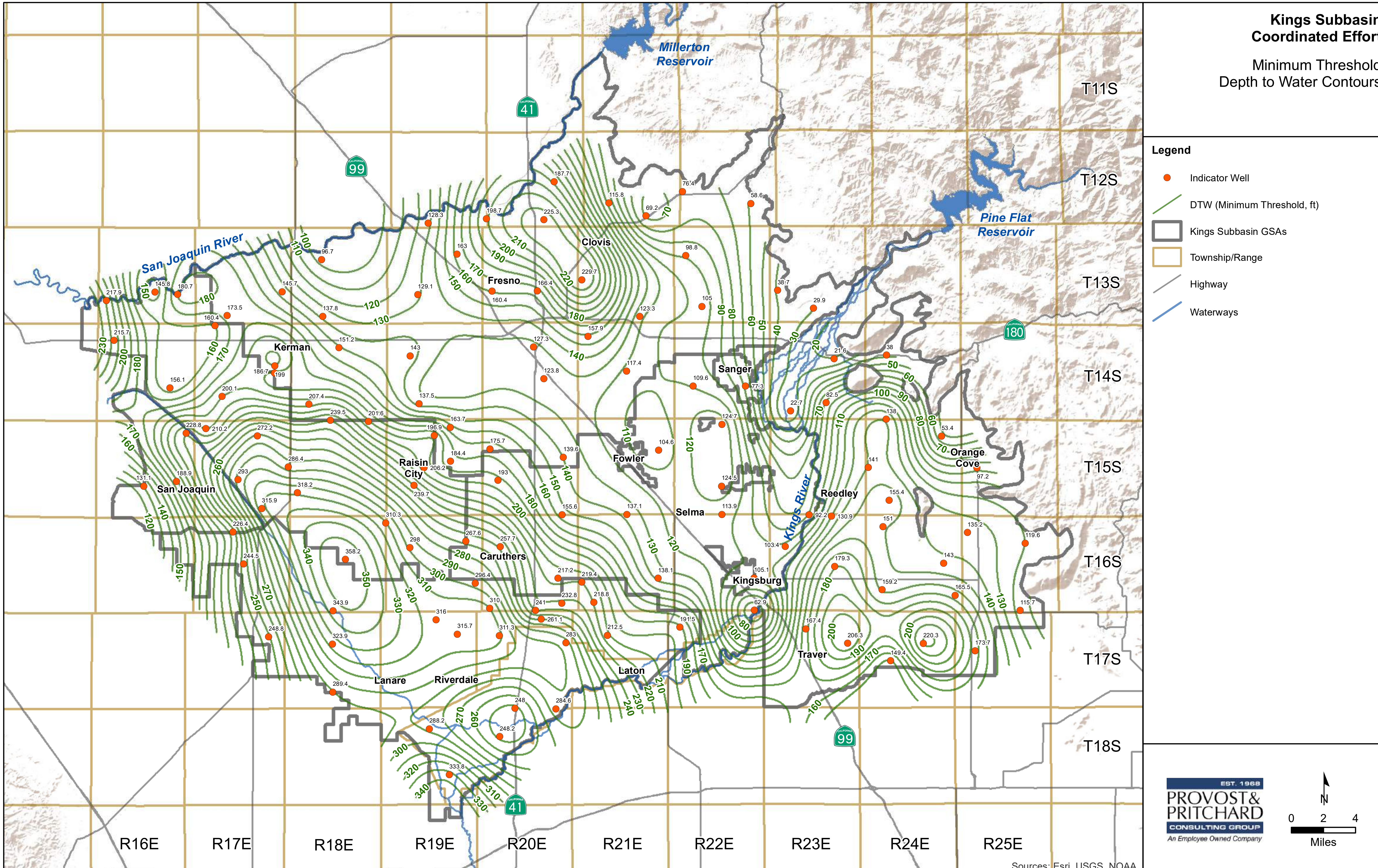

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Appendix 5 A Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans

ARTICLE 3. Technical and Reporting Standards

§ 352. Introduction to Technical and Reporting Standards

This Article describes the monitoring protocols, standards for monitoring sites, and other technical elements related to the development or implementation of a Plan.

Note: Authority cited: Section 10733.2, Water Code.

Reference: Section 10733.2, Water Code.

§ 352.2. Monitoring Protocols

Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows:

(a) Monitoring protocols shall be developed according to best management practices.

(b) The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department, or may adopt similar monitoring protocols that will yield comparable data.

(c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.

Note: Authority cited: Section 10733.2, Water Code.

Reference: Sections 10727.2, 10728.2, 10729, and 10733.2, Water Code.

§ 352.4. Data and Reporting Standards

(a) The following reporting standards apply to all categories of information required of a Plan, unless otherwise indicated:

(1) Water volumes shall be reported in acre-feet.

(2) Surface water flow shall be reported in cubic feet per second and groundwater flow shall be reported in acre-feet per year.

(3) Field measurements of elevations of groundwater, surface water, and land surface shall be measured and reported in feet to an accuracy of at least 0.1 feet relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.

(4) Reference point elevations shall be measured and reported in feet to an accuracy of at least 0.5 feet, or the best available information, relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.

(5) Geographic locations shall be reported in GPS coordinates by latitude and longitude in decimal degree to five decimal places, to a minimum accuracy of 30 feet, relative to NAD83, or another national standard that is convertible to NAD83.

(b) Monitoring sites shall include the following information:

(1) A unique site identification number and narrative description of the site location.

(2) A description of the type of monitoring, type of measurement taken, and monitoring frequency.

(3) Location, elevation of the ground surface, and identification and description of the reference point.

(4) A description of the standards used to install the monitoring site. Sites that do not conform to best management practices shall be identified and the nature of the divergence from best management practices described.

(c) The following standards apply to wells:

(1) Wells used to monitor groundwater conditions shall be constructed according to applicable construction standards, and shall provide the following information in both tabular and geodatabase-compatible shapefile form:

(A) CASGEM well identification number. If a CASGEM well identification number has not been issued, appropriate well information shall be entered on forms made available by the Department, as described in Section 353.2.

(B) Well location, elevation of the ground surface and reference point, including a description of the reference point.

(C) A description of the well use, such as public supply, irrigation, domestic, monitoring, or other type of well, whether the well is active or inactive, and whether the well is a single, clustered, nested, or other type of well.

(D) Casing perforations, borehole depth, and total well depth.

(E) Well completion reports, if available, from which the names of private owners have been redacted.

(F) Geophysical logs, well construction diagrams, or other relevant information, if available.

(G) Identification of principal aquifers monitored.

(H) Other relevant well construction information, such as well capacity, casing diameter, or casing modifications, as available.

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

(3) Well information used to develop the basin setting shall be maintained in the Agency's data management system.

(d) Maps submitted to the Department shall meet the following requirements:

(1) Data layers, shapefiles, geodatabases, and other information provided with each map, shall be submitted electronically to the Department in accordance with the procedures described in Article 4.

(2) Maps shall be clearly labeled and contain a level of detail to ensure that the map is informative and useful.

(3) The datum shall be clearly identified on the maps or in an associated legend.

(e) Hydrographs submitted to the Department shall meet the following requirements:

(1) Hydrographs shall be submitted electronically to the Department in accordance with the procedures described in Article 4.

(2) Hydrographs shall include a unique site identification number and the ground surface elevation for each site.

(3) Hydrographs shall use the same datum and scaling to the greatest extent practical.

(f) Groundwater and surface water models used for a Plan shall meet the following standards:

(1) The model shall include publicly available supporting documentation.

(2) The model shall be based on field or laboratory measurements, or equivalent methods that justify the selected values, and calibrated against site-specific field data.

(3) Groundwater and surface water models developed in support of a Plan after the effective date of these regulations shall consist of public domain open-source software.

(g) The Department may request data input and output files used by the Agency, as necessary. The Department may independently evaluate the appropriateness of model results relied upon by the Agency, and use that evaluation in the Department's assessment of the Plan.

Note: Authority cited: Section 10733.2, Water Code.

Reference: Sections 10727.2, 10727.6, and 10733.2, Water Code.

Appendix 6 A Project Information Forms

NKGSA Project Information

Form date: April 19, 2019

Submitted On June 30, 2019

Project Name	Bakman Water Meter Project
GSA Party that Project will Benefit	Bakman Water Company
GSA Party Contact	Shay Bakman
GSA Party Email	shay@bakmanwater.com
Agency Implementing	Bakman Water Company

Project Description

Bakman Water Company is installing water meters on all of its approximately 2,450 service connections in its service area. The project will provide an estimated 20% reduction in usage which is approximately 870 acre-feet per year of benefit. Bakman has initiated meter installation, however is including in the GSP because the benefits of the project are just starting to be observed.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	870

Provide a detailed description of how annual benefit was quantified.

The estimate of 20% conservation is based on recent studies and local case studies from the City of Fresno, Clovis and Kerman that have observed 20-26% reduction in usage from leakage reduction and conservation measures.

LOCATION

Township	13
Range	21
Section	31
Latitude	36.750802
Longitude	-119.722604
Description	Throughout Bakman Service Area

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The installation of meters will reduce demand thereby reducing the amount of groundwater pumped, helping slow the decline of groundwater levels and retaining more water in groundwater storage.

Type of Project

- [ ] Increase Supply
- [x] Demand Reduction

Explain:

Meter installation has shown to reduce water demands through leak reduction and volume pricing.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	n/a	n/a

Is CEQA Complete?

- [x] Yes
- [ ] No

If complete, please explain.

CEQA has been completed.

PROJECT STATUS

- [ ] Conceptual (no feasibility or study work initiated)
- [ ] Planning (feasibility study and analysis work initiated)
- [ ] Preliminary Design (feasibility study completed)
- [x] Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year 2015

Construction/Implementation Finish Year 2025

Timeframe to Accrue Benefits From 2025

Timeframe to Accrue Benefits To 2055

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The project does not rely on surface water.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

Bakman is regulated by the CPUC for water service and has the legal authority and mandate to install water meters by 2025.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $2907000

Describe the funding source or how these costs will be met.

Bakman has received a grant from the Department of Water Resources for meter installation.

Project O&M/On-going $12500

Source(s)

Bakmans annual operations funds.

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY

NKGSA Project Information

Form date: April 19, 2019

Submitted On April 30, 2019

Project Name	Biola Groundwater Recharge Project
GSA Party that Project will Benefit	Biola Community Services District
GSA Party Contact	Felipe Perez
GSA Party Email	Felipe.Perez@biolacsd.org
Agency Implementing	Same

Project Description

Construct a canal turnout and pipeline to deliver surface water from FID Herndon Canal to an existing storm drain basin that will be enlarged to hold 30 acre-feet of water.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	150

Provide a detailed description of how annual benefit was quantified.

The basin will be capable of percolating 2.5 a-f/day based on percolation tests. Assuming 60 days per year for percolation time, the total amount is 150 a-f /yr.

Biola DWR GWR_Pre-Design Rpt.pdf

LOCATION

Township	13
Range	18
Section	16
Latitude	36.800000
Longitude	-120.020800
Description	South of H Street and East of Howard Avenue in Biola

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The project will allow the percolation of surface water to replenish groundwater.

Type of Project

- [x] Increase Supply
- [ ] Demand Reduction

Explain:

The project will allow the percolation of surface water to replenish groundwater which leads fo increased supply.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	Fresno Irrigation District	Surface water supply agreement & encroachment
	County of Fresno	Encroachment permit

Is CEQA Complete?

- [ ] Yes
- [x] No

PROJECT STATUS

- [ ] Conceptual (no feasibility or study work initiated)
- [ ] Planning (feasibility study and analysis work initiated)
- [x] Preliminary Design (feasibility study completed)
- [ ] Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year 2019

Construction/Implementation Finish Year 2020

Timeframe to Accrue Benefits From 2021

Timeframe to Accrue Benefits To 2071

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The project will utilize surface water from Fresno Irrigation District for recharge. FID and Biola Community Services District are working on an agreement for water supply.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

the Biola CSD owns and operates the storm water basin that will be used for the recharge project.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $705,000

Describe the funding source or how these costs will be met.

Biola CSD has received a grant from the California Department of Water Resources to design and construct the project.

Project O&M/On-going $2,000

Source(s)

Operational costs for maintenance of the basin will come from Biola CSD operational funds.

NKGSA Project Information

Form date: April 19, 2019

Submitted On May 1, 2019

Project Name	Marion Recharge Basin Improvements
GSA Party that Project will Benefit	City of Clovis
GSA Party Contact	Paul Armendariz
GSA Party Email	PaulA@cityofclovis.com
Agency Implementing	City of Clovis

Project Description

Improve recharge at the Marion Recharge Basins through a variety of measures to increase percolation including routine maintenance and capital projects.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	2,500

Provide a detailed description of how annual benefit was quantified.

Quantity is estimated. They City is entertaining the use of a proprietary product and/or installing dry wells to increase groundwater percolation.

LOCATION

Township	12
Range	21
Section	32
Latitude	36.847497
Longitude	-119.697005
Description	Northwest Area of Alluvial and Sunnyside Avenues

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The additional water recharged at the basin will help replenish the local aquifer and reduce declining groundwater levels in the area of the project. Relatedly, the addition of water recharged at the basin site will directly help to increase the amount of groundwater storage available for pumping during dry periods.

Type of Project

- [x] Increase Supply
- [ ] Demand Reduction

Explain:

Water recharged at the basin site will directly help to increase the amount of groundwater storage available for pumping during dry periods.

REGULATORY/PERMITTING (354.33.b.3)

Is CEQA Complete?

- [x] Yes
- [ ] No

PROJECT STATUS

- [ ] Conceptual (no feasibility or study work initiated)
- [ ] Planning (feasibility study and analysis work initiated)
- [ ] Preliminary Design (feasibility study completed)
- [ ] Ready for Construction/Implementation
- [x] Planning (feasibility study and analysis work initiated)

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year	2020
Construction/Implementation Finish Year	2021
Timeframe to Accrue Benefits From	2021
Timeframe to Accrue Benefits To	2040

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The City of Clovis has an existing Cooperative Agreement with FID for surface water and two existing

Water Banking Agreements. Excess surface water allocation that is not used at the SWTP is diverted to the Marion Basins for recharge.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

City staff owns and operates the existing recharge basins.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital TBD

Describe the funding source or how these costs will be met.

Clovis will fund the project through user enterprise funds and/or will apply for a grant

Project O&M/On-going TBD

Source(s)

City staff owns and operates the existing recharge basins.

NKGSA Project Information

Form date: April 19, 2019

Submitted On May 1, 2019

Project Name	ST-WRF Expansion
GSA Party that Project will Benefit	City of Clovis
GSA Party Contact	Paul Armendariz
GSA Party Email	PaulA@cityofclovis.com
Agency Implementing	City of Clovis

Project Description

Expand the existing 2.8 MGD Clovis Sewage Treatment/Water Reuse Facility (ST-WRF) to 5.6 MGD and then to 8.4 MGD

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	9,400

Provide a detailed description of how annual benefit was quantified.

2.8 MGD equates to 3,100 AFY (Current)
5.6 MGD equates to 6,300 AFY (2030)
8.4 MGD equates to 9,400 AFY (2042)

LOCATION

Township	13
Range	22
Section	18
Latitude	36.792239
Longitude	-119.614105
Description	Ashlan and Leonard

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

Use of recycled water (RW) for irrigation replaces the need to irrigate with potable groundwater and/or surface water. Indirect recharge occurs in landscaped areas. The City also intends to work with the SWRCB on recharge of RW at the Clovis Marion Basins. The additional water recharged at the basin will help replenish the local aquifer and reduce declining groundwater levels.

Type of Project

- [ ] Increase Supply
- [x] Demand Reduction

Explain:

Use of recycled water (RW) for irrigation directly offsets the use of potable groundwater and/or surface water to irrigate and/or recharge.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	State Water Resources Control Board	Water Supply permit and NPDES permit

Is CEQA Complete?

- [x] Yes
- [ ] No

If complete, please explain.

The expansions were included in the master plan upgrade in 2017 and a SEIR was completed.

PROJECT STATUS

- [ ] Conceptual (no feasibility or study work initiated)
- [ ] Planning (feasibility study and analysis work initiated)
- [ ] Preliminary Design (feasibility study completed)
- [ ] Ready for Construction/Implementation
- [x] Planning (feasibility study and analysis work initiated)

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year 2030

Construction/Implementation Finish Year 2042

Timeframe to Accrue Benefits From 2030

Timeframe to Accrue Benefits To 2070

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

This project does not rely on surface water

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

The City owns the ST-WRF and currently contracts the operation of the ST-WRF.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $40.2M

Describe the funding source or how these costs will be met.

$20.1M for expansion to 5.6 MGD
$20.1M for expansion to 8.4 MGD

The City will pay for these projects via Sewer Capital Developer Funds.

Project O&M/On-going $2.5M annually

Source(s)

O&M of the existing facility is contracted out and paid for by sewer user enterprise funds. City staff may take over O&M at the time of the expansion to 5.6MGD

NKGSA Project Information

Form date: April 19, 2019

Submitted On April 30, 2019

Project Name	Clovis SWTP Expansion
GSA Party that Project will Benefit	City of Clovis
GSA Party Contact	Paul Armendariz
GSA Party Email	PaulA@cityofclovis.com
Agency Implementing	City of Clovis

Project Description

Expand the existing SWTP 22.5 MGD to a total of 45 MGD.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	25,000

LOCATION

Township	13
Range	21
Section	12
Latitude	36.820052
Longitude	-119.639619
Description	Leonard south of Bullard

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The water used through the surface water treatment plant offsets groundwater that is pumped to meet the City's demands.

Type of Project ☑ Increase Supply ☐ Demand Reduction

Explain:

This project will offset groundwater pumping.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	SWRCB - Division of Drinking	Water Supply Permit

Is CEQA Complete? ☑ Yes ☐ No

If complete, please explain.

The project was included in the SEIR completed with the Water Master Plan Update in 2018.

PROJECT STATUS

- ☐ Conceptual (no feasibility or study work initiated)
- ☐ Planning (feasibility study and analysis work initiated)
- ☐ Preliminary Design (feasibility study completed)
- ☐ Ready for Construction/Implementation
- ☑ Planning (feasibility study and analysis work initiated)

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year 2030

Construction/Implementation Finish Year 2031

Timeframe to Accrue Benefits From 2031

Timeframe to Accrue Benefits To 2070

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the

water supply for the project.

The City of Clovis has an existing Cooperative Agreement with FID for surface water and two existing Water Banking Agreements. The City is also working with FID on an updated Cooperative agreement and additional water supplies.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

This will be a City owned and operated facility. Surface water delivery will be coordinated with FID.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital	$30,000,000

Describe the funding source or how these costs will be met.

This project will be funded by Water Capital Developer Funds.

Project O&M/On-going	TBD

Source(s)

Additional staff will be required to operate the plant expansion.

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY

NKGSA Project Information

Form date: April 19, 2019

Submitted On April 30, 2019

Project Name	Clovis SWTP Pretreatment
GSA Party that Project will Benefit	City of Clovis
GSA Party Contact	Paul Armendariz
GSA Party Email	PaulA@cityofclovis.com
Agency Implementing	Clovis

Project Description

This project will construct effective pretreatment for the existing 22.5 MGD surface water treatment plant (SWTP) so that the plant can continuously run during times of high turbidity in the raw water source.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	2000

Provide a detailed description of how annual benefit was quantified.

On average, the SWTP produces approximately 60% of the City's total water demand during the winter and spring months. It is estimated that the plant would be able to produce an average of an additional 125 MG per month over a 5 month (Jan - May) period which equates to 2,000 AF per year.

LOCATION

Township	13
Range	21
Section	12
Latitude	36.820052
Longitude	-119.639619
Description	Leonard south of Bullard

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [ ] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The water used through the surface water treatment plant offsets groundwater that is pumped to meet the City's demands.

Type of Project

- [x] Increase Supply
- [ ] Demand Reduction

Explain:

This project will help the City utilize its current surface water allocation and will offset groundwater pumping.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	SWRCB - Division of Drinking Water	Water Supply Permit Amendment

Is CEQA Complete?

- [x] Yes
- [ ] No

PROJECT STATUS

- [ ] Conceptual (no feasibility or study work initiated)
- [ ] Planning (feasibility study and analysis work initiated)
- [ ] Preliminary Design (feasibility study completed)
- [ ] Ready for Construction/Implementation
- [x] Planning (feasibility study and analysis work initiated)

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year

2020

Construction/Implementation Finish Year

2021

Timeframe to Accrue Benefits From 2021

Timeframe to Accrue Benefits To 2040

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The City of Clovis has an existing Cooperative Agreement with FID for surface water and two existing Water Banking Agreements.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

The City owns and operates the existing 22.5 MGD SWTP.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $1,025,000

Describe the funding source or how these costs will be met.

This project will be funded by Water User Enterprise Funds.

Project O&M/On-going $10,000

Source(s)

The annual operational costs are anticipated to be minimal as City staff already operates the existing facility.

NKGSA Project Information

Form date: April 19, 2019

Submitted On April 30, 2019

Project Name	Central Basin Recharge Project
GSA Party that Project will Benefit	North Kings GSA
GSA Party Contact	Adam Claes
GSA Party Email	aclaes@fresnoirrigation.com
Agency Implementing	Fresno Irrigation District

Project Description

The Fresno Irrigation District's Central Basin Project is approximately 90-acres of groundwater banking and recharge facilities at three locations that will yield a usable surface water supply as well as recharge the aquifer. The project includes approximately 90-acres of recharge basins at three locations and multiple monitoring wells. The project will expand the available water supply to the region. Kings River flood water and local flood water conveyed through FID's canals will be delivered to the basin sites for recharge.

This project component is a continuation of the collaboration between FMFCD and FID to provide flood protection and better manage the region's water resources. The project will address several current needs facing the region, including improving regional water self-reliance and providing additional surface and groundwater storage to adapt to climate change. The project will also contribute to water security, create a conjunctive use facility, increase water supply reliability, provide needed groundwater recharge to slow/prevent groundwater contaminant plume migration, decrease risk of flooding, facilitate the Kings River Fisheries Management program and create increased wetted area.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	2592

Provide a detailed description of how annual benefit was quantified.

Consistent with the expected benefits stated in the project's Proposition 1 grant application, an estimation of the recharge potential of the project was originally calculated based on the available surface supply, basin volume (360AF, 90 wetted acres at 4 feet deep), diversion capacity (100cfs) and assumed infiltration rate of 0.25ft/day. Figure 8 shows the total potential recharge for the basin using these assumptions for the years data was available. (Of note, Fancher Creek data after 2000 was not available at the time of this application). A 50-year estimation was then prepared and is included as Figure 9 in the attached report. The recharge potential using only the Kings and Fancher water supplies was estimated to be 2,592 AF/yr. It is important to understand that the 2,592AF/yr is an average number. In dry years, the amount recharged using these surface water supplies may be zero, however in wet years, the amount of water recharged will exceed 6,000AF. This is clearly indicated in both Figures 8 and 9 of the attached report.

After the original expected annual benefit was calculated for the Proposition 1 grant application, the project was later reduced in size from 100 acres to 90 acres. However, using a still conservative recharge estimate of 0.3 ft/day infiltration rate, the project at three sites is estimated to recharge 2,717 AF/yr, which exceeds the originally planned estimate of 2,592 AF/yr. The 2,592 AF/yr will still be used as a conservative estimate.

Attachment 09 Technical Report Summary.pdf

LOCATION

Township	14
Range	20
Section	31
Latitude	36.676891
Longitude	-119.840065
Description	Location above is for the Central & Hughes location. Multiple locations (N/E Lincoln & Orange Ave, S/E East & Malaga Ave, S/W Central & Hughes Ave)

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- ☑ Chronic lowering of groundwater levels
- ☐ Seawater Intrusion ☐ Land Subsidence
- ☑ Reduction of groundwater storage
- ☐ Degraded water quality
- ☐ Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The project is a groundwater recharge facility that will replenish the groundwater aquifer using available surface water supplies. This project will help bolster groundwater levels as well as add additional water to the area's groundwater storage.

Type of Project ☑ Increase Supply ☐ Demand Reduction

Explain:

This project will allow additional surface water supplies, that would have otherwise left our region, to stay within the NKGSA and be recharged into the aquifer. This water will increase the amount of groundwater supply available for use.

REGULATORY/PERMITTING (354.33.b.3)

Permits

Permitting Agency	Permit Type

	State Water Resources Control Board	Storm Water Pollution Prevention Plan
	San Joaquin Valley Air Pollution Control District	Dust Control Plan

Is CEQA Complete? ☑ Yes ☐ No

If complete, please explain.

The Initial Study/Mitigated Negative Declaration for CEQA for the project was completed and the Notice of Determination was filed with the County on February 21, 2018.

PROJECT STATUS

- ☐ Conceptual (no feasibility or study work initiated)
- ☐ Planning (feasibility study and analysis work initiated)
- ☐ Preliminary Design (feasibility study completed)
- ☑ Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year 2018

Construction/Implementation Finish Year 2020

Timeframe to Accrue Benefits From 2020

Timeframe to Accrue Benefits To 2070

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The project would allow FID to increase its use of Kings River surface water supplies through the project. The project will capture, store, and recharge surface water normally lost from the Kings River, allowing for sustained management. Recharging the water that is diverted into the project during wet years will help replenish the groundwater and can be stored to be used during dry years.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

FID owns the properties the project sites will be constructed on. FID will use water from its Kings River water rights to recharge at the facility.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital 6500000

Describe the funding source or how these costs will be met.

Through a joint grant application with Fresno Metropolitan Flood Control District with other projects, FID's Central Basin Project was awarded Proposition 1 Stormwater Grant Program grant funding with a 30% local match. FID's local match will come from the District's Water Purchase Fund.

Project O&M/On-going $15000

Source(s)

The District will operate and maintain the basin sites in accordance with its operation and maintenance of other facilities using existing staff and FID funds.

NKGSA Project Information

Form date: April 19, 2019

Submitted On June 30, 2019

Project Name	Savory Pond Expansion
GSA Party that Project will Benefit	Fresno Irrigation District
GSA Party Contact	Adam Claes
GSA Party Email	aclaes@fresnoirrigation.com
Agency Implementing	Fresno Irrigation District

Project Description

FID will expand the expanding Savory Pond to an approximately 30-acre recharge basin near the corner of Lincoln & Chestnut Avenues. The project will provide an estimated 1,200AF per year of groundwater recharge to the aquifer. The project will include construction of basin levees, new turnout and flow measurement into the basin, fencing and other basin improvements.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	1200

Provide a detailed description of how annual benefit was quantified.

The estimated recharge benefit is based on an assumed infiltration rate of 0.4 feet per day, for 100 days at the 30 acre basin site. The 0.4 feet per day is considered conservative based on recharge rates at the existing site and other nearby basins. 100 days of delivery of water to the recharge basin is an average annual amount that is also conservative based on available FID surface water supplies.

2019-0402-Proposed Parcel Split Exhibit Final.pdf

LOCATION

Township	15
Range	20
Section	1
Latitude	36.650833
Longitude	-119.738314
Description	northwest of Lincoln and Chestnut Avenues

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The project is a groundwater recharge facility that will replenish the groundwater aquifer using available surface water supplies. This project will help bolster groundwater levels as well as add additional water to the area's groundwater storage.

Type of Project

- [x] Increase Supply
- [ ] Demand Reduction

Explain:

This project will allow surface water that may have otherwise been lost to the region to stay within FID and the NKGSA and recharged into the aquifer. The project will increase the amount of groundwater supply available for use.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	State Water Resources Control Board	Storm Water Poluution Prevention Plan
	San Joaquin Valley Air Pollution Control District	Dust Control Permit

Is CEQA Complete?

- [ ] Yes
- [x] No

If complete, please explain.

A portion of the property has been used as a pond for many years. CEQA has not been initiated on the remainder of the project.

PROJECT STATUS

- [ ] Conceptual (no feasibility or study work initiated)
- [ ] Planning (feasibility study and analysis work initiated)
- [x] Preliminary Design (feasibility study completed)
- [ ] Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year	2020
Construction/Implementation Finish Year	2022
Timeframe to Accrue Benefits From	2022
Timeframe to Accrue Benefits To	2072

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The project will utilize FID existing Kings River surface water supplies. In wet years, FID has available surface supply that can be diverted to this basin for recharge. The project will capture, store and recharge surface water that may have otherwise been lost to the region.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

FID owns the property for the project. FID will use water from its existing Kings River water rights.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital	$2000000

Describe the funding source or how these costs will be met.

Funding will come from FID's Water Purchase Fund to construct the facility.

Project O&M/On-going	$10000

Source(s)

The District will operate and maintain the basin in accordance with its operation and maintenance of other facilities using existing staff and FID funds.

NKGSA Project Information

Form date: April 19, 2019

Submitted On April 30, 2019

Project Name	Wagner Recharge Basin
GSA Party that Project will Benefit	Fresno Irrigation District
GSA Party Contact	Adam Claes
GSA Party Email	aclaes@fresnoirrigation.com
Agency Implementing	Fresno Irrigation District

Project Description

The project is a 60-acre groundwater recharge basin, including earthwork and structures. The project will provide approximately 200 AF of flood water surface storage and recharge approximately 2,300 AF/year annual average. Floodwater and other available surface waters will be delivered to the new basin and recharged into the aquifer.

The primary purpose of this project is to halt, and ultimately reverse, the current groundwater overdraft in the area by utilizing unused regional flood water supplies available to FID and provide for sustainable management of surface and groundwater.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year 2300

Provide a detailed description of how annual benefit was quantified.

The project would allow FID to increase its use of Kings River surface water supplies through the project. The project will capture, store, and recharge surface water normally lost from the Kings River, allowing for sustained management. Recharging the water that is diverted into the project during wet years will help replenish the groundwater and can be stored to be used during dry years.

The project will recharge water at the project site, putting 2,300 AF/year of water into the aquifer. The project will capture and recharge flood water lost to the region, and the recharged water will be available for pumping by nearby or new wells.

The expected annual benefit was calculated using the actual recharge rates for FID's groundwater banking facilities (Waldron, Lambrecht, Empire, and Boswell). Attached is the project's Proposition 1 grant funding pre-application for more details.

2019-0222 Pre-App compressed opt.pdf

LOCATION

Township	13
Range	19
Section	18
Latitude	36.802994
Longitude	-119.948421
Description	Southeast Shaw and Westlawn Avenues

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

This project is a groundwater recharge facility that will replenish the groundwater aquifer using available surface water supplies. This project will help bolster groundwater levels as well as add additional water to the area's groundwater storage.

Type of Project

- [x] Increase Supply
- [ ] Demand Reduction

Explain:

This project will allow additional surface water supplies, that would have otherwise left our region, to stay within the NKGSA and be recharged into the aquifer. This water will increase the amount of groundwater supply available for use.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	State Water Resources Control Board	Storm Water Pollution Prevention Plan
	San Joaquin Valley Air Pollution Control District	Dust Control Plan

Is CEQA Complete?

- [x] Yes
- [ ] No

If complete, please explain.

The Initial Study/Mitigated Negative Declaration for CEQA for the project was completed and the Notice of Determination was filed with the County on December 20, 2017.

PROJECT STATUS

- [ ] Conceptual (no feasibility or study work initiated)
- [ ] Planning (feasibility study and analysis work initiated)
- [x] Preliminary Design (feasibility study completed)
- [ ] Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year	2019
Construction/Implementation Finish Year	2021
Timeframe to Accrue Benefits From	2021
Timeframe to Accrue Benefits To	2071

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The project would allow FID to increase its use of Kings River surface water supplies through the project. The project will capture, store, and recharge surface water normally lost from the Kings River, allowing for sustained management. Recharging the water that is diverted into the project during wet years will help replenish the groundwater and can be stored to be used during dry years.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

FID owns the property the project will be constructed on. FID will use water from its Kings River water rights to recharge at the facility.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $4276780

Describe the funding source or how these costs will be met.

FID is currently applying for Proposition 1 state grant funding. FID's portion will come from the District's Water Purchase Fund.

Project O&M/On-going $10000 per year

Source(s)

The District will operate and maintain the basin in accordance with its operation and maintenance of other facilities using existing staff and FID funds.

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY

NKGSA Project Information

Form date: April 19, 2019

Submitted On June 30, 2019

Project Name	FID On-Farm Recharge Program
GSA Party that Project will Benefit	Fresno Irrigation District
GSA Party Contact	Adam Claes
GSA Party Email	aclaes@fresnoirrigation.com
Agency Implementing	Fresno Irrigation District

Project Description

FID will establish a program to offer and encourage growers to perform on-farm recharge during wet years when flood release water from the Kings River or CVP Friant system are available for delivery and would otherwise be lost to the region.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	10000

Provide a detailed description of how annual benefit was quantified.

The program is in the conceptual phase and will be dependent on grower's willing to take surface water during wet periods. Floodwater is typically available every 3-4 years. A conservative estimate of 40,000AF of supply could be available for this program, netting an average annual benefit of 10,000AF if there are willing landowners within the District.

LOCATION

Township	14
Range	19
Section	6
Latitude	36.738848
Longitude	-119.943227
Description	Throughout the entire District

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- ☑ Chronic lowering of groundwater levels
- ☐ Seawater Intrusion ☐ Land Subsidence
- ☑ Reduction of groundwater storage
- ☐ Degraded water quality
- ☐ Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The project would allow FID to increase use of available surface waters typically lost to the region but delivering water to growers during non-typical irrigation periods for flood recharge on their property. The recharge would reduce declining groundwater levels and increase the amount of water in storage.

Type of Project ☑ Increase Supply ☐ Demand Reduction

Explain:

Having growers willing to accept flood release water during wet years for recharge on their farms will capture and recharge water not typically delivered into the basin.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	n/a	n/a

Is CEQA Complete? ☑ Yes ☐ No

If complete, please explain.

This program is anticipated to be exempt from CEQA as the project will deliver water through existing conveyance and delivery facilities.

PROJECT STATUS

- ☑ Conceptual (no feasibility or study work initiated)
- ☐ Planning (feasibility study and analysis work initiated)
- ☐ Preliminary Design (feasibility study completed)
- ☐ Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year 2025

Construction/Implementation Finish 2025

Year

Timeframe to Accrue Benefits From 2025

Timeframe to Accrue Benefits To 2075

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The project will utilize existing surface water rights that FID has but is unable to utilize in wet years or when storage is limited.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

FID has the water right for the supply considered. FID will not divert water to landowner property without their consent.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $100000

Describe the funding source or how these costs will be met.

A minimal cost of the program is anticipated. A conservative estimate of $100,000 is considered for evaluation of alternatives, communication with growers, study of priority areas, potential effects on crop yields or other considerations needed. No infrastructure is anticipated to be required. FID will fund out of its Water Purchase Fund.

Project O&M/On-going $10000

Source(s)

The program may require increased operational staffing during winter months. FID will fund ongoing operations through existing operation funds.

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY

NKGSA Project Information

Form date: April 19, 2019

Submitted On June 12, 2019

Project Name	Nielsen Recharge Facility
GSA Party that Project will Benefit	City of Fresno
GSA Party Contact	Glenn Knapp
GSA Party Email	glenn.knapp@fresno.gov
Agency Implementing	City of Fresno

Project Description

This project is to expand the City's groundwater recharge program and includes land acquisition, development of new recharge basins, structures and conveyance sytems such as pipelines, canal turn-outs, metering systems, and interties. The project goal is to optimize groundwater recharge efforts so as to balance groundwater extractions as laid out in the City's 2014 Metropolitan Water Resources Plan.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	3,500

Provide a detailed description of how annual benefit was quantified.

The provided value is the measured flow that was delivered to the facility last year for groundwater recharge purposes.

LOCATION

Township	14
Range	19
Section	1
Latitude	36.7450
Longitude	119.8578
Description	southwest Fresno

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion ☐ Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

As part of the City's long-term effort to replenish the groundwater aquifer this project applies available surface water supplies to excavated recharge basins so it may percolate into the groundwater system. This is a focused effort to eliminate lowering of the groundwater levels and improve groundwater storage.

Explain:

Continued growth within the City's Sphere of Influence requires proactive measures in acquiring additional groundwater recharge areas, and development of new structures and surface water conveyance systems in eliminating groundwater overdraft conditions. This project aids in ensuring the long-term reliability of the groundwater aquifer.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	City of Fresno - Building & Safety Division	Grading Plan
	City of Fresno - Development Department	Conditional Use Permit
	San Joaquin Valley Air Pollution Control District	Dust Control Plan

Is CEQA Complete? ☑ Yes ☐ No

If complete, please explain.

An IS/MND was prepared for the project and completed 2/11/2011.

PROJECT STATUS

- [ ] Conceptual (no feasibility or study work initiated)
- [ ] Planning (feasibility study and analysis work initiated)
- [ ] Preliminary Design (feasibility study completed)
- [x] Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year 8/12/2015

Construction/Implementation Finish Year 2/28/2016

Timeframe to Accrue Benefits From 2016

Timeframe to Accrue Benefits To 2116

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The City's contract supply for Kings River water through the Fresno Irrigation District is fairly reliable. In periods of extended or severe droughts water may not be available for recharge purposes. It is anticipated however that recharge operations will be possible for most years

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

The City owns the recharge facility property and has a secure contract for water supplies. All applicable legal authorities are in-place for this project.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $3,657,000

Describe the funding source or how these costs will be met.

Water Division & Wastewater Enterprise funds.

Project O&M/On-going $74,000

Source(s)

Water Division and Wastewater revenue.

NKGSA Project Information

Form date: April 19, 2019

Submitted On June 14, 2019

Project Name	Northeast Surface Water Treatment Facility Expansion
GSA Party that Project will Benefit	City of Fresno
GSA Party Contact	Brock Buche
GSA Party Email	brock.buche@fresno.gov
Agency Implementing	City of Fresno

Project Description

The NE-SWTF Expansion Project is part of the City's near-term program to attain and maintain the sustainable use of water resources. This project is for the 30-MDG expansion of the existing surface water treatment facility for a total capability of 60-MGD. To enable water from the expansion to reach further into the City large diameter transmission mains will also be constructed. This project will meet future growth demands and ensure groundwater utilization attains and remains at safe-yield levels.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	30,840

Provide a detailed description of how annual benefit was quantified.

Production yield is based on the plant expansion running 335-days per year at a rate of 30-MDG (this is only for the expansion). Actual production may vary on supply availability and other factors.

LOCATION

Township	12
Range	20
Section	13
Latitude	36.8839
Longitude	119.7387
Description	Northeast Fresno

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The utilization of surface water reduces the City's reliance on groundwater thus less groundwater is pumped which will avoid lowering of groundwater levels.

Using surface water also allows groundwater storage to recover.

Explain:

The City has contracts with the USBR & FID for surface water supplies. The NESWTF permits the treatment of both sources and will further expand potable water supplies.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	City of Fresno - Development Department	Conditional Use Permit
	City of Fresno - Building & Safety Division	Building Permits
	City of Fresno - Public Works	Traffic Control Plan
	State Water Resources Control Board	Storm Water Pollution Prevention Plan
	San Joaquin Valley Air Pollution Control Board	Dust Control Plan

Is CEQA Complete?

- [ ] Yes
- [x] No

If complete, please explain.

The NESWTF Expansion is included in the Programmatic EIR for the 2014 Metropolitan Water Resources Management Plan, but will require a site specific review prior to project commencement. It is anticipated that since this project has been preliminarily evaluated at the programmatic level further review will be carried-out satisfactorily within CEQA guideline requirements.

PROJECT STATUS

- ☐ Conceptual (no feasibility or study work initiated)
- ☐ Planning (feasibility study and analysis work initiated)
- ☑ Preliminary Design (feasibility study completed)
- ☐ Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year 2021

Construction/Implementation Finish Year 2025

Timeframe to Accrue Benefits From 2025

Timeframe to Accrue Benefits To 2125

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The City's contracts for surface water supplies has historically been fairly reliable. There in recent years however been instances where the USBR supply has seen dramatic reductions. The sizing of surface water treatment facilities takes into account the infrequent supply restrictions and will be capable of running in all but the most severe-drought periods.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

The City of Fresno owns the treatment site property and all of the distribution system pipelines will be located in public rights-of-way. All applicable legal authorizes are in-place for this project.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $161,500,000

Describe the funding source or how these costs will be met.

Funding for this project will come from a combination of developer fees, bonds, loans, and Water Division Enterprise.

Project O&M/On-going $4,845,000

Source(s)

Water Division revenue.

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY

NKGSA Project Information

Form date: April 19, 2019

Submitted On June 13, 2019

Project Name	Residential Water Meter Retrofit Project
GSA Party that Project will Benefit	City of Fresno
GSA Party Contact	Brock Buche
GSA Party Email	brock.buche@fresno.gov
Agency Implementing	City of Fresno

Project Description

In 2004, California passed State Assembly Bill 514, which requires "urban water suppliers" who receive water from the federal CVP through existing USBR water service contracts, install water meters on all residential service connections on or before January 1, 2013. The City maintains a contract for 60,000 acre feet of surface water every year from the CVP through the USBR. To comply with this bill and to take acts to reduce water consumption all residential services will be equipped with meters.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	43,600

Provide a detailed description of how annual benefit was quantified.

Residential meter installation contracts commenced in 2010 and run through the end of 2012. Per capita water consumption from 2007 through 2011 averaged 277 gpcd. Per capita consumption after meters were installed, excluding the drought period of 2012-2016, averages 201 gpcd (2017 & 2018). The population at the end of 2011 was 513,358. Applying the per capita water consumption values from before and after meter installation yields a 43,600 AF reduction for the base 2011 population.

LOCATION

Township	14
Range	20
Section	3
Latitude	36.7397
Longitude	119.7845

Description Citywide

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

Implementation of volumetric billing incentives conservation and reduces water consumption. The reduced consumption is directly correlated to reduced groundwater pumping and avoidance of lowering groundwater levels.

Additionally, reduced reliance on groundwater permits for the recovery of groundwater storage.

Explain:

The implementation of volumetric billing enables consumers to acknowledge their use of commodities and incentives conservation. Prior to the installation of water meters average per capita water use in the City was approximately 277 gpcd for the period of 2007 to 2011, and historically had been as high as 324 gpcd in 2001. After meters were installed on all residential services with completion of the project at the end of 2012, it was the first time consumers had the opportunity to understand their water use behaviors. Present day per capita use for 2017 & 2018 is now at 201 gpcd. This project had a significant beneficial impact with demand reduction.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	N/A	N/A

Is CEQA Complete? [x] Yes [ ] No

If complete, please explain.

As part of the Residential Water Meter Retrofit Project an environmental assessment was completed and a Negative Declaration was adopted. A Notice of Determination was then filed with the Fresno County Clerk's Office.

PROJECT STATUS

- ☐ Conceptual (no feasibility or study work initiated)
- ☐ Planning (feasibility study and analysis work initiated)
- ☐ Preliminary Design (feasibility study completed)
- ☑ Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year 6/15/2010

Construction/Implementation Finish Year 12/30/2012

Timeframe to Accrue Benefits From 2012

Timeframe to Accrue Benefits To 2112

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

N/A.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

All work for the project was performed under the authority of the City of Fresno and its legally binding contract requirements and oversight. All applicable legal authorities are in-place for this project.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $76,829,600

Describe the funding source or how these costs will be met.

This project was funded through SRF loans, IRWMP grants, 2010 Bonds, and Water Division Enterprise funds.

Project O&M/On-going $150,000

Source(s)

Water Division revenue.

NKGSA Project Information

Form date: April 19, 2019

Submitted On June 14, 2019

Project Name	Southeast Reclamation Facility and Distribution System
GSA Party that Project will Benefit	City of Fresno
GSA Party Contact	Brock Buche
GSA Party Email	brock.buche@fresno.gov
Agency Implementing	City of Fresno

Project Description

As part of the City's long-term goal to utilize resources sustainably the development of a recycled water program will be key. This project includes design and construction of an initial 8-MGD tertiary treatment facility with transmission and distribution mains. The reclaimed water produced and distributed in the southeast region will provide a direct potable water offset, thus reducing the reliance on and use of groundwater supplies.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	4,420

Provide a detailed description of how annual benefit was quantified.

Production yield is based on the tertiary treatment facility operating 335-days per year at a rate of 8-MGD.

LOCATION

Township	13
Range	21
Section	29
Latitude	36.7772
Longitude	119.7009
Description	Southeast Fresno

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The continued development of recycled water reduces the City's use of groundwater thus reducing pumping of this resource and avoiding the lowering of levels.

The reduced use of groundwater also permits the recovery of groundwater storage.

Explain:

The application of recycled water to landscape areas and other suitable commercial and industrial applications provides a means to offset the use of potable supplies. The vision is to expand reclamation efforts in a strategic and cost-effective manner to reduce the reliance on groundwater while maintain it as a sustainable and renewable resource.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	City of Fresno - Development Department	Conditional Use Permit
	City of Fresno - Building & Safety Division	Building Permits
	City of Fresno - Public Works	Traffic Control Plan
	State Water Resources Control Board	Storm Water Pollution Prevention Plan
	San Joaquin Valley Air Pollution Control District	Dust Control Plan

Is CEQA Complete? ☐ Yes ☑ No

If complete, please explain.

Preparation of the IS/MND for this project is presently underway.

PROJECT STATUS

- ☐ Conceptual (no feasibility or study work initiated)
- ☐ Planning (feasibility study and analysis work initiated)
- ☑ Preliminary Design (feasibility study completed)
- ☐ Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year	1/15/2021
Construction/Implementation Finish Year	1/15/2025
Timeframe to Accrue Benefits From	2025
Timeframe to Accrue Benefits To	2125

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

N/A.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

The City of Fresno owns the treatment site property and all of the distribution system will be located in the public rights-of-way. All applicable legal authorities are in-place for this project.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $155,000,000

Describe the funding source or how these costs will be met.

Project funding will be a combination of development fees, bonds, loans, and enterprise funds.

Project O&M/On-going $4,650,000

Source(s)

Wastewater Division revenue.

NKGSA Project Information

Form date: April 19, 2019

Submitted On June 11, 2019

Project Name	Southeast Surface Water Treatment Facility
GSA Party that Project will Benefit	City of Fresno
GSA Party Contact	Glenn Knapp
GSA Party Email	glenn.knapp@fresno.gov
Agency Implementing	City of Fresno

Project Description

Design, construction, start-up, and commissioning of the new Southeast Surface Water Treatment Facility (SESWTF) and associated large diameter transmission mains. New facility is required to treat surface water diverted from the Kings River through canal and raw water pipeline system. Historically, the City has largely relied on groundwater to meet municipal water demands. The SESWTF will utilize surface water supplies and permit the balanced use of both groundwater and surface water, thus greatly reducing groundwater extractions.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	82,240

Provide a detailed description of how annual benefit was quantified.

Production yield is based on the plant running 335-days per year at a rate of 80-MGD. Actual production may vary depending on supply availability and other factors.

LOCATION

Township	13
Range	21
Section	34
Latitude	36.7594
Longitude	119.6764
Description	SE Fresno

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The utilization of surface water reduces the City's reliance on groundwater thus less groundwater is pumped which will avoid lowering of groundwater levels.

Using surface water also allows groundwater storage to recover.

Explain:

The City has contracts with the USBR & FID for surface water supplies but has not been able to fully utilize them. The SESWTF permits the treatment of the Kings River resource to expand potable water supplies.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	City of Frenso - Building & Safety Division	Building Permits
	City of Fresno - Public Works	Traffic Control Plan
	County of Fresno - Public Works	Traffic Control Plan
	State Water Resources Control Board	Storm Water Pollution Prevention Plan
	San Joaquin Valley Air Pollution Control District	Dust Control Plan

Is CEQA Complete?

- [x] Yes
- [ ] No

If complete, please explain.

The City prepared an update to its Metropolitan Water Resources Management Plan which included the SESWTF in the associated Plan EIR. CEQA has been completed for this project.

PROJECT STATUS

- [ ] Conceptual (no feasibility or study work initiated)
- [ ] Planning (feasibility study and analysis work initiated)
- [ ] Preliminary Design (feasibility study completed)
- [x] Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year	12/31/2015
Construction/Implementation Finish Year	9/28/2018
Timeframe to Accrue Benefits From	2018
Timeframe to Accrue Benefits To	2118

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The City's contract supply for Kings River water through Fresno Irrigation District is fairly reliable. The allocation each year is based on hydrologic conditions. It is anticipated that in dry years water otherwise used for groundwater recharge will be diverted to the SESWTF for treatment.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

The City owns the treatment site property and has a secure contract for water supplies. All applicable legal authorizes are in-place for this project.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital	$314,600,000

Describe the funding source or how these costs will be met.

Significant project funding is in the form of SRF low interest loans.

Project O&M/On-going	$4,500,000

Source(s)

Water Division revenue.

NKGSA Project Information

Form date: April 19, 2019

Submitted On June 14, 2019

Project Name	Southwest Reclamation Facility and Distribution System
GSA Party that Project will Benefit	City of Fresno
GSA Party Contact	Brock Buche
GSA Party Email	brock.buche@fresno.gov
Agency Implementing	City of Fresno

Project Description

As part of the City's long-term goal to utilize resources sustainably the development of a recycled water program will be key. This project includes the design and construction of an initial 5-MGD tertiary treatment facility and transmission and distribution system. The reclaimed water produced and distributed in the southwest region will provide a direct potable water offset, thus reducing the reliance on and use of groundwater supplies.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	5,140

Provide a detailed description of how annual benefit was quantified.

Production yield is based on the tertiary treatment facility operating 335-days per year at a rate of 5-MGD.

LOCATION

Township	14
Range	19
Section	21
Latitude	36.7049
Longitude	119.9085
Description	Southwest Fresno

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The development of reclamation water reduces the City's use of groundwater thus reduces pumping of this resource and avoiding the lowering of levels.

The reduced use of groundwater also permits the recovery of groundwater storage.

Explain:

The application of recycled water to landscape areas and other suitable commercial and industrial applications provides a means to offset the use of potable supplies for higher beneficial uses. The vision is to expand reclamation efforts in a strategic and cost-effective manner to reduce the reliance on groundwater while maintaining it as a sustainable and renewable resource.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	City of Fresno - Development Department	Conditional Use Permit
	City of Fresno - Building & Safety Division	Building Permits
	City of Fresno - Public Works	Traffic Control Plan
	County of Fresno - Public Works	Traffic Control Plan
	State Water Resources Control Board	Storm Water Pollution Prevention Plan
	San Joaquin Valley Air Pollution Control District	Dust Control Plan

Is CEQA Complete? [x] Yes [ ] No

If complete, please explain.

An initial study and Mitigated Negative Declaration was prepared and adopted for the project.

PROJECT STATUS

- ☐ Conceptual (no feasibility or study work initiated)
- ☐ Planning (feasibility study and analysis work initiated)
- ☐ Preliminary Design (feasibility study completed)
- ☑ Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year	12/14/2014
Construction/Implementation Finish Year	11/29/2019
Timeframe to Accrue Benefits From	2019
Timeframe to Accrue Benefits To	2119

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

N/A.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

The City of Fresno owns the treatment site property and all of the distribution system will be located in the public right-of-way. All applicable legal authorities are in-place for this project.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $114,600,000

Describe the funding source or how these costs will be met.

Funding sources include bonds, SRF loans, and Wastewater Enterprise funds.

Project O&M/On-going $3,438,000

Source(s)

Wastewater Division revenue.

NKGSA Project Information

Form date: April 19, 2019

Submitted On June 12, 2019

Project Name	T-3 Surface Water Treatment Facility
GSA Party that Project will Benefit	City of Fresno
GSA Party Contact	Glenn.Knapp
GSA Party Email	glenn.knapp@fresno.gov
Agency Implementing	City of Fresno

Project Description

This project is for the construction of a 3 million gallon water storage tank and 4-MDG surface water treatment facility (with possible future expansion to 8-MGD). The project will include, engineering & design, construction of tank, booster pumps, operations and treatment buildings, and associated site improvements.

As development continues in the southeast region of Fresno, the need for supplemental water system infrastructure and production is required to meet peak summertime demands. The project goal is to utilize surface water supplies to meet these new demands rather than groundwater.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	2,210

Provide a detailed description of how annual benefit was quantified.

Production yield is based on the treatment plant running 180-days per year at a rate of 4-MGD. Actual production may vary depending on supply availability and other factors.

LOCATION

Township	13
Range	21
Section	22
Latitude	36.7878
Longitude	119.6681

Description Southeast Fresno

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- ☑ Chronic lowering of groundwater levels
- ☐ Seawater Intrusion ☐ Land Subsidence
- ☑ Reduction of groundwater storage
- ☐ Degraded water quality
- ☐ Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The utilization of surface water reduces the City's reliance on groundwater thus less groundwater is pumped and the lowering of levels avoided.

Using surface water also allows groundwater storage to recover.

Explain:

The City has contracts with the USBR & FID for surface water supplies but has not been able to fully utilize them. The T-3 facility permits the treatment of surface water to expand potable water supplies.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	City of Fresno - Development Department	Conditional Use Permit
	City of Fresno - Building & Safety Division	Building Permits
	City of Fresno - Public Works	Traffic Control Plan
	County of Fresno - Public Works	Traffic Control Plan
	State Water Resources Control Board	Storm Water Pollution Prevention Plan
	San Joaquin Valley Air Pollution Control District	Dust Control Plan

Is CEQA Complete? ☑ Yes ☐ No

If complete, please explain.

An IS/MND was prepared and adopted for this project; E C09-158, completed10/16/2009.

PROJECT STATUS

- ☐ Conceptual (no feasibility or study work initiated)
- ☐ Planning (feasibility study and analysis work initiated)
- ☐ Preliminary Design (feasibility study completed)
- ☑ Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year	2/21/2011
Construction/Implementation Finish Year	11/21/2013
Timeframe to Accrue Benefits From	2013
Timeframe to Accrue Benefits To	2163

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The City's contract supply of Kings River water through the Fresno Irrigation District is fairly reliable. The allocation each year is based on hydrologic conditions. It is anticipated water otherwise used for recharge will be directed to the T-3 facility in dry years for treatment.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

The City of Fresno owns the treatment site property and has a secure contract for water supplies. All applicable legal authorities are in-place for this project.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $21,819,800

Describe the funding source or how these costs will be met.

Water Division enterprise funds and 2010 bond funds.

Project O&M/On-going $500,000

Source(s)

Water Division revenue.

NKGSA Project Information

Form date: April 19, 2019

Submitted On April 29, 2019

Project Name	Ricchiuti Recharge Basin Project
GSA Party that Project will Benefit	Garfield Water District
GSA Party Contact	Nicholas Keller
GSA Party Email	kelweg1@aol.com
Agency Implementing	Garfield Water District

Project Description

The Garfield Water District, as a part of its current reorganization, proposes to annex into the District the remaining portion of APN 580-040-01. Said parcel contains an existing five (5) acre basin, which is owned by Frances M. and Partick V Ricchiuti. Following annexation, the District proposes to construct a delivery connection from its distribution system to the existing basin to allow for the delivery of surface water for recharge into the basin. Basin improvements include the installation of a metered turnout facility and a conveyance pipeline. An exhibit depicting the basin location and proposed improvements is attached.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	150

Provide a detailed description of how annual benefit was quantified.

The estimate of recharge benefit is based on the basin size, multiplied by the anticipated recharge rate, multiplied by the number of days water is available for recharge. The five (5) acre site is anticipated to have an infiltration/percolation rate of .625 feet per day with water being available an average of 240 days per year.

Ricchiuti Recharge Basin.pdf

LOCATION

Township	12
Range	21
Section	7
Latitude	36.903908

Longitude -119.727265

Description 2,850 ft North and 800 ft West of the intersection of Copper Ave and Willow Ave

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The additional water recharged at the basin site will help replenish the local aquifer and reduce declining groundwater levels in the area of the project. Related, the addition of water recharged at the basin site will directly augment the amount of groundwater in storage available for pumping during dry periods.

Type of Project

- [x] Increase Supply
- [ ] Demand Reduction

Explain:

The proposed project will allow the District to have a metered connection to an existing basin for the purpose of introducing available surface water supply to assist in recharging the groundwater reservoir.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	San Joaquin Valley Air Pollution Control District	Dust Control Permit

Is CEQA Complete?

- [ ] Yes
- [x] No

PROJECT STATUS

- [x] Conceptual (no feasibility or study work initiated)
- [ ] Planning (feasibility study and analysis work initiated)
- [ ] Preliminary Design (feasibility study completed)
- [ ] Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year	2020
Construction/Implementation Finish Year	2020
Timeframe to Accrue Benefits From	2020
Timeframe to Accrue Benefits To	2070

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The proposed project will recharge surface water delivered by the District. The surface water will either be from the District's Central Valley Project (CVP) - Friant Division Class 1 supply or other sources of water which may become available to the District through the declarations made by the Bureau of Reclamation or purchases made by the District.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

Following the completion of the reorganization process, the proposed project will be located within the District's Boundaries. The proposed conveyance pipeline and turnout will be constructed within easements obtained by the District. Frances M and Patrick V Ricchiuti will maintain ownership and operation of the basin. The District will coordinate surface water deliveries for recharge with the landowner's senior use of the basin.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital	$175,000

Describe the funding source or how these costs will be met.

The District may pursue grant funding through the U.S. Bureau of Reclamation's WaterSMART program to help pay for a portion of the project costs. The proposed project will otherwise be funded by the District landowners.

Project O&M/On-going	$250

Source(s)

The annual operation costs are anticipated to be minimal. The District's Watermaster will coordinate delivery of the surface water to the basin.

NKGSA Project Information

Form date: April 19, 2019

Submitted On May 30, 2019

Project Name	Lions Park Groundwater Recharge project
GSA Party that Project will Benefit	City of Kerman
GSA Party Contact	Ken Moore
GSA Party Email	kmoore@cityofkerman.org
Agency Implementing	City of Kerman

Project Description

The City's Lion's Park Stormwater Basin serves the majority of the west side of the City. The stormwater collection system for the Basin currently includes an intertie with FID's Siskiyou Lateral No. 146 pipeline at a structure on the west side of Siskiyou Avenue, north of Kearney Boulevard. Currently, the intertie only allows for occasional overflows via overtopping of a weir into the City's stormwater collection system. The proposed project would install the valving, piping, and metering equipment necessary to allow for regular distribution of FID surface water into the City's stormwater collection system, to be conveyed to the Lion's Park Stormwater Basin for groundwater recharge purposes

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	195

Provide a detailed description of how annual benefit was quantified.

The estimated recharge volume was calculated based on the basin size, percolation/recharge rate, and number of days water would be available for recharge. The Basin is anticipated to be maintained approximately half full, resulting in a wetted area of 5.79 acres. The percolation/recharge rate used, 0.25 feet per day, is from master-planning and permitting done for the City's WWTP, which has similar soil characteristics. The City assumed 135 days per year of available surface water from FID.

LOCATION

Township	14
Range	17
Section	12
Latitude	36.723697
Longitude	-120.071666

Description Lions Park Stormwater Basin

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- ☑ Chronic lowering of groundwater levels
- ☐ Seawater Intrusion ☑ Land Subsidence
- ☐ Reduction of groundwater storage
- ☐ Degraded water quality
- ☐ Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The groundwater recharge will help replenish the underlying aquifer and increase groundwater storage for groundwater pumping during dry years. One of the City's domestic water supply wells, Well No. 9A, is located at Lion's Park, immediately adjacent to the Basin.

Type of Project ☑ Increase Supply ☐ Demand Reduction

Explain:

The project will result in additional groundwater recharge at Lion's Park Basin through the use of FID surface water.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	Fresno Irrigation District	Encroachment Permit

Is CEQA Complete? ☐ Yes ☑ No

PROJECT STATUS

- ☑ Conceptual (no feasibility or study work initiated)
- ☐ Planning (feasibility study and analysis work initiated)
- ☐ Preliminary Design (feasibility study completed)
- ☐ Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year 2021

Construction/Implementation Finish 2021

Year

Timeframe to Accrue Benefits From 2021

Timeframe to Accrue Benefits To 2071

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The project will rely on surface water from FID. The City is working with FID on a an agreement for surface water allocation.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

The City of Kerman owns the Lion's Park Stormwater Basin and stormwater collection system that will be used to convey FID surface water to the Basin.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $41,000

Describe the funding source or how these costs will be met.

Water Operations Capital Reserves

Project O&M/On-going $5,000

Source(s)

The annual operational costs are anticipated to be minimal. The City of Kerman operational crews currently maintain the basin the cost of which is currently in the annual budget. The operational crews will coordinate the delivery of water to the basin in accordance with the anticipated agreement with FID.

NKGSA Project Information

Submitted On Friday, April 19, 2019

Project Name	Basin CF - Stormwater Recharge and Flood Protection Project
GSA Party that Project will Benefit	Malaga County Water District
GSA Party Contact	Jim Anderson
GSA Party Email	laura.facciani@gmail.com
Agency Implementing	Fresno Metropolitan Flood Control District

Project Description

This project will construct an intertie (connection) between FMFCD's existing Basin "CF" with FID's Washington Colony Canal No. 15 to allow for the delivery of surface water for recharge into the basin. Basin improvements include a basin pump station, telemetry system, internal basin pipeline, basin relief pipeline, canal intertie structure and appurtenant facilities. An exhibit depicting the basin location and proposed improvements is attached. The basin is used for local urban stormwater capture to prevent localized flooding. Currently, there is no pipeline to convey water from the nearby canal to the basin. The project will construct the intertie and is estimated to provide approximately 1,000 acre-feet per year.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	970

Provide a detailed description of how annual benefit was quantified.

The estimate of recharge benefit is based on the basin size, multiplied by the anticipated recharge rate, multiplied by the number of days water is available for recharge. The 20 acre site will have an approximately 18 acre wetted basin area and is anticipated to have an infiltration/percolation rate of 0.45 feet per day based on actual infiltration rates observed at other nearby FMFCD basins. For estimating purposes, it has been assumed that water will be available an average of 120 days per year.

FMFCD Basin CF.pdf

LOCATION

Township	14
Range	21

Section	32
Latitude	36.675020
Longitude	-119.715033
Description	Southeast of Central and Peach Avenues

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The additional water recharged at the basin will help replenish the local aquifer and reduce declining groundwater levels in the area of the project. Relatedly, the addition of water recharged at the basin site will directly help to increase the amount of groundwater storage available for pumping during dry periods.

Type of Project

- [x] Increase Supply
- [ ] Demand Reduction

Explain:

The project will create a connection to an existing basin that will allow additional surface water supply to recharge the aquifer.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type
	State Water Resources Control Board	NPDES General Permit for Storm Water Discharge
	San Joaquin Valley Air Pollution Control District	Dust Control Permit
	County of Fresno	Grading Permit

Is CEQA Complete?

- [x] Yes
- [ ] No

If complete, please explain.

The project was included in the District's Subsequent Environmental Impact Report (SEIR) completed on 12/13/17 for the 2016 District Service Plan.

PROJECT STATUS

- ☐ Conceptual (no feasibility or study work initiated)
- ☐ Planning (feasibility study and analysis work initiated)
- ☑ Preliminary Design (feasibility study completed)
- ☐ Ready for Construction/Implementation

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year	2021
Construction/Implementation Finish Year	2021
Timeframe to Accrue Benefits From	2021
Timeframe to Accrue Benefits To	2071

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

The project will recharge surface water delivered by Fresno Irrigation District. Malaga County Water District is currently working with Fresno Irrigation District to determine an agreement for delivery of surface water.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

FMFCD owns and operates the existing Basin CF and will manage the design and construction of the project. Malaga County Water District is currently discussing with FMFCD the terms of agreement for construction. FMFCD will maintain ownership and operation of the basin. FMFCD will coordinate surface water deliveries for recharge with FID.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $1,072,036

Describe the funding source or how these costs will be met.

The project is pursuing grant funding through the IRWM Implementation Grant program. If grant funding cannot be secured, the FMFCD and Malaga will need to determine a different funding source for the project.

Project O&M/On-going $10,000

Source(s)

The annual operational costs are anticipated to be minimal. FID and FMFCD operational crews will coordinate delivery of water to the basin in accordance with the existing operations for delivery of water to numerous other basins. FMFCD will include maintenance activities and costs in its annual budget for operations and maintenance, subject to existing agreements for reimbursement of basin de-siltation and weed control.

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY

NKGSA Project Information

Form date: April 19, 2019

Submitted On May 14, 2019

Project Name	PCWD residential meter installation
GSA Party that Project will Benefit	Pindedale County Water District
GSA Party Contact	Jason Franklin
GSA Party Email	jdf-pcwd@sbcglobal.net
Agency Implementing	Pinedale County Water District

Project Description

The District has initiated efforts to secure funding for plans to install residential water meters (including multi-unit customers) and switch from a fixed flat-rate to a volumetric rate based on consumption. The project also includes replacing 8,050 feet of old main lines. The project will be bolstered by outdoor water restrictions and conservation efforts.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	210

Provide a detailed description of how annual benefit was quantified.

Studies show a range of 15% - 20% reduction in water usage when water utilities switch to volumetric charging for consumptive use. Fresno reduced it's per capita water use by 17% when it started charging a volumetric rate in 2013. To be conservative, we will expect a 10% reduction in use. In addition to letting us be able to charge for use, the meters have leak detection technology that will enable us to notify customers of on-site leaks.

pacinst-metering-in-california.pdf

LOCATION

Township	12
Range	20
Section	33
Latitude	36.842012
Longitude	-119.801209

Description Location is District office. Project is District wide.

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- ☐ Chronic lowering of groundwater levels
- ☐ Seawater Intrusion ☐ Land Subsidence
- ☑ Reduction of groundwater storage
- ☐ Degraded water quality
- ☐ Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

The reduction in demand will relieve stress on the local aquifer, aiding the natural recharge to replenish the amount of groundwater storage.

Type of Project ☐ Increase Supply ☑ Demand Reduction

Explain:

Customers will use water more conservatively when they are being charged a volumetric rate.

REGULATORY/PERMITTING (354.33.b.3)

Is CEQA Complete? ☐ Yes ☑ No

PROJECT STATUS

- ☐ Conceptual (no feasibility or study work initiated)
- ☐ Planning (feasibility study and analysis work initiated)
- ☐ Preliminary Design (feasibility study completed)
- ☐ Ready for Construction/Implementation
- ☑ Planning (feasibility study and analysis work initiated)

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year 2022

Construction/Implementation Finish Year 2022

Timeframe to Accrue Benefits From 2023

Timeframe to Accrue Benefits To 2073

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

N/A

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

Pinedale County Water District owns, operates, and maintains the distribution system that the new meters will be connected to.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital	$7,000,000

Describe the funding source or how these costs will be met.

Cost is a rough estimate. We are pursing State funding which should cover half the project cost. The remainder will be funded through a long-term loan.

Project O&M/On-going	$35,000

Source(s)

This cost covers the subscription costs for using the system and normal repair/replacement of meters and transponders.

NORTH KINGS GROUNDWATER SUSTAINABILITY AGENCY

NKGSA Project Information

Form date: April 19, 2019

Submitted On January 20, 2020

Project Name	County of Fresno NKGSA Recharge Program
GSA Party that Project will Benefit	County of Fresno
GSA Party Contact	Glenn Allen
GSA Party Email	glallen@fresnocountyca.gov
Agency Implementing	County of Fresno

Project Description

This project will implement priority projects identified in the Northeast Fresno-Clovis Area Recharge Potential and Groundwater Investigation (April 2015), to provide groundwater recharge in the County of Fresno area east of FID within the NKGSA. The report identified 19 possible projects, including recharge within Big Dry Creek, Dog Creek, as well as dedicated recharge basin sites. The County of Fresno will further evaluate the project list and identify priority projects for implementation.

EXPECTED ANNUAL BENEFIT (354.44.b.5)

Acre-feet per year	2000

Provide a detailed description of how annual benefit was quantified.

The expected annual project benefits have not been evaluated in detail as the County still needs to further identify specific projects and their expected annual benefit. The study identified several sites. The estimated project benefit will be dependent on a water supply agreement and the duration of the availability of that supply. Recharge within Big Dry Creek and Dog Creek will likely provide significant volume of recharge if water supply allows for recharge during the summer months.

LOCATION

Township	12
Range	21
Section	24
Latitude	36.870851
Longitude	-119.629405
Description	various locations within the county area

AFFECTED SUSTAINABILITY INDICATOR (354.44b)

Check all that apply:

- [x] Chronic lowering of groundwater levels
- [ ] Seawater Intrusion
- [ ] Land Subsidence
- [x] Reduction of groundwater storage
- [ ] Degraded water quality
- [ ] Depletions of interconnected surface water

Provide a narrative explanation of how the project addresses each Sustainability Indicator selected.

This program will provide groundwater recharge within the County area.

Type of Project

- [x] Increase Supply
- [ ] Demand Reduction

Explain:

This program will provide groundwater recharge.

REGULATORY/PERMITTING (354.33.b.3)

Permits

	Permitting Agency	Permit Type

Is CEQA Complete?

- [ ] Yes
- [x] No

PROJECT STATUS

- [ ] Conceptual (no feasibility or study work initiated)
- [ ] Planning (feasibility study and analysis work initiated)
- [ ] Preliminary Design (feasibility study completed)
- [ ] Ready for Construction/Implementation
- [x] Planning (feasibility study and analysis work initiated)

SCHEDULE (354.44.b.4)

Construction/Implementation Start Year 2025

Construction/Implementation Finish Year 2030

Timeframe to Accrue Benefits From 2030

Timeframe to Accrue Benefits To 2070

WATER SUPPLY (354.44.b.6)

If the project relies on surface water, provide an explanation of the source reliability of the water supply for the project.

This program will be dependent on securing a water supply.

LEGAL AUTHORITY (354.44.b.7)

Describe the Agencies legal authority to implement this project.

The County has land use authority and can develop the basin project, but it will be dependent on a water supply. Recharge in the creek will be dependent on approval from various agencies.

COST & FUNDING SOURCE (354.44.b.7)

Project Capital $8000000

Describe the funding source or how these costs will be met.

The funding source for the County has not yet been identified.

Project O&M/On-going $50000

Source(s)

O&M costs have not been estimated so the value shown is just a placeholder. Operational costs for recharge in creek channels and basins is not anticipated to be that high.