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 is a result that would cause significant and undesirable reduction in the long-term viability of domestic, agricultural, municipal or environmental uses over the planning and implementation period of this GSP. ~~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~~. Groundwater levels will continue to decline until the basin can reach sustainability. **Figure ES-8** shows a typical well hydrograph and the planned incremental overdraft mitigation to reach the M~~m~~easurable ~~o~~Objective and sustainability in 2040. The M~~m~~easurable O~~o~~bjective is the elevation at an Indicator Well that will be stabilized and maintained over time. This is the elevation at each Indicator Well that the GSAs will be managing the basin to maintain. ~~will include an extension of a current hydrograph gradually stabilizing, and a~~ A M~~m~~inimum T~~t~~hreshold is the groundwater elevation at an Indicator Well that when exceeded in combination with minimum thresholds at other Indicator Wells, may cause an undesirable result in the basin. The Minimum Threshold elevations have been set based on 5-year drought conditions. ~~defined as the depth of groundwater predicted if a historic 5-year drought occurred.~~ The GSAs in the basin acknowledge that some shallow wells will go dry, so the GSAs will develop a shallow well mitigation program to help address the impacts to wells that are shallower than the minimum thresholds within the basin. A more detailed description of the proposed shallow well mitigation program is included in Chapter 6.

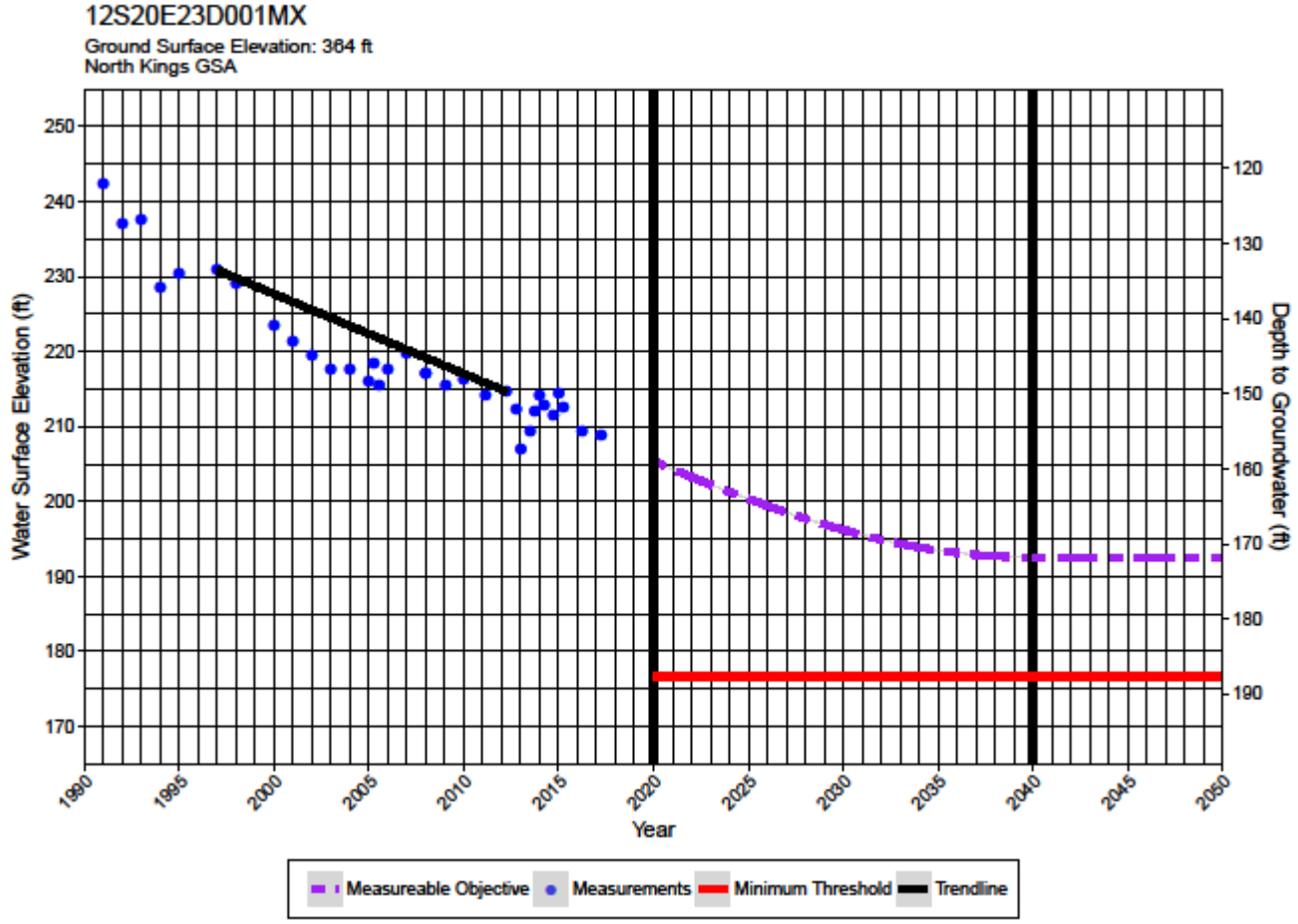


Figure ES-8 Typical NKGSA Well Hydrograph with Phased Mitigation to Reach Sustainability

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 connected~~not connected~~ to groundwater along some reaches in NKGSA, but may be disconnected in other reaches~~within the NKGSA~~. The ~~; however the~~ Kings River is likely interconnected in NKGSA. 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). These

programs could mitigate for any surface water depletion from well pumping. Nevertheless, more information is needed to fully understand the interconnection between surface water and groundwater in the NKGSA. As a result, a detailed data gap study will be performed to identify interconnected sections, evaluation if wells are impacting surface water, and whether those impacts require development of sustainable management criteria. ~~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**.

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 SGMA regulations define Undesirable Results for groundwater levels as:

> *"Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods."* [CWC §10721(x)(1)]

The undesirable result for chronic lowering of groundwater levels is a result that would cause significant and undesirable reduction in the long-term viability of domestic, agricultural, municipal or environmental uses over the planning and implementation period of this GSP. 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. Primary concerns related to Undesirable Results for groundwater levels were:

- Groundwater levels declining in dry periods to a point that they will not likely recover during normal/wet periods
- A significant and unreasonable number of shallow domestic wells going dry

Identification of Undesirable Results is based on the monitoring network of Indicator Wells described in Section 5. The GSAs in the Kings Basin have defined the Undesirable Result as occurring when 15% of the Indicator Wells have exceeded the Minimum Threshold during a single monitoring event. This value was chosen to provide a balance between unanticipated hydrology, potentially erroneous data, and coverage of a significant area within the GSA. Exceedance of a Minimum Threshold at a single Indicator Well is not necessarily sufficient to indicate GSA-wide conditions are causing undesirable results.

The sustainability goal and the undesirable results provide the qualitative basis for the quantitative sustainable management criteria described below:

- **Measurable Objective** is the quantitative goal that will allow the basin to achieve its sustainability goal within the 20-year planning period. More specifically, the measurable objective is the elevation at an Indicator Well that will be stabilized and maintained over time. The measurable objective has been set such that there is a reasonable margin of operational flexibility that will accommodate droughts, climate change, and conjunctive use operations. The GSAs in the basin will manage the basin to the measurable objectives using adaptive management and implementing the projects and management actions described in Section 6 when needed to ensure sustainability will be achieved.

  The basin is currently not in a sustainable condition, and GSAs recognize that it will take several years to reach sustainability. The measurable objective was set based on the decline in each Indicator Well within the monitoring network during a recent period of average surface water deliveries within the basin from 1997 to 2012, and an incremental mitigation correction planned to reach sustainable water levels during the planning period. Hence, the Measurable Objective is based on what is considered a reasonable level of continued decline, since halting the overdraft before 2040 would not be practical or even feasible given the current and anticipated future water supply conditions. A more detailed description of the measurable objective is included later in this section.

- **Interim Milestones** are 5-year target groundwater levels at each Indicator Well that have been set for the basin to reach sustainability over the 20-year planning period. The interim milestones have been set based on the long-term average hydrologic conditions and the planned projects and management actions the GSAs will use to make incremental improvement toward sustainability over the 20-year planning period. The GSAs will manage the basin to these Interim Milestones during the planning period by comparing hydrologic conditions to historic average conditions and implementing management actions if needed to maintain a path to sustainability.
- **Minimum Threshold** is the groundwater elevation at an Indicator Well that when exceeded in combination with minimum thresholds at other Indicator Wells, may cause an undesirable result in the basin. More specifically for groundwater levels, the minimum threshold is the groundwater elevation below which significant and unreasonable impacts to beneficial users occurs. As noted previously, the primary concerns for groundwater users and uses were groundwater levels declining to a point that would not recover to sustainable levels, or declining to levels that would cause a significant and unreasonable number of shallow wells to go dry. 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 triggers for operational change.

  The Kings Basin GSAs recognize that some wells will go dry, and the GSAs have indicated that it is not significant and unreasonable impacts if less than 15% of the shallow wells in the basin go dry. However, DWR has indicated through public comment and direct consultation with the basin that GSAs need to demonstrate how an impact to even just one single well is not significant and unreasonable. The shallowest wells in the basin are typically private domestic wells. Using the shallowest wells within the basin as a control to maintain water levels is impractical considering well construction has varied significantly and many wells may have been constructed too shallow, not considering or having been approved for sustainable or planned groundwater elevations.

  Agricultural uses are the largest groundwater user within the basin and agriculture production is the primary economic driver for the region. Setting minimum thresholds to maintain water levels to the shallowest well in an area would cause a significant and unreasonable economic impact to the basin' s varied groundwater users, including agriculture users and the many communities that are solely groundwater dependent because of the significant demand reduction it would require for all users. This is especially true when considering that suitable wells can be constructed deeper within the basin. The Kings Basin has a very large aquifer with existing water levels well above the base of the unconfined aquifer, and as shown in Chapter 2 – Basin Setting, recent water levels are several hundred feet above the base of the aquifer in much of the basin. Because the aquifer is so significant and of such good quality in most of the basin, a productive well of suitable quality can still be constructed as water levels continue to decline until sustainability is reached.

  Considering the economic, social and environmental impacts to domestic, agricultural, municipal and other groundwater users as well as the correlation to other sustainable management criteria, the basin plans to have groundwater levels continue to decline until sustainability can be reached within the planning period, but develop a program to address shallow well impacts. The Minimum Thresholds have been set below the measurable

objective based on the needed operational flexibility to accommodate dry hydrologic conditions. Operational flexibility is the elevation difference between the Measurable Objective and the Minimum Threshold. During dry periods, more groundwater pumping will occur causing groundwater levels to decline below measurable objective levels. This Operational Flexibility is based on a five-year drought period. This amount of Operational Flexibility is consistent with other GSPs in the State that were approved. A more detailed description of the minimum threshold is included later in this chapter.

The GSAs in the basin acknowledge that some shallow wells will go dry, so the GSAs will develop a shallow well mitigation program to help address the impacts to wells that are shallower than the minimum thresholds within the basin. A more detailed description of the proposed shallow well mitigation program is included in Chapter 6. At the time of the initial GSP submittal in January of 2020, not all of the GSPs in the Kings Basin included an analysis of the potential shallow well impacts. Each GSP now includes an analysis of the potential number of shallow wells impacted by the Minimum Thresholds.

These terms are illustrated in **Figure 4-2.**

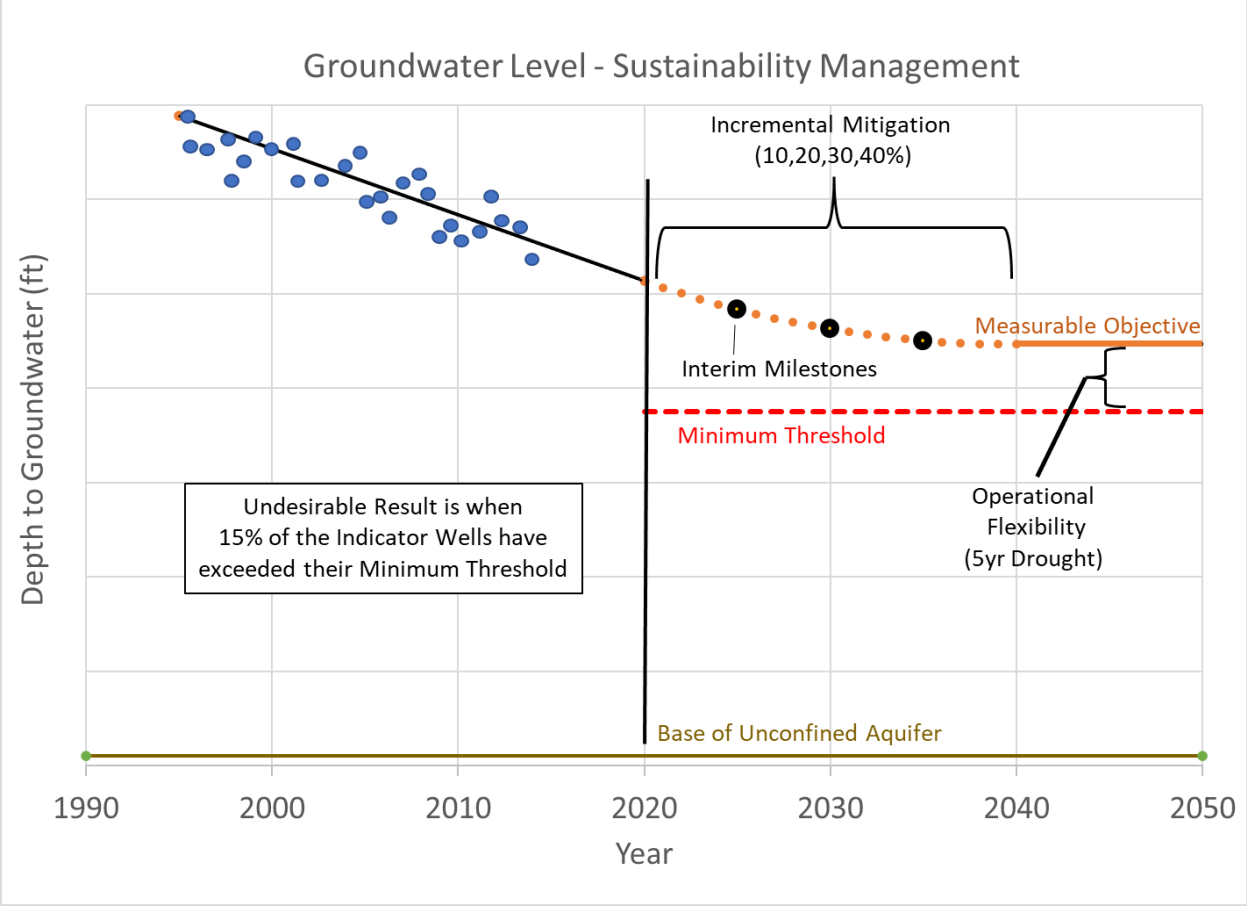
~~The GSAs within the Kings Subbasin have defined the Undesirable Result for groundwater levels to be significant and unreasonable when either the water level has declined to a depth that a new productive well cannot be constructed or when the water level has declined to a depth that water quality cannot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



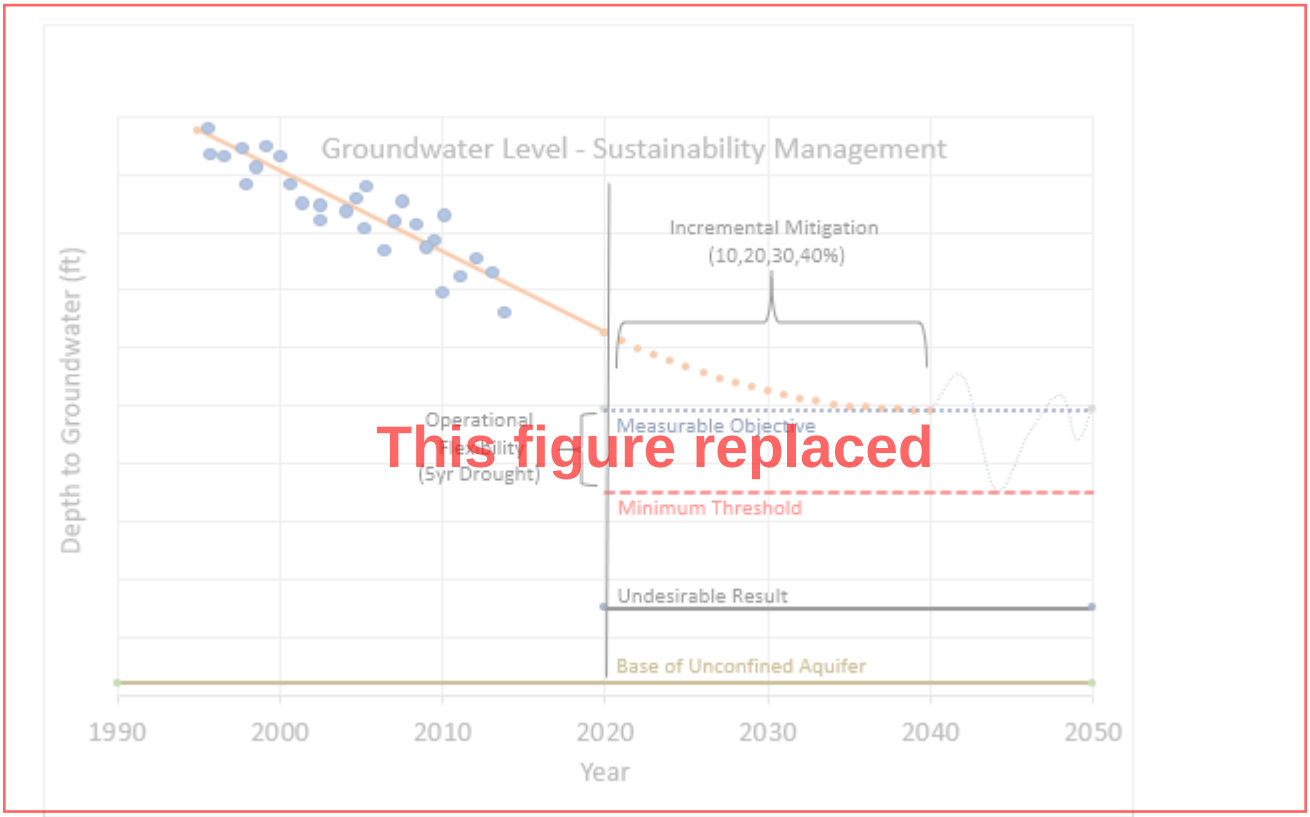


Figure 4-2 Groundwater Level - Sustainability Management

~~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.

Each Indicator Well has a unique Minimum Threshold elevation, so ~~T~~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.
- Reduction of long-standing surface water supplies as a result of State or Federal regulations leading to the need for increased groundwater pumping in the Kings Basin or neighboring basins.

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.

The GSAs in the Kings Basin have defined the Undesirable Result as occurring when 15% of the Indicator Wells in a GSA have exceeded the Minimum Threshold during a single monitoring event (spring or fall). For the North Kings GSA, that is 5 of the 34 Indicator Wells listed in the monitoring network discussion. The 15% was chosen to provide a balance between unanticipated hydrology, potentially erroneous data, and coverage of a significant area within the GSA. ~~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. The development of shallow well mitigation program described in Chapter 6 will help to address some of the potential effects to shallow well owners.

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. As described previously, the exceedance of the minimum threshold at 15% of the Indicator Wells in the GSA is significant and will trigger further investigation and management actions by the GSA. 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 for the unconfined aquifer. 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. For most Indicator Wells in the network, the operational flexibility below the measurable objective was set based on the actual

decline during the historic 2012-2016 drought and increased by 20% to estimate the impacts of a five-year drought. The Operational Flexibility was used because of changing hydrologic conditions and concerns for extended periods of drought in the future. This amount of Operational Flexibility is consistent with methods used in other GSPs approved by the State. The minimum thresholds were set by adding that distance below the measurable objective for each Indicator Well in the network. As additional data and understanding is gained during the planning period, it is recognized that the Minimum Threshold elevations may be updated. ~~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 required by the regulation, the Minimum Thresholds for chronic lowering of groundwater levels were established based on the rate of groundwater elevation decline considering historic trends, water year types and projected water use in the basin. As mentioned previously, the minimum thresholds have been set below the shallowest wells in the basin in some areas, but the GSAs are planning a shallow well mitigation program to help address these impacts.

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. For most Indicator Wells in the network, t~~T~~he actual decline during the historic 2012-2016 drought was determined at each Indicator Well in the monitoring network and increased by 20%. That~~e~~ 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 rate of decline during the 2012-2016 drought was observed to be roughly three times the average rate of decline.

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. As with all sustainable management criteria, it is recognized that future data may allow for refinement of these thresholds.

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.~~ The GSAs of the basin have identified Interconnected Surface Water as a data gap and will be investigating this further over the next few years.

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. Basin representatives have met with other basin representatives to begin discussions on inter-basin concerns, but additional discussion and determinations are needed. 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 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 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.~~

Well construction has varied over the years and wells have been constructed at varying depths, and the construction depth of all wells in the basin is not known at this time. Some wells, even recently constructed wells, may have been poorly constructed or constructed too shallow for long-term operation. SGMA does not require the GSA to maintain current water levels or prevent any wells from going dry. Rather, the GSA is required to stabilize and correct groundwater decline. The Kings Basin has a very large aquifer with existing water levels well above the base of the unconfined aquifer. As shown in Chapter 2 – Basin Setting, recent water levels are several hundred feet above the base of the aquifer in much of the subbasin. Much of the subbasin has a significant amount of water available below the Measurable Objective and even below the Minimum Threshold levels.

The GSA recognizes that some shallow wells will likely go dry until water levels have been stabilized. Without SGMA and the proposed incremental mitigation by the GSA, the shallow wells would have gone dry sooner, requiring the landowners to deepen these existing wells. However, the GSAs will develop a well mitigation program to help address impacts to shallow wells that may go dry above the minimum threshold. A more detailed description of the minimum threshold is included later in this chapter, and a description the proposed mitigation program is included in Chapter 6.

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. Using this period for the analysis is also consistent with SWRCB comments and studies performed by UCDavis. The results of this analysis are shown in -Figure 4-3**.**

~~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**.~~

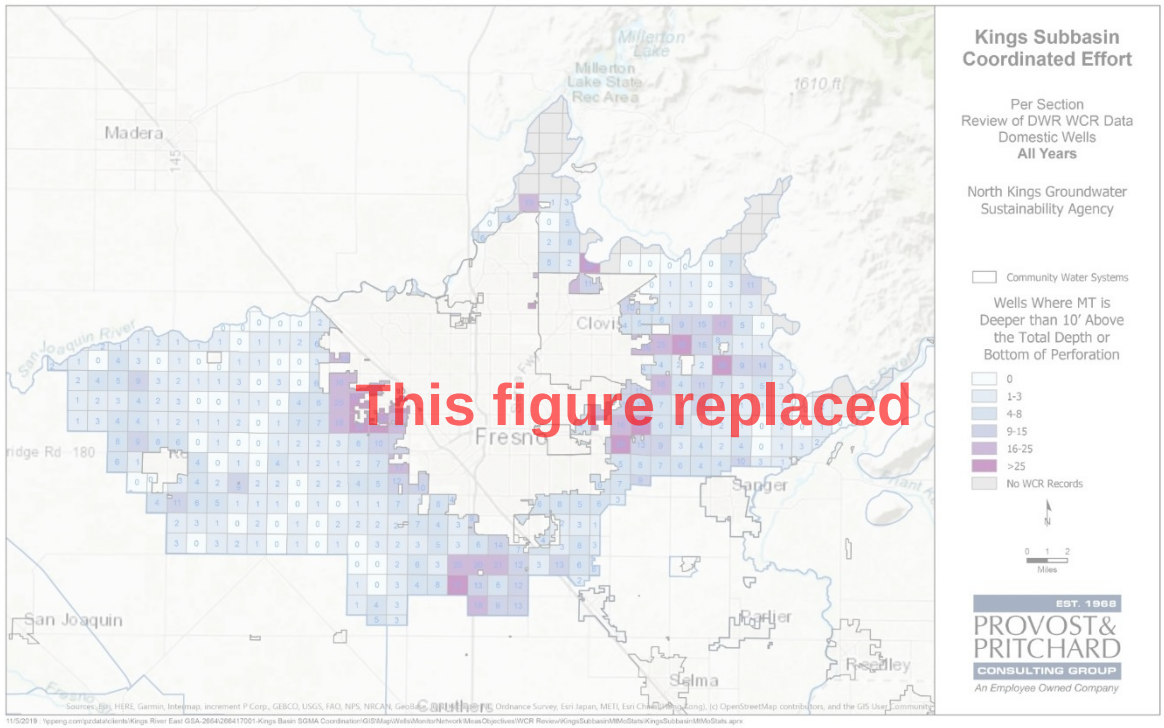
~~For each of the four comparisons, the~~ The number of domestic wells shallower than the minimum threshold or measurable objective were totaled and compared to the total number of domestic well records. As mentioned previously, the total number of domestic wells used in these calculations is based on DWR records, and may include abandoned, destroyed, or inactive wells. 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 number of impacted wells is lower than what is shown. These numbers may be refined as the GSP is implemented and more information becomes available.~~**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.~~



~~Figure 4-3 Domestic Wells from All Years compared to Minimum Threshold~~

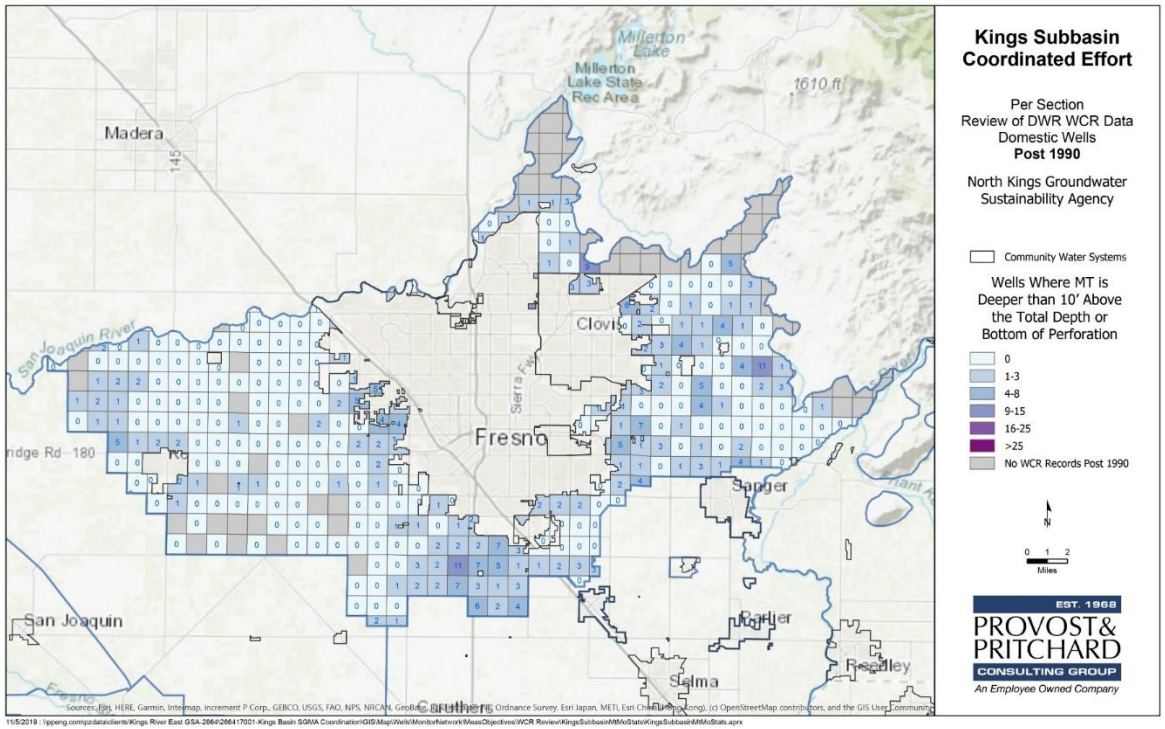
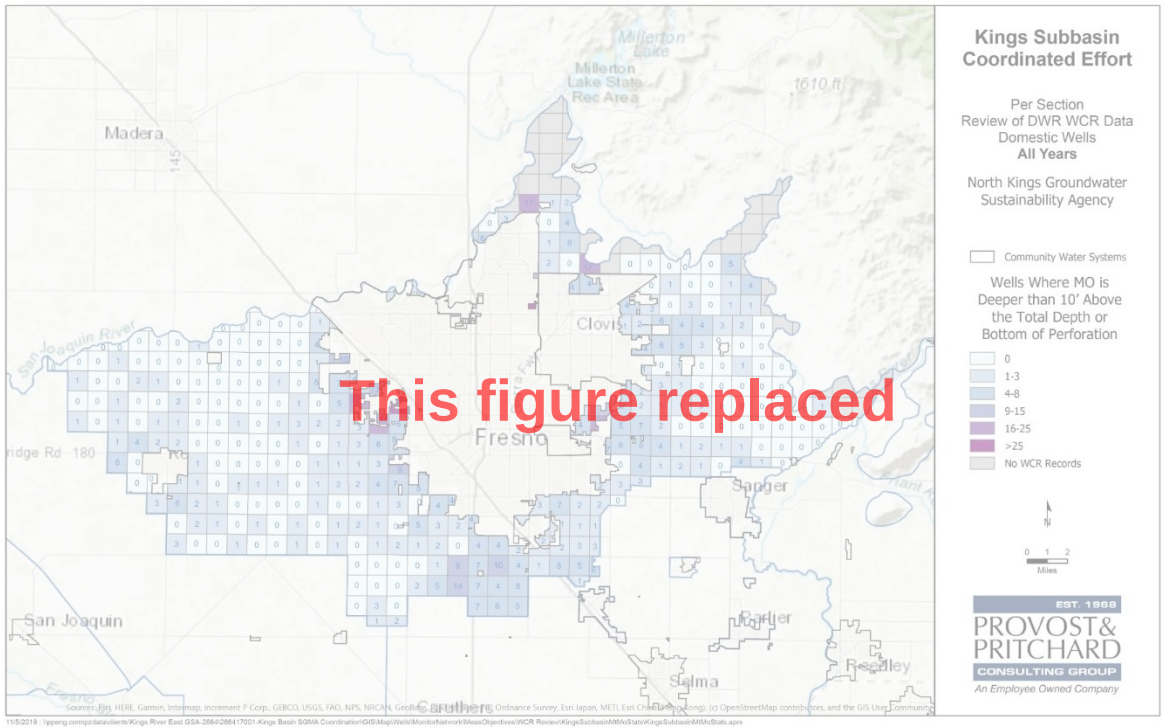


Figure 4-3 Post 1990 Domestic Wells compared to Minimum Threshold



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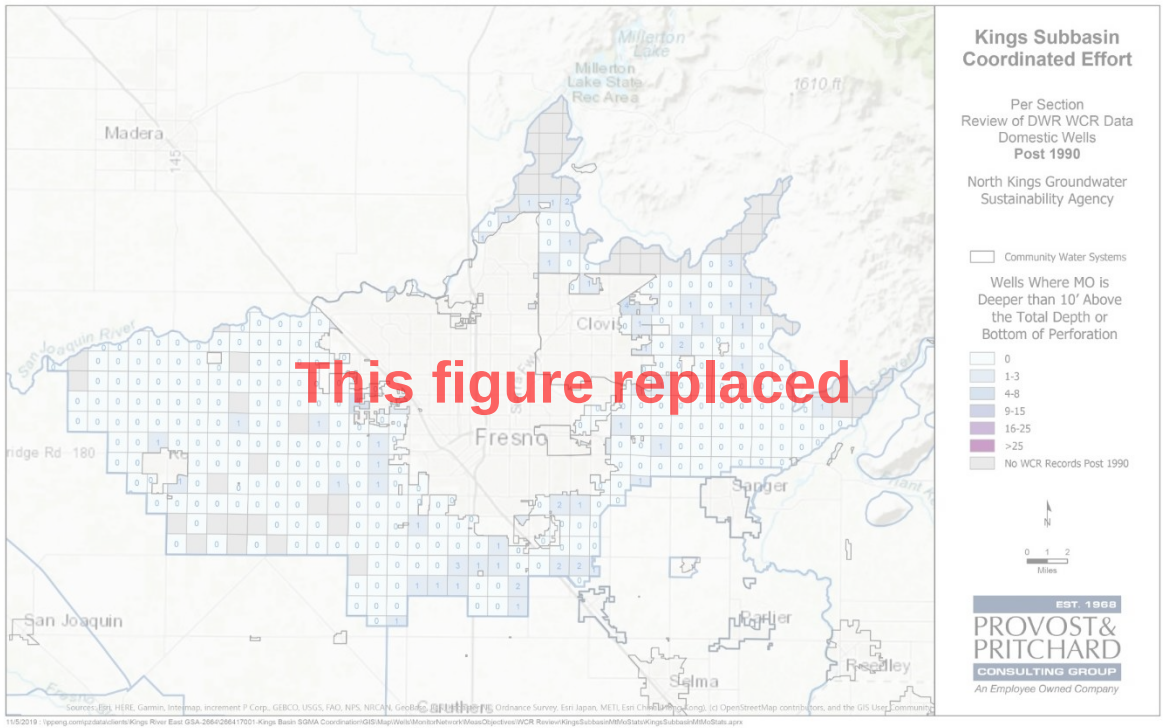
~~Figure 4-5 Domestic Wells from All Years compared to Measurable Objective~~



~~Figure 4-6 Post 1990 Wells compared to Measurable Objective~~

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. This GSP will become the basis for local regulatory standards.

4.2.2.6 Measurement of Minimum Thresholds

Regulation Requirements:

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

Groundwater level readings will be made at indicator wells in accordance with water level measurement protocols described in Chapter 5 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 Measurable Objective is the quantitative goal that will allow the basin to achieve its sustainability goal within the 20-year planning period. More specifically, the measurable objective is the elevation at an Indicator Well that will be stabilized and maintained over time. The measurable objective has been set such that there is a reasonable margin of operational flexibility that will accommodate droughts, climate change, and conjunctive use operations. The GSAs in the basin will manage the basin to the measurable objectives using the projects and management actions described in Section 6.

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 Minimum Threshold for Representative Monitor Wells 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.

A margin of operational flexibility, or margin of safety, allows for variation in groundwater levels due to historical water budgets, seasonal and yearly variations, and drought and also takes into consideration levels of uncertainty. Drought years may cause pumping to increase, but wet years may provide enough opportunity for surface water recharge to offset drought years. The operational flexibility for each well in the GSA will vary based on current groundwater levels and rate of decline. As shown in -Figure 4-2, 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. Indicator wells are being used to establish measurable objectives and minimum thresholds.

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.

Although the undesirable result (as defined) may not occur until water levels are below the minimum threshold, the basin will use the 5-year milestones and minimum threshold levels as trigger for operational change. The GSAs will manage the basin to these Interim Milestones during the planning period by comparing hydrologic conditions to historic average conditions and implementing management actions if needed to maintain a path to sustainability.

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 4-5**.

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Table 4-5 Estimate of Groundwater in Storage between Measurable Objective and Minimum Threshold

GSA	Volume (Acre-Feet)
Central Kings	680,000

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.

This section unedited

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 4-7.**

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) for wells that have had recent historic concentrations of Chemicals of Concern above MCLs, the degradation of water quality to a level in excess of 20% greater than the recent historically high concentration of the Chemical of Concern in the well.~~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 when shown to be altered by groundwater pumping or recharge activities. ~~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 4-7 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. However, some of these causes are not the GSA's responsibility and include, but are not limited to:~~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; and
- The accumulated effects of regulated and unregulated waste discharge streams from wastewater treatment facilities, septic systems, industry, food processors, feed lots, and dairies.~~;~~

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

- 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) for wells that have had recent historic concentrations of Chemicals of Concern above MCLs, the degradation of water quality to a level in excess of 20% greater than the recent historically high concentration of the Chemical of Concern in the well.~~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 when shown to be altered by groundwater pumping and recharge activities.

Regulation Requirements:

§354.26 (b) The description of undesirable results shall include the following:

(3) Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.

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

Minimum Threshold values have been established by two different methods, as follows:

- Numeric values for MCLs (i.e. California potable water standards) as identified in **Table 4-8**, where concentrations of chemicals of concern were recently below MCLs; or
- For wells that have had recent concentrations of Chemicals of Concern above MCLs, the degradation of water quality to a level in excess of 20% greater than the recent historically high concentration of the Chemical of Concern in the well. The 20% increase was selected as a criterion to provide a reasonable balance between natural fluctuations and uncertainty in the data with the desire to minimize further degradation.

~~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**.~~

Based on available data, **Table 4-9** shows the historical maximum concentration of Chemicals of Concern and where MCL exceedances have occurred. Minimum Threshold numeric values in these instances will be set at a 20% increase to the indicated table values. If water quality sampling indicates a Minimum Threshold exceedance, then an evaluation will need to occur to determine if the exceedance is a result of groundwater management activities. **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.**
~~**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.**~~

Table 4-9 Chemicals of Concern with Historic Exceedances of MCLs (2015 to 2021)

Well ID	Well Type	Arsenic (µg/L)	1,2,3-Trichloropropane (TCP) (µg/L)	Hexavalent Chromium (µg/L)	Dibromo-Chloropropane (DBCP) (µg/L)	Methyl Tert-Butyl Ether (MTBE) (µg/L)	Nitrate as N (mg/L)	Uranium (pCi/L)	Tetrachloroethylene (PCE) (µg/L)	Trichloroethylene (TCE) (µg/L)
1000018-001	Public Supply	2.8	ND	NA	0.77 (0.92)	ND	7.1	NA	ND	ND
1000023-013	Public Supply	2.8	0.063 (0.076)	1	ND	ND	3.1	NA	ND	ND
1000039-002	Public Supply	2.3	ND	NA	ND	ND	4.7	NA	ND	ND
1000078-004	Public Supply	2.4	ND	1.2	ND	ND	10 (10.2)	NA	ND	ND
1000104-001	Public Supply	0	ND	NA	ND	ND	2	NA	ND	ND
1000201-001	Public Supply	0	ND	NA	ND	ND	4.2	NA	ND	ND
1000208-001	Public Supply	2.6	ND	NA	ND	ND	2.4	NA	ND	ND
1000217-001	Public Supply	2.7	ND	17	ND	ND	2	NA	ND	ND
1000259-002	Public Supply	5.7	ND	ND	ND	ND	0.56	NA	ND	ND
1000279-002	Public Supply	2.7	0.075 (0.09)	NA	0.088	ND	2.3	NA	ND	ND
1000362-003	Public Supply	4.8	ND	NA	ND	ND	2.5	NA	ND	ND
1000366-001	Public Supply	1.4	ND	NA	ND	ND	5.1	NA	ND	ND
1000447-067	Public Supply	2.4	ND	NA	ND	ND	2.4	NA	ND	ND
1000467-001	Public Supply	4.2	ND	0.33	0.038	ND	3.6	NA	ND	ND
1000492-001	Public Supply	NA	NA	NA	NA	NA	6.3	NA	NA	NA
1000514-003	Public Supply	ND	ND	NA	ND	ND	4.1	NA	ND	ND
1000552-001	Public Supply	NA	NA	NA	NA	NA	2.3	NA	NA	NA
1000554-002	Public Supply	1.8	ND	NA	ND	ND	11 (13.2)	NA	ND	ND
1000555-002	Public Supply	2.3	ND	NA	NA	ND	5.7	NA	ND	ND
1000578-001	Public Supply	2.4	ND	ND	0.042	ND	0.81	NA	ND	ND
1000632-001	Public Supply	9.9	ND	ND	NA	ND	2.6	10	ND	ND
1010003-050	Public Supply	ND	ND	NA	ND	ND	9.3	NA	ND	ND
1010007-019	Public Supply	ND	ND	3.6	ND	ND	6.6	NA	ND	ND
1010007-099	Public Supply	2.4	ND	4.1	ND	ND	2.8	9.6	0.62 (0.74)	ND
1010007-147	Public Supply	ND	0.007 (0.008)	4.5	ND	ND	4.7	1.7	ND	ND
1010007-178	Public Supply	ND	ND	3.1	ND	ND	3.6	NA	ND	ND
1010007-230	Public Supply	2.4	ND	2.1	ND	ND	1.5	NA	ND	ND
1010007-272	Public Supply	ND	ND	ND	ND	ND	1.5	NA	ND	ND
1010007-274	Public Supply	ND	ND	ND	ND	ND	4.6	NA	ND	ND
1010007-328	Public Supply	2.4	ND	7.1	ND	ND	5.3	3.7	ND	ND
1010018-014	Public Supply	6.6	ND	31 (37.2)	ND	ND	2	NA	ND	ND
1010018-015	Public Supply	8.5	0.005 (0.006)	32 (38.4)	ND	ND	2.8	NA	ND	ND
1010018-017	Public Supply	4.5	0.009 (0.011)	21 (25.2)	ND	ND	3.2	NA	ND	ND
1010049-003	Public Supply	2.94	ND	NA	ND	NA	27.2 (32.6)	NA	NA	NA
1010057-003	Public Supply	1.53	ND	NA	ND	ND	7.16	29.48 (35.38)	ND	ND
California MCLs		**10**	**0.005**	**20***	**0.2**	**0.013**	**10**	**20**	**0.005**	**0.005**

Notes:
* = Currently no MCL value. USGS Health Based Screening Level listed instead.
NA = Not analyzed
ND = Not detected
Cells highlighted when max concentration is greater than the MCL. Minimum Threshold numeric values set at a 20% increase to the indicated max concentration value. Minimum Threshold actual values in parenthesis.

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 compared against the Minimum Threshold values as discussed above. ~~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 compared against the Minimum Threshold values as discussed above. ~~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**~~**Table 4-10**. Available construction information for these wells is included in ~~**Table 4-10**~~**Table 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 (**Figure 5-4**). The chemicals of concern that the individual wells are routinely monitored for are summarized in **Table 4-7**.

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-~~10~~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~~ 8 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 Rotarty	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 Rotarty	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 Rotarty	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 Rotarty	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 Rotarty	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 Rotarty	10	UNK	265	265	3/15/2006	GP	120-265	50
1000467-001	USA Waste of California	Well 01 - Raw	YES	Reverse Rotarty	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 Rotarty	12	22	320	320	2/3/1992	GP	315-610	300
1010007-328	City of Fresno	Well 170 - RAW	YES	Reverse Rotarty	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 Rotarty	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 Rotarty	16	28	312	312	12/1/1971	GP	162-312	50
1000447-067	E&J Gallo	Well 08 Raw	YES	Reverse Rotarty	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 Rotarty	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 Rotarty	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 Rotarty	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

If a Minimum Threshold exceedance occurs, a site-specific investigation will be conducted to try to determine if groundwater pumping has contributed to the groundwater quality degradation. The investigation may include, but will not be limited to the following:

- Verification of groundwater gradient and flow direction in the area in question;
- Changes in the historic cropping record in the area compared against historic groundwater quality data;
- Groundwater quality compared against groundwater level changes in the area;
- Available groundwater pumping records for wells in the area will be reviewed and compared against groundwater quality trends;
- Available groundwater recharge records for recharge sites in the area will be reviewed and compared against groundwater quality data;
- A Phase I Environmental Site Assessment (Phase I ESA) could potentially be performed in order to assess the possibility of degradation resulting from third party activities.

Should investigations indicate GSA actions have contributed to groundwater quality degradation, then management actions described in Chapter 6 will be implemented in the area where the water quality has changed.

~~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

As described in Section 3.2.6, land subsidence within the Kings Basin primarily occurs in the western one-third of the basin from pumping below the Corcoran Clay. The eastern extent of the Corcoran Clay is shown in Figure 3-38. Some pumping below the Corcoran Clay does occur within the Kings subbasin, but a significant amount of the land subsidence within the Kings is believed to be attributable to pumping from below the Corcoran Clay that occurs outside of the Kings Subbasin.

DWR staff has indicated that the intent of SGMA was that land subsidence be avoided or minimized based to the extent within the GSAs control. Once groundwater levels have stabilized within the basin, land subsidence should be minimized. Measurable objectives for land subsidence were set based on this requirement.

~~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 4-10** and **Table 4-11** respectively. More details and the methodology to set the criteria can be found later in Section 4.5.~~

~~**Table 4-10 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 4-11 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.

SGMA defines an ~~An~~ undesirable result for land subsidence as that which ~~would be the~~causes significant and unreasonable interference with surface land uses. ~~loss of functionality of structures, infrastructure, and major damage to roads within the Kings Basin due to land subsidence.~~ The terms "significant and unreasonable" are not defined in the regulations, rather the conditions leading to this classification are determined by the local GSA, beneficial users, and the basin they are a part of. The primary concern related to interference with surface land uses in the Kings Basin is subsidence reducing the capacity of gravity flow water conveyance facilities such as canals or river channels. Subsidence within a portion of a river channel or canal could prevent conveyance of flood water in river channels increasing the risk of flooding adjacent land, or the subsidence within sections of an irrigation canal could restrict or prevent delivery of irrigation water to agricultural land.~~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.~~ The conveyance capacity of the Kings River channel is critical for both the conveyance of flood water and delivery of surface water for irrigation supplies. During flood periods, the conveyance capacity of the Kings River is necessary to route water through portions of the basin without causing flooding of lands adjacent to the river. During the irrigation season, the conveyance of surface water for irrigation from the Kings River and through irrigation canals is needed to maintain agricultural practices within the basin. These conveyance facilities are gravity flow systems, relying on open channel hydraulic pressure to convey water through the existing channels. Subsidence that lowers the canal or channel at the headworks or within a section of channel may prevent the channel from maintaining the water levels needed to convey the needed capacity of the channel, thereby restricting deliveries unless mitigated. Defining the Undesirable Result was based on the criteria to maintain adequate channel capacity within the river system and irrigation canals to continue historic surface water deliveries.

~~Based on the~~From discussions with stakeholders, local agencies 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; but only deep subsidence from declining groundwater levels is found in within the western portions of the basin, primarily outside of NKGSA. Excessive pumping below the Corcoran Clay that occurs within the basin and outside the basin could cause the Undesirable Result of subsiding portions of a gravity flow channel or canal that reduces the conveyance capacity of that facility.

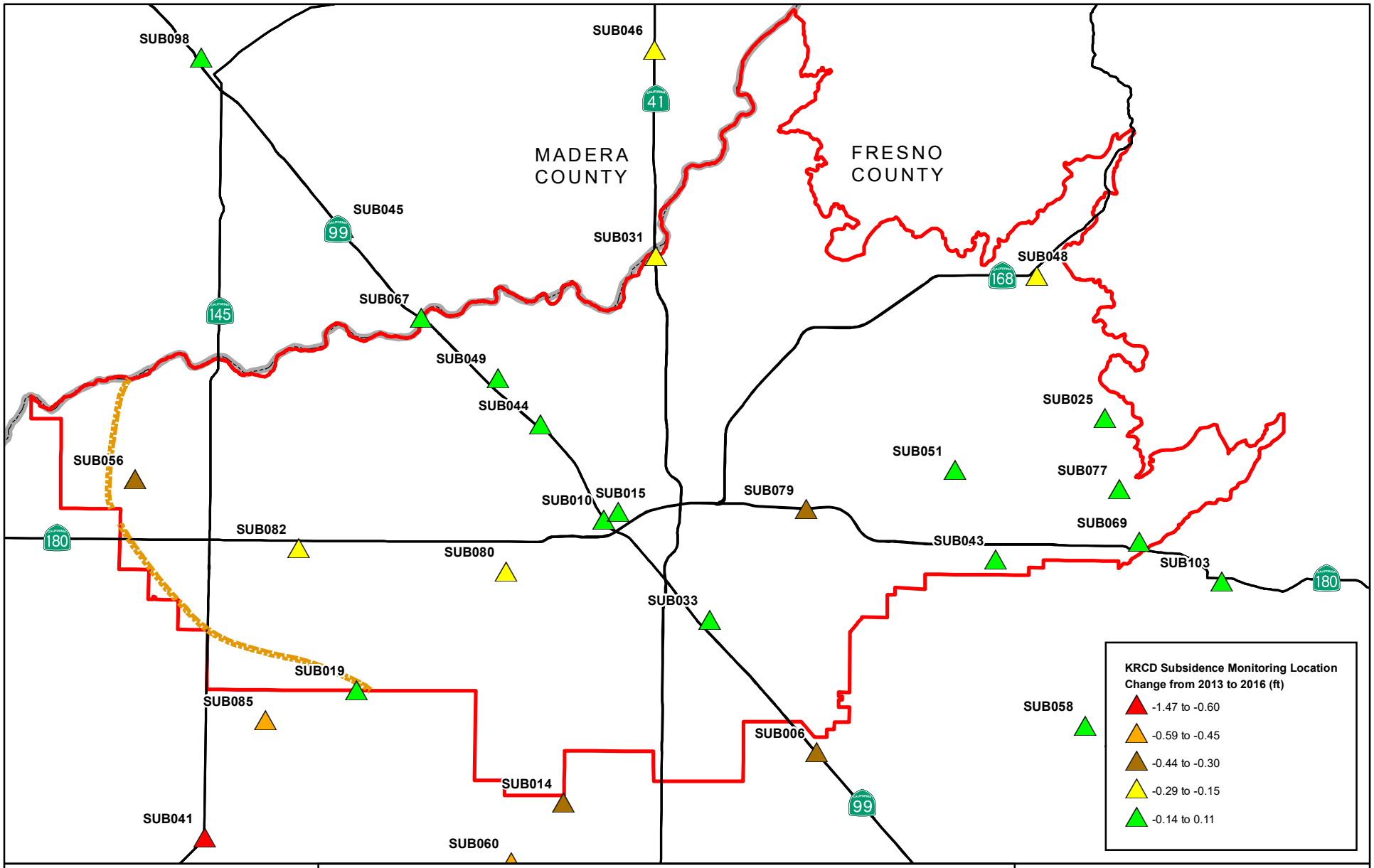
Excessive groundwater pumping can contribute to deep subsidence across a broad area, resulting in aquifer compaction, loss of storage capacity, and adverse effects to surface features, such as bridges, canals, flood control systems, and water supply pipelines that rely on gravity flow.

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 3-38. 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 3-38, 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.



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

Figure 4-4

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 when and where the effects of subsidence cause an ~~the~~ Undesirable Result is based on the combination of exceedances of minimum thresholds. ~~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.~~ The proposed subsidence monitoring network will measure the annual rate and cumulative subsidence to verify those variables have not exceeded the minimum threshold. The exceedance of the minimum threshold within a 36 square-mile area (roughly a Township) is significant based on how the basin has determined the minimum thresholds described later in this section. The exceedance of the annual rate or cumulative subsidence minimum threshold would potentially be significant to the stakeholders in the proximity, and potentially downstream. A minimum threshold exceedance would warrant further evaluation by the GSA and potential action.

~~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~~GSA, the main ~~problems~~ concerns related to land subsidence are the impacts to gravity driven water conveyance structures such as canals or river channels. ~~, 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.~~

Within the GSA, the primary gravity flow systems are the Kings River, San Joaquin River and various irrigation canals. The beneficial uses and users could potentially be affected by:

- Flooding over the river levees if subsidence lowers a section of channel, decreasing capacity and hindering the ability of the Kings River or San Joaquin River to convey flood flows or irrigation water.

- Reduced conveyance capacity in irrigation canals caused by subsidence in a section of irrigation canal preventing delivery of surface water needed for crop irrigation or groundwater recharge to downstream water users.
- Roadways or bridges needing to be reconstructed to accommodate the raising of canal/channel banks that have been impacted by subsidence. These improvements can require additional road right of way requirements to raise channel crossings as well as transportation impacts during construction.
- Gravity flow cast-in-place pipelines needing to be repaired if cracking occurs because of subsidence.

An additional impact of subsidence to beneficial uses is that 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 and, as a cross-check, the GSA gathers subsidence data from sites historically monitored by KRCD. The San Joaquin and Kings River levees are monitored annually by KRCD. ~~(see Monitoring Network Section 5.6), therefore~~The minimum thresholds have~~will~~ been set GSA-wide based on loss of conveyance capacity ~~using the historical data across the Kings Basin~~ and will be 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~~within each GSA and InSAR mapping over the entire Basin. The exceedance of the minimum threshold over a 36 square-mile area may be considered significant based on how the basin has determined the minimum thresholds.

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.

Even though some subsidence has occurred in a small western portion of the NKGSA, the NKGSA is not currently experiencing any known significant subsidence issues along river channel or canal facilities. Any subsidence impacts within the basin on canals or river system have been mitigated by raising a portion of the canal or levee bank to restore overall conveyance capacity.. While there are

known locations where some capacity restriction has occurred because of land subsidence, as described in 3.2.6, there has been some minimal land subsidence in other portions of the NKGSA. The minimum threshold has been set based on the amount of subsidence critical river channel and canal infrastructure can typically tolerate. The most vulnerable facilities in the GSA are irrigation canals due to their reliance on gravity flow as well as pipelines that may be subject to cracking. Irrigation canals in the GSA generally have about 3 feet of freeboard, which is the distance from the top of water surface to top of canal bank. Freeboard allows for operational flexibility so the water does not overtop the canal or channel. Hence, subsidence causing an elevation change of up to three feet difference between the head of a canal and the canal terminus can be tolerated before there is a loss of operational capacity. However, uniform subsidence along a canal reach would not impact the canal gradient or freeboard, so the spatial distribution of subsidence will be important in determining how specific facilities are impacted. The minimum threshold was set at 3 feet of subsidence. The Kings River Levees have more than three feet of freeboard and can therefore tolerate this amount of subsidence before capacity is impacted.

Although an exact correlation between the groundwater level minimum thresholds and the anticipated amount of subsidence cannot be made, it is important to understand that subsidence will likely continue to occur during the planning period (2020-2040) until water levels are stabilized at the water level measurable objective in the Kings Subbasin as well as neighboring subbasins. Once water levels are stabilized at the measurable objective level then the minimum threshold for subsidence allows for water levels to drop to the minimum threshold level during drought conditions.

~~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.

The water level SMCs are for the unconfined aquifer and confined aquifer groundwater levels would be needed to represent land subsidence. 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.

For area of concern within the basin, primarily west of NKGSA, the groundwater level and pumping from the confined aquifer are considered a data and the project to fill those data gaps. The western GSAs within the basin have included a data gap project in their GSPs to address this issue. The data gap project will include estimating groundwater pumping from the confined aquifer and identifying more confined aquifer wells to be able to develop a potentiometric surface.

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 4-12** below as an annual land subsidence rate and a maximum cumulative land subsidence amount.~~

~~**Table 4-12 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 4-6, and the recent subsidence map, Figure 4-5, 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 showing historic subsidence within the GSA that were ~~used~~ considered in establishing the minimum threshold for land subsidence are included in this section. Table 4-9 shows the summary of total land subsidence in NKGSA as estimated by different agencies over various time frames and Table 4-10 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.~~

The criteria for cumulative subsidence was based on the amount of subsidence that could be tolerated for critical infrastructure. Irrigation canals are considered the most vulnerable infrastructure due to their reliance on gravity flow; they can tolerate up to 3 feet of subsidence based on the typical amount of freeboard found in most canals. Significant and unreasonable conditions would occur if the total freeboard was lost due to subsidence, causing canal overtopping and loss of capacity. It should be noted that 3 feet of subsidence in the GSA would not necessarily cause an undesirable result, since the subsidence would need to cause a difference of 3 feet along the canal reach (i.e. 3 feet of subsidence at the head of the canal and no subsidence at the canal terminus). The spatial distribution of subsidence could cause the impact to the freeboard to range anywhere from zero to three feet. Uniform subsidence along a canal reach would not necessarily cause a loss of any capacity or freeboard. However, three feet of subsidence is the minimum amount that could cause significant issues. To address subsidence before reaching the Minimum Threshold, subsidence of one feet within a 36 square mile area in the GSA would trigger the following actions:

1. Capacity analysis to evaluate the impact of subsidence on critical infrastructure. If no capacity issues are identified, then there is no undesirable result
2. If there is a capacity issue, then the facility will be mitigated through modifications and retrofits
3. If the facility cannot be restored to its original functions, then significant actions may be needed, such as reductions in pumping or importation of surface water supplies, to minimize further subsidence.

Minimum threshold exceedances may occur due to subsidence that originates outside of the GSA. The minimum threshold is set based on what the GSAs believe they can directly control. If subsidence appears to be encroaching into basin from other regions as shown by InSAR data, then

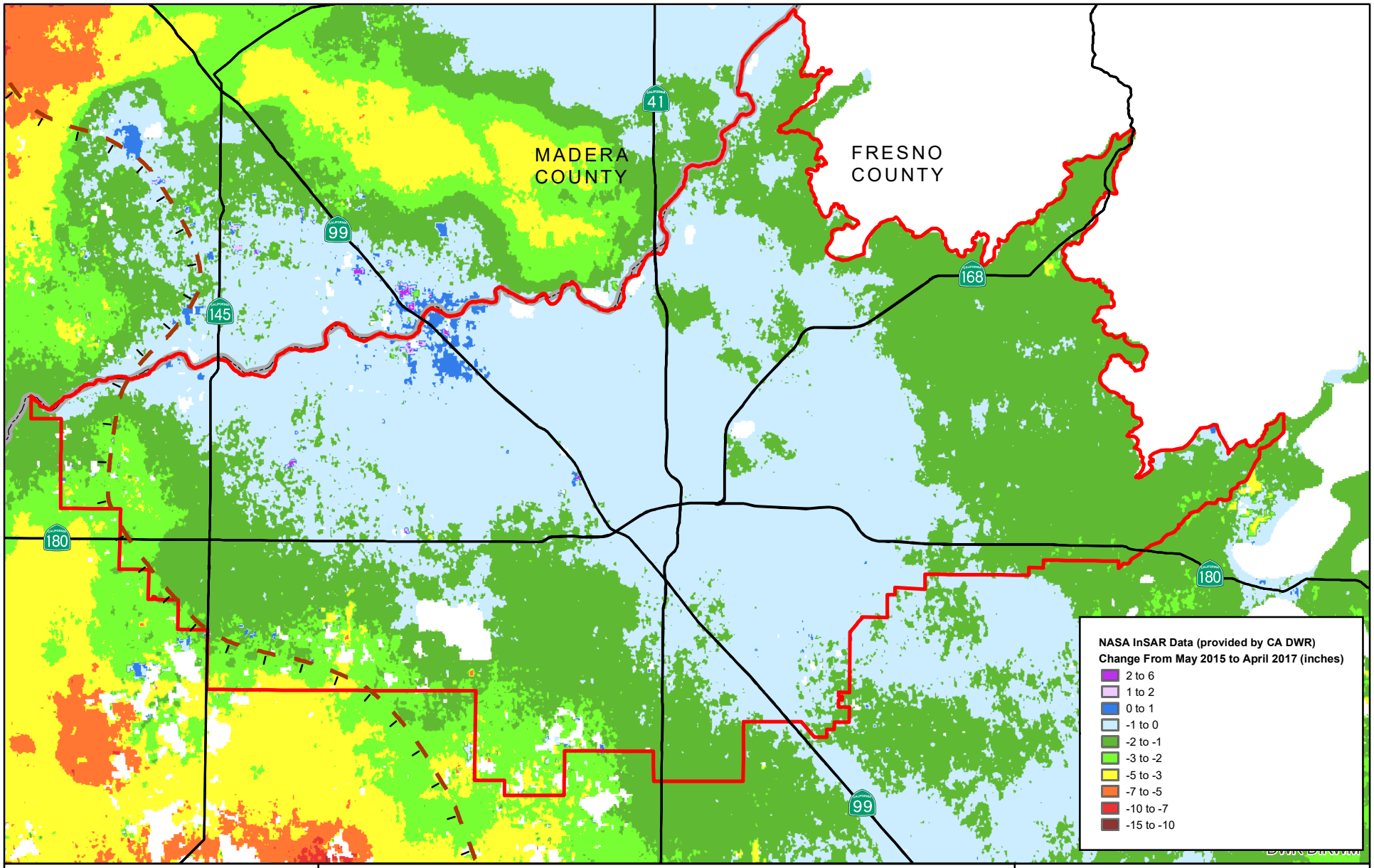
neighboring GSAs will be contacted to coordinate studies that would need to be performed to evaluate the sources of subsidence in the basin and in the neighboring GSAs, and to coordinate mitigation efforts.

Table 4-9 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 4-10 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



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

N

0 2 4
Miles

Legend

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

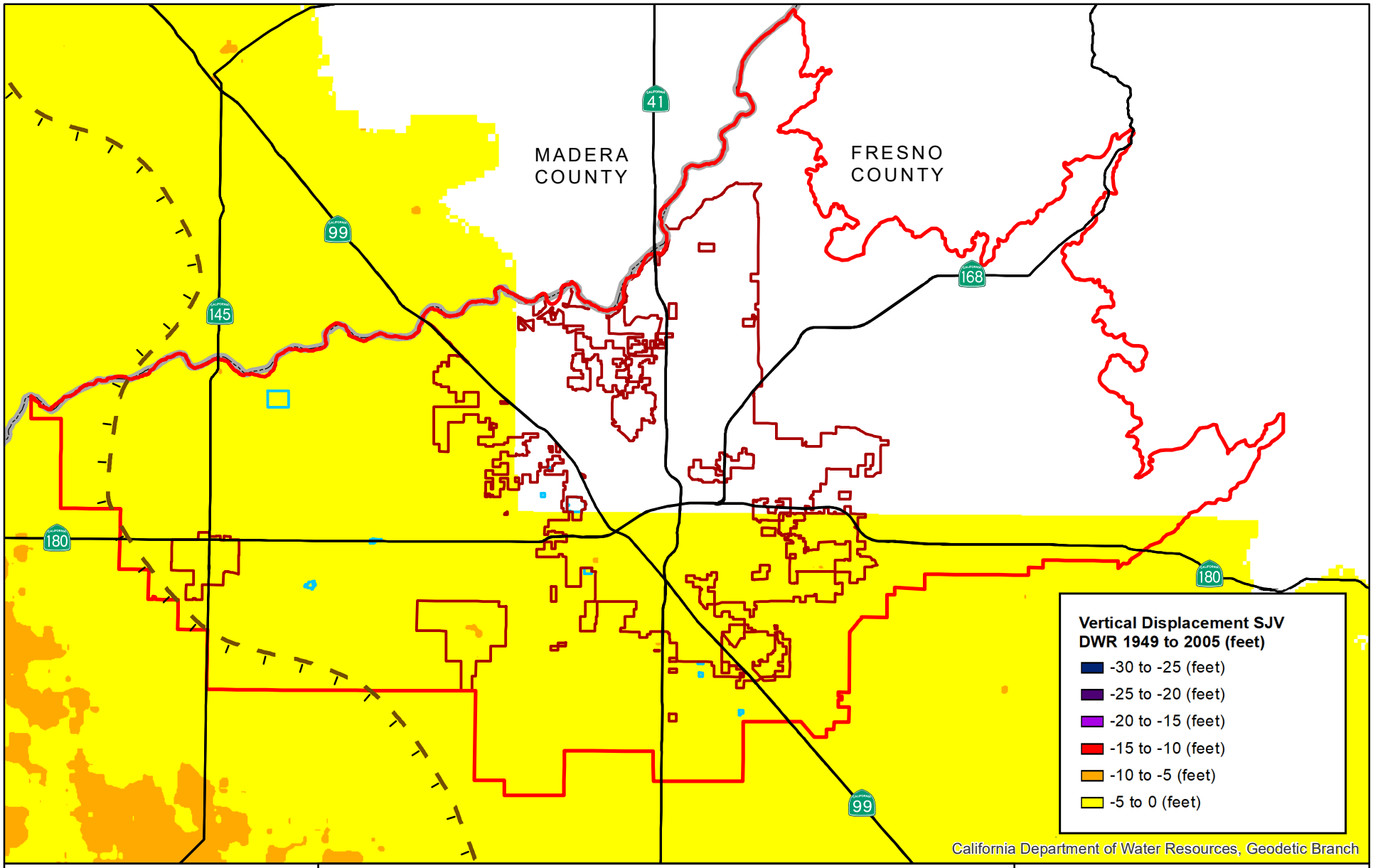
The legend shows the change in ground surface elevation from May 2015 to April 2017. The positive values indicate rebound while the negative values indicate land subsidence.

North Kings GSA

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

6/28/2019 : G:\North Kings GSA-2643\264317001-Groundwater Sustainability Plan\GIS\Map\Presentation\subsidence_nasa 052015_042017.mxd

Figure 4-5



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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
Department of Water Resources
1949-2005

Figure 4-6

8/15/2019 : G:\North Kings GSA-2643\264317001-Groundwater Sustainability Plan\GIS\Map\Presentation\subsidence_dwr.mxd

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

- Groundwater Levels. 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. Although an exact correlation between the groundwater level minimum thresholds and the anticipated amount of subsidence cannot be made, it is important to understand that subsidence will likely continue to occur during the planning period (2020-2040) until water levels are stabilized at the water level measurable objective. Once water levels are stabilized at the measurable objective level then the minimum threshold for subsidence allows for water levels to drop to the minimum threshold level during drought conditions.
- Groundwater Storage. Land subsidence impacts storage change when there is inelastic land subsidence. Once inelastic land subsidence occurs, the loss in storage cannot be reversed.
- Sea Water Intrusion. This indicator is not applicable to this basin.
- Groundwater Quality. Research conducted by Stanford University and Community Water Center supports the premise that arsenic can reside within pore water of clay strata within aquifers and is released due to overpumping. Though historic groundwater pumping shows no link to current groundwater arsenic concentrations, there is a potential for land subsidence to be related to water quality. Further investigation and research are required to know the vertical locations/extent of subsidence, the presence of arsenic within clay pores, and potential impacts to surrounding aquifer water quality.
- Interconnected Surface Water. Land subsidence is not directly related.

~~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 4-15** lists the relationship to land subsidence for each sustainability indicator.~~

~~**Table 4-15- 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 4-5 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. NKGSA cannot control land subsidence that originates outside of GSA boundaries and outside the Basin boundaries. 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. If it were to occur, the beneficial uses and users could potentially be affected by the flooding over the river levees or loss of conveyance capacity to delivery surface water through various irrigation canals for crop irrigation or groundwater recharge. Decreased channel capacity could also hinder the ability to convey flood flows. Downstream water users and neighboring GSAs could also be impacted if they were anticipating capture and recharge of said flows.

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.

DWR staff has indicated that the intent of SGMA was that land subsidence be avoided or minimized based to the extent within the GSAs control. Once groundwater levels have stabilized within the basin, land subsidence should be minimized. Measurable objectives for land subsidence were set based on water levels stabilizing and minimizing impacts to critical infrastructure. It is assumed that land subsidence would stabilize as the water levels stabilize as part of the water level measurable objectives.

Measurable Objective Parameter	Measurable Objective Quantity
Annual Land Subsidence Rate	1 inch/year

The Measurable Objective for annual land subsidence rate will be 1 inch/year, to allow for the error of the InSAR data.

The Measurable Objective for maximum cumulative land subsidence will be 0 inches over 20 years. Though the measurable objective during the implementation may be exceeded due to the error in

the InSAR data and water levels still stabilizing, the goal is to have no subsidence once the basin and neighboring basins reach sustainability in 2040. Even after water levels have stabilized there is the potential for residual subsidence. Residual subsidence, also called delayed subsidence, occurs when the land surface continues to decline for a period even after groundwater levels have been stabilized. This phenomenon likely occurs due to the delayed propagation of the piezometric decline in the fine-grained layers and viscous deformations typical of fine-grained materials. Also, in dry years when groundwater levels decline below the groundwater level measurable objective, there may be some land subsidence that occurs in areas with confined aquifer pumping during initial groundwater declines. It is believed that once groundwater levels have declined to a certain level and rise back up, there will not be additional subsidence that occurs.

~~The Measurable Objectives for land subsidence are shown in **Table 4-16** below as an annual land subsidence rate and a maximum cumulative land subsidence amount.~~

~~**Table 4-16 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.~~

~~**Figure 4-10 Land Subsidence, USBR 2011-2016**~~

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~~ 36 inches 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.

The water level SMCs are for the unconfined aquifer and confined aquifer groundwater levels would be needed to represent land subsidence. 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.

The interim milestones will be based on the cumulative amount of subsidence observed within a 36 square mile area over five year incremental periods. The interim milestones are 1 feet of subsidence over a 5-year period.

Subsidence of one feet within a 36 square mile area in the GSA over 5 years would trigger the following actions:

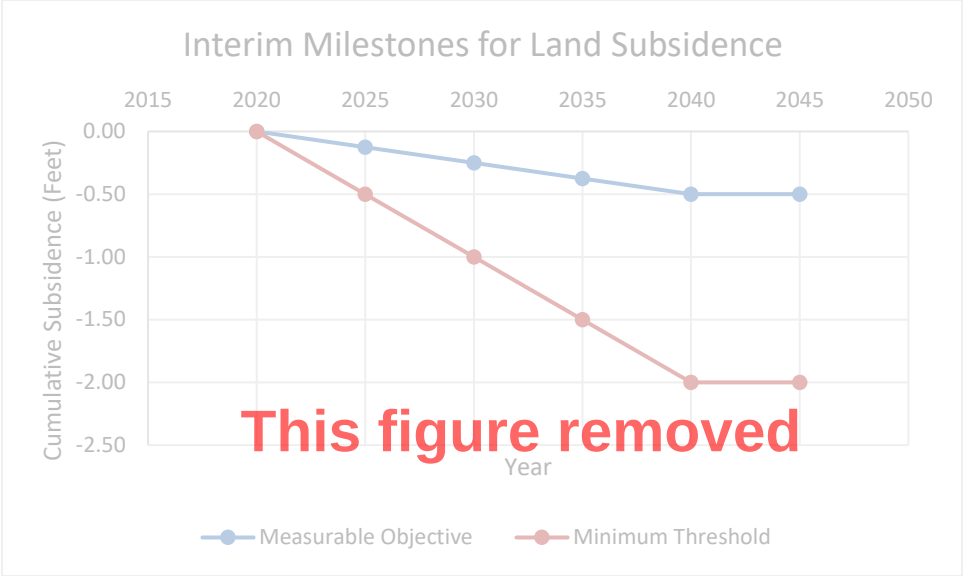
1. Capacity analysis to evaluate the impact of subsidence on critical infrastructure. If no capacity issues are identified, then there is no undesirable result
2. If there is a capacity issue, then the facility will be mitigated through modifications and retrofits
3. If the facility cannot be restored to its original functions, then significant actions may be needed, such as reductions in pumping or importation of surface water supplies, to minimize further subsidence.

If land subsidence exceeds the interim milestone, then there will be increased monitoring of impacts to infrastructure and coordination with neighboring GSAs who may be causing the NKGSA undesirable results. If the land subsidence exceeds the Minimum Threshold and causes an undesirable result, then NKGSA will implement actions identified in Section 4.6.2.1.

~~**Table 4-17** 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 4-17 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

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.

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.

An undesirable result would occur if groundwater pumping directly caused significant and unreasonable depletions of surface water. This would require the following: 1) surface water and groundwater are hydraulically connected; 2) groundwater pumping is causing a significant reduction in surface water flows; 3) the surface water depletion is not being mitigated by the GSA or other

agencies/river management programs; and 4) third parties are being adversely impacted by the surface water depletion.

Figure 4-7 is a map of the Kings Subbasin, the main waterways, and other features related to interconnected surface water-groundwater. Both the San Joaquin River and Kings River travel through or abut portions of the NKGSA.

Interconnection Status

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, 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 Spring 2016 groundwater depth contours that show groundwater depths in the area of the San Joaquin River range from approximately 60 to 150 feet below ground.

Shallow piezometers were placed along portions of the San Joaquin River edge as part of the San Joaquin River Restoration Program. This data was evaluated for evidence of interconnection of surface water and groundwater, but the information is inconclusive at this time and additional monitoring is required.

The upper reaches of the Kings River are found in NKGSA, including a portion that has minimum fish flow releases. The entire reach of the Kings River within the NKGSA is believed to be interconnected. Groundwater levels adjacent to the river are very stable in some areas, with very little annual fluctuation. In addition, some area may be a gaining river.

San Joaquin 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).

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. Many of the agreements state that the Holding Contracts are entitled both to surface water and groundwater that results from percolation of river water.

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.

All Restoration flows and Holding Contract flows must be maintained even if losses in the River are larger than assumed in the Settlement, (i.e., Reclamation will release additional water from Friant Dam such that the volume and timing of these flows are not otherwise impaired).

Kings River Fisheries Management Program
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 that a stretch of the Kings River through the NKGSA does not go dry and minimum flows must be maintained regardless of river losses.

Data Gap Analysis
Overall, additional information is needed to better define the status of surface water-groundwater connection and the extent of surface water depletions, if any, in the GSA. As a result, the GSA has identified these as data gaps that must be researched before sustainable management criteria can be developed. Chapter 6 includes the description of a project called "Interconnected Surface Water-Groundwater Data Gap Analysis." This is a high priority project that will include the following primary tasks:

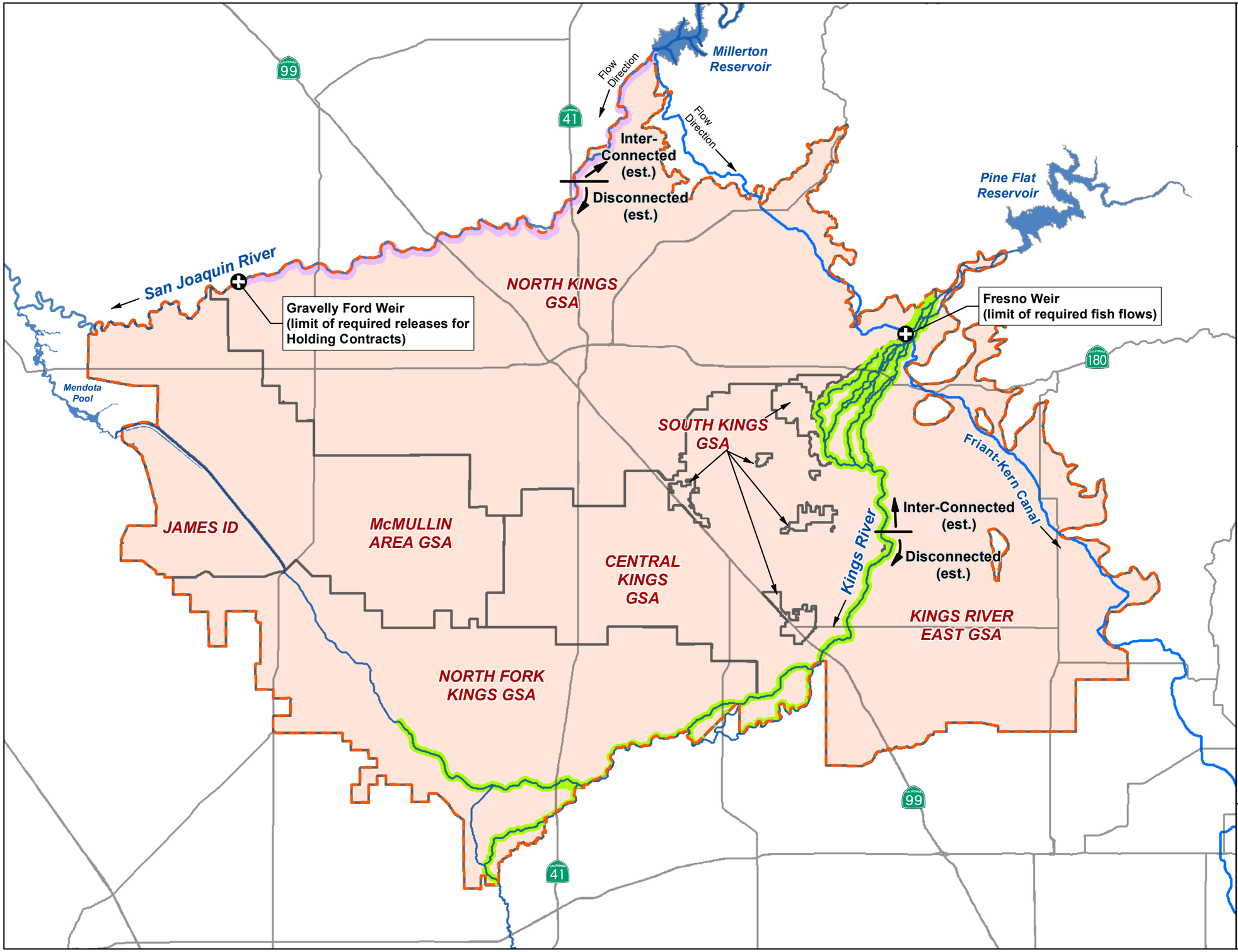
1. Determine interconnection status of river reaches in the GSA based on various reports, studies, models and data
2. Coordinate with water rights holders and river management programs to determine how they impact and mitigate for surface water depletions, and if these efforts reduce or obviate the need for actions by the GSA
3. Evaluate impacts of groundwater pumping on surface water depletion using a model, analytical tool or other calculation method.

The study will provide the information needed to develop sustainable management criteria. Refer to Chapter 6 for more details on the project.

Kings Subbasin

Surface Water Features

Figure 4-7



Legend

- Weir
- Holding Contract Lands
- Riparian Water Right Users
- Kings Subbasin GSAs
- Kings Subbasin (2019)
- Highway

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

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Figure 4-7 Kings Subbasin Surface Water Features

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 4-12Figure 4-12Figure 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.

San Joaquin River

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 4-13Figure 4-13Figure 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 4-14Figure 4-14Figure 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).

Kings River

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

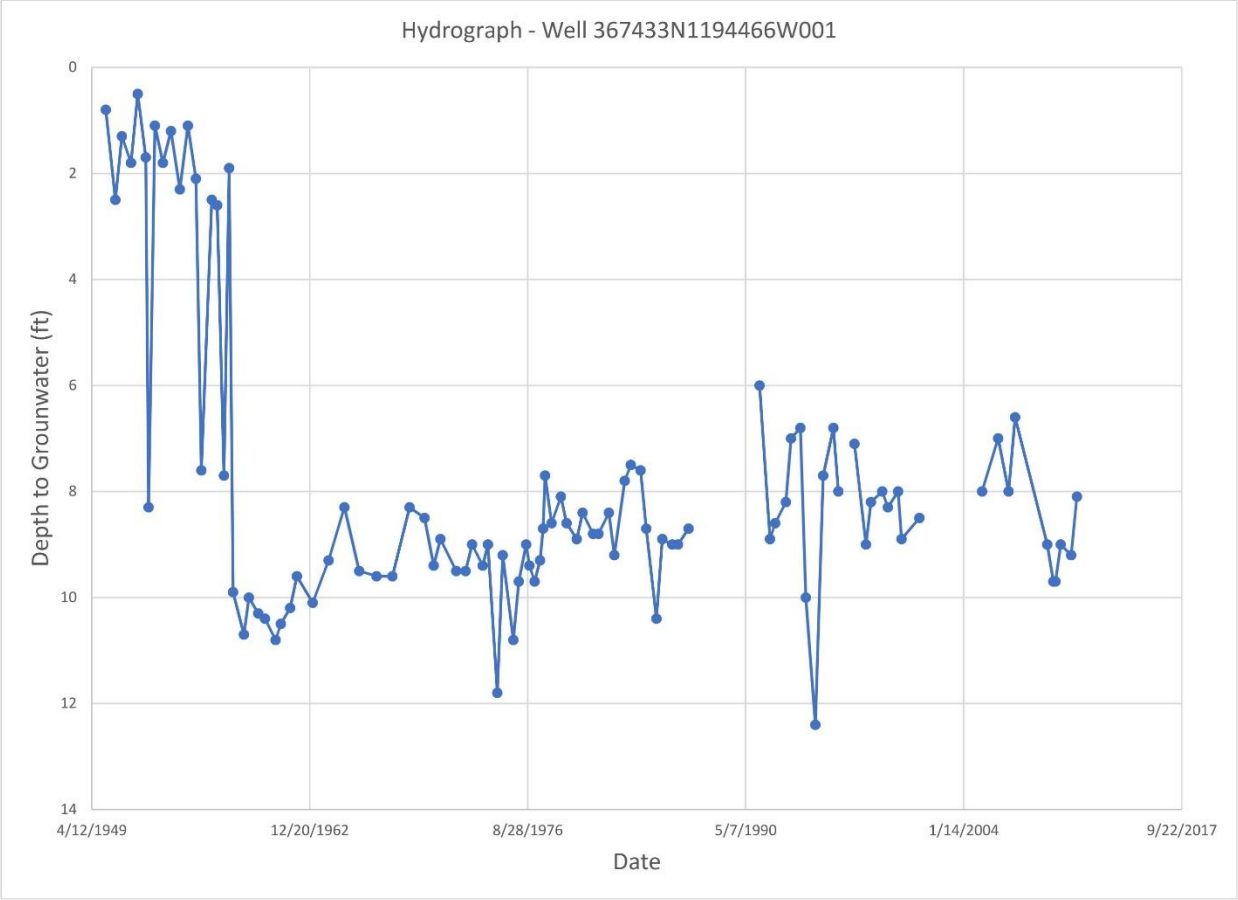
~~same direction as the river and is interconnected with stream flow in the reach between Highway 180 and Reedley. This area is downstream from where the NKGSA borders the Kings River. KDSA further indicates that along the reach of the Kings River upstream of the Reedley narrows, the groundwater is indicated 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 4-12Figure 4-12Figure 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 4-15Figure 4-15Figure 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.~~

~~Figure 4-12 Areas of Potential Interconnected Surface Water~~

~~Figure 4-13 Groundwater Elevation Contours Spring 2016~~

~~**Figure 4-14 Groundwater Depth Contours Spring 2016**~~



~~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 4-16Figure 4-16Figure 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.~~

~~Figure 4-16 2018 USBR Holding Contract Map~~

~~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****Figure 4-17****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.~~

~~Figure 4-17 Kings River and Fresno Weir Location~~

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.

San Joaquin River

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.

Kings River

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 (c) 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.

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
23	North Kings GSA	SW-GW Interconnection Data Gap Analysis	Perform study to fill data gaps on interconnected surface water so sustainable management criteria can be developed. Due to the lengthy project description more information is provided after this table.	Project benefits will be data and information needed to evaluate and prevent adverse impacts to surface water users	NA	NA	2023	2025	2025	$100,000 to $2 million for entire Kings Subbasin. Costs by GSA will vary.
24	North Kings GSA	Domesitc Well Mitigation Program	Perform a study to develop policies and procedures for a domestic well mitigation program for wells that go dry due to declining water levels. Due to the lengthy project description more information is provided after this table.	Project benefits will be a detailed framework for a program to mitigate domestic wells that go dry.	NA	NA	2023	2026	2030	Initial basin-wide effort - $70,000. Additional costs for each GSA to refine program, develop funding and perform outreach

SUPPLEMENTARY PROJECT INFORMATION

PROJECT NO. 23: SURFACE WATER – GROUNDWATER INTERCONNECTION DATA GAP ANALYSIS

The Kings Basin proposes to perform additional research and data gathering to fill data gaps related to analysis of interconnected surface water and groundwater.

Project Description

The GSA currently lacks sufficient information on where local rivers are interconnected with groundwater, to what extent groundwater pumping is depleting surface water, if at all, and how river management programs ameliorate impacts of surface water depletions.

The study described below will help provide a better picture of the extent groundwater pumping is impacting surface water and whether the GSA considers those impacts to be significant and unreasonable. This information can then be used to develop sustainable management criteria.

The work will be performed in three general phases:

Phase 1: Determine Interconnection Status
Phase 2: Coordinate with Water Rights Holders and River Management Programs
Phase 3: Evaluate Impacts of Groundwater Pumping on Surface Water

These three phases are described below in more detail, including specific tasks that may be required to fill existing data gaps.

Phase 1: Determine Interconnection Status-
The purpose of this phase is to determine which reaches of the rivers, if any, are interconnected with groundwater. Some existing information was documented in the 2020 GSPs, but more research will be performed to better define reaches that may be interconnected. Reaches that are determined to be interconnected will be addressed in Phases II and III described later. Reaches that are not interconnected will not be evaluated further, and sustainable management criteria for surface water-groundwater interconnection will not be established in these areas.

Existing studies, reports and models will be reviewed to determine if interconnection has already been firmly established within the GSA area. Sources that will be reviewed include:

- USGS Reports
- San Joaquin River Restoration Project Reports
- Department of Water Resources Reports
- Central Valley Hydrologic Model
- ICONS Dataset Tool
- Groundwater Sustainability Plans for neighboring GSAs
- Other studies and models not listed above

The next step will include evaluating water level data from existing riverside wells, existing piezometers, and regional groundwater contour maps to assess interconnection. This will also include collecting data on river flows and river stage, when available. A comparison of river bottom to groundwater levels will be made, and in accordance with guidance documents an assumption of depth of unlikely interconnection may be made to determine areas of impact. River thalweg elevations will also be surveyed in specific locations, if needed.

If the presence of interconnection cannot be determined with existing information, then riverside piezometers may need to be installed to collect water level data for comparison to river flow and river stage. Due to the seasonal and annual variability of flows, the piezometers may need to be monitored for several years before conclusions on the interconnection status can be made.

Phase 2 - Coordinate with Water Rights Holders and River Management Programs~~.~~
Several factors unique to the Kings River and San Joaquin River impact river releases, river seepage and depletion of surface waters. These include Holding Contracts along the San Joaquin River, San Joaquin River Restoration Program Flows, riparian water users along the Kings River, the Kings River Fisheries Management Program, and highly variable surface water supplies. The agencies involved with these programs will be contacted to discuss the SGMA requirements, existing data available, future data needs and sustainable management criteria. Working with these agencies and the water rights holders, the GSA will develop a framework for evaluating and managing river reaches that are interconnected with groundwater.

These existing river management programs currently account for river losses, which help to mitigate for surface water depletion. Consequently, the conclusions from these discussions may determine that groundwater pumping is not causing significant and unreasonable depletion of surface water, or they may conclude that additional efforts are needed to quantify surface water depletion (see Phase III below) to eventually develop sustainable management criteria.

Phase 3 – Evaluate Impacts of Groundwater Pumping on Surface Water~~.~~
This phase would include estimating the impact of groundwater pumping on surface water depletions for use in ultimately establishing sustainable management criteria for the 2025 GSP update. This work would only be performed in areas known to be interconnected under Phase I, and determined to be potentially impacted based on discussions with other agencies described in Phase II.

The first step will be to select a model, analytical tool or calculation method for estimating groundwater pumping impacts on the rivers. The tool will be selected based on several factors, especially what is most practical and useful with the existing data available.

A zone of influence (distance from the river's border) will be established along interconnected areas to identify corridors along rivers where pumping could have a significant impact on river flows. These will define the study areas. Groundwater pumping from these areas will be estimated. Surface water depletion will be estimated using the selected tool. Surface water depletion will vary by season and different hydrologic year types. Investigations will also look at whether the study area is already fully developed (i.e., built-out), and the likelihood of any future increases in groundwater pumping in the corridor.

Development of sustainable management criteria is not included or described in this project, since it will depend on the results from the aforementioned tasks. However, sustainable management criteria will be developed based on the legal requirements established under SGMA.

Measurable Objectives Addressed

The project will provide information to help manage interconnected surface water and groundwater in the GSA.

Circumstances and Criteria for Implementation

This is a high priority project that is necessary to understand, manage and limit the impacts from depletion of surface waters from groundwater pumping. The GSAs are committed to implementing this project. The hydrogeologic analyses will be performed using standard methods and best practices.

Process for Public Notification

The public and relevant entities will be given the opportunity and time to comment on the results of any data analysis, which will be discussed at GSA board meetings and presented in Annual SGMA reports or 5-year GSP updates.

Permitting and Regulatory Requirements

Permits will be required for new monitoring wells, if they are needed. Since the wells would not extract water, obtaining the well permits should not be a problem. Right-of-way agreements or easements may be needed depending on where the wells are located. No other permits or approvals are expected to be necessary for the program.

Status and Schedule

Following is a preliminary schedule for each of the three project phases:

Phase	Description	Period
1	Determine Interconnection Status	Jan 2023– December 2023*
2	Coordinate with Water Rights Holders and River Management Programs	January 2024 – December 2024
3	Evaluate Impacts of Groundwater Pumping on Surface Water	January 2024 – December 2025

* If piezometers need to be installed to evaluate interconnection, then several years of monitoring may be required to firmly establish the interconnection status. Preferably, data would be collected and analyzed for several hydrologic year types, including dry, normal and wet years. This could result in certain river sections falling behind the schedule shown in the table above.

Evaluation of Benefits

The project will provide the data and information necessary to develop sustainable management criteria for interconnected surface water-groundwater. This could benefit surface water users by eliminating adverse impacts to their water supply from groundwater pumping, if any.

How will the Management Actions be Accomplished

The project will be implemented by the GSA using available funding. No surface water or groundwater source are required for implementation.

Estimated Costs

The total combined cost of the project for all seven GSAs in the Kings Basin is estimated to vary from $100,000 to $2 million. The actual cost for each individual GSA will vary based on their local conditions. Total costs will vary based on the length of river found to be interconnected, whether piezometers need to be installed, whether existing river management programs obviate the need for developing sustainable management criteria, and the type of analysis tool developed.

Installing piezometers could cost several hundred thousand dollars. Development of a numerical model for the San Joaquin and Kings Rivers could be as much as $500,000 to $1 million and would be of limited use until sufficient data is collected to calibrate the model. Other analytical methods would likely cost significantly less.

Initial studies and investigations will be funded with existing GSA funds. Piezometers and a numerical model would likely require supplemental funding, such as State or Federal grants.

PROJECT NO. 24: DOMESTIC WELL MITIGATION PROGRAM

This project includes development of a domestic well mitigation program for wells that go dry due to declining water levels. Specific details still need to be developed as part of the project, and a general description is provided below. This program was developed with guidance from the *Framework for a Drinking Water Well Impact Mitigation Program* (Self Help Enterprises et al.)

Project Description

The Kings Basin and the North Kings GSA have been in overdraft for many years resulting in a significant lowering of the regional and local groundwater elevations, and a significant reduction in the amount of useable groundwater in storage. The North Kings GSA plans to correct the overdraft by 2040 as required by SGMA, however there will be a continued decline through 2040 until water levels have stabilized. Stabilizing groundwater levels immediately or raising groundwater levels is not feasible without significant land fallowing given the current water supply conditions, and would have devastating immediate economic impacts. Although water levels will be stabilized by 2040 at the Measurable Objective level, they will reach lower levels during dry years. The maximum anticipated lower water level is called the Minimum Threshold. As a result, some domestic wells are expected to go dry during the SGMA implementation period (2020-2040). This is generally limited to shallow domestic wells, since most irrigation wells and agency-owned wells are typically deeper and have often been designed to account for declining water levels. However, some small water supply systems and certain agricultural wells may be impacted and may be considered for mitigation. As described within the GSP, most of the basin has several hundred feet of aquifer with suitable water quality below current water levels.

A Domestic Well Mitigation Program (Program) is proposed to be developed and implemented for wells that have gone dry or are in imminent threat of going dry. The policies and procedures for the Program will be developed through a basin-wide effort, then each GSA can modify the Program to meet their specific needs and will perform public outreach, develop funding, and implement the program for their GSA.

The overall process for developing and implementing a Domestic Well Mitigation Program is outlined below:

1. Review other existing and planned well mitigation programs within other GSAs throughout the State
2. Evaluate the merits of partnering with or expanding any current local or State programs.
3. Develop policies and procedures with input from GSAs and stakeholders
4. Develop detailed inventory of domestic wells
5. Predict number of potentially impacted wells and identify high priority areas
6. Secure long-term funding for the program
7. Perform public outreach to landowners and stakeholders
8. Develop database and registration system for wells owners to sign up
9. Develop criteria for qualifying wells
10. Evaluate each application and determine merits for funding

Following are discussions on specific topics that will be investigated during program development:

Evaluation Process:
An application form will be developed for landowners to request mitigation for domestic well impacts. A detailed step-by-step evaluation process will also be documented.

The following are some of the items that will be considered when evaluating applications for mitigation:

- What is causing loss of well capacity? Decline in water levels or other issues such as plugged screens, the well pump, etc.
- The appropriateness of the original well design and construction. Can the well be deepened, or would a new well be needed?
- The percentage (if any) of well owner's mitigation responsibility and other sources of potential funding.
- What is the best mitigation option? Installing a new well, well deepening, other option.

Mitigation:
If a well requires mitigation, then several options may be considered including:

- Installing a new well
- Deepening the well if it has an open bottom
- Modifying pump equipment
- Modify current pumping practices (i.e., reduce or cycle pumping from a nearby well)

Deepening a well could be the most economical option but will only be technically feasible if the well is an open bottom well. When necessary, a new well may need to be constructed. The program may have different contribution levels for deepening a well versus construction of an entirely new well. The age and condition of the well impacted will be considered, and the GSA will develop standard depreciated value of wells by age based on published literature, guidelines and local understanding.

The need for short-term solutions, such as providing bottled water and water tanks while a well is being mitigated, will be considered as part of the program. Landowners will be encouraged to contact the GSA before their well goes completely dry to avoid these circumstances. In addition, protocols will be established to help process applications and approve well mitigation in an expedient manner.

Design Criteria-
The GSA will develop minimum design criteria for new wells. New wells will need to meet State and GSA Well Standards to receive any reimbursement, and will be subject to routine monitoring by the GSA. Criteria will also be considered for materials used in construction of the well, and minimum depth beyond existing or anticipated future groundwater levels.

Outreach-
Public outreach and education will be performed during development of the mitigation program and prior to implementation.

Comments on the draft mitigation program will be solicited during initial development of the policies and procedures. If a Proposition 218 election is needed to establish funding, then education on the program will be an integral part of garnering support for any new fees or assessments.

Prior to implementation, extensive outreach will be needed to notify landowners of the program requirements and how they can apply for assistance. Outreach may need to be performed in multiple languages as appropriate for the GSA. Outreach methods could include workshops, mailings, flyers, website postings, Board meeting announcements, etc.

The GSA is fully committed to developing a Domestic Well Mitigation Program. The GSA will seek funding from existing State and/or Federal programs to supplement local GSA funding after landowners approve a new tax or assessment to fund the program.

Measurable Objectives Addressed
The program will directly address the impacts of the chronic lowering of groundwater levels and reduction in groundwater storage by providing funding for replacement wells or well modifications to eligible landowners.

Circumstances and Criteria for Implementation

This is a high priority program that is necessary to mitigate the impacts of declining water levels and provide water supply to meet basic health and safety needs. The GSAs are committed to implementing this program. No funding is currently available for the program, so various sources, such as grants, funding through existing state programs, and land-based assessment or water user fees, will be investigated. If the landowners do not approve funding the program through a ballot measure (such as Proposition 218 election), this would signify low public support for the program, and the lack of funding could jeopardize implementation. Any election-based assessment process will need to incorporate public outreach to educate voters on the project benefits.

Process for Public Notification

The public and relevant entities will be given the opportunity and time to comment on the Domestic Well Mitigation Program prior to adoption by the GSA Board. The GSA will also provide the public with an opportunity to comment on CEQA studies, if any.

Permitting and Regulatory Requirements

The Domestic Well Mitigation Program may require a CEQA Initial Study but will more likely qualify for a CEQA exemption. The program could also qualify for a Programmatic EIR. If the wells owners are reimbursed for the well construction then the GSA would not be responsible for any permits. No other permits are expected to be necessary for the program.

Status and Schedule

The policies and procedures for the Domestic Well Mitigation Program will be developed as a Basin-wide effort by the end of 2024. This will likely include coordination with other local mitigation programs, evaluation of a range of potential policies and procedures, economic studies, and preparation of a final report. Each GSA will then modify the Program as needed for their specific conditions and seek to develop a funding mechanism for the Program. Funding development for the Program is anticipated to take 12-24 months. Once the program is funded, a public outreach program will be implemented and the Domestic Well Mitigation Program will be initiated. The GSAs have been and will be reviewing well construction permits to recommend future well construction below minimum threshold levels. Currently in the Kings Basin, several domestic well mitigation programs are already being implemented by other entities for low-income residents. During program development, the GSAs will refer landowners to these local programs as well as other resources and funding programs from the County, State or non-profit organizations. Some of the programs include: California Safe and Affordable Drinking Water (SADW) Fund, Safe and Affordable Funding for Equity and Resilience (SAFER) program, Proposition 1 funding, and programs being administered by Self-Help Enterprises. These programs can assistance with well replacement, as well as interim support such as bottled water and storage tanks while waiting for a new well.

Evaluation of Benefits

The program will help to ensure that owners of domestic wells that have gone dry as a result of water levels declining to minimum threshold water levels are not impacted and maintain a reliable water supply for basic health, safety and consumption.

How will the Project be Accomplished

The project will be implemented by the GSA once fully developed and a funding source is identified. This program relies on available groundwater. There is no surface water source required for implementation.

Estimated Costs

Following are preliminary estimated costs for implementing the program. These will be refined during project development and finalized prior to efforts to secure funding.

Development of Policies and Procedures. The estimated cost to develop the Domestic Well Mitigation Program policies and procedures is $70,000, which will be split among the different GSAs in the Kings Groundwater Subbasin. Each GSA will then modify the Program, if needed, to be compatible with their specific conditions.

Develop Funding. The Subbasin will collaborate with programs and funding sources that already exist. Each GSA will need to develop long-term funding. This could include preparation of grant applications, a Proposition 218 election, or other options. These costs will vary by GSA.

Public Outreach. Public outreach will be performed in each GSA. These costs will vary by GSA and will be estimated during development of the Program.

Project Administration. General administration costs for the program will vary by GSA and will be determined during the development of the Program.

Well Mitigation. Well mitigation costs will vary by GSA and location within each GSA in accordance with groundwater levels and the specific minimum thresholds that have been determined. An estimate of well mitigation costs will be developed by each GSA as part of their Program development and funding plan development. For reference, in 2022, a local well driller quoted $60 to $75/lineal foot for a new domestic well, which does not include costs for the pump or other appurtenances. The cost to abandon a well is approximately $5,000. Assuming an estimated cost per well for mitigation of $40,000 and estimated 1,000 wells in the basin that might need to be mitigated during the implementation period until water levels stabilize, the total cost of this program could be $40,000,000. A contingency funding plan may need to be developed if the number of impacted wells is found to be significantly higher than estimated.

The funding source for this Program is yet to be identified. The GSA will investigate several funding sources including grants, land-based assessment, and water use fees and collaborate with programs and funding sources that already exist. The State has many existing grant programs for community water systems and well construction funding. County, state and federal assistance will be needed to successfully implement this program. Grants may help to defray some costs, but a local funding source will also be needed, so the GSA landowners will likely need to be taxed to fund the program. The GSAs or individual water agencies may need to perform a Proposition 218 election to increase fees to fund the program. The GSAs will also work with local NGOs that may be able to provide assistance or seek grant monies to help fund the program.

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
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 4.2. 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 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	

Management Action No.:	**EO1 and EO2**

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)
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)

Management Action No.: WH1 through WH3

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.

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

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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.