

SUSTAINABILITY GOAL AND UNDESIRABLE RESULTS

Appendix 6 to Kaweah Subbasin Coordination Agreement

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Appendix

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6. Sustainability Goal and Undesirable Results

6.1 Introduction

This ~~Appendix~~Section provides location-specific significant and unreasonable conditions as well as undesirable results sustainable management criteria (SMC) for ~~four~~ five of the six sustainability indicators to guide and support the Kaweah Subbasin Groundwater Sustainability Agencies (GSAs) in developing sustainable management criteria (SMC) in their individual groundwater sustainability plans (GSP), including establishing minimum thresholds and measurable objectives with integrated interim milestones. ~~This Appendix includes Section 3 of this GSP presents~~ the Subbasin-scale SMC guidance as required by 23 Cal. Code Regs. §§354.22-.26, i.e., the sustainability goal and a complete listing of undesirable results, including their causes, criteria and effects on beneficial uses and users. ~~As discussed in Chapter 3, p~~Pursuant to 23 Cal. Code Regs. §354.26(d) no sustainable management criteria need to be set at this time for the undesirable results of ~~Interconnected Surface Waters and~~ Seawater Intrusion. Thus, pursuant to 23 Cal. Code Regs. §354.26(e)¹, ~~those~~ undesirable results associated with Seawater Intrusion will not be discussed herein.

6.2 General Approach

As described later in this ~~Section~~Appendix, the Subbasin identified minimum thresholds, based on declining groundwater levels (hereinafter “water level” or “level”) that result in significant and unreasonable results to the beneficial uses and users of groundwater within the Kaweah Subbasin~~would otherwise occur during the 20-year SGMA implementation period devoid of any GSP projects and management actions (pre-SGMA floor).~~ Measurable objectives are similarly based on using a trend line approach to afford the ability to provide a buffer for drought years prior to encountering minimum thresholds~~using this trend line.~~ The relationship of these measurable objectives and the long-term success in achieving the objectives is discussed in the context of neighboring GSAs in the Subbasin and their respective actions undertaken during GSP implementation.

The Kaweah Subbasin GSAs developed SMC within a framework of data, which currently has gaps. Every effort was made to coordinate SMC between the three GSAs. If SMCs (such as minimum thresholds and measurable objectives) vary substantially between adjacent GSAs, then the GSAs will ~~coordinate and~~ endeavor to adjust the particular SMC as additional data becomes available so that the GSAs eliminate any substantial variance which could inhibit a GSA from implementing its GSP and achieving sustainability within its jurisdictional area.

The metrics and approaches to be employed by the Subbasin for the six sustainability indicators are shown in **Table 6-1**.







¹ 23 Cal. Code Regs. §354.26(e) provides “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.

6.3 Sustainability Goal

23 Cal. Code Regs. § 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 and 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.*

Table 6-1: Sustainable Management Criteria by Sustainability Indicator

Table 6-1: Sustainable Management Criteria by Sustainability Indicator


SMC Summary for Kaweah Subbasin		
Sustainability Indicators	Basis for Minimum Threshold	Basis for Measurable Objective
 <u>Chronic Lowering of Groundwater Levels</u>	<u>Protection of greater than the 90th percentile of all beneficial uses and users without allowing a greater rate of historical level decline¹</u>	<u>Flexibility for at least 5 years of drought storage</u>
 <u>Reduction in Storage</u>	<u>Calculated based on groundwater levels²</u>	<u>Calculated based on groundwater levels²</u>
 <u>Land Surface Subsidence</u>	<u>Total subsidence of no more than 9 - feet, and a subsidence rate of no more than 0.67 feet/year</u>	<u>Zero Subsidence</u>
 <u>Water Quality</u>	<u>Reference to other regulators³</u>	<u>Reference to other regulators³</u>
 <u>Seawater Intrusion</u>	<u>Not Applicable</u>	<u>Not Applicable</u>
 <u>Interconnected Surface Waters</u>	<u>50% of channel losses in selected waterways⁴</u>	<u>30% of channel losses in selected waterways⁴</u>






¹ Determined by representative monitoring sites in Analysis Zones

² Storage volume changes and associated SMC determined as function of water level changes

³ e.g. SWRCB Division of Drinking Water requirements for public supply wells, RWQCB Irrigated Lands Regulatory Program

⁴ This indicator applies to the East Kaweah and Greater Kaweah GSAs. The two GSAs will be implementing a Work Plan to fill data gaps and better refine understanding of location and impacts caused by groundwater pumping

SMC Summary for GKGSA			
Sustainability Indicators	Minimum Threshold	Measurable Objective	Optimal Objective⁺
 <u>Water Level Declines</u>	<u>Pre-SGMA floor (2040 Interecept)²</u>	<u>2030 Interecept³</u>	<u>Water Added (P&MA)⁴</u>

	Reduction in Storage	Calculated based on water levels ⁵	Calculated based on water levels ⁵	Calculated based on water levels ⁵
	Land Surface Subsidence	Benchmark Surveys	Benchmark Surveys	NA
	Water Quality	Reference to other regulators ⁶	Reference to other regulators ⁶	NA
	Seawater Intrusion	Establish non-applicability	Establish non-applicability	NA
	Interconnected Surface Waters	Establish non-applicability	Establish non-applicability	NA

¹ Per section 354.30(g) of the GSP Regulations re improving basin conditions

² Pre-SGMA floor as determined by representative monitoring sites in Hydrogeologic Zones

³ 2030 intercept of Pre-SGMA floor projection as determined by representative monitoring sites in GSA

⁴ Estimated with by the numerical model or empirical analysis incorporating projects and management actions

⁵ Storage volume changes and associated SMC determined as function of water level changes

⁶ e.g. SWRCB Division of Drinking Water requirements for public supply wells, RWQCB Irrigated Lands Regulatory Program

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

This goal statement complies with §354.24 of the Regulations. This Goal will be achieved by:

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

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

6.4 Groundwater Levels

23 Cal. Code Regs § 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 undesirable results are derived from the Basin Setting (Appendix 2A) and its characterization as described in the Hydrogeologic Conceptual Model, the historical, current, and projected groundwater conditions and trends, and stakeholder input. The three Subbasin GSAs have concurred with the undesirable results, their causes, determination criteria and effects, all as defined in this section. The sustainability indicators used to determine undesirable results are referenced herein. This section complies with §354.26 of the Regulations.~~

The terms “significant and unreasonable” are not defined by SGMA, and are left to GSAs to define within their GSPs. The process to define “significant and unreasonable” began with stakeholder and landowner discussions. In the view of the Kaweah Subbasin GSAs and its stakeholders, the following impacts from lowering groundwater levels are viewed as “significant and unreasonable” as they would directly impact the long-term viability of beneficial uses/users (domestic, agricultural, municipal, etc.) to meet their reasonable water demands through groundwater:

- Inability of the groundwater aquifer to recover in periods of average/above average precipitation following multi-year drought periods
- Dewatering of a subset of existing wells below the bottom of the well
- Substantial increase in costs for pumping groundwater, well development, well construction, etc. that impact the economic viability of the area
- Adverse effects on health and safety
- Interfere with other sustainability indicators

~~The GSAs within the Kaweah Subbasin have determined that undesirable results for groundwater levels may be significant and unreasonable when basinwide loss of industrial, municipal, and domestic pumping well capacity occurs due to lowering groundwater levels.~~

6.4.1 -Causes leading to Undesirable Results

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

The primary cause of groundwater conditions that would lead to chronic lowering of groundwater levels is groundwater pumping in excess of natural and artificial recharge over a multi-year period

~~that includes both wetter than average and drier than average conditions. A transition to permanent crops and development of large dairies have both hardened water demand in all years. In addition to natural drought-cycles, the increase in groundwater pumping may also be the result of restricted access to imported supplies due to a variety of factors, including but not limited to, increased restrictions in the Delta, which may increase the likelihood imported supplies from Millerton Lake will be delivered outside the Kaweah Subbasin. The restriction of imported supplies may return the Kaweah Subbasin to a state it existed in prior to the development of the Friant Division of the Central Valley Project. Climate change may also affect the availability and rate upon which natural and artificial recharge is available. Undesirable results associated with groundwater level declines are caused by over pumping or nominal groundwater recharge operations during drought periods such that groundwater levels fall and remain below minimum thresholds. Over pumping and lack of recharge is area specific, and some GSA Management Areas experience greater adverse impacts than others.~~

6.4.2 *Criteria to Define Undesirable results*

23 Cal. Code Regs § 354.26 (b). *The description of undesirable results shall include the following: (2) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to 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.*

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

~~The GSAs within the Kaweah Subbasin have determined that undesirable results for groundwater levels may be significant and unreasonable when a subset of existing and active wells is dewatered. This is being described this way because the Subbasin has a significant data gap related to where all active wells are, how the active wells are constructed and how much the active wells are pumping. The Subbasin GSAs have plans to obtain this information from local landowners in the future. As this data gap is addressed, the description of an Undesirable Result for the Kaweah Subbasin will be further refined based on the more complete and accurate information.~~

~~Groundwater elevations shall serve as the sustainability indicator and metric for chronic lowering of groundwater levels and, by proxy, for groundwater storage. Justification for use of groundwater elevations as a proxy in this instance is provided in Section 5. An Undesirable Result occurs when one-third of the monitoring sites exceed the respective minimum threshold groundwater elevation.~~

~~It is the preliminary determination, after consideration of all users and uses, that the percentages values identified herein represent a sufficient number of monitoring sites in the Subbasin such that their exceedance would represent an undesirable result for water-level declines and, reduction in~~

groundwater storage, ~~land subsidence, and interconnected surface waters where applicable.~~ ~~Screen interval-Total completion depth~~ data for all beneficial users (agricultural, municipal, and domestic wells), as identified in the technical Appendix 6-1 and 6-2 attached to this Appendix~~Section 5.3.2,~~ has been ~~scrutinized-evaluated~~ and ~~undesirable results are defined by a determination has been made that~~ the ~~quantitypercentage~~ of wells completely dewatered by 2040 ~~if Minimum~~ ~~Thresholds are met or exceeded.~~ ~~not be exceeded would not constitute an undesirable result.~~ However, the Kaweah Subbasin GSAs are committing to implementing a Mitigation Program to mitigate certain impacts to active wells as groundwater levels transition to a more sustainable long-term condition (see Appendix 6-3). Based on future observed groundwater ~~conditions in the future~~levels and not less frequently than at each five-year assessment, the GSAs will evaluate whether these ~~percentages-values~~ need to be changed.

6.4.3 Evaluation of Multiple Minimum Thresholds

23 Cal. Code Regs § 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 Kaweah Subbasin GSAs, ~~in coordination with other GSAs in the basin~~ will utilize multiple wells to monitor and manage the GSAs and Subbasin. A detailed description of ~~each~~the GSA's monitoring network ~~are~~is included in the Monitoring Network Section ~~4 of this of their respective~~ GSPs.

6.4.4 Potential Effects on Beneficial Uses and Users

Using the above-described criteria, the GSAs evaluated potential undesirable results to agricultural, domestic, industrial, and municipal beneficial uses. Overall, based on the best available data, the projects and management actions to be implemented by each GSA are predicted to decelerate and arrest chronic lowering of groundwater levels by 2040. Potential impacts to wells associated with groundwater level declines in the transition period between 2020 and 2040 were evaluated through an analysis of well completed depths (see Appendix 6-1). Potential effects of lowered groundwater levels on the various beneficial uses of groundwater in the Kaweah Subbasin are as follows:

Agricultural – Potential effects to agricultural beneficial uses and users from lowered groundwater levels include financial impacts to lower pumps, repair/replace wells, and increased pumping costs. Analysis of well depths that could be affected by lowering groundwater levels to the minimum thresholds has been completed (see Appendix 6-2).

Domestic – Some domestic uses and users of groundwater may be impacted by continued lowering of groundwater levels during the transition period from January 2020 to December 2040. Analysis of well depths that could be affected by lowering groundwater levels to the minimum thresholds has been completed (see Appendix 6-2). Lowering groundwater levels below the total depth of

shallow domestic wells could lead to added costs to haul in water supplies, tie into other available supplies, consolidation with existing water service providers, or requiring other form of mitigation

Industrial & Municipal – Potential effects to industrial beneficial uses and users from lowered groundwater levels include financial impacts to lower pumps, repair/replace wells, and increased pumping costs. Analysis of well depths that could be affected by lowering groundwater levels to the minimum thresholds has been completed (see Appendix 6-2).

To address potential effects on agricultural, domestic and industrial beneficial uses and ensure access to water until the Subbasin reaches a sustainable groundwater level condition, each GSA will adopt a Mitigation Program or Programs consistent with the framework described further in the next section. Because of this mitigation, the resulting impacts as described herein during the implementation period are not considered significant and unreasonable.

6.4.5 Mitigation Program

The Subbasin is committing to developing a Mitigation Program that evaluates and protects beneficial users from lowering groundwater levels and subsidence. The core tenants of well mitigation are coordinated here; however, each GSA will develop and implement GSA-specific programs based on the localized needs of their jurisdictions. The GSAs will take appropriate action to implement the Program no later than June 30, 2023. The key factors to be included are listed below. A draft well mitigation plan template is included in Appendix 6-3.

- Identification of the priority wells to be mitigated, with approximate quantification
- An investigation and vetting process to confirm well priority and impacts
- A listing of the mitigation methods, including both short and long-term options
- Estimated costs of mitigation methods and funding mechanism(s)
- Implementation schedule

6.5 Groundwater Storage

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

The Groundwater Storage minimum thresholds are the same as groundwater levels and groundwater elevations across the GSA and Subbasin and were used to calculate the amount of groundwater in storage below the Minimum Thresholds to the base of the aquifer. An undesirable result in groundwater storage may be significant and unreasonable if the total amount of water in storage was less than the estimated amount of groundwater in storage below the Minimum Threshold or other factors identified in section 6.4 occur.

6.5.1 Causes leading to Undesirable Results

23 Cal. Code Regs § 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.*

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

6.5.2 Criteria to Define Undesirable results

23 Cal. Code Regs § 354.26 (b). *The description of undesirable results shall include the following: (2) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to 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 water-level sustainability indicator is used as the driver for calculated changes in groundwater storage. Given assumed hydrogeologic parameters of the Subbasin, direct correlations exist between changes in water levels and estimated changes in groundwater storage, and water levels are to serve as a metric for groundwater storage reductions as well. As such, when one-third of the Subbasin representative monitoring sites for water levels exceed their respective minimum thresholds, an undesirable result for storage will be deemed to occur. ~~Given assumed hydrogeologic parameters of the Subbasin, direct correlations exist between changes in water levels and estimated changes in groundwater storage, and water levels are to serve as a metric for groundwater storage reductions as well.~~ As discussed in Section 5.3.1, ~~t~~he current estimated volume of groundwater in storage in the Subbasin of 15 to 30 MAF is sufficient such that further depletion over the implementation period is not of a level of concern such that an undesirable results would emerge during the GSP implementation period.

6.5.3 Potential Effects on Beneficial Uses and Users

23 Cal. Code Regs § 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 interest, and other potential effects that may occur or are occurring from undesirable results.*

The potential effects to beneficial uses and users of reductions in groundwater storage are essentially the same as for declines in water levels. In most cases, the direct correlation is with declines in levels; however, some beneficial uses may be tied more specifically to loss of groundwater in storage.

6.6 Land Subsidence

23 Cal. Code Regs § 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.*

Land subsidence may be considered significant and unreasonable if there is a loss of a functionality of a structure or a facility to the point that, due to subsidence, the structure or facility cannot reasonably operate without either significant repair or replacement.

6.6.1 Causes leading to Undesirable Results

23 Cal. Code Regs § 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.*

Geology - The geology of the Subbasin appears to have greater potential for subsidence the further west you go. Generally, it is understood that the multi-aquifer area has the greatest potential for subsidence due to the presence of the deep confined aquifer. However, even in the single aquifer area, there are disconnected clays that appear to be deposited similarly to the Corcoran Clay. These clays also have the potential to subside, but do not seem to have the high potential of other areas because the aquifer is not fully confined. This speaks to why there is still subsidence in eastern portions of the Subbasin, east of the Corcoran Clay.

Deep Aquifer - The Subbasin understands that deep pumping from pressurized aquifer zones is primarily related to subsidence. In the Kaweah Subbasin this would generally be below the Corcoran Clay. However, the specific zone below the Corcoran Clay that is subsiding is not currently known. It is also understood that some small component of subsidence is related to water level declines in the upper aquifer.

Declining Levels & Drilling Deeper - The Subbasin understands that the chronic lowering of groundwater levels is related to the triggers for subsidence. As groundwater levels decline, landowners choose to drill deeper wells to restore their access to available groundwater supplies. When new deeper wells are drilled, the geology below the previous well and above the base of the new well is subjected to new impacts from the new well. Generally, the Subbasin views the effort to stabilize groundwater levels as critical to future success in dealing with subsidence. As groundwater pumping is reduced across the Subbasin, groundwater level declines will diminish, and fewer wells will be drilled deeper which will reduce the development of subsidence across the Subbasin.

Undesirable results associated with subsidence are caused ~~by over-pumping or nominal groundwater recharge operations during drought periods such that groundwater levels fall and remain below minimum thresholds~~ groundwater pumping from deep wells that tap pressurized zones with fine grained deposits that experience declining groundwater levels. ~~Over-pumping and~~

~~lack of recharge are area specific, and s~~Some GSA Management Areas experience greater adverse impacts than others. Over-pumping during drought periods, which may result in new lows in terms of groundwater elevations, is of particular concern based on current scientific understanding of subsidence trends in this region. ~~Regional correlations of groundwater levels versus subsidence trends remain difficult to ascertain because groundwater levels occur at a local scale and subsidence occurs at a broader/regional scale.~~

6.6.2 Criteria to Define Undesirable results

23 Cal. Code Regs § 354.26 (b). *The description of undesirable results shall include the following: (2) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to 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 Kaweah Subbasin GSAs understand that impacts from subsidence have been occurring in the Kaweah Subbasin for many years. However, the rate of subsidence has seemed to increase significantly around 2007. Deep wells have collapsed with compression failures, the ground surface has slowly changed elevations over time, and some linear systems dependent on grade have experienced capacity reductions. Also, during the same period many other facilities have not experienced those negative impacts, and why some have versus others not is still very difficult to understand. Shallow wells are generally not viewed as being at risk of subsidence impacts. The Kaweah Subbasin GSAs have attempted to consider all local infrastructure, land uses and groundwater users relative to current and potential subsidence impacts and develop a view of groundwater conditions (Minimum Threshold elevations) that would avoid Undesirable Results in the Subbasin.

The Kaweah Subbasin GSAs understand that groundwater wells are very important infrastructure for all landowners across the Subbasin. For this reason, the Kaweah Subbasin GSAs view that an Undesirable Result (UR) would occur if a significant portion of the existing deep wells in the Kaweah Subbasin became inoperable (collapsed) due to subsidence. The Kaweah Subbasin GSAs understand that the Friant-Kern Canal is a facility of statewide importance (critical infrastructure) that delivers San Joaquin River surface water to parties in the Kaweah Subbasin and beyond. For that reason, the Kaweah Subbasin GSAs also view that a UR would occur if the capacity of the Friant-Kern Canal was significantly impacted by subsidence. The Kaweah Subbasin GSAs understands that local flood control channels are very important infrastructure for all landowners across the Kaweah Subbasin. For that reason, the Kaweah Subbasin GSAs view that a UR would occur if the capacity of flood control channels in the Subbasin are significantly impacted by subsidence. And lastly, the Kaweah Subbasin GSAs understand that certain main canals are very important for landowners across the Kaweah Subbasin because their function is critical to continued use of surface water in Subbasin, which reduces demand for groundwater and provides the ability to recharge aquifers in wet years. For that reason, the Kaweah Subbasin GSAs view that a UR would occur if the capacity of certain main canals in the Subbasin are significantly impacted by subsidence.

Subsidence RMS sites will be monitored for ground surface elevation annually each fall. The primary criteria for evaluation will be the reduction in land surface elevation from the beginning of the Implementation Period (if that data is available). There will be two methods of identifying an Undesirable Result (UR) for the Subbasin. For the area outside of the Friant-Kern Canal alignment, when one-third of the Subbasin RMSs outside the Friant-Kern Canal band decline below their respective MT elevations, that will be viewed as a UR. For a one-mile band on either side of the Friant-Kern Canal, if any of the MT elevations in that band reach an MT elevation that will be viewed as a UR.

The primary criteria and metric the GSAs will monitor will be the total amount of reduction in land surface elevation and areal extent of such elevation changes.

~~The primary criteria and metric will be the annual rate of reduction in land surface elevation and areal extent of such elevation changes. An undesirable result will occur when one third of the Subbasin subsidence monitoring sites exceed their respective minimum thresholds. In addition, GKGSA will evaluate cumulative subsidence at each of the interim milestones as described in Section 5. The water level sustainability indicator will be considered for differential land subsidence, although the current body of knowledge relative to subsidence and local and regional declines in water levels is limited. As set forth in Section 5.3.6, subsidence rates that represent minimum thresholds have been identified that reflect recent historical rates in the GKGSA region. Within the eastern portions of the Subbasin, the East Kaweah GSA has established minimum thresholds using a metric tied to loss of conveyance capacity in the Friant Kern Canal which traverses from north to south through that GSA.~~

For many of the impacts listed above, Subsidence becomes a land surface is only a problem when it is differential in nature i.e., elevation shifts across the areal extent of infrastructure deemed of high importance. For example, subsidence linearly along a major highway is manageable if gradual in its occurrence. In contrast, localized subsidence traversing across a highway, if sizable, would cause major cracking of the pavement surface and become a significant hazard to travelers. The same comparisons may be made for other infrastructure as well.

~~For this reason, should~~ If an exceedance of a minimum threshold at a monitoring site ~~occurs~~, the applicable GSA will reach out to the County, cities, water districts, and others, both public and private, and inquire as to any infrastructure that has been damageds which may ~~be occurring~~ determine-require a corrective course of action if deemed necessary. A broad areal extent of land subsidence thus may not be of major concern, with the exception of the associated loss of aquifer system water storage capacity.

6.6.3 Potential Effects on Beneficial Uses and Users

23 Cal. Code Regs § 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 interest, and other potential effects that may occur or are occurring from undesirable results.*

The Kaweah Subbasin GSAs understand that impacts from subsidence have been occurring in the Kaweah Subbasin for many years. Some of the understood impacts are briefly discussed below:

Flood Channels - Rivers and creeks generally begin in watersheds in the foothills and mountains east of the Subbasin and flow downhill to the southwest toward the historic Tulare Lake. Part of the Kaweah Subbasin's history involves regular floods, and that is why dams were built on local rivers and streams to protect communities and farmlands from regular flood events. However, even though the dams exist, they only provide protection up to a certain magnitude flooding event. Subsidence has not been observed to diminish the capacity of local flood channels, but it theoretically could impact capacity under the right circumstances. Also, subsidence could cause a change to the amount of sediment that is moved by the system. However, there are parties responsible for the maintenance of these channels and incremental impacts are likely being addressed through maintenance.

Local Flooding - Ground surface changes can affect flood zones as well as flood control levees. Local flood control levees are maintained by agencies responsible for maintaining their effectiveness. In 2017 a local flood control levee was raised by several feet to address subsidence concerns, but that was the first such project on that levee in decades and it was completed in just a few months. The planned development of new recharge projects and the increased use of wet year surface water should more than mitigate potential modifications to existing flood zones.

Local Canals - These linear facilities are very important related to GSA Management Strategies. If their capacity is significantly impacted, it may require GSAs to shift to greater pumping reductions.

Regional Canals - These linear facilities, like the Friant-Kern Canal, usually have regional significance and have users across large sections of the Southern San Joaquin Valley. The cost of repairing subsidence impacts on these facilities are too expensive for the Kaweah Subbasin to bear. For that reason, other management strategies like pumping restrictions to stabilize groundwater levels will be imposed instead.

Shallow Wells - Shallow wells that do not have significant exposure to the confined aquifer below the Corcoran Clay do not appear to be at risk from subsidence.

Deep Wells - Wells that have significant exposure to the confined aquifer below the Corcoran Clay are at risk of collapse due to subsidence that is mostly linked to that zone. A preliminary estimate of significant and unreasonable impacts can be established by looking at well construction practices. Subsidence mainly occurs in the deeper aquifers, and therefore well collapse due to subsidence typically only affects deeper wells. Conversations with local well drillers and suppliers indicates that deeper wells are now commonly outfitted with compression sleeves (personal communication). These compression sleeves allow well casings to telescope in response to subsidence, preventing casing collapse (Turnbull, 2022). Each compression sleeve allows 6 feet of compression, and often wells are equipped with 1 or 2 sleeves (personal communication). This allows for 6 to 12 feet of subsidence without causing collapse.

Railroads - There are several railroads throughout the Subbasin that convey goods along predefined routes and the facilities also have flood control structures, like culverts, along their alignments. The observed grade changes that have occurred from subsidence do not appear to be significant for local railroads and their culverts appear to be staying stable with adjacent properties. However, steep localized subsidence can be a significant issue in terms of the cost of repairs.

Natural Gas Pipelines - Along Highway 99 there is a significant natural gas pipeline. Over the past several years this facility has been worked on at various points, but it appears the efforts related to issues other than subsidence.

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

The Kaweah Subbasin GSAs have attempted to consider all local infrastructure, land uses and groundwater users relative to current and potential subsidence impacts and develop a view of groundwater conditions (MT elevations) that would avoid Undesirable Results in the Subbasin. Again, the Kaweah Subbasin GSAs view that stabilized groundwater levels as critical to the future success of dealing with subsidence. As groundwater pumping is reduced across the Subbasin, groundwater level declines will diminish, and fewer wells will be drilled deeper which will reduce the development of subsidence across the Subbasin.

6.6.4 Evaluation of Multiple Minimum Thresholds

23 Cal. Code Regs § 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 Kaweah Subbasin GSAs will use measurements taken at multiple subsidence benchmarks and Interferometric Synthetic Aperture Radar (InSAR) data to monitor and manage subsidence in the GSA and Subbasin. A detailed description of each GSA's monitoring networks are included in the Monitoring Networks Section of their respective GSPs. The Subbasin, in coordination with other GSAs in the basin will utilize multiple wells to monitor and manage the GSA and basin. A detailed description of the GSA's monitoring network is included in Section 4 of this GSP.

6.6.5 Mitigation Program

The Subbasin is committing to developing a Mitigation Program that evaluates and protects beneficial users from certain land subsidence impacts. The core tenants of subsidence mitigation are coordinated in the Mitigation Program through this Coordination Agreement; however each GSA will develop and implement GSA-specific programs based on the localized needs of their jurisdictions. The GSAs will take appropriate action to implement the Program no later than June 30, 2023. The key factors to be included below. A draft well mitigation plan template is included in Appendix 6-3.

- Identification of the priority land surface infrastructure to be mitigated, with approximate quantification

- An investigation and vetting process to confirm priority and impacts
- A listing of the mitigation methods, both short and long-term options
- Estimated costs of mitigation methods and funding mechanism(s)
- Implementation schedule

6.7 Degraded Water Quality

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

An undesirable result may be significant and unreasonable if groundwater quality is adversely impacted by groundwater pumping and recharge projects and these impacts result in groundwater no longer being generally suitable for agricultural irrigation and/or domestic use.

6.7.1 Causes leading to Undesirable Results

23 Cal. Code Regs § 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.*

Undesirable results associated with water quality degradation can result from pumping localities and rates, as well as other induced effects by implementation of a GSP, such that known plumes and contaminant migration could threaten production well ~~viability~~quality. Well production depths too may draw out contaminated groundwater, both from naturally occurring and man-made constituents which, if MCLs are exceeded, may engender undesirable results. Declining groundwater levels may or may not be a cause, depending on location. In areas where shallow groundwater can threaten the health of certain agricultural crops, rising water levels may be of concern as well.

6.7.2 Criteria to Define Undesirable results

23 Cal. Code Regs § 354.26 (b). *The description of undesirable results shall include the following: (2) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to 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.*

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

established MCLs or other agricultural constituents of concern set by applicable regulatory agencies. The metrics for degraded water quality shall be measured by MCL compliance or by other constituent content measurements where appropriate. These metrics will include measurements for the following constituents where applicable:

- Arsenic
- Nitrate
- Chromium-6
- DBCP
- TCP
- PCE
- Sodium
- Chloride
- Perchlorate
- TDS

As explained in Section 5.3.4, in regions where agriculture represents the dominant use of groundwater, Agricultural Water Quality Objectives will serve as the metric as opposed to drinking water MCLs within public water supply jurisdictions. An exceedance of any of the MCL or agricultural metrics Agricultural Water Quality Objectives as defined herein at any representative monitoring sites will trigger a management action within the applicable Management Area or GSA, subject to determination that the exceedance was caused by actions of the GSA. MCLs and water quality objectives are listed in each of the Kaweah Subbasin GSPs Appendix 3A and these are subject to changes as new water quality objectives are promulgated by the State of California and the Federal EPA. The Subbasin will provide updates in our annual reports and GSP Updates throughout the implementation periods of 2020 to 2040.

6.7.3 Potential Effects on Beneficial Uses and Users

23 Cal. Code Regs § 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 interest, and other potential effects that may occur or are occurring from undesirable results.*

The potential effects of degraded water quality from migrating plumes or other induced effects of GSA actions include those upon municipal, small community and domestic well sites rendered unfit for potable supplies and associated uses, and/or the costs to treat groundwater supplies at the well head or point of use so that they are compliant with state and federal regulations. Potential effects also include those upon irrigated agricultural industries, as certain mineral constituents and salt build-up can impact field productivity and crop yields.

6.7.4 Evaluation of Multiple Minimum Thresholds

23 Cal. Code Regs § 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 Subbasin, in coordination with other GSAs in the basin will utilize multiple wells to monitor water quality and manage the GSA and basin. A detailed description of the GSA's monitoring network is included in the Monitoring Networks Section 4 of this-their respective GSPs.

6.8 Interconnected Surface Waters

Interconnected surface waters within the Kaweah Subbasin are a significant data gap that needs more development through collection of additional data and further studied through the development of a technical analysis tool. The East Kaweah and Greater Kaweah GSAs are developing a work plan to collect data and analyze interconnected surface water presence and potential impacts from groundwater pumping (see Management Action Section of each respective GSP for more detail on these work plans.

6.8.1 Causes Leading to Undesirable Results

23 Cal. Code Regs § 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.*

Undesirable results associated with interconnected surface waters are understood to be caused by several factors. Some of these factors may include groundwater pumping, drier hydrology, and changes within the upper watershed, or some combination of those factors. Within the Kaweah Subbasin, there are currently significant data gaps related to understanding the potential locations of interconnected surface waters and their nexus to depletions caused by groundwater pumping. More information is intended to be developed and shared through a work plan being coordinated and implemented by the East and Greater Kaweah GSAs. The preliminary schedule for the work plan is in Table 6-2. Pending data gathered and/or timing of such data, there may be shifts or re-ordering of phases/tasks to better adapt and facilitate completion.

Table 6-2 Anticipated Interconnected Surface Water Work Plan Schedule

Phase	Description	Estimated Timeline
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1	<u>Additional research; data gap filling (monitoring well installation, stream gauge installation, etc.); data collection</u>	<u>October 2022 – June 2024</u>
2	<u>Analytical Tool Development – the type of tool will be determined with additional data and research</u>	<u>March 2023 – December 2023</u>
3	<u>Interconnection Analysis and Determination</u>	<u>January 2024 – July 2024</u>
4	<u>SMC Development and Incorporation into 2025 GSP</u>	<u>July 2024 – January 2025</u>

6.8.2 Criteria to Define Undesirable results

23 Cal. Code Regs § 354.26 (b). The description of undesirable results shall include the following: (2) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to 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 Kaweah Subbasin (East Kaweah and Greater Kaweah GSAs specifically) are implementing a work plan that is intended to provide a clearer definition of where potentially interconnected surface waters are located and to what extent adverse impacts related to groundwater pumping are present and can be defined and quantified. At the current time (July 2022), the primary criteria and metric for defining and quantifying adverse impacts and undesirable results will be the estimated percentage of losses within potentially interconnected channels, measured as a rate or volume of depletion of surface water, until the work plan provides more information. Currently, there is not sufficient data to definitively set rate of depletions on other data. Increased channel losses reduce the amount of surface water that can be delivered throughout the Kaweah Subbasin. Delivery of surface water is a critically important part of sustainably managing the Kaweah Subbasin, thus impacts that reduce the ability to deliver surface water can become significant and unreasonable and ultimately lead to an undesirable result. The initial percentages being used for SMC are 50% losses due to groundwater pumping for the MT and 30% losses due to groundwater pumping for the MO. The East Kaweah and Greater Kaweah GSS will implement a work plan intended to fill data gaps by the 2025 GSP Update. Better definition and criteria for significant and unreasonable impacts and, ultimately, undesirable results in the locations identified as having interconnected surface waters are envisioned to be available from the proposed work plan.

6.8.3 Potential Effects on Beneficial Uses and Users

23 Cal. Code Regs § 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 interest, and other potential effects that may occur or are occurring from undesirable results.

Currently identified potential beneficial uses/users related to interconnected surface water within the East and Greater Kaweah GSA regions of the Kaweah Subbasin are surface water users, riparian and/or groundwater dependent ecosystems, and water rights holders. As more data becomes available, the Work Plan may add or subtract to these uses/users in whole or part of the reaches of the selected waterways. The potential effects of depletions to interconnected surface water, when approaching or exceeding minimum thresholds and thus becoming an undesirable result include:

- Increased losses in interconnected surface waterways used for surface water conveyance, reducing water supply reliability and volumes.
- Negatively and significantly impacting the health of riparian and/or groundwater dependent ecosystems.
- Violating laws and doctrines governing California’s surface water rights.

6.8.4 Evaluation of Multiple Minimum Thresholds

23 Cal. Code Regs § 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 Kaweah Subbasin GSAs will utilize a variety of methods, to be determined based on data gained through the implementation of the work plan, to monitor and manage interconnected surface waters in the GSA and Subbasin. Further detail necessary for properly evaluating interconnected surface water and the potential relationship to groundwater pumping in the Kaweah Subbasin is anticipated to be gained through implementation of the work plan.

6.7.5 Undesirable results

23 Cal. Code Regs § 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.

~~No interconnected surface waters as defined in SGMA have been identified in any Kaweah Subbasin GSAs as described more thoroughly in the basin setting. Some of the Plans have identified this issue as a data gap and have committed to increasing monitoring.~~

6.86.9 Seawater Intrusion

6.8.16.9.1 Undesirable results

23 Cal. Code Regs § 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.

There is no potential for seawater intrusion to occur in the Kaweah Subbasin as described more thoroughly in the basin setting. Thus, no criteria need to be established.