Staff Report for April 24, 2019: ESJ GWA Advisory Committee Meeting
Agenda Item #2: Sustainability Indicators.

Submitted by Woodard & Curran

Meeting Agenda

1. **Approval of April 10 Minutes** (No accompanying staff report)
2. **Sustainability Indicators**
    a. **Land Subsidence**
    b. **Depletion of Interconnected Surface Water**
3. **Monitoring Network** (No accompanying staff report)
4. **Groundwater-Dependent Ecosystems** (No accompanying staff report)
5. **Inter-basin Coordination** (No accompanying staff report)
6. **Next Steps and Key Decisions for the GWA** (No accompanying staff report)
7. **May Agenda Items** (No accompanying staff report)

Agenda Item #2: Sustainability Indicators
Identification of undesirable results, minimum thresholds, measurable objectives, and interim milestones; and definition of violation for each of the six sustainability indicators

Minimum Thresholds and Measurable Objectives (Overview, and specifics for Declining Groundwater Levels)

ISSUE SUMMARY

1.1 INTRODUCTION

Several requirements of GSPs fall under the heading of "Sustainable Management Criteria." These criteria include:

- Sustainability Goal
- Undesirable Results
- Minimum Thresholds
- Measurable Objectives

The development of these criteria for the Eastern San Joaquin GSP relied upon information about the basin developed in the hydrogeologic conceptual model, the descriptions of current and historical groundwater conditions, the water budget, and input from stakeholders during the GSP development process.

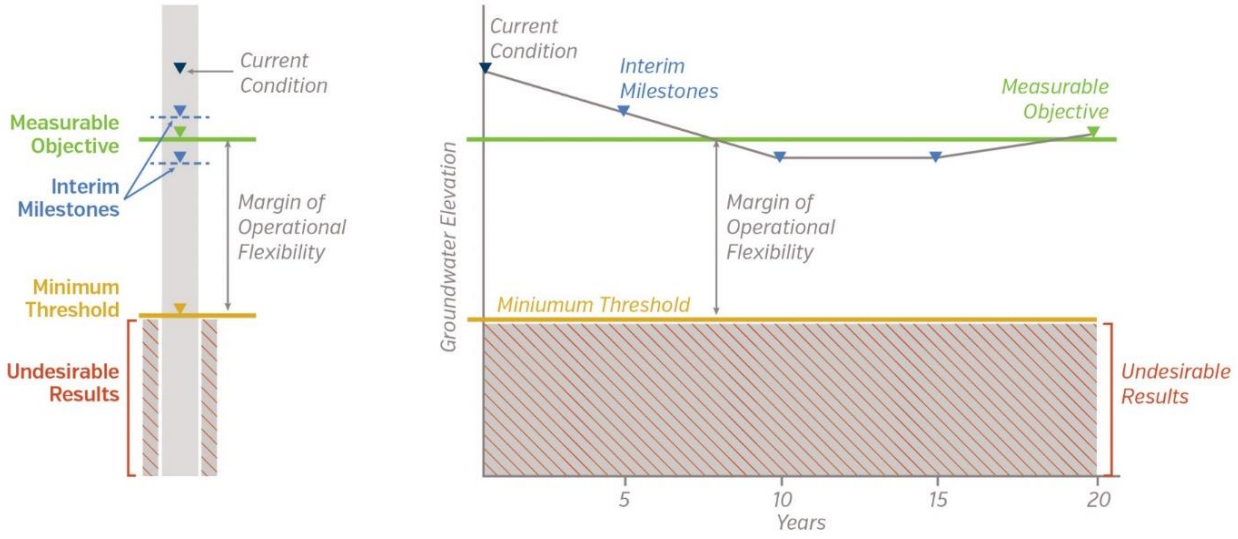
This GSP considers the six sustainability indicators defined by SGMA in the development of sustainable management criteria. SGMA allows several pathways to meet the distinct local needs of each basin, including development of sustainable management criteria, usage of other sustainability indicators as a proxy, and identification as not being applicable to the basin. Because of limited data availability for other parameters, groundwater levels are proposed to be utilized as a proxy for minimum thresholds and measurable objectives for groundwater storage and land subsidence.

Sustainable Management Criteria Definitions

- **Undesirable Results** – Significant and unreasonable negative impacts associated with each sustainability indicator, avoidance of which is used to guide development of GSP components
- **Minimum Threshold** – Quantitative threshold for each sustainability indicator used to define the point at which undesirable results may begin to occur
- **Measurable Objective** – Quantitative target that establishes a point above the minimum threshold that allows for a range of active management in order to prevent undesirable results
- **Interim Milestones** – Targets set in increments of five years over the implementation period of the GSP to put the basin on a path to sustainability
- **Margin of Operational Flexibility**: The range of active management between the measurable objective and the minimum threshold

See Figure 1 for a graphic that demonstrates the relationship between the Sustainable Management Criteria terms.

Figure 1: Sustainable Management Criteria Definitions Graphic (Groundwater Levels Example)



1.2 SUSTAINABILITY GOAL

SGMA defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation of the GSP without causing undesirable results. The sustainability goal succinctly states the GSAs' objectives and desired conditions of the Subbasin. The Subbasin is heavily reliant on groundwater and users recognize the basin has been in overdraft for a long period. undesirable results that have been experienced in the Subbasin are discussed in greater detail below. These include lowering of water levels in some areas of the Subbasin and increased salinity along the western boundary.

The preliminary proposed Sustainability goal description for the ESJ Subbasin is:

> *to maintain an economically-viable groundwater resource for the beneficial use of the people of the Eastern San Joaquin Subbasin by operating the basin within its sustainable yield or by modification of existing management to address unforeseen future conditions.*

The GSP's sustainability goal will allow groundwater levels to continue to decline during the implementation period as projects are implemented and basin operations are changed, provided there are no undesirable results. The goal will be expanded to include additional information on how the goal will be achieved, consistent with SGMA regulations, once the implementation plan has been developed. This includes description of measures and explanation of how the goal will be achieved in 20 years.

This sustainability goal is supported by the locally-defined minimum thresholds that sufficiently prevent undesirable results, presented later in this section. Demonstration of stable groundwater levels on a long-term average basis combined with the absence of undesirable results will support a determination that the basin is operating within its sustainable yield and the conclusion that the sustainability goal has been achieved.

1.3 OVERVIEW OF UNDESIRABLE RESULTS

The GSP Emergency Regulations (California Code of Regulations, Title 23, § 354.26) present the requirements for describing undesirable results as follows:

"(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."

“(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."

"(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."

"(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."

"(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."

"(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."

To determine areas of current or historical undesirable results, GSA representatives were provided with maps displaying active and inactive wells located within the boundaries of their GSA for the years 1992, 2015, and 2017. These timeframes were selected to capture the effects of the end of two most recent droughts (1992 and 2015), as well as current basin conditions. GSA representatives were asked to indicate on the maps which wells, if any, are experiencing or have in the past experienced issues related to chronic lowering of groundwater levels.

Follow-up conversations were carried out with the GSAs to confirm these designations and definitions accordingly. GSAs were met with individually and in groups to confirm and identify any undesirable results occurring in their area of the Subbasin.

1.4 OVERVIEW OF MINIMUM THRESHOLDS

Understanding of potential undesirable results and basin conditions was built on language in established in prior planning work in the region—including Integrated Regional Water Management Plans, the 2004 Groundwater Management Plan, Agricultural Water Management Plans, and the MokeWISE Water Program—model development, and anecdotal data from GSAs.

Minimum Thresholds and Measurable Objectives (Land Subsidence)

ISSUE SUMMARY

1.5 LAND SUBSIDENCE

1.5.1 Undesirable Results

The ESJ Subbasin has not experienced subsidence historically, in large part due to the hydrogeology of the Subbasin. Potential causes of future undesirable results for land subsidence would include significant increases in groundwater production beyond what is currently projected, resulting in dewatering of compressible clays in the subsurface, which are not known to be common in the ESJ Subbasin. The potential causes of substantial increases in groundwater production are the same as those addressed through the chronic lowering of groundwater levels sustainability indicator.

If land subsidence conditions were to reach undesirable results levels, the adverse effects could potentially cause damage to infrastructure, including water conveyance facilities and flood control facilities. This could impact the ability to deliver surface water, resulting in increased groundwater use, or could impact the ability to store and convey flood water. These could have adverse effects to property values or public safety.

1.5.2 Minimum Thresholds and Measurable Objectives

Justification for Using Groundwater Levels as a Proxy

GSP regulations allow GSAs to use groundwater levels can be used as a proxy metric for any sustainability indicator, provided the GSP demonstrates that there is a significant correlation between groundwater levels and the other metrics. DWR indicates two possible approaches:

1) ***Demonstrate that the minimum thresholds and measurable objectives for chronic declines of groundwater levels are sufficiently protective to ensure significant and unreasonable occurrences of other sustainability indicators will be prevented. In other words, demonstrate that setting a groundwater level minimum threshold satisfies the minimum threshold requirements for not only chronic lowering of groundwater levels but other sustainability indicators at a given site.***

2) *Identify representative groundwater elevation monitoring sites where minimum thresholds and measurable objectives based on groundwater levels are developed for a specific sustainability indicator. In other words, the use of a groundwater level minimum threshold is <u>not</u> intended to satisfy the minimum threshold requirements for chronic lowering of groundwater but is intended solely for establishing a threshold for another sustainability indicator.*

Option 1) above allows the use of groundwater levels as a proxy metric for this sustainability indicator, as there is significant correlation between groundwater levels and land subsidence. Use of groundwater levels as a proxy is necessary, given the lack of direct monitoring for land subsidence in the Subbasin. Additionally, land subsidence is driven by a lowering of groundwater levels in the aquifer, and historical declines in groundwater levels are not known to results in subsidence in the ESJ Subbasin. Additional declines in groundwater levels will be mitigated by the groundwater level thresholds. Subsidence is not expected to occur, based on the minimum thresholds for groundwater levels as compared to historical groundwater levels. The same numeric definitions for undesirable results and minimum thresholds would be applied to both the chronic lowering of groundwater levels sustainability indicator and the land subsidence sustainability indicator.

Land subsidence can only occur if two conditions are met: subsurface materials are dewatered, and those dewatered subsurface materials are compressible. Historical declines in groundwater levels have not resulted in subsidence, suggesting that subsurface materials in the geologic units historically affected by groundwater elevation fluctuations are not compressible. If the basin were to operate within the margin of operational flexibility proposed for groundwater levels, future dewatering

would continue to occur in the same geologic units historically affected by groundwater elevation fluctuations. It is anticipated that additional declines in groundwater levels would affect dewatered the materials in a manner consistent with historical dewatering, which resulted in no known subsidence. As a result, projected elevation declines are not expected to result in subsidence, and groundwater level minimum thresholds are protective.

QUESTION FOR CONSIDERATION: Should the approach to defining undesirable results and setting minimum thresholds and measurable objectives be adopted for use in the GSP?

CONSULTANT RECOMMENDATION
The consultant recommendation is to implement the recommended minimum thresholds and measurable objects described in the sections above.

- **Proposed Minimum Threshold:** Consistent with groundwater levels minimum thresholds
- **Proposed Measurable Objective:** Consistent with groundwater levels measurable objectives
- **Proposed Interim Milestones:** Consistent with groundwater levels interim milestones
- **Proposed Definition of Undesirable Result:** Consistent with groundwater levels definition of undesirable result

ADVISORY COMMITTEE RECOMMENDATION
Advisory Committee to consider on April 24, 2019

BOARD RECOMMENDATION
Board to consider on May 8, 2019

ISSUE SUMMARY

1.6 DEPLETIONS OF INTERCONNECTED SURFACE WATER

1.6.1 Undesirable Results

Description of Undesirable Results

The undesirable result related to d*epletions of interconnected surface water* is defined in SGMA as:

> *Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.*

The undesirable result for depletions of interconnected surface water in the Eastern San Joaquin Subbasin is depletions that result in reductions in flow or levels of major rivers and streams that are hydrologically connected to the basin such that the reduced surface water flow or levels have a significant and unreasonable adverse impact on beneficial uses of the surface water within the Subbasin over the planning and implementation horizon of this GSP.

Major rivers and streams include the streams that potentially have hydraulic connection to groundwater system in certain reaches: Calaveras River, Mokelumne River, San Joaquin River, and Stanislaus River. Many of the smaller creeks and streams are used for conveyance of irrigation water and do not have impacted natural flow; thus these systems have not been considered in quantifying depletions.

Potential Causes of Undesirable Results

Potential causes of future undesirable results for the depletions of interconnected surface water indicator could result from lowered groundwater levels.

Potential Effects of Undesirable Results

If depletions of interconnected surface water were to reach levels causing undesirable results, effects could include reduced flow and stage within rivers and streams in the Subbasin to the extent that insufficient surface water would be available to support diversions for agricultural uses, diversions for urban uses, or to support regulatory environmental requirements. This could result in increased groundwater production, changes in irrigation practices and crops grown, and could cause adverse effects to property values and the regional economy. Reduced flows and stage, along with potential associated changes in water temperature, could also negatively impact aquatic species in the rivers and streams. Such impacts are tied to the inability to meet minimum flow requirements, which are defined for the Mokelumne, Stanislaus, and San Joaquin Rivers, which, in turn, are managed through operations at Camanche Dam and Woodbridge Dam; Goodwin Dam; and the San Joaquin River at Vernalis gage, respectively.

Approach 1: Set Minimum Threshold and Measurable Objective Using Stream Model Estimates

Approach 1 quantifies modeled stream losses under non-wet conditions and establishes thresholds to protect against significant and unreasonable stream depletion.

Identification of Undesirable Results

This undesirable result is considered to occur during GSP implementation when groundwater pumping causes a depletion of major interconnected rivers and streams in the Subbasin that exceeds the minimum threshold, based on an average annual value over the most recent 5-year period using model results from the Historical Simulation using the ESJWRM. Smaller streams not used for conveyance are incorporated into the analysis as increased depletions on the smaller streams due to regional groundwater conditions will also be reflected in increased depletions in the larger streams.

Minimum Thresholds

The minimum threshold for depletions of interconnected surface water is established as a rate of surface water depletions caused by groundwater use that may have adverse impacts on beneficial uses of the surface water and may lead to undesirable results. This rate is established as a total value for all major rivers and streams within the ESJ Subbasin, as discussed above.

Minimum thresholds are set for basin-wide depletions of interconnected surface water. Thresholds for individual rivers or reaches were not necessary as there are no rivers or streams that are more sensitive to losses, either from a flow or stage standpoint or from a diversions standpoint. There are no identified likely adverse impacts on beneficial uses of surface water within the Subbasin caused by depletions of interconnected surface water. With the absence of such impacts, a minimum threshold is established to manage downstream flow from the Subbasin.

The minimum threshold for depletions of interconnected surface water is defined based on stream losses. Quantification of depletions is relatively challenging and requires significant data on both groundwater levels near streams and stage information. Depletions are the additional losses or reduced gains caused by groundwater production; quantification would require an estimate of losses and gains without groundwater production, which is difficult to estimate accurately, in addition to the estimates of losses and gains with groundwater production. Instead, losses are used with the understanding that these losses are correlated with depletions, even if they are also correlated with higher streamflows.

The minimum threshold is quantified based on maximum historical period losses, plus a buffer. Historical levels of losses have not been locally identified as causing undesirable results. The ESJWRM Historical Simulation identifies the maximum losses as occurring within the wettest years, based on the San Joaquin Valley Water Year Hydrologic Classification. These losses are substantially driven by high river stage and wider river conditions caused by these wet conditions, much more so than by groundwater levels. As these wet year depletion values are less tied to groundwater conditions than other year types, wet year losses were removed from the analysis to identify a minimum threshold. Similarly, wet years are not be subject to comparisons with the minimum threshold.

Critical, dry, below normal, and above normal water years, based on the San Joaquin Valley Water Year Hydrologic Classification, were used to define the minimum threshold value. The maximum stream loss from the ESJWRM Historical Simulation is 167,300 AFY. As this level of losses is not known to have caused undesirable results, a buffer is added to the maximum historical depletion in the amount of the total range in losses over the Historical Simulation within these year types: 89,200 AFY. Thus, the minimum threshold for non-wet-years is the sum of the maximum annual depletion within the Historical Simulation and the range in losses over the Historical Simulation: 167,300 AFY + 89,200 AFY = 256,500 AFY. Rounding, we establish the minimum threshold for depletions as 250,000 AFY.

Monitoring for comparison with the minimum threshold will be performed through continued update and simulation using the ESJWRM. Total net losses will be calculated based on an average of the most recent 5-year period, not including wet years. This 5-year average would be compared to the minimum threshold.

Measurable Objectives and Interim Milestones

Measurable objectives are target thresholds set above minimum thresholds at a point that allows for active management of the basin during dry periods without reaching the minimum threshold. The condition between the measurable objective and the minimum threshold is known as the margin of operational flexibility (MoOF). The MoOF is intended to accommodate droughts, climate change, conjunctive use operations, or other groundwater management activities.

Like the minimum threshold, the measurable objective for depletions of interconnected surface water was established based on the simulation using the numerical groundwater and surface water model, ESJWRM. A Sustainability Simulation was developed to guide long-term groundwater management, leading to stable groundwater levels.

The average estimated annual stream loss of 123,900 AF using the results from the ESJWRM Sustainability Run is the measurable objective for depletions of interconnected surface water. As with the minimum threshold analysis, wet year stream losses were not incorporated into the analysis to establish the measurable objective. An objective of 125,000 AFY (rounded) is set for overall, non-wet-year stream losses, encompassing net gains and losses across all simulated rivers and streams.

Monitoring for comparison with the measurable objective will be performed through continued update and simulation using the ESJWRM. Total net losses will be calculated based on an average of the most recent 5-year period, not including wet years. This 5-year average would be compared to the measurable objective.

As the measurable objective is similar to the current level of losses, interim milestones for 2025, 2030, and 2035 are established at the same 125,000 AFY level.

Approach 2: Using Groundwater Levels as a Proxy

Justification for Using Groundwater Levels as a Proxy

GSP regulations allow GSAs to use groundwater levels can be used as a proxy metric for any sustainability indicator, provided the GSP demonstrates that there is a significant correlation between groundwater levels and the other metrics. DWR indicates two possible approaches:

1) ***Demonstrate that the minimum thresholds and measurable objectives for chronic declines of groundwater levels are sufficiently protective to ensure significant and unreasonable occurrences of other sustainability indicators will be prevented. In other words, demonstrate that setting a groundwater level minimum threshold satisfies the minimum threshold requirements for not only chronic lowering of groundwater levels but other sustainability indicators at a given site.***

2) *Identify representative groundwater elevation monitoring sites where minimum thresholds and measurable objectives based on groundwater levels are developed for a specific sustainability indicator. In other words, the use of a groundwater level minimum threshold is <u>not</u> intended to satisfy the minimum threshold requirements for chronic lowering of groundwater but is intended solely for establishing a threshold for another sustainability indicator.*

In order to use the minimum thresholds and measurable objectives for chronic lowering of groundwater levels as a proxy for interconnected surface water, the stream depletions experienced below where undesirable results for groundwater levels are reached must be reasonable.

The historical depletion of interconnected surface water is not known to be significant or unreasonable. Therefore, the stream losses in the historical simulation are assumed to have no associated undesirable results. If groundwater levels were to fall to the proposed groundwater level thresholds, there is an associated level of additional stream depletions but undesirable results for this indicator are unlikely. Depletions above this volume are unlikely, as groundwater levels below minimum thresholds and with undesirable results would be required.

The current draft groundwater level minimum thresholds were evaluated to check for groundwater level undesirable results (non-dry year pairings where 25% or more wells fall below their minimum thresholds) based on existing future simulations (i.e., projected conditions simulation and sustainable simulation). The sustainable simulation does not result in groundwater level undesirable results, but the projected conditions simulation does result in groundwater level undesirable results. The additional stream losses that occurred in the projected conditions simulation compared to the historical simulation are estimates of depletions as they can be linked directly to increased groundwater pumping. The additional depletions in the projected conditions simulation are 70,000 AFY, which is approximately 1.4% of total stream outflows. An additional 70,000 AFY of stream depletions is proposed to not be considered either significant or unreasonable. Depletions greater than an additional 70,000 AFY require groundwater levels that would

be classified as undesirable results under the groundwater level sustainability indicator. Therefore, groundwater level thresholds are protective of the depletion of interconnected surface water.

QUESTION FOR CONSIDERATION: Which approach should be recommended for defining undesirable results and setting minimum thresholds and measurable objectives?

CONSULTANT RECOMMENDATION (APPROACH 2)

Approach 1:

- **Proposed Minimum Threshold:** Maximum Historical Simulation stream loss (critical, dry, below normal, and above normal water years) plus buffer equal to historical range
- **Proposed Measurable Objective:** Average Sustainable Simulation stream loss (critical, dry, below normal, and above normal water years)
- **Proposed Interim Milestones:** 5-year milestones along a linear trend between current condition and the measurable objective
  Proposed Definition of Violation: Undesirable results are considered to occur when the 5-year average stream losses for the Sustainable Simulation exceed the minimum threshold as a result of groundwater pumping

Approach 2 (Recommended):

- **Proposed Minimum Threshold:** Consistent with groundwater levels minimum thresholds
- **Proposed Measurable Objective:** Consistent with groundwater levels measurable objectives
- **Proposed Interim Milestones:** Consistent with groundwater levels interim milestones
- **Proposed Definition of Violation:** Consistent with groundwater levels definition of undesirable result

ADVISORY COMMITTEE RECOMMENDATION
Advisory Committee to consider on April 24, 2019

BOARD RECOMMENDATION
Board to consider on May 8, 2019