3-33 of the 2020 GSP. These constituents included salinity as total dissolved solids (TDS), arsenic, nitrate, 1,2,3-trichloropropane (TCP), and 1,2-dibromo-3-chloropropane (DBCP). However, these figures did not present these data in relationship to the principal aquifers. Sections 4.3.1 through 4.3.8 of this Addendum provide a discussion for each of these constituents within each of the primary aquifers that are referred to as A-zone, B-zone, and C-zone (see Section 2). Based on further review of the data since the submittal of 2020 GSP, uranium, sulfate, and chloride were added to the constituents for assessment within the Subbasin. SMCs will be developed for the COCs presented in Section 4.3.9.

Data used for the discussion below is from the Groundwater Ambient Monitoring & Assessment Groundwater Information (GAMA) System available from the California State Water Resources Control Board GeoTracker™ system. Data used from GAMA is included in Appendix C. For the discussion, the constituents are compared to state and federal secondary maximum contaminant levels (SMCL) include TDS, sulfate, and chloride. Arsenic, nitrate, uranium, TCP, and DBCP concentartions were compared to the primary maximum contaminant levels (MCL)). CCR Title 22 (Title 22) SMCLs are reported as “recommended" “upper”, and “short term” SMCLs. Constituent concentrations lower than the recommended SMCL (for example, 500 mg/L for TDS) are desirable for a higher degree of consumer acceptance. Constituent concentrations ranging to the Upper SMCL (for example, 1,000 mg/L for TDS) are acceptable if it is neither reasonable nor feasible to provide water with lower concentrations. Constituent concentrations ranging to the short-term SMCL (for example, 1,500 mg/L for TDS) are acceptable only for existing community water systems on a temporary basis pending construction of treatment facilities or development of acceptable new water sources. For the purposes of the discussions presented below, the upper SMCLs are used.

It is also noted, as shown on Figure 4-1, that for a large portion of the basin the agricultural uses (AGR) and municipal uses (MUN) of groundwater have been de-designated within the Basin Plan (SWRCB R5-2017-0032) due to salinity and currently are not required to be monitored according to the Regional Water Quality Control Board (RWQCB) and the Tulare Lake Basin Plan Amendment unless projects are proposed that would trigger monitoring in this area. As such, at this time, SMCs for these constituents will not be developed for these areas. If in the future this designation is changed, then the development of SMCs will be prepared accordingly for these areas.

4.3.1 TDS

Figure 4-2 presents the historic Subbasin-wide distribution of TDS in groundwater. Figures 4-2 (a), (b), and (c) show this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Figure 4-2(d) shows the distribution for wells where the screen intervals are unknown. As seen on Figure 4-2(d), the screen interval for the majority of wells within the GAMA system are unknown.

Figure 4-2 (a) shows that only one well with reported screen intervals within A-zone had a reported TDS concentration above the Upper SMCL of 1,000 mg/L. Figure 4-2 (d) shows that numerous wells where the screen intervals are not known have reported TDS concentrations above the Upper SMCL. However, the majority of these wells are located within the de-designated portion of the Subbasin.

Sources of TDS, or salinity, include naturally occurring and anthropogenic sources. Naturally occurring sources include brackish and saline marine connate waters that exist within the de-designated area and at depth beneath the useful aquifers throughout most of the Central Valley. A detailed discussion of these sources is provided in Section 3.2.5 of the 2020 GSP.

4.3.2 Nitrate

Figure 4-3 presents the historic Subbasin-wide distribution of nitrate in groundwater reported as nitrate as nitrogen (N). Figures 4-3 (a), (b), and (c) show this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Figure 4-3 (d) shows the distribution for wells where the screen intervals are unknown. As seen on Figure 4-3 (d), the screen interval for the majority of wells within the GAMA system are unknown.

Figure 4-3 (b) shows that only one well with reported screen intervals within the B-zone had a reported nitrate as N concentration above the MCL of 10 mg/L. Figure 4-3 (d) shows that several wells where the screen interval are not known have reported Nitrate as N concentrations above the MCL. Most of these wells are located outside of the de-designated portion of the Subbasin.

Sources of nitrate are anthropogenic, mostly related to agricultural practices. A discussion of these sources is provided in Section 3.2.5 of the 2020 GSP.

4.3.3 Arsenic

Figure 4-4 presents the historic Subbasin-wide distribution of arsenic in groundwater. Figures 4-4 (a), (b), and (c) show this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Figure 4-4 (d) shows the distribution for wells where the screen intervals are unknown. As seen on Figure 4-4 (d), the screen interval for the majority of wells within the GAMA system is unknown.

Figures 4-4 (a) through (d) show that arsenic has been reported above the MCL of 0.0010 mg/L within the three primary aquifer zones. Figure 4-4 (d) shows that several wells where the screen interval are not known across the Subbasin including the de-designated portion have reported arsenic concentrations above the MCL.

Sources of arsenic are naturally occurring. A discussion of these sources is provided in Section 3.2.5 of the 2020 GSP.

4.3.4 Uranium

Figure 4-5 presents the historic Subbasin-wide distribution of uranium in groundwater. Figures 4.5 (a), (b), and (c) show this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Figure 4-5 (d) shows the distribution for wells where the screen intervals are unknown.

Uranium above the MCL of 20 pCi/L (30 ug/L) was reported in 4 wells completed in northwest portion of the Subbasin for B-zone (Figure 4-5 [b]) and one well in this same area for wells where the screen interval is not known (Figure 4-5 [d]). Sources of uranium are naturally occurring in sediments sourced from the Sierra Nevada.

4.3.5 1,2,3-TCP

Figure 4-6 presents the historic Subbasin-wide distribution of 1,2,3-TCP in groundwater. Figures 4.6 (a), (b), and (c) show this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Figure 4-6 (d) shows the distribution for wells where the screen intervals are unknown. As seen on these figures, 1,2,3-TCP is reported above the MCL of 0.005 µg/L in the three primary aquifer zones. All of the wells listed for B-zone and C-zone had reported concentrations of 1,2,3-TCP above non-detect levels within the Subbasin.

Sources of 1,2,3-TCP are anthropogenic. A discussion of these sources is provided in Section 3.2.5 of the 2020 GSP.

4.3.6 DBCP

Figure 4-7 presents the historic Subbasin-wide distribution of DBCP in groundwater. Figures 4.7 (a), (b), and (c) show this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Figure 4-7 (d) shows the distribution for wells where the screen intervals are unknown. As seen on these figures, DBCP has not been reported above the MCL of 0.2 µg/L in any well monitored within the Subbasin.

4.3.7 Sulfate

Figure 4-8 presents the historic Subbasin-wide distribution of sulfate in groundwater. Figures 4.8 (a), (b), and (c) show this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Figure 4-8 (d) shows the distribution for wells where the screen intervals are unknown. As seen on Figure 4-8 (d), the screen interval for the majority of wells within the GAMA system is unknown.

No well with known screen interval information in the Subbasin had reported sulfate concentrations above the Upper SMCL of 500 mg/L (Figure 4-8 (a) through (c)). Figure 4-8 (d) shows that numerous wells where the screen interval are not known have reported sulfate concentrations above the Upper SMCL across the Subbasin including in the de-designated portion.

Sources of sulfate are both naturally occurring and anthropogenic. Naturally occurring sources are related to sulfate rich minerals that occur within the sediments. Anthropogenic sources are mostly related to agricultural practices. A discussion of these sources is provided in Section 3.2.5 of the 2020 GSP.

4.3.8 Chloride

Figure 4-9 presents the historic Subbasin-wide distribution of chloride in groundwater. Figures 4.9 (a), (b), and (c) show this distribution for the A-zone, B-zone, and C-zone primary aquifers, respectively. Figure 4-9 (d) shows the distribution for wells where the screen intervals are unknown. As seen on Figure 4-9 (d), the screen interval for the majority of wells within the GAMA system are unknown.

No well with known screen interval information in the Subbasin had reported chloride concentrations above the Upper SMCL of 500 mg/L (Figures 4-8 (a) through (c)). Figure 4-8 (d) shows that numerous wells where the screen interval are not known have reported sulfate concentrations above the Upper SMCL across the Subbasin with the majority of these wells being in the de-designated portion.

Sources of chloride are both naturally occurring similar to those discussed for TDS in Section 4.2.1. A discussion of these sources is provided in Section 3.2.5 of the GSP.

4.3.9 Constituents of Concern

Based on the information presented in Section 4.3.1 through 4.3.8, SMCs were developed for the following identified COCs:

- Salinity (measured as total dissolved solids [TDS])
- Nitrate (measured as nitrate as N)
- Arsenic
- Uranium
- 1.2.3-TCP
- Sulfate
- Chloride

DBCP is not considered a COC because no concentrations above the MCL have been reported in the Subbasin as discussed in Section 4.3.6. If future data for this constituent or other constituents becomes available that indicate a concern for the GSAs, then SMCs following the approach presented below will be developed.

4.4 Undesirable Results for Degraded Groundwater Quality

> **23 CCR §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 for degraded water quality in the Subbasin would be the result stemming from a causal nexus between groundwater-related GSP activities, such as groundwater extraction or recharge, and a degradation in groundwater quality that causes a significant and unreasonable reduction in long-term viability of domestic, agricultural, municipal, or environmental uses over the planning and implementation horizon of this GSP (see Section 4.5 for potential water quality effects to beneficial uses). The causal nexus reflects that the undesirable results are water quality issues associated with groundwater pumping and other GSP-related activities rather than water quality issues resulting from land use practices, naturally occurring water quality issues, or other issues not associated with groundwater pumping and other groundwater-related activities.

Within applicable areas of the Subbasin, the causal nexus would be related to increases of the following constituents resulting from GSP-related activities.

It should be noted that water quality issues outside of the causal nexus are generally covered by other regulatory frameworks. Impacted sites are regulated by the RWQCB, California Department of Toxic Substances Control, and the U.S. Environmental Protection Agency (EPA). Drinking water quality is regulated by the State Water Resources Control Board, Division of Drinking Water (SWRCB-DDW). Potential impacts by agricultural practices are regulated through Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), Irrigated Lands Regulatory Program (ILRP), and California Department of Pesticide Regulation (DPR).

The GSAs do not have control over the presence of naturally occurring constituents in aquifer materials. Known anthropogenic constituents in groundwater include salinity, nitrate, sulfate, and 1,2,3-TCP. Salinity and sulfate also have naturally occurring sources as discussed in Section 4.2.7. In the event that there is a causal nexus determined between elevated concentrations of constituents of concern and GSP-related activities, the GSAs will consider establishing SMCs for such COCs. Management actions and studies were presented in Chapter 6 of the 2020 GSP with additions presented in Section 5 of this Addendum. Implementation of these projects, management actions, and studies will be implemented pending the availability of grant or other funding, as appropriate research partners are identified and partnerships formed, or as needed for Subbasin management with the goal of further evaluating the fate and transport of COCs.

4.4.1 Identification of Undesirable Results

As discussed above and in Chapter 3 of the 2020 GSP, degraded water quality in the Subbasin occurs from both anthropogenic and natural sources and increases in these constituents not related to GSP-related activities are not considered undesirable results as part of this GSP. However, the GSAs are taking a pro-active approach by developing an "early warning" system to assess groundwater quality trends within the Subbasin. Water quality data will be assessed on an annual basis by aquifer zones. In each annual report, at each representative monitoring well, a trend analysis will be conducted using a statistical method such as the Mann Kendall trend test, for each of the COCs. Trend analysis will not be conducted until at least six samples have been collected for each analyte at each individual RMS well. If the statistical assessment indicates an upward trend as defined by the Mann Kendall test, then an assessment will be conducted to evaluate if there is a relationship between this trend and changing water levels and if these changing water levels are a result of GSP-related activities.

Using the pro-active approach, an undesirable result for degraded water quality is triggered or considered "significant and unreasonable" as follows:

- A representative monitoring well within an individual aquifer zone exceeds the MT for two consecutive measurements when exceedances can be tied to a causal nexus between GSP-related activities and water quality and the individual well has been exhibiting an upward trend.
- When MTs are exceeded with no observable upward trend, when 25% of representative monitoring wells within an individual aquifer zone exceeds the MT for two consecutive measurements at each location where these MT exceedances can be tied to a causal nexus between GSP-related activities and water quality. Twenty-five percent of the representative monitoring wells were selected because no observable upward trend would indicate a non-GSP-related activity at an individual well. Although exceedances of MTs at 25% of the representative monitoring wells with no observable upward trend still indicate non-GSP-related activity, assessing the causal nexus with water quality at this value will provide a factor of safety.

Protective efforts that will be implanted by the GSAs if the statistical assessment conducted each year indicates an upward trend for one or more COCs that can be tied to a causal nexus of GSP-related activities are discussed in Section 4.7.

4.4.2 Potential Causes of Undesirable Results

Water quality degradation has been linked to some anthropogenic activities (see Chapter 3 of the 2020 GSP) and can result from pumping activities. Groundwater pumping may result in water quality degradation due to the migration of contaminant plumes. Additionally, in some areas pumping from deep wells has caused naturally occurring soil contaminants (arsenic, uranium) to leach out and dissolve into groundwater, which may cause undesirable results.

There are no known anthropogenic contaminant plumes within the Subbasin; however, elevated concentrations of salinity in groundwater have been known to exist in some areas of the western Subbasin since the early 1900s. Salinity is considered to have increased over the past 100 years. Additionally, groundwater quality typically varies with depth above and below the Corcoran Clay. In many portions of the Subbasin, salinity is lower beneath the Corcoran Clay. In portions of the Subbasin (Figure 4-1), the agricultural uses (AGR) and municipal uses (MUN) of groundwater have been de-designated within the Basin Plan (SWRCB R5-2017-0032) due to salinity and currently are not required to be monitored according to the RWQCB and the Tulare Lake Basin Plan Amendment unless projects are proposed that would trigger monitoring in this area.

Groundwater quality is currently comprehensively monitored in the Subbasin by regulatory agencies. These agencies rely on existing regulations and policies to define undesirable results related to the deterioration of groundwater quality. The agencies and coalitions include the ILRP, GAMA, RWQCB, CV-SALTS, and cities and communities within the Subbasin.

Conditions that may cause an undesirable result for degraded water quality include changes in the location (both vertically and horizontally) and volume of groundwater pumping or managed groundwater recharge, both resulting in the contribution to and/or potential mobilization of COCs as a result of these activities.

4.4.3 Potential Effects of Undesirable Results

Should undesirable results occur with respect to groundwater quality, the amount of usable groundwater in the Subbasin could be reduced. If treatment is not feasible, this degradation could affect the groundwater supplies for agricultural, municipal, industrial, and domestic needs. Additional costs would be incurred as some treatment could be needed, some supply wells may have to be deepened or their pumps lowered, new wells may have to be drilled, and yields may be reduced. Also, should undesirable results occur with respect to groundwater quality, the amount of usable groundwater in storage may be reduced. A more detailed discussion of potential water quality effects to beneficial uses is presented in Section 4.1.

4.5 Minimum Thresholds for Degraded Groundwater Quality

> **23 CCR §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.*

As discussed in Section 4.3, three of the COCs, TDS, chloride, and sulfate have Title 22 SMCLs reported as recommended, upper, and short term SMCLs. For SMCs only the Recommended SMCL and Upper SMCL are used as discussed in this section and following sections. The other four constituents, nitrate, arsenic, uranium and 1,2,3-TCP have Primary MCLs.

For the Subbasin, the MTs for degraded water quality is established as the higher of: (1) the Upper SMCL for TDS (1,000 mg/L), chloride (500 mg/L) and sulfate (500 mg/L) and Primary MCL for nitrate as N (10 mg/L), arsenic (0.010 mg/L), uranium (20 pCi/L), and 1,2,3-TCP (0.005 µg/L) or (2) current water quality conditions for all constituents defined as data available from 2000 to January 2020 at the representative monitoring well or nearby well within the same aquifer zones described in Section 3.1.8 of the Basin Setting chapter of the 2020 GSP, using the maximum concentration detected for each constituent. For 1,2,3-TCP, limited data has been collected and analytical methods and detection limits have changed. As such MTs have been set at the MCL regardless of past concentrations. Further assessment of the MT for 1,2,3-TCP will be conducted as additional data are collected. Table 4-1 reflects the MTs for degraded water quality at each representative monitoring site. Minimum thresholds for degraded water quality are established consistent with California drinking water standards and California's Antidegradation Policy (State Board Resolution 68-16). The selected MTs for degraded water quality reflect input to the GSAs who conduct regular public meetings and received feedback from local landowners and other stakeholders and are expected to avoid undesirable results in the Subbasin. It should be noted that the concentrations presented for MTs in some cases reflect ambient groundwater quality, where additional treatment may be necessary to meet state and federal MCLs for drinking water.

As discussed above for portions of the Subbasin, the agricultural uses (AGR) and municipal uses (MUN) of groundwater have been de-designated within the Basin Plan due to salinity and currently are not required to be monitored according to the RWQCB and the Tulare Lake Basin Plan Amendment unless projects are proposed that would trigger monitoring in this area. As such, no MTs are set for these areas. If projects are proposed that would trigger monitoring in these areas, then the development of groundwater quality SMCs will be considered.

4.5.1 Relationship to Other Sustainability Indicators

Described below are the relationship between MTs for each sustainability indicator, including an explanation of how it was determined that basin conditions at the MTs for degraded water quality will avoid undesirable results for each of the other applicable sustainability indicators to the Subbasin. Minimum thresholds for degraded water quality are selected to avoid undesirable results for the other applicable sustainability indicators in the Subbasin.

- **Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage**. There are limited groundwater quality data available in the Subbasin to support a connection between groundwater levels or storage changes and elevated concentrations of COCs. However, the MTs established for degraded water quality could impact direct use of supplemental water supplies for groundwater recharge projects, where ambient water quality may constrain supplies available for recharge or require additional treatment prior to land application or injection, and could thus limit the ability to maintain the measurable objectives established for the chronic lowering of groundwater levels or reduction of groundwater storage sustainability indicator if such projects were to be identified for implementation.

- **Seawater Intrusion**. This sustainability indicator is not applicable to the Subbasin.
- **Land Subsidence**. Based on local knowledge and the best available science, degraded water quality and land subsidence MTs are not related. Therefore, MTs for degraded water quality are not anticipated to cause undesirable results for land subsidence.
- **Depletion of Interconnected Surface Water**. For areas within the Subbasin where interconnected surface water may exist, MTs for degraded water quality are established to be protective of drinking water standards or current water quality (based on available data from 2000 to 2020) where current conditions exceed drinking water standards (the highest beneficial use of water in California), consistent with California's Antidegradation Policy. Additionally, the volume of surface water in the interconnected surface water courses in the Subbasin is much larger than the volume of water that the aquifer is contributing to those streams. As such, while surface water quality is not within the purview of SGMA, the MTs for degraded water quality are not anticipated to degrade the quality of interconnected surface water.

4.6 Representative Monitoring Sites for Degraded Groundwater Quality

Groundwater quality is monitored in the Subbasin by regulatory agencies using existing regulations and policies. Constituents and sample frequencies are determined by existing programs set to drinking water standards and listed with the applicable monitoring agency in Table 4-2. The Subbasin will continue monitoring groundwater quality using the existing monitoring program standards as determined by the SWRCB-DDW. Within the Tulare Lake Subbasin Groundwater Quality Monitoring Network, there are instances where a COC is not monitored at a well location as the constituent is not considered a concern to drinking water and therefore not included in an existing monitoring program. Uranium is the least monitored COC within the GSA's network but is listed as a COC due to higher concentrations found along the northwest portion of the Subbasin where it is monitored.

At this time, the GSAs only monitor the B-zone and C-zone. Water quality monitoring within the A zone is considered a data gap as regulatory programs that observe the perched aquifer do not sample for the constituents discussed in Section 4.1. The GSAs will continue to look for additional monitoring locations for all three aquifers within areas for domestic and environmental uses as well as outside of de-designated areas. Monitoring wells installed by a GSAs to resolve data gaps will be added to the groundwater quality network, such as South Fork Kings GSA's recently installed well "SL-1". These wells will be sampled for COCs annually. The GSAs will search for wells within domestic areas that are screened in the B zone and will commit to sampling these wells on an annual basis. Groundwater quality monitoring locations are shown on Figure 4-10 with well construction included in Table 4-1.

Water quality results will continue to be reported as part of the GSA's Annual Report which is submitted to DWR every year by April 1st. The GSAs will observe statistical analytical trends annually and coordinate with the existing monitoring program managers to receive data prior to public publication and evaluate whether the results are indicative of GSP-related activities and need further assessment. If further assessment is needed, the GSAs will coordinate with the existing monitoring program managers to collect confirmation samples and collectively investigate the cause of groundwater quality issues.

4.7 Measurable Objectives for Water Quality

23 CCR §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.*

The measurable objective for degraded water quality for TDS, sulfate, and chloride are as follows:

- Where current conditions are below the recommended SMCL, the measurable objective is the recommended SMCL.
- Where current conditions are above the recommended SMCL, the measurable objective is set as the current water quality conditions based on data available from 2000 to January 2020 at the representative monitoring well or nearby well within the same aquifer zone using the tolerance interval approach. The tolerance interval is one of the approved statistical methods described in Title 27, Division 2, Subdivision 1, Chapter 3, Subchapter 3, Article 1, Section 20415(e)(8)(C) for establishment of concentration limits.
- The purpose of a tolerance interval approach is to define a concentration range, or tolerance interval, from well data within which a large proportion of the monitoring observations should fall with a high probability. The proportion of the population included in the tolerance interval is referred to as the coverage. The probability with which the tolerance interval includes the proportion of the population is referred to as the tolerance coefficient. The upper and lower bounds of the tolerance interval are referred to as the tolerance limits. The upper tolerance limit (UTL) will be used to calculate the MOs for the Subbasin.
- Consistent with USEPA and state recommendations, a 95 percent coverage and 95 percent tolerance coefficient will be used. The upper 95 percent tolerance limit will contain at least 95 percent of the distribution of observations from well data.
- In the event that well-specific data or nearby well data in the same aquifer zone are not present, the measurable objective has been set at the recommended SMCL. As data are collected from these wells, the MO will be reevaluated and if data is over the SMCL the MO will be established as the UTL. A minimum of six samples will be collected prior to calculating the MO using the tolerance interval approach. Prior to collection of six samples, the MO will be the average value of sample collected.

The measurable objective for degraded water quality for nitrate (as N), arsenic, uranium, and 1,2,3-TCP are as follows:

- The current water quality conditions on data available from 2000 to January 2020 at the representative monitoring well or nearby well within the same aquifer zone using the ULT of each constituent.
- In the event that well-specific data or nearby well data in the same aquifer zone are not present, the measurable objective has been set at 70 percent of the MCL per the adaptive management trigger system described in the *Framework for a Drinking Water Well Impact Mitigation Program* (Self-Help Enterprises et al., n.d.)]. As described above, as data are collected from these wells, the MO will be re-established using the tolerance interval approach.

As discussed in Section 4.3 for MTs, past data for 1,2,3-TCP is questionable due to changes in analytical methods and detection methods. As such, for the COC the MO has been set at 70 percent of the MCL for all RMS wells. As additional data are collected for this COC, additional analysis will be conducted, and the MO modified as appropriate following the approach described in this Section.

4.8 Data Gaps

Data gaps for the degraded groundwater quality include the following:

- Currently, regulatory programs do not sample domestic wells for the COCs within the A-zone.
- B-zone RMS wells do not include domestic wells.

To fill these data gaps, the GSAs will coordinate with other agencies such as the RWQCB and SWRCB-DDW to identify wells that are already monitored within the areas identified as data gaps. For identified wells that are sampled but not for the COCs, the GSAs will request the COCs be added to the sampling list. If wells cannot be identified through these programs, the GSAs will identify existing domestic wells that can be sampled and sample them on an annual basis for the COCs.

4.9 Protective Efforts

Protective efforts that will be employed by the GSAs for degraded groundwater quality if the statistical assessment conducted each year as described in Section 4.3 indicates an increasing concentration trend for one or more COCs that can be tied to a causal nexus of GSP-related activities. These protective efforts will include one or more of the following actions so that the observed increasing trend does not produce an undesirable result:

- Coordinate with agencies and coalitions responsible for groundwater quality concerns by requesting data prior to public publication and notifying agencies of increasing trends.
- Additional geochemical testing to assess potential water/sediment interactions that could result in increases of the COC, specifically for the naturally occurring constituents.
- Aquifer testing to assess transport mechanisms for increases in concentrations.

- Zonal testing of wells to assess if there are specific areas of the aquifer zone where the increases are occurring.
- Restrictions in pumping both laterally and vertically to assess if these changes will reduce or eliminate the increasing trend.

5 PROJECTS AND MANAGEMENT ACTIONS TO ADDRESS POTENTIAL IMPACTS

The GSP identifies five classes of projects that would be implemented to address potential impacts to beneficial uses, including:

- Construction of new and modification of existing conveyance facilities;
- Above-ground surface water storage projects;
- Recharge basins and/or water banking in or out of the Subbasin;
- On-farm flooding; and
- Aquifer Storage and Recovery (ASR).

No substantive changes to these potential project actions are anticipated based on the revisions to the SMC for groundwater level, subsidence, and water quality.

The GSP also identifies a variety of management actions that each GSA would consider for implementation. The management actions listed below are from the GSP submitted in 2020. Additional management action details based on the revised SMC have been added. These additional details are highlighted in ***bold italics***.

Project Policies as needed for Project Implementation

- Construction of new and modification of existing conveyance facilities;
- Above-ground surface water storage projects;
- Recharge basins and/or water banking in or out of the Subbasin;
- On-farm flooding; and
- Aquifer Storage and Recovery (ASR).

Outreach activities

- Education on groundwater use
- ***Education on water budgets***
- ***Education on subsidence***
- ***Education on water quality***
- ***Web-based tools for landowner input and confirmation of well completion details***

Groundwater Allocation

- Development of GSA level groundwater allocation

- Development of landowner groundwater allocation
- Groundwater marketing and trade

Fee Assessments

- Pumping fees for groundwater extractions
- Pumping fees for groundwater allocation exceedances
- Fees for operation and management of groundwater extractions
- ***Voluntary Cost-Share Programs for Well Owners***
- Well efficiency program to improve pumping efficiency in non-de-minimus wells
- Metering program to install meters in non-de-minimus wells
- Water quality monitoring program for domestic well owners

Coordination and Co-management of Kings County Groundwater Regulations

- Annual monitoring and reporting requirements for non-de-minimus wells
- Require new developments (non-de minimis extractors) to prove sustainable water supplies if land use conversion is not a conservation measure
- ***Develop a well registration program for all parcels in Kings County***
- ***Develop overlay maps for a well permit program that can also be used for land use planning***
- ***Fees and/or well construction and monitoring requirements for land development proposals/permits requiring groundwater supply***
- ***Fees and/or siting and monitoring requirements for land development proposals/permits involving critical infrastructure that would be vulnerable to subsidence.***

Mitigation Plan Framework

- See Appendix D for more details

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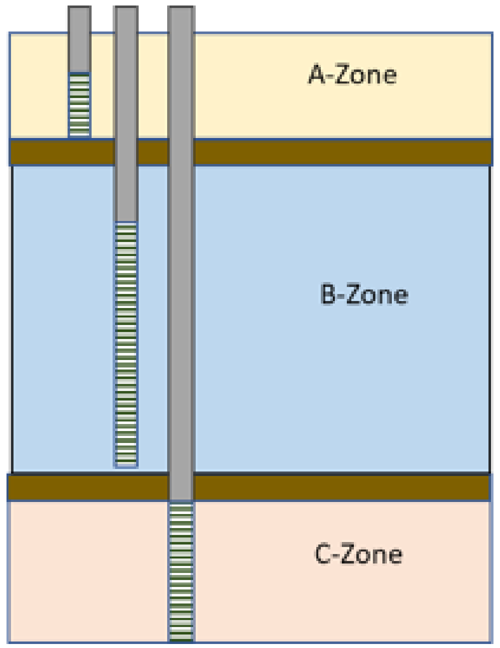
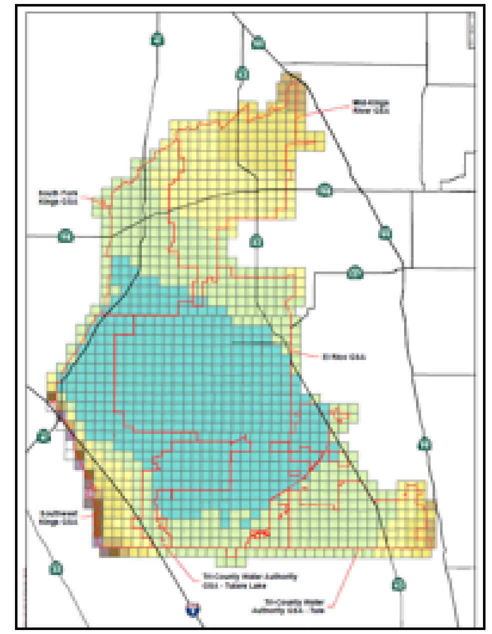
FIGURES

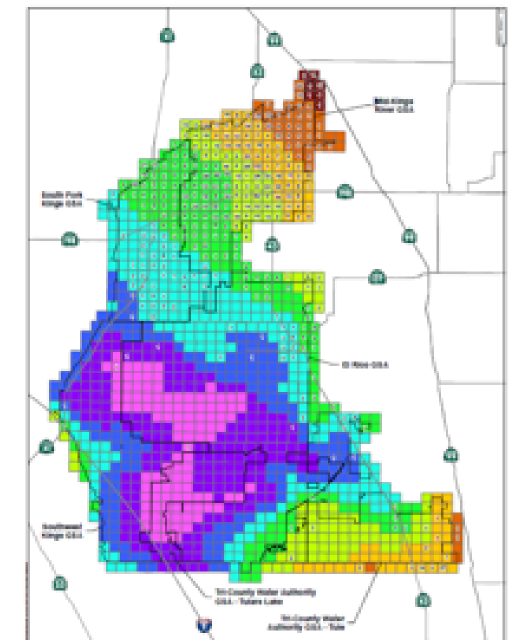
1 Aquifer Zones

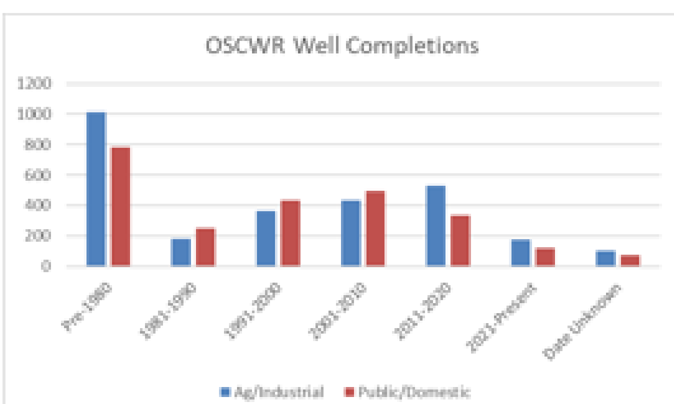


2 Topography at TRS-Scale

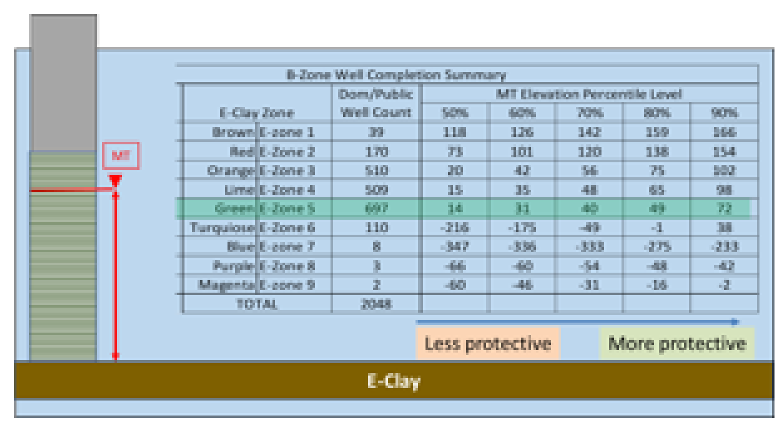


3 E-clay elevation at TRS-Scale





4 OSCWR Database of all DOM & AGR Wells



B-Zone Well Completion Summary

E-Clay Zone		Dom/Public Well Count	MT Elevation Percentile Level				
			50%	60%	70%	80%	90%
Brown	E-zone 1	39	118	126	142	159	166
Red	E-Zone 2	170	73	101	120	138	154
Orange	E-Zone 3	510	20	42	56	75	102
Lime	E-Zone 4	509	15	35	48	65	98
Green	E-Zone 5	697	14	31	40	49	72
Turquoise	E-Zone 6	110	-216	-175	-49	-1	38
Blue	E-zone 7	8	-347	-336	-333	-275	-233
Purple	E-Zone 8	3	-66	-60	-54	-48	-42
Magenta	E-zone 9	2	-60	-46	-31	-16	-2
TOTAL		2048					

5 Statistical Analysis for Regional MT

6 Reality Check vs Original RMS MT

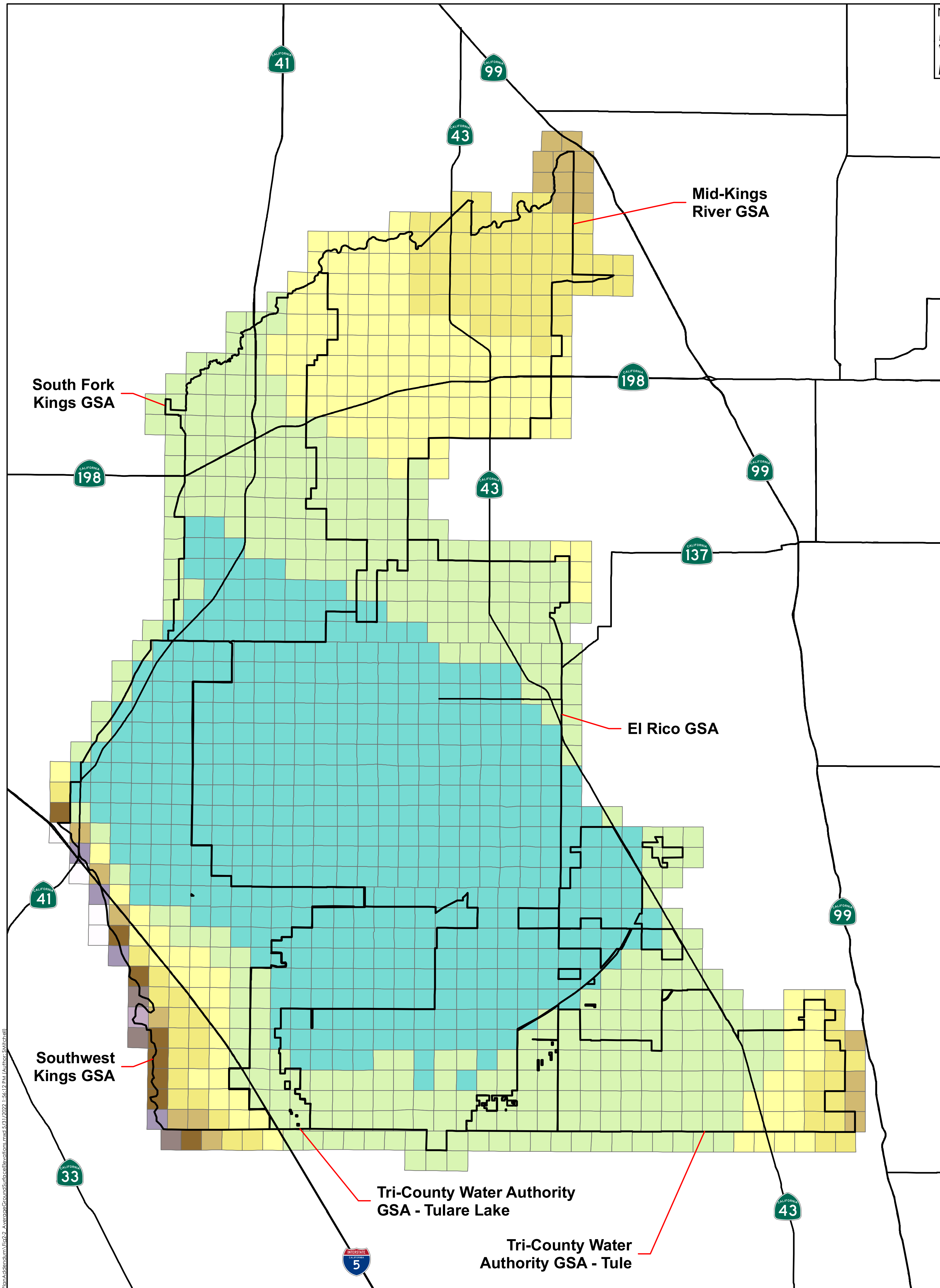
Notes:
AGR = Agricultural
DOM = Domestic
E-Clay = Corcoran Clay
OSWCR = Online System of Well Completion Reports
MT = Minimum Threshold
RMS = Representative Monitoring Site
SMC = Sustainable Management Criteria
TRS = Township, Range, Section

Overview Schematic of Process for Developing SMC for Groundwater Level
Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County

Geosyntec consultants

Project No.: SFO138 | June 2022

Figure 2-1



Legend

Mean ground surface elevation (feet msl) [1,2]

- 181.6 - 206.9
- 207.0 - 232.2
- 232.3 - 257.4
- 257.5 - 282.7
- 282.8 - 308.0
- 308.1 - 333.2
- 333.3 - 358.5
- 358.6 - 383.8
- 383.9 - 409.0
- 409.1 - 434.3
- Groundwater Sustainability Agency (GSA) boundary

5 2½ 0 5 Miles

Map of Average Ground Surface Elevation by Township/Range/Section (TRS)

Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County

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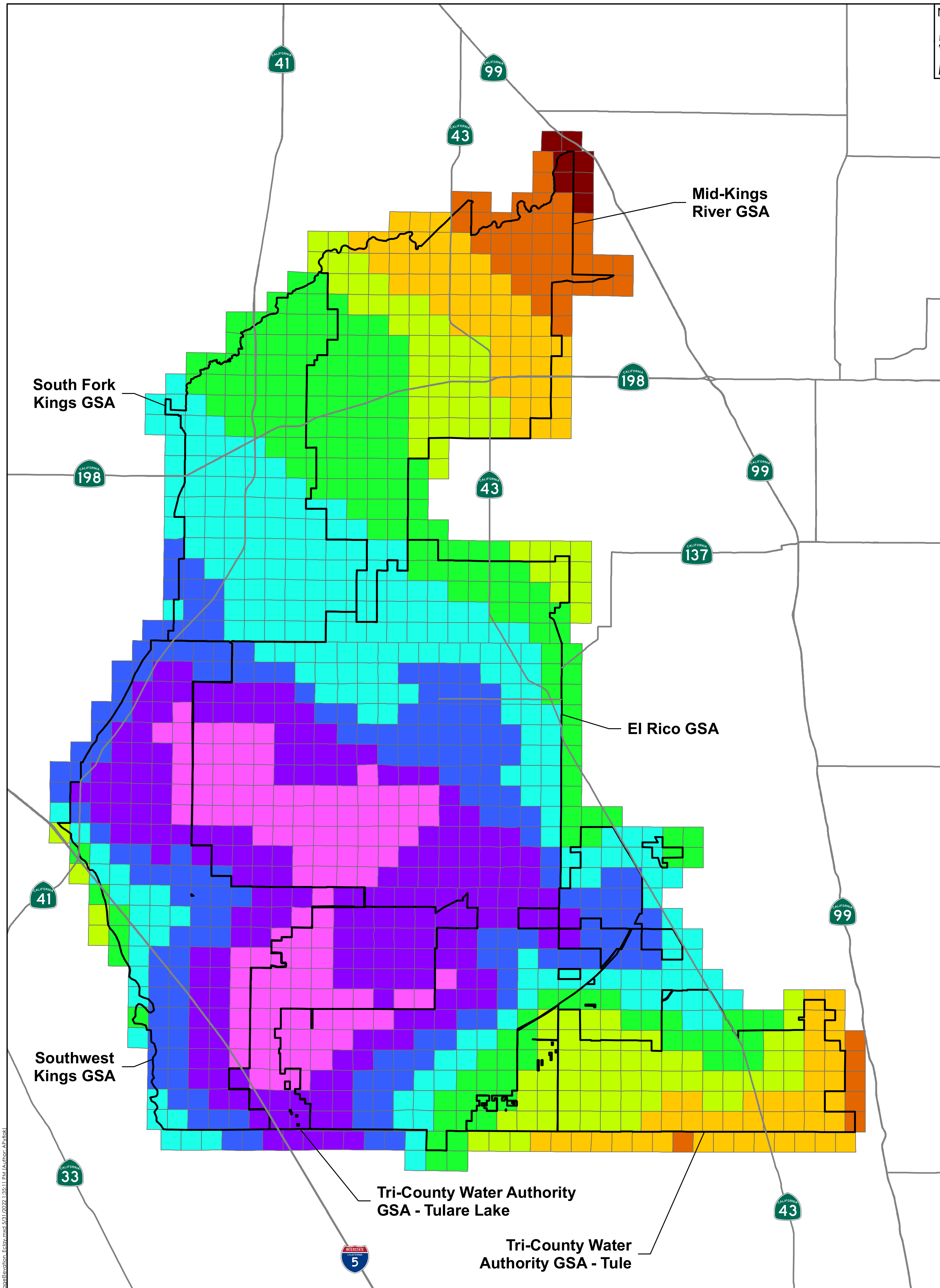
Figure 2-2

Project No.: SFO138 May 2022

Note:
1) U.S. Geological Survey (USGS), National Elevation Dataset (NED), 1/3 arc-second Digital Elevation Model (DEM). Accessed 3 March 2022.
2) Mean ground surface elevation per section was calculated using the Zonal Statistics tool in ESRI Spatial Analyst.

P:\GIS\SFO138 - Tulare Lake GSP Update 2022\Projects\2022_GroundwaterSustainabilityPlanAddendum\Fig2-2_AverageGroundSurfaceElevations.mxd 5/31/2022 1:56:12 PM (Author: SMitchell)



Legend

Average elevation of top of E-clay per section (feet msl)

- < -600
- -599 - -500
- -499 - -400
- -399 - -300
- -299 - -200
- -199 - -100
- -99 - 0
- 1 - 100
- > 100
- Groundwater Sustainability Agency (GSA) boundary

Notes:

Depth to the top of Corcoran Clay (E-clay) was determined using USGS Progessional Paper 1766's Corcoran Clay dataset. The same dataset was used to create Figure 3-19a of the Tulare Lake Subbasin GSP. An elevation raster was created then compared against a ground elevation raster to find the elevation to the top of the E-clay. Mean ground surface elevation per section was calculated using the Zonal Statistics tool in ESRI Spatial Analyst

5 2½ 0 5 Miles

Map of Average Elevation by Township/Range/Section (TRS)

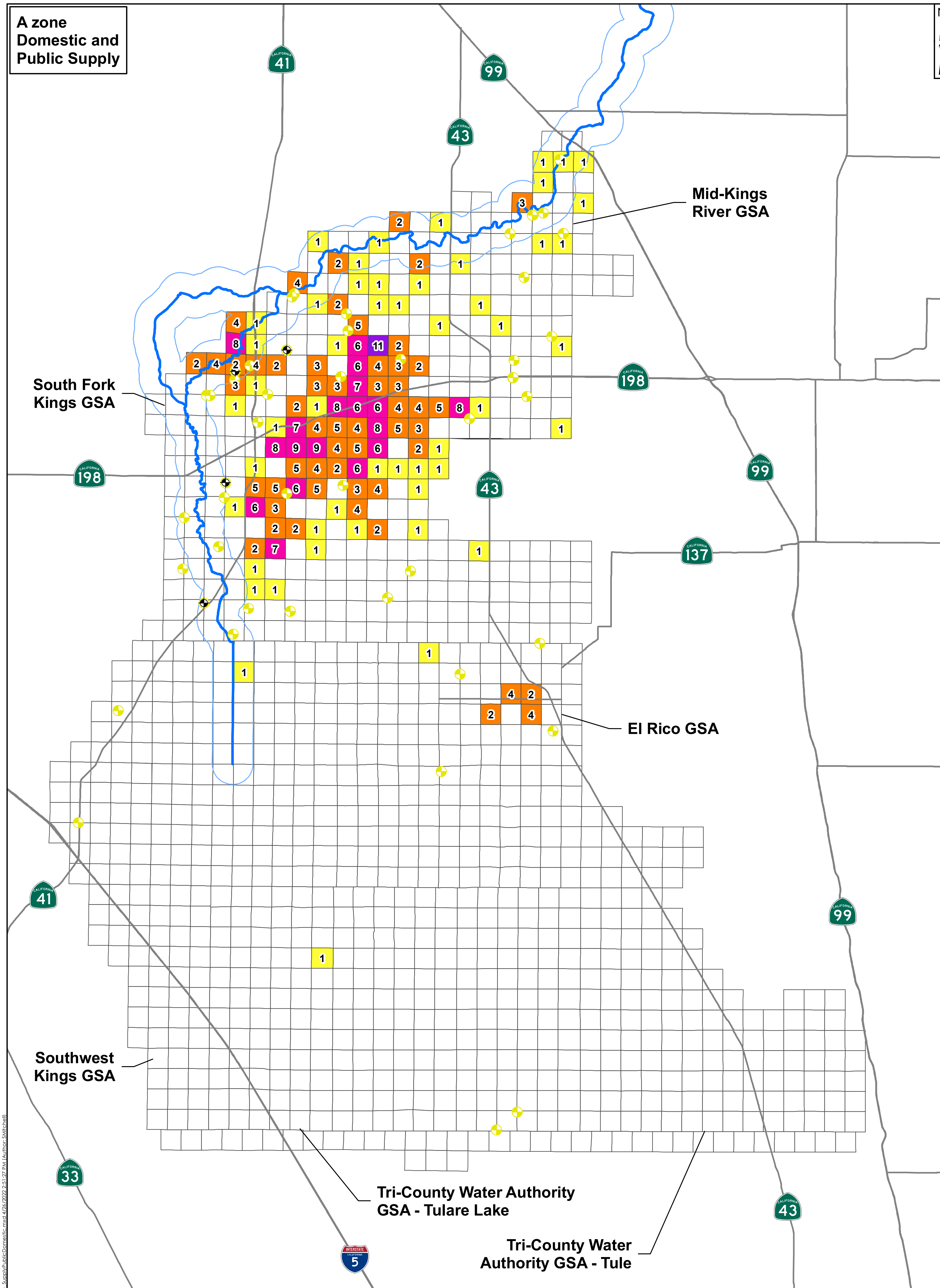
Groundwater Sustainability Plan Agenda
Tulare Lake Subbasin, Kings County

Geosyntec consultants

Figure 2-3

Project No.: SFO138

May 2022



Legend

- RMS Wells
- Groundwater Sustainability Agency (GSA) boundary
- Kings River
- River Zone

Wells per Section

- 0
- 1
- 2 - 5
- 6 - 10
- 11 - 15

5 2½ 0 5 Miles

Map of Wells Completed in A-zone for Public/Domestic Purpose of Use

Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County

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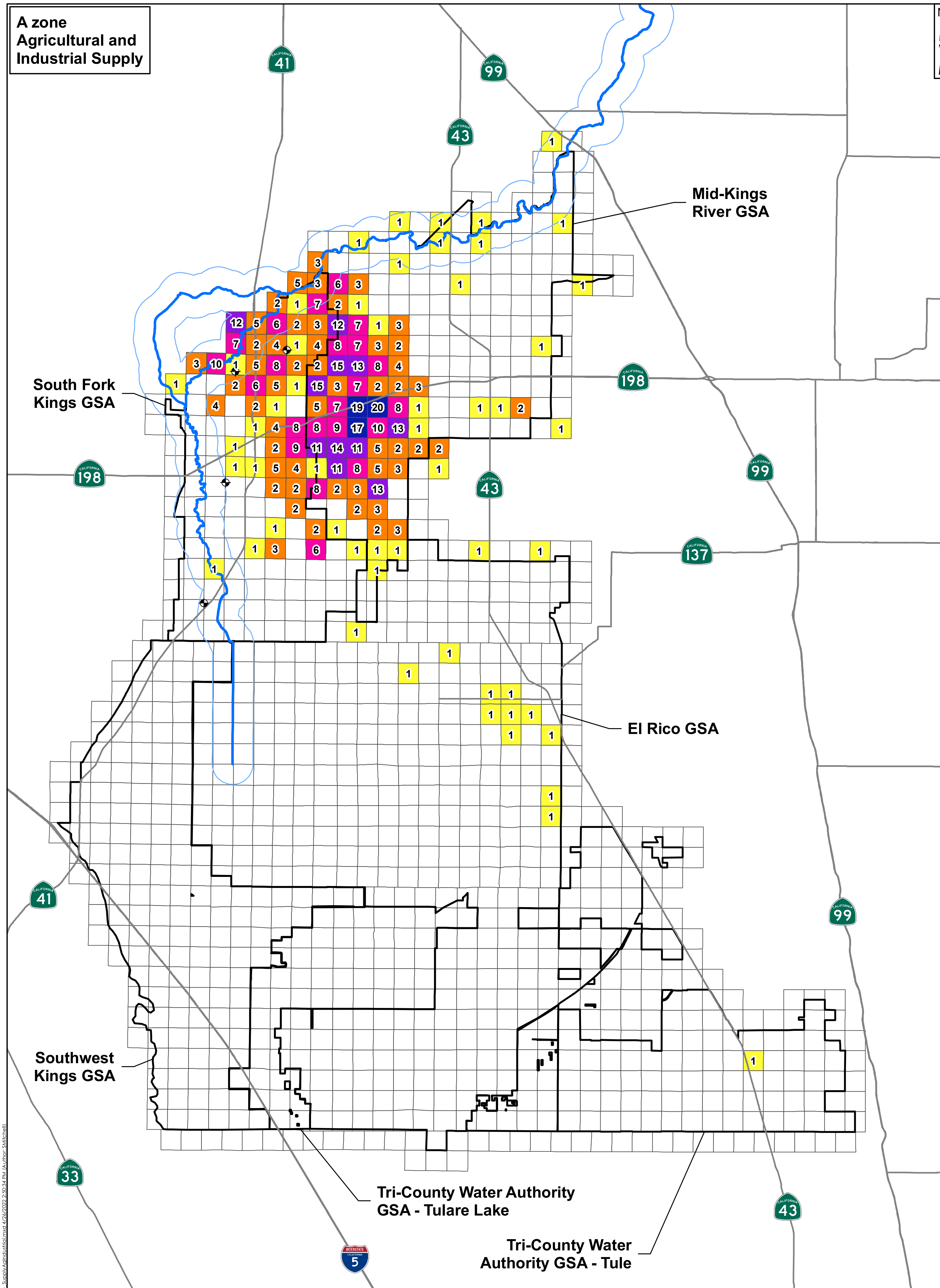
Figure **2-4a**

Project No.: SFO128 | April 2022



Legend

- RMS Wells
- Groundwater Sustainability Agency (GSA) boundary
- Kings River
- River Zone

Wells per Section

- 0
- 1
- 2 - 5
- 6 - 10
- 11 - 15
- 16 - 20

5 2½ 0 5 Miles

Map of Wells Completed in A-zone for Agricultural/Industrial Purpose of Use

Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County

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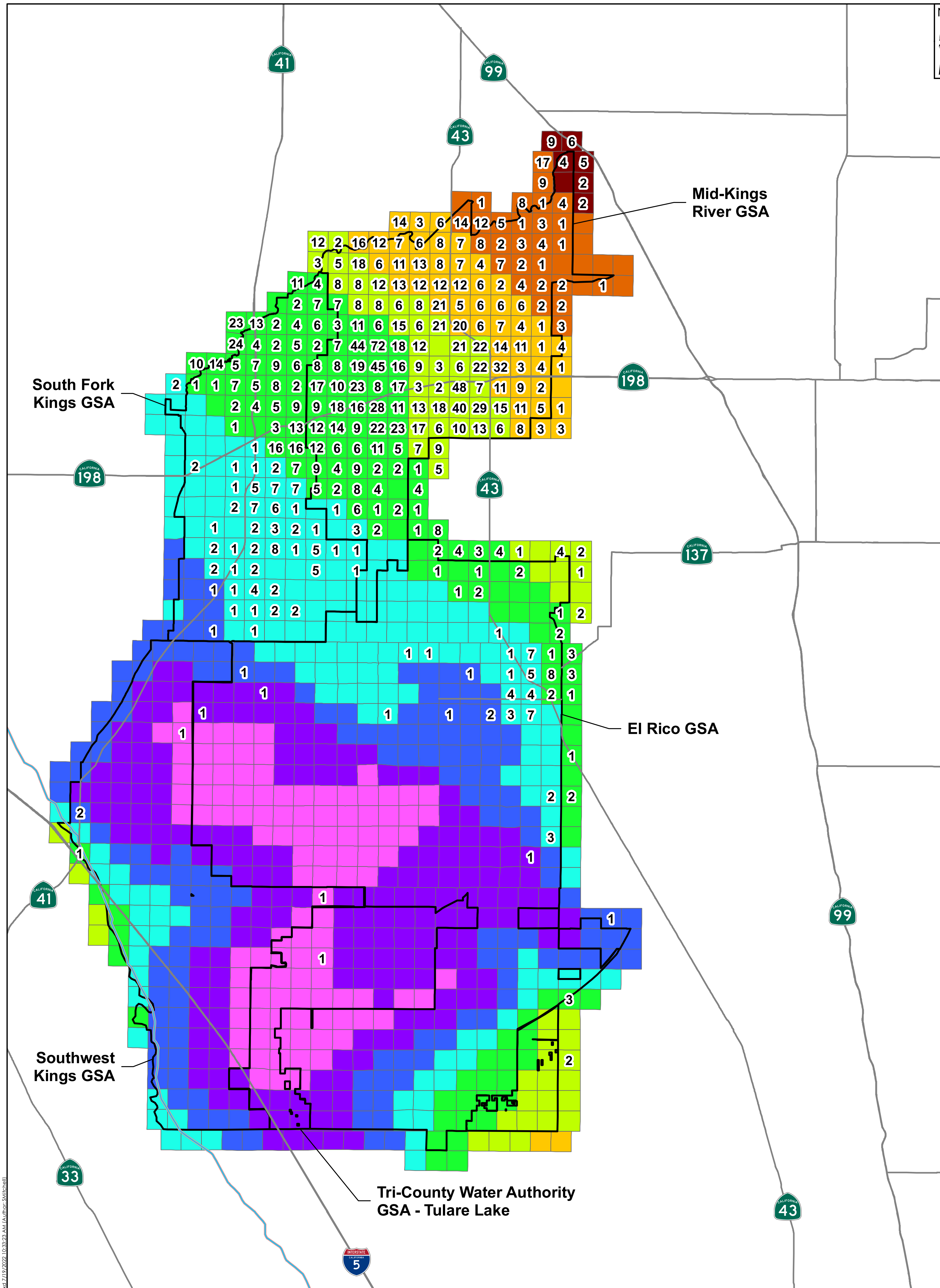
Figure

2-4b

Project No.: SFO128

April 2022



Legend

Mean E clay surface elevation (feet msl)

- < -600
- -599 - -500
- -499 - -400
- -399 - -300
- -299 - -200
- -199 - -100
- -99 - 0
- 1 - 100
- > 100

Groundwater Sustainability Agency (GSA) boundary[1]

Highways[2]

California Aqueduct[3]

References:
1) California Department of Water Resources.
2) U.S. Census Bureau.
3) U.S. Geological Survey.

4 2 0 4 Miles

Wells Completed in Shallow Aquifer Public/Domestic Purpose of Use

Tulare Lake Subbasin

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Figure **2-5a**

Project No.: SFO138 | July 2022

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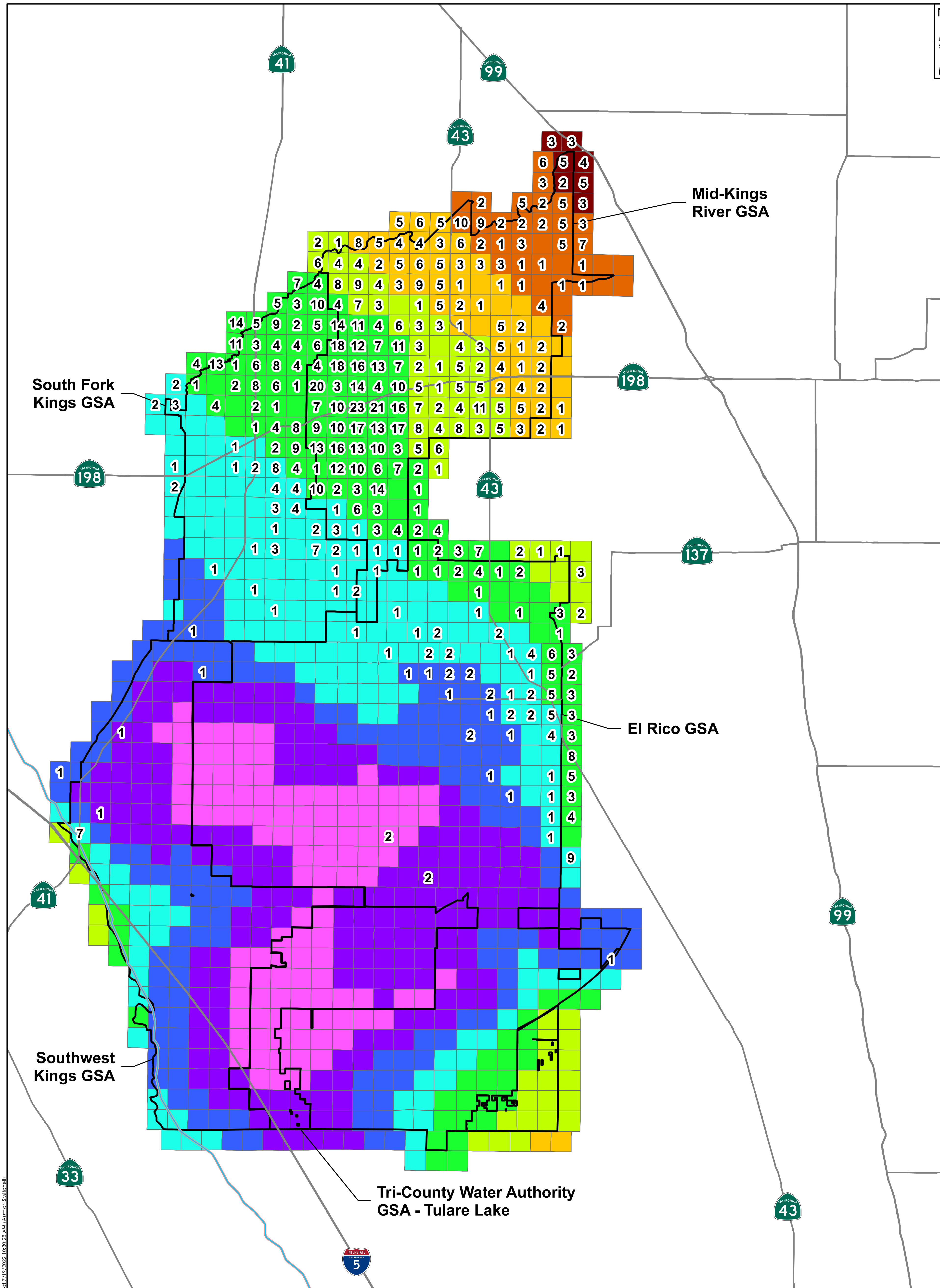


Legend

Mean E clay surface elevation (feet msl)

- < -600
- -599 - -500
- -499 - -400
- -399 - -300
- -299 - -200
- -199 - -100
- -99 - 0
- 1 - 100
- > 100

Groundwater Sustainability Agency (GSA) boundary[1]

Highways[2]

California Aqueduct[3]

References:
1) California Department of Water Resources.
2) U.S. Census Bureau.
3) U.S. Geological Survey.

4 2 0 4 Miles

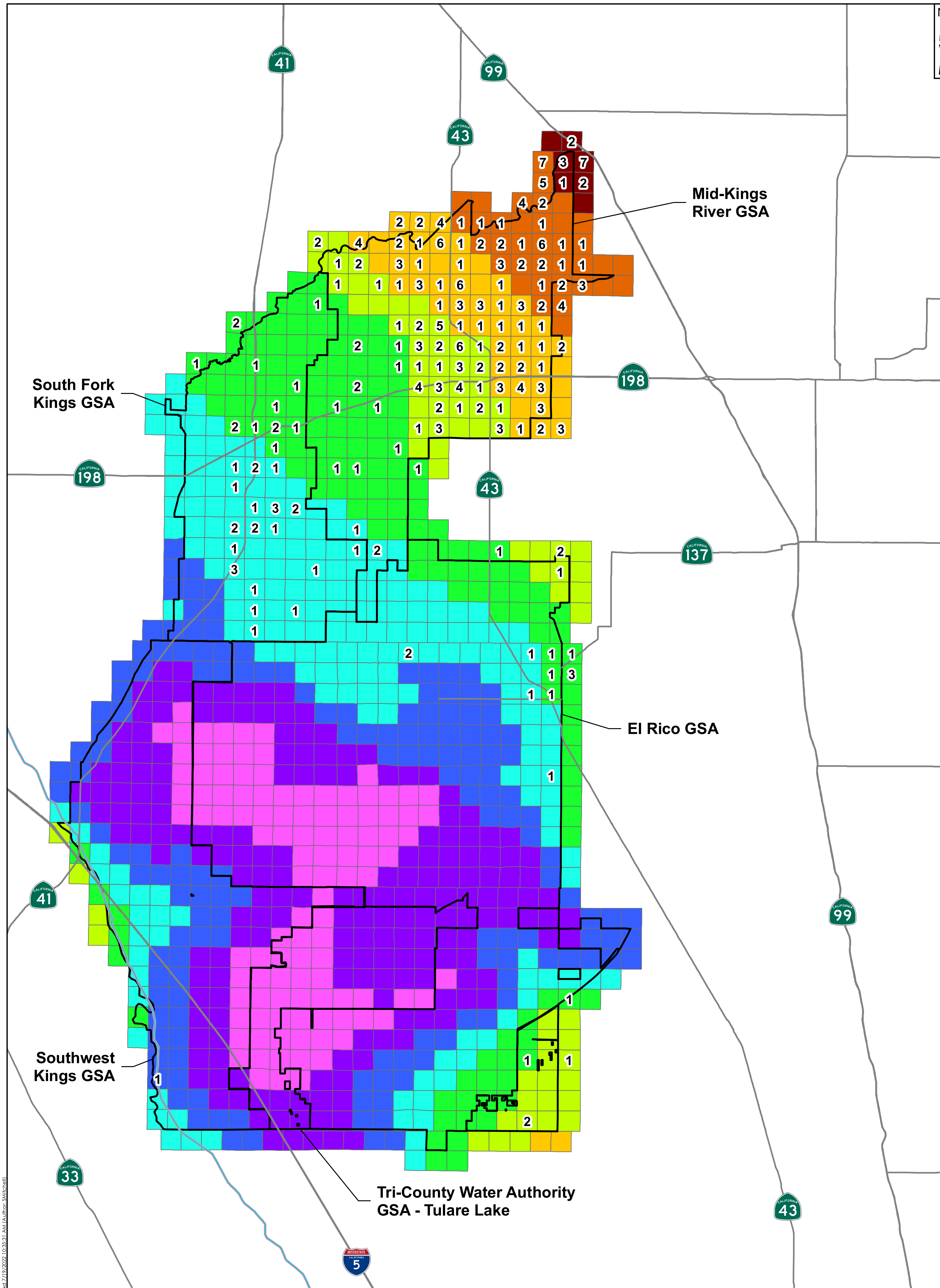
Wells Completed in Shallow Aquifer Agricultural/Industrial Purpose of Use

Tulare Lake Subbasin

Geosyntec consultants

Figure **2-5b**

Project No.: SFO138 | July 2022



Legend

Mean E clay surface elevation (feet msl)

- < -600
- -599 - -500
- -499 - -400
- -399 - -300
- -299 - -200
- -199 - -100
- -99 - 0
- 1 - 100
- > 100

Groundwater Sustainability Agency (GSA) boundary[1]

Highways[2]

California Aqueduct[3]

References:
1) California Department of Water Resources.
2) U.S. Census Bureau.
3) U.S. Geological Survey.

4 2 0 4 Miles

Wells Completed in Deep Aquifer Public/Domestic Purpose of Use

Tulare Lake Subbasin

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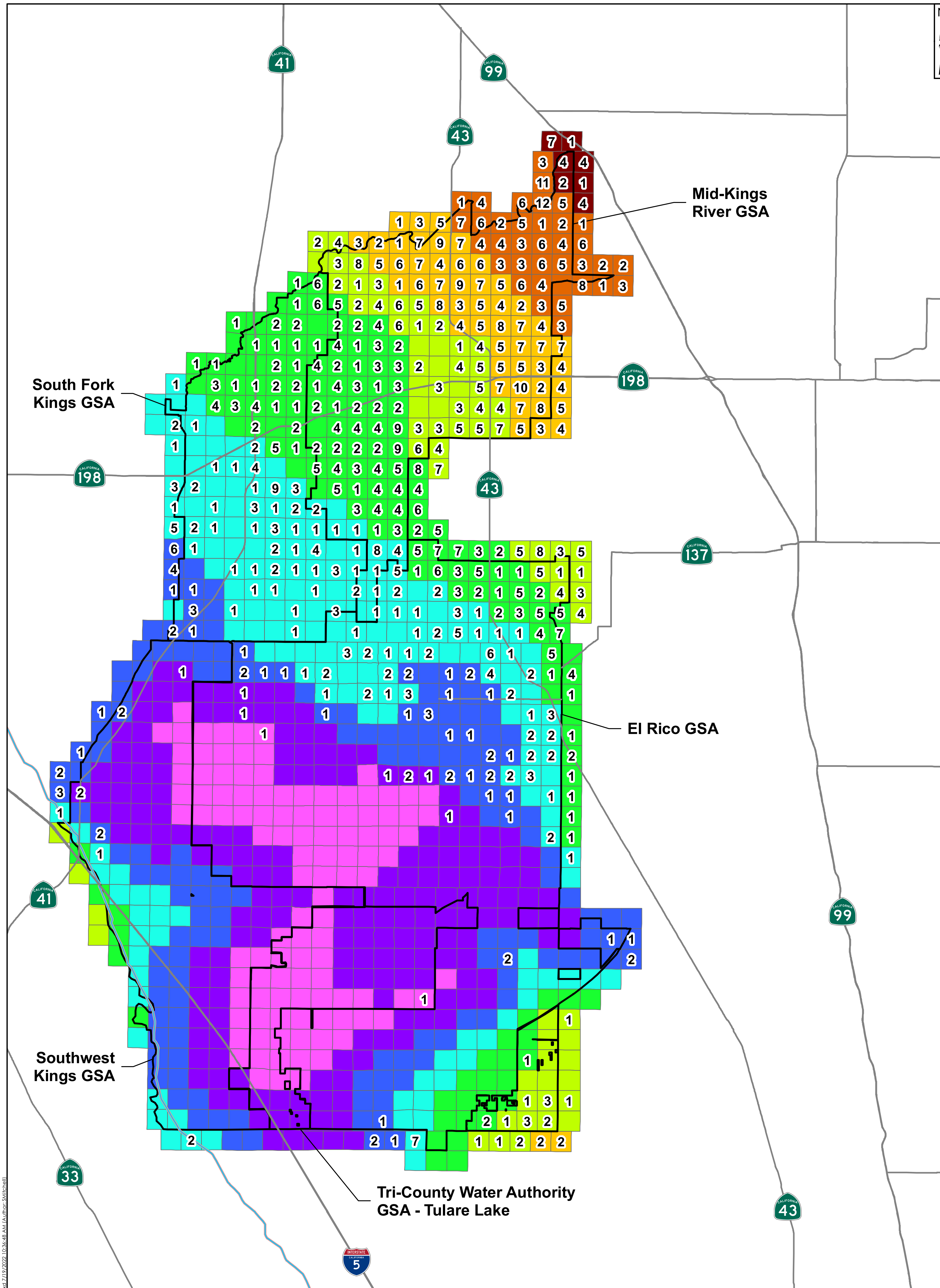
Project No.: SFO138

July 2022

Figure

2-6a



Legend

Mean E clay surface elevation (feet msl)

- < -600
- -599 - -500
- -499 - -400
- -399 - -300
- -299 - -200
- -199 - -100
- -99 - 0
- 1 - 100
- > 100

Groundwater Sustainability Agency (GSA) boundary[1]

Highways[2]

California Aqueduct[3]

4 2 0 4 Miles

Wells Completed in Deep Aquifer Agricultural/Industrial Purpose of Use

Tulare Lake Subbasin

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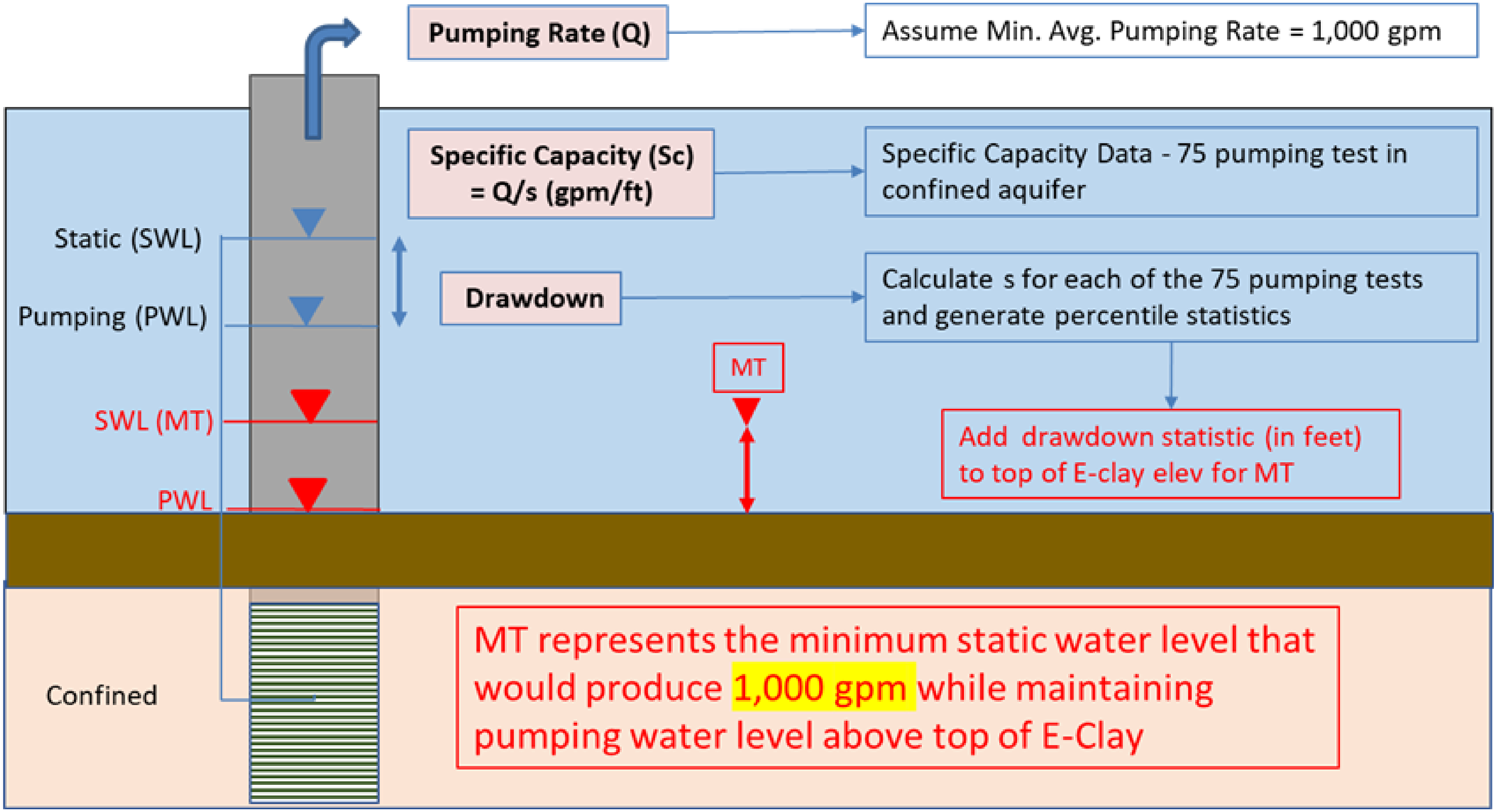
Figure

2-6b

Project No.: SFO138

July 2022

References:
1) California Department of Water Resources.
2) U.S. Census Bureau.
3) U.S. Geological Survey.



Notes:
Avg. = Average
E-Clay = Corcoran Clay
Gpm = Gallons per minute
Min. = Minimum
MT = Minimum Threshold
PWL = Pumping Water Level
SWL = Static Water Level

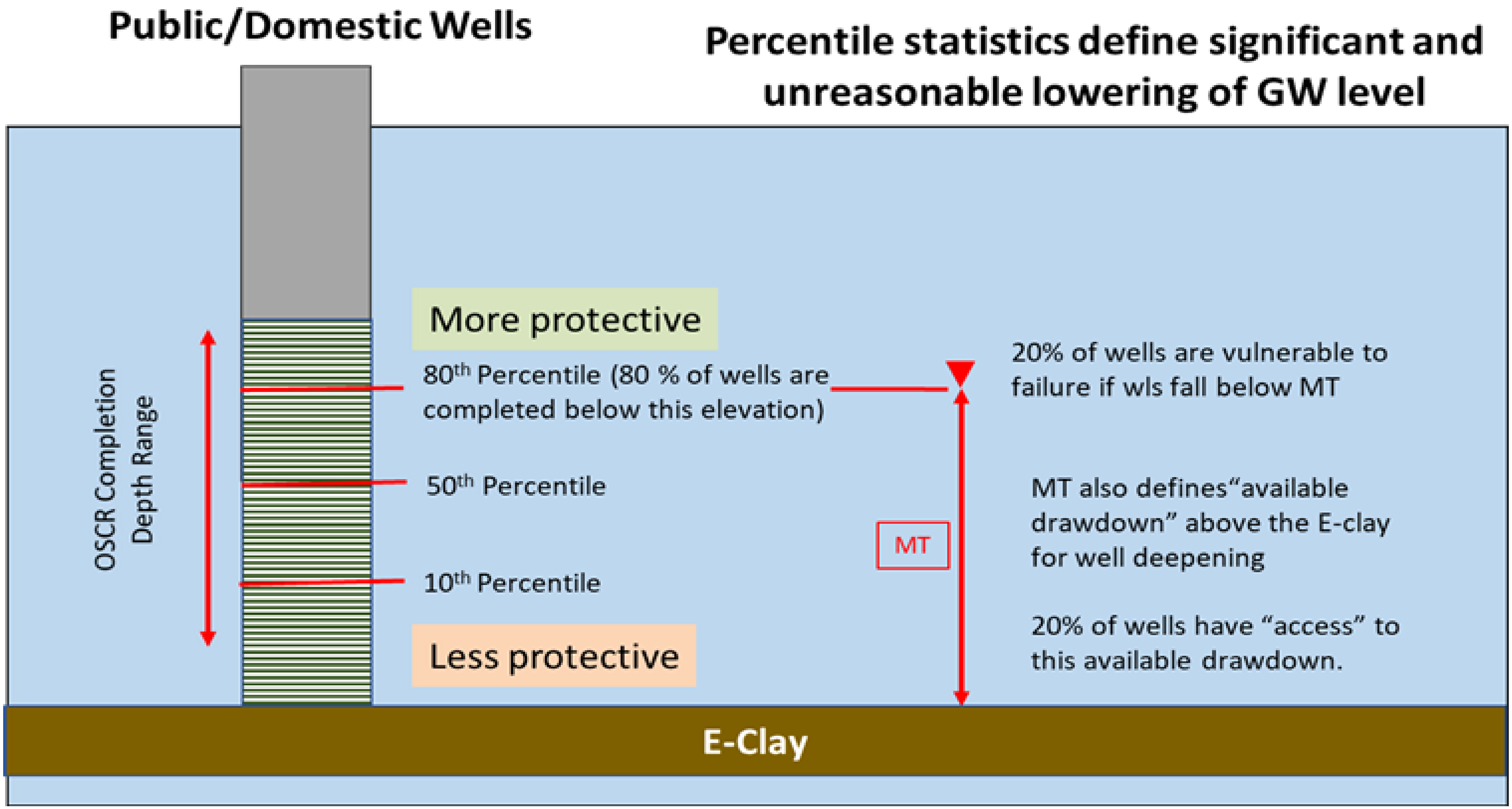
Schematic of Methodology for Calculating MT for Groundwater Level in the C-Zone

Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County

Geosyntec consultants

SFO138 | May 2022

Figure 2-7



Notes:
E-Clay = Corcoran Clay
GW = Groundwater
MT = Minimum Threshold
OSWCR = Online System of Well Completion Reports
WLs = Water levels

Schematic of Methodology for Calculating MT for Groundwater Level in the B-Zone
Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County

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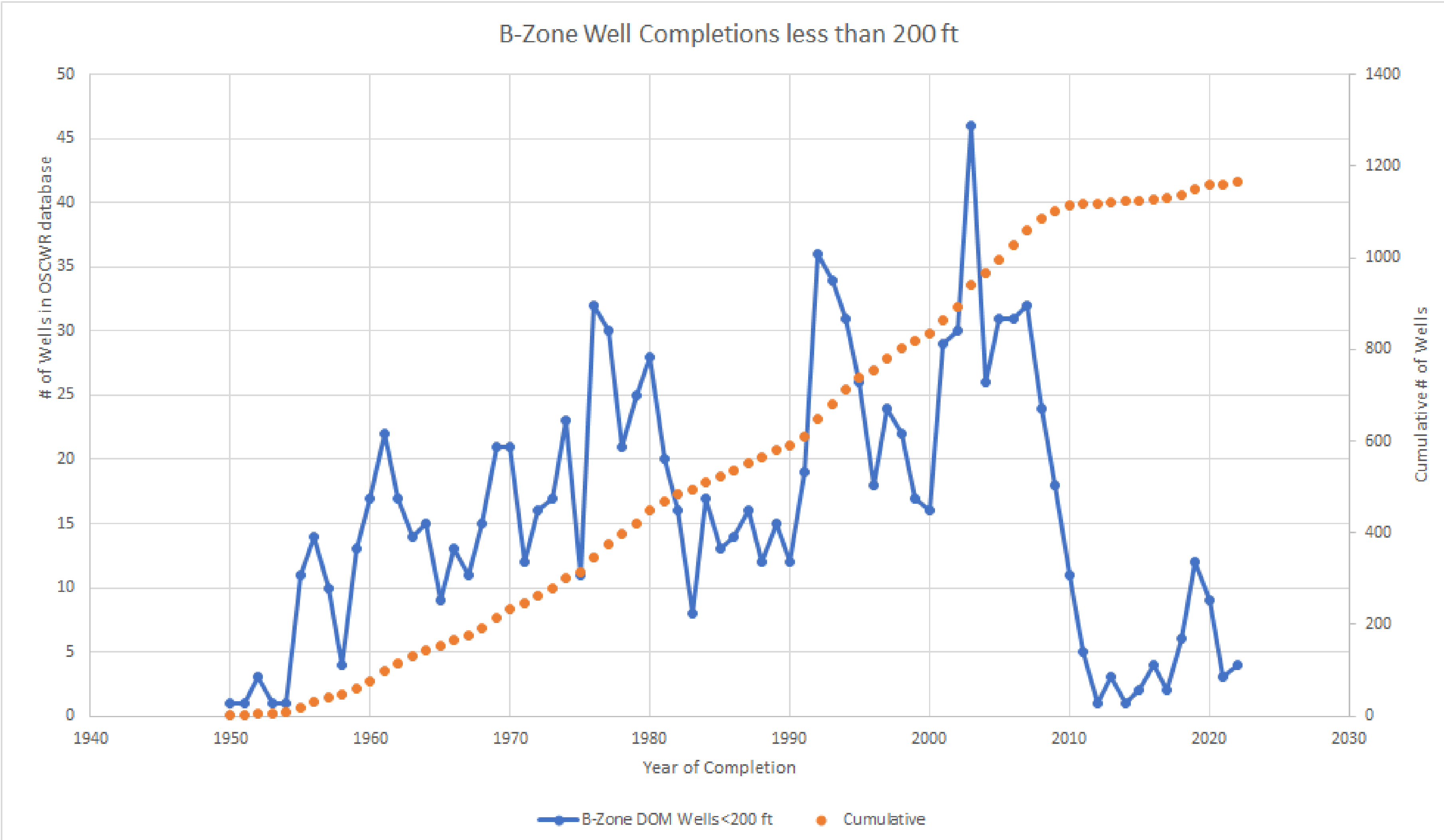
SFO138 | May 2022

Figure 2-8



Notes:
DOM = Domestic
OSCWR = Online System of Well Completion

Graph of OSCWR Well Depths Less than 200 feet by Year of Completion

Groundwater Sustainability Plan Addendum

Tulare Lake Subbasin, Kings County

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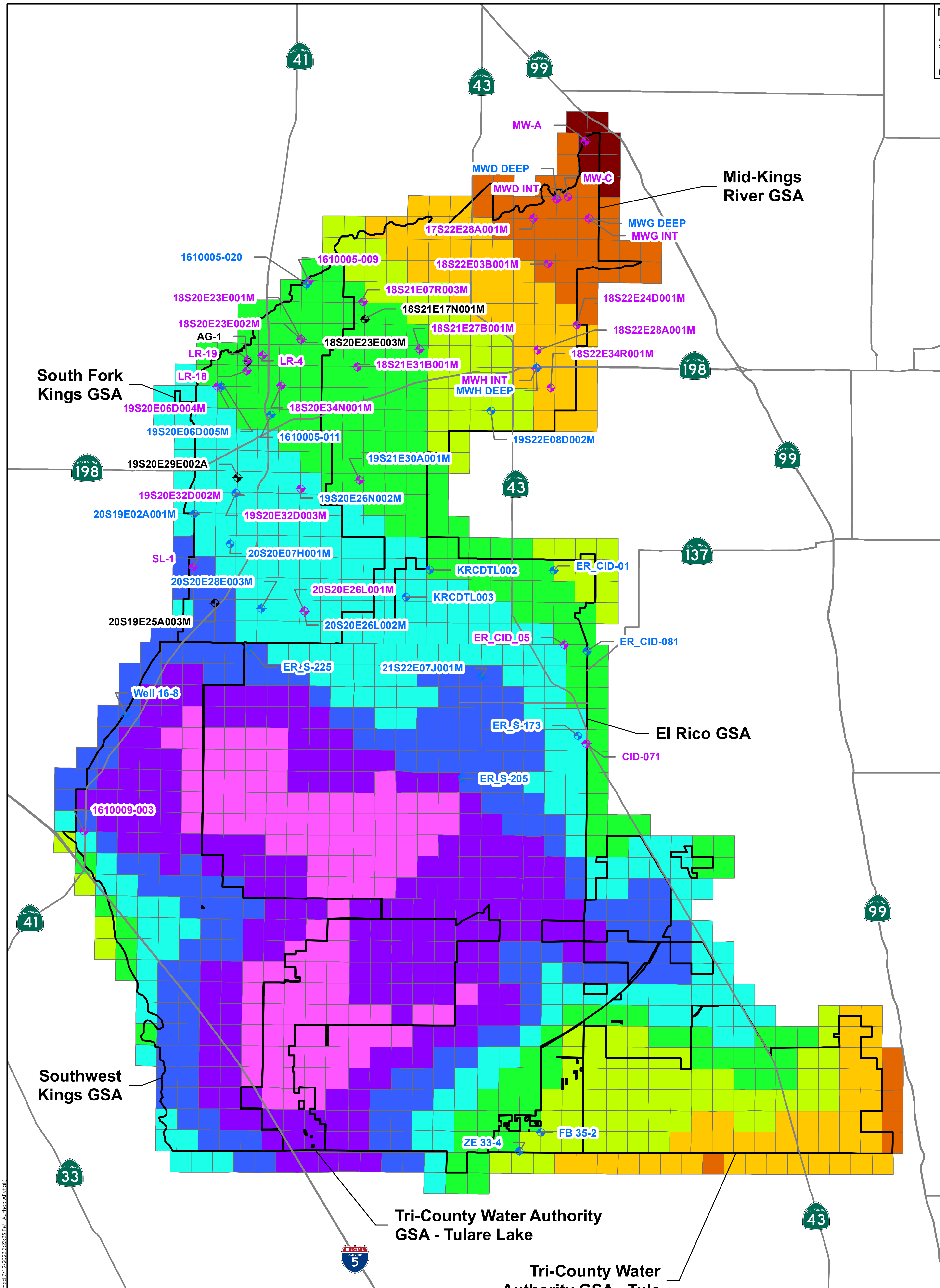
Project No.: SFO138

June 2022

Figure 2-9



Legend

Average elevation of top of E-clay per section (feet msl)

- < -600
- -599 - -500
- -499 - -400
- -399 - -300
- -299 - -200
- -199 - -100
- -99 - 0
- 1 - 100
- > 100
- Groundwater Sustainability Agency (GSA) boundary

Representative Monitoring Sites

- A-zone
- B-zone
- C-zone

5 2½ 0 5 Miles

RMS Well Locations

Groundwater Sustainability Plan Agenda

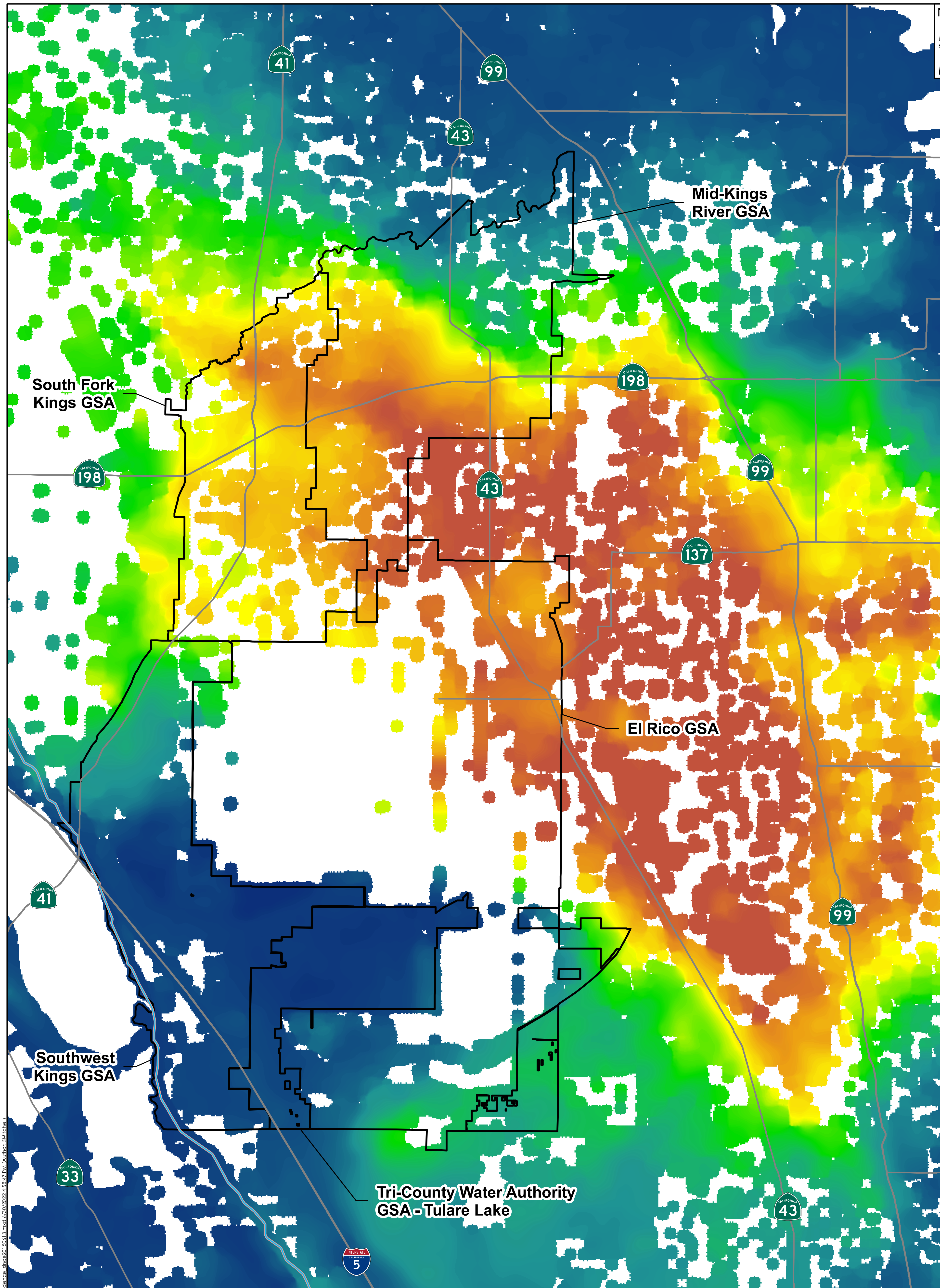
Tulare Lake Subbasin, Kings County

Geosyntec consultants

Figure 2-10

Project No.: SFO138

July 2022



Legend

Mean regional vertical ground displacement (feet) [1]

High : 0

Low : -5.8

Groundwater Sustainability Agency (GSA) boundary[1]

Highways[2]

California Aqueduct[3]

Notes:

- Total Vertical Ground Displacement between 13 June 2015 and 1 January 2022, from TRE ALTAMIRA InSAR.
- White areas represent areas with no data.

References:

1) California Department of Water Resources.
2) U.S. Census Bureau.
3) U.S. Geological Survey.

4 2 0 4 Miles

Regional (i.e., total) Subsidence Between 2015 and 2022

Tulare Lake Subbasin

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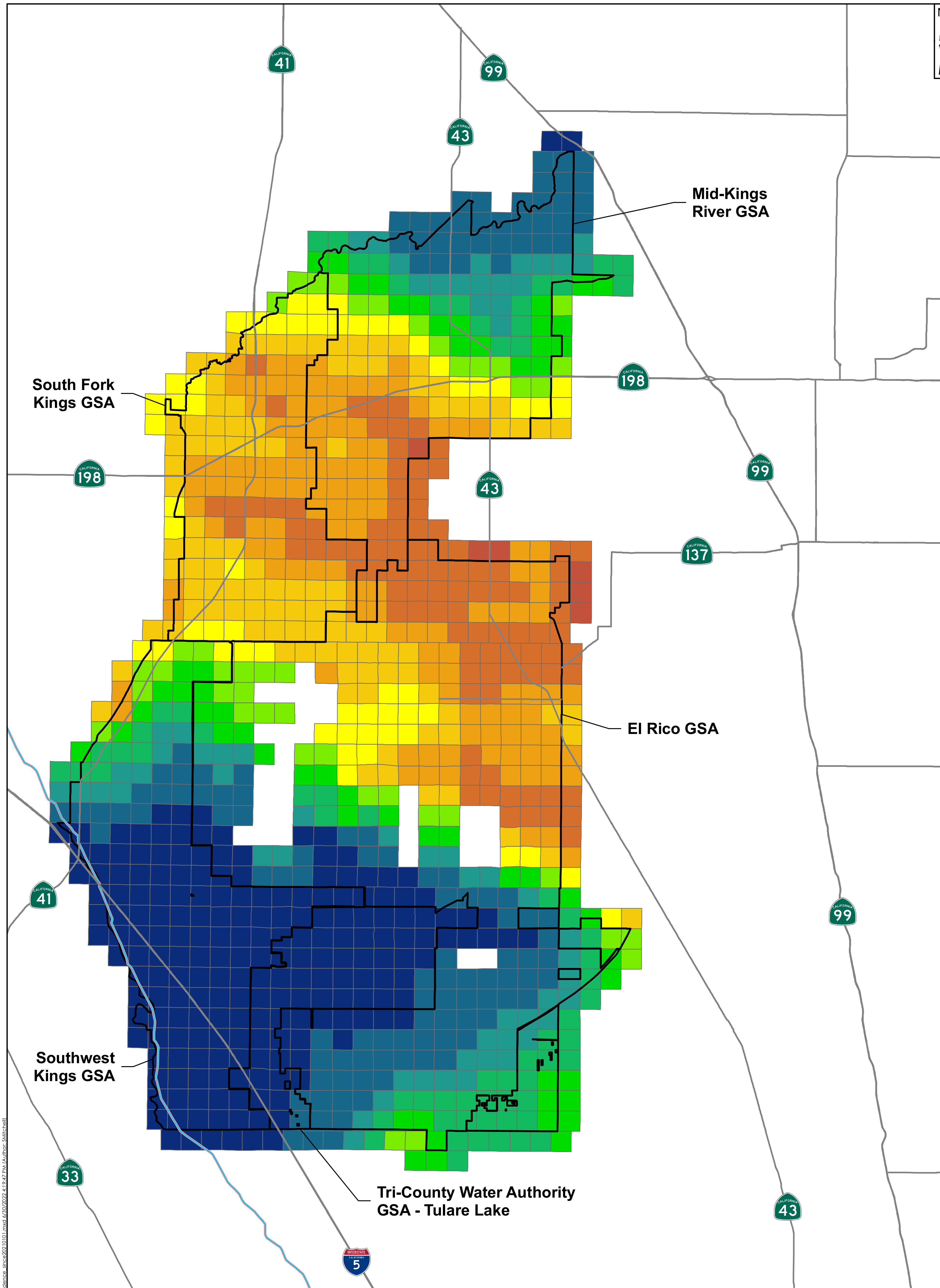
Project No.: SFO138

June 2022

Figure

3-1



Legend

Mean vertical ground displacement per section (feet) [1]

- -0.90 - -0.99
- -0.80 - -0.89
- -0.70 - -0.79
- -0.60 - -0.69
- -0.50 - -0.59
- -0.40 - -0.49
- -0.30 - -0.39
- -0.20 - -0.29
- -0.10 - -0.19
- 0.00 - -0.09
- 0.01 - 0.1

- Groundwater Sustainability Agency (GSA) boundary
- Highways[2]
- California Aqueduct[3]

Notes:
- Mean vertical ground displacement calculated by taking average total vertical ground displacement between 1 January 2021 and 1 January 2022 for each section from TRE ALTAMIRA InSAR.
- White areas represent areas with no data.

References:
1) California Department of Water Resources.
2) U.S. Census Bureau.
3) U.S. Geological Survey.

4 2 0 4 Miles

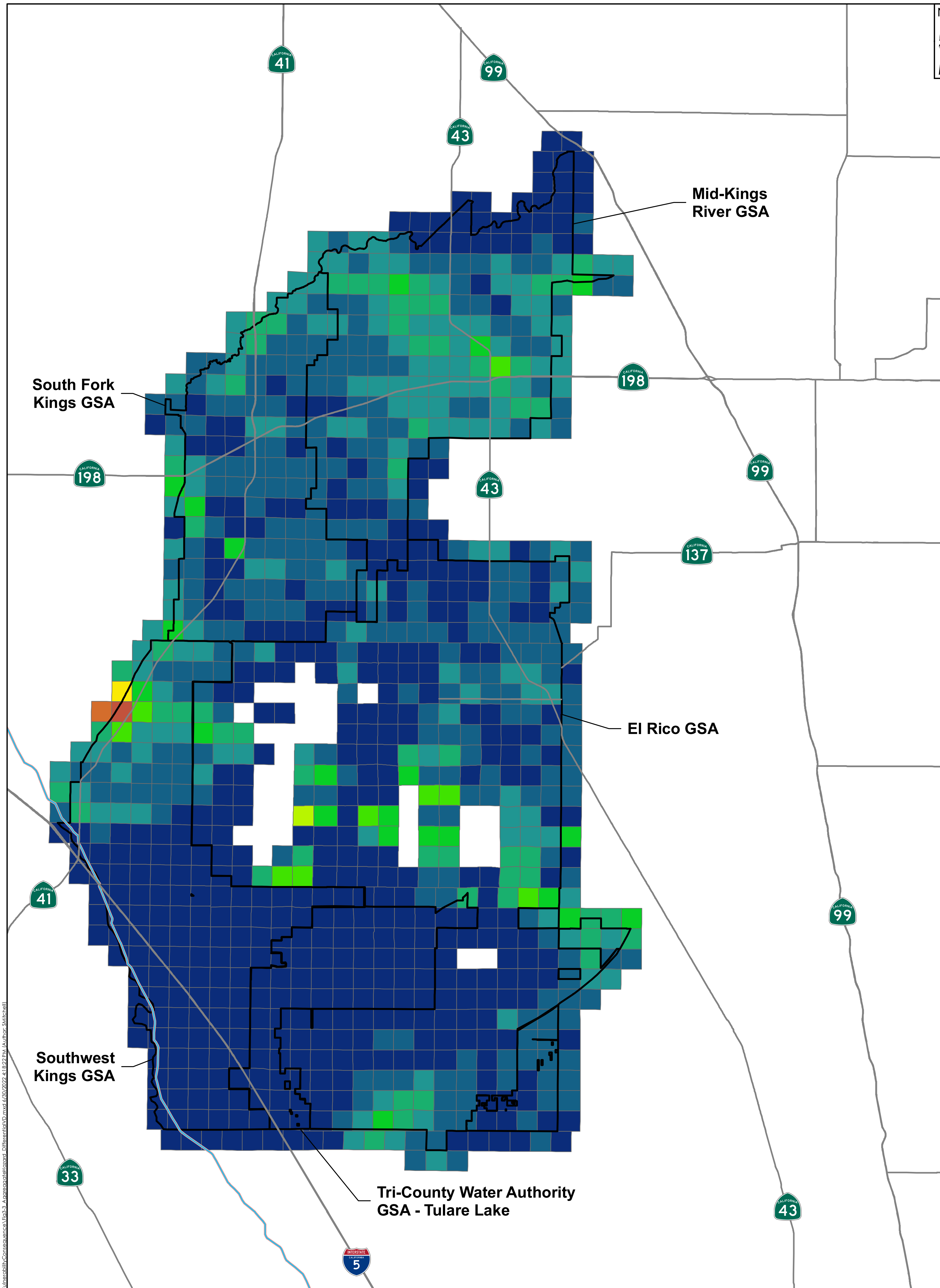
TRS Average Total Subsidence (2021-2022)
H-Map (1)
Tulare Lake Subbasin

Geosyntec consultants

Figure **3-2**

Project No.: SFO138 June 2022

P:\GIS\SFO138 - Tulare Lake GSP Update 2022\Projects\202205_Subsidence\Fig3-2_Subsidence_since20210101.mxd 6/30/2022 4:19:47 PM (Author: SMitchell)



Legend

Mean differential vertical ground displacement per section (feet) [1]

- 0.0000 - 0.0025
- 0.0026 - 0.0050
- 0.0051 - 0.0075
- 0.0076 - 0.0100
- 0.0101 - 0.0125
- 0.0126 - 0.0150
- 0.0151 - 0.0175
- 0.0176 - 0.0200
- 0.0201 - 0.0225
- 0.0226 - 0.0250
- 0.0251 - 0.0275
- 0.0276 - 0.0300
- Groundwater Sustainability Agency (GSA) boundary[1]
- Highways[2]
- California Aqueduct[3]

Notes:
- Mean differential vertical ground displacement calculated by taking average differential vertical ground displacement between 1 January 2021 and 1 January 2022 for each section from TRE ALTAMIRA InSAR.
- White areas represent areas with no data.

References:
1) California Department of Water Resources.
2) U.S. Census Bureau.
3) U.S. Geological Survey.

4 2 0 4 Miles

TRS Average Differencial Subsidence (2021-2022)
H-Map (2)
Tulare Lake Subbasin

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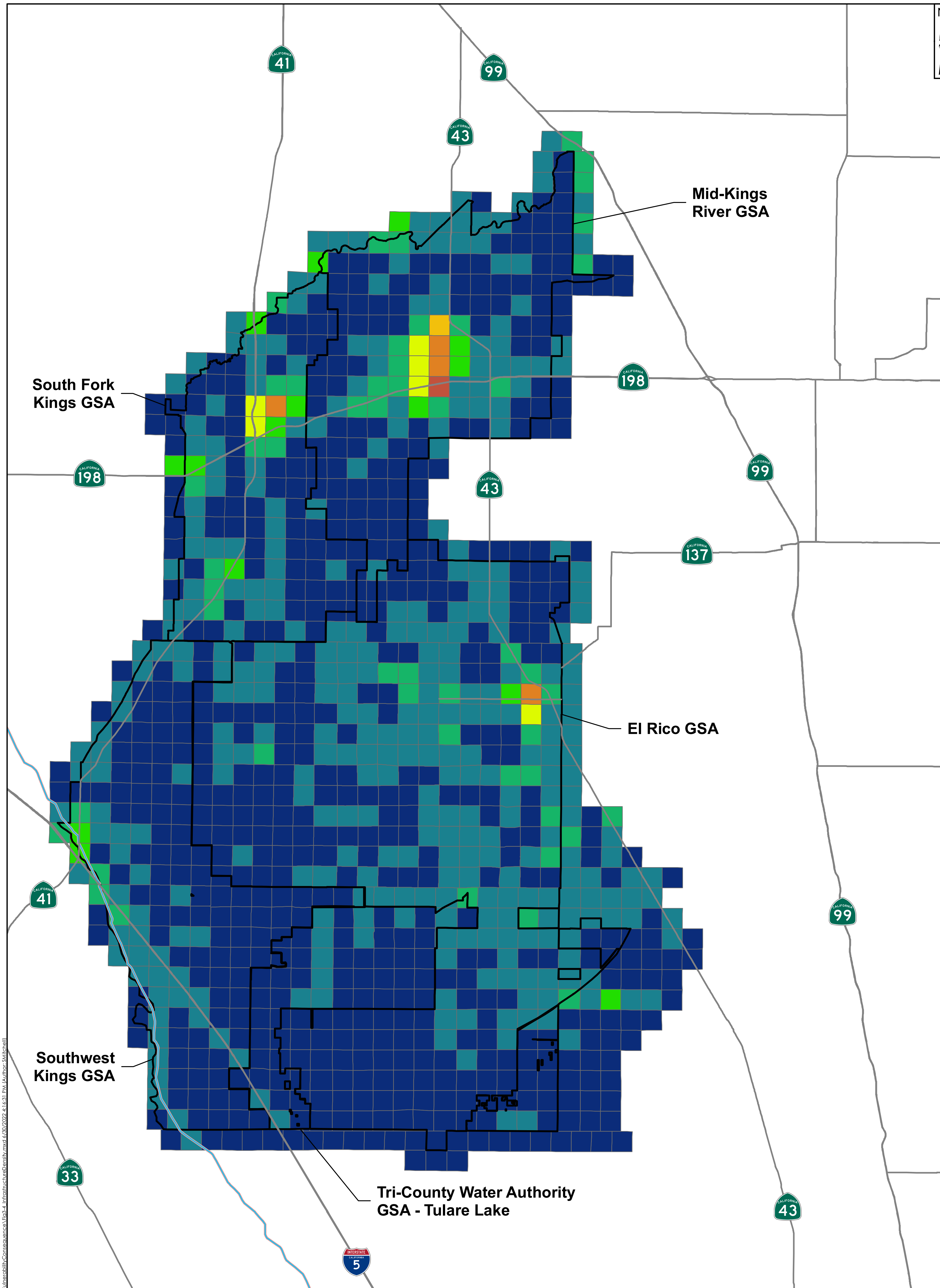
Project No.: SFO138 June 2022

Figure **3-3**

P:\GIS\SFO138 - Tulare Lake GSP Update 2022\Projects\20220531_CriticalInfrastructure_VulnerabilityConsequence\Fig3-3_AggregateHazard_DifferentialVD.mxd 6/30/2022 4:18:22 PM (Author: SMitchell)



Legend

Infrastructure density score per section

- 0.00 - 5.00
- 5.01 - 10.00
- 10.01 - 15.00
- 15.01 - 20.00
- 20.01 - 25.00
- 25.01 - 30.00
- 30.01 - 35.00
- 35.01 - 40.00
- Groundwater Sustainability Agency (GSA) boundary[1]
- Highways[2]
- California Aqueduct[3]

Notes:
- Density calculated by summing the following infrastructure values within each section:
  - Canals and Aqueducts (linear, 1 per mile)
  - High Speed Rail right-of-way (linear, 1 per mile)
  - Levees (linear, 1 per mile)
  - Pipelines (linear, 1 per mile)
  - Railroads (linear, 1 per mile)
  - Roads (linear, 1 per mile)
  - Airports/Runways (points, 1 per each)
  - Bridges (points, 1 per each)
  - Emergency Facility Buildings (points, 1 per each)

References:
1) California Department of Water Resources.
2) U.S. Census Bureau.
3) U.S. Geological Survey.

TRS Total Infrastructure Density Map
Tulare Lake Subbasin

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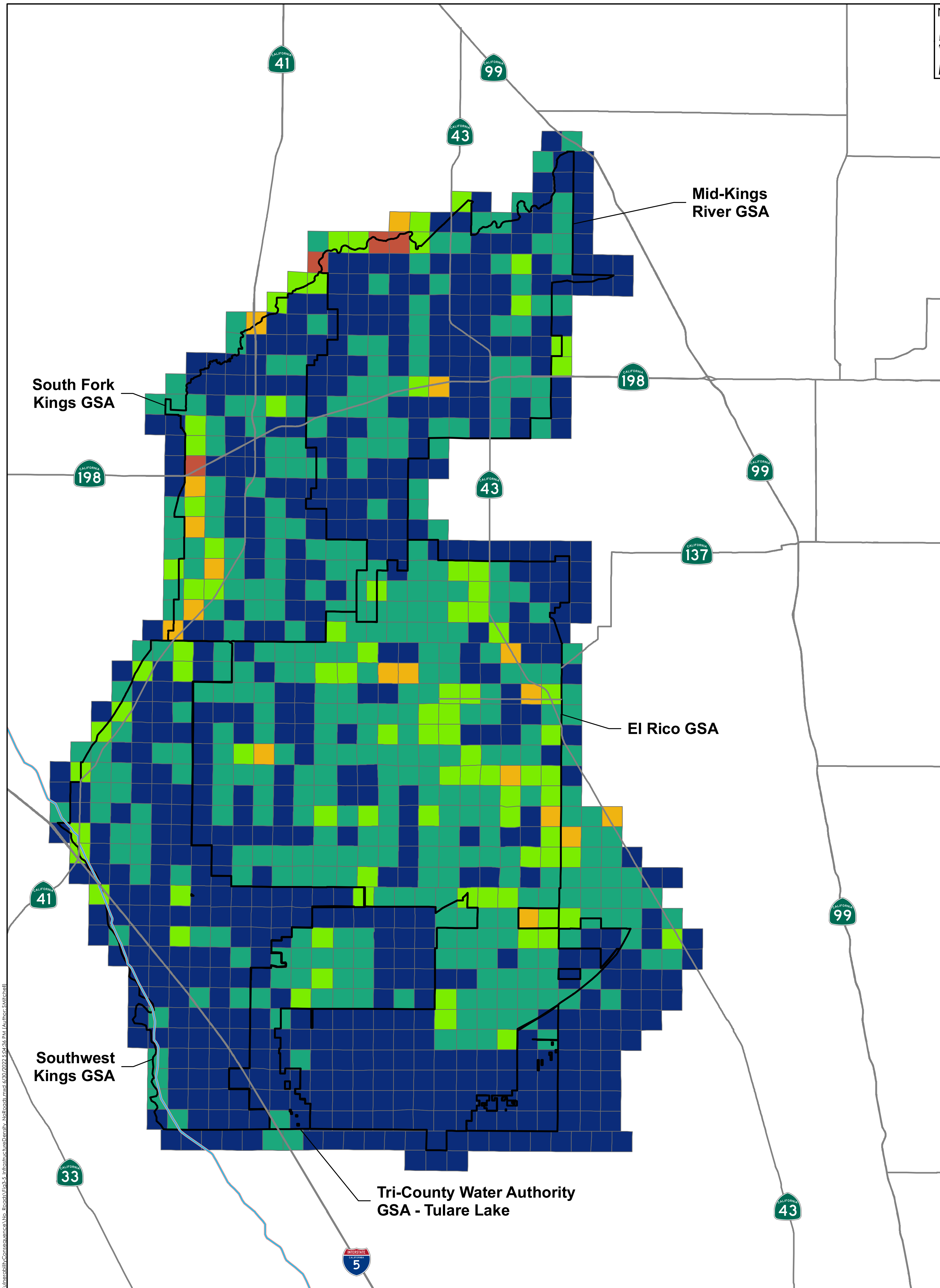
Project No.: SFO138 | June 2022

Figure **3-4**

P:\GIS\SFO138 - Tulare Lake GSP Update 2022\Projects\20220531_CriticalInfrastructure_VulnerabilityConsequence\Fig3-4_InfrastructureDensity.mxd 6/30/2022 4:16:31 PM (Author: SMitchell)



Legend

Infrastructure density score per section (no roads)

- 0.00 - 2.00
- 2.01 - 4.00
- 4.01 - 6.00
- 6.01 - 8.00
- 8.01 - 10.00

Groundwater Sustainability Agency (GSA) boundary[1]

Highways[2]

California Aqueduct[3]

Notes:

- Density calculated by summing the following infrastructure values within each section:
  - Canals and Aqueducts (linear, 1 per mile)
  - High Speed Rail right-of-way (linear, 1 per mile)
  - Levees (linear, 1 per mile)
  - Pipelines (linear, 1 per mile)
  - Railroads (linear, 1 per mile)
  - Airports/Runways (points, 1 per each)
  - Bridges (points, 1 per each)
  - Emergency Facility Buildings (points, 1 per each)

References:

1) California Department of Water Resources.
2) U.S. Census Bureau.
3) U.S. Geological Survey.

TRS Total Infrastructure Density Map, Excluding Roads
V-Map (1)
Tulare Lake Subbasin

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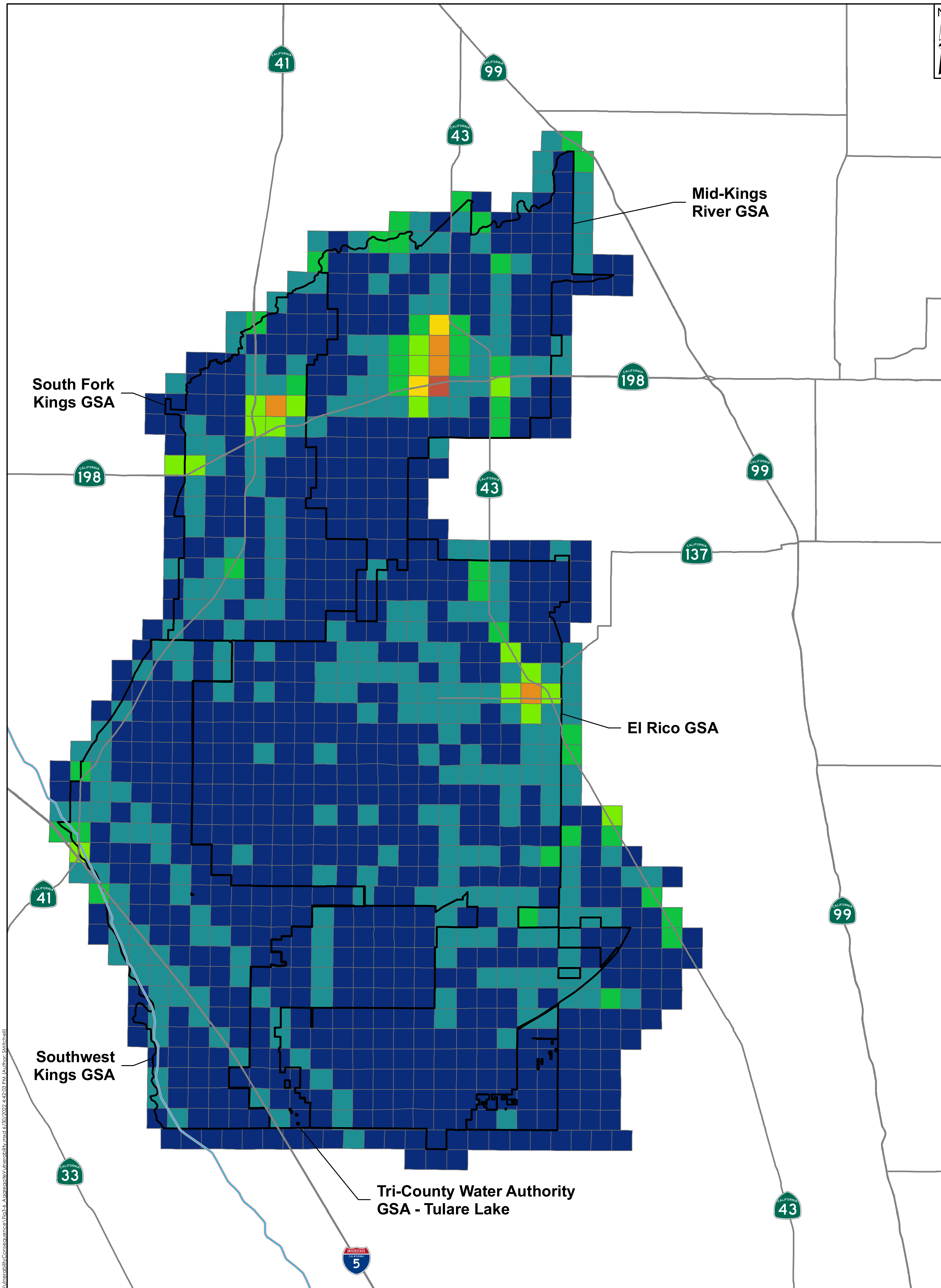
Figure **3-5**

Project No.: SFO138 | June 2022



Legend

Aggregate vulnerability score per section

- 0.000 - 0.010
- 0.011 - 0.020
- 0.021 - 0.030
- 0.031 - 0.040
- 0.041 - 0.050
- 0.051 - 0.060
- 0.061 - 0.070

- Groundwater Sustainability Agency (GSA) boundary[1]
- Highways[2]
- California Aqueduct[3]

Notes:
- The aggregate vulnerability score (V) for each section was calculated by multiplying the density score for each class of infrastructure per section by the associated LMT for that class of infrastructure.
- Infrastructure excludes roads.

References:
1) California Department of Water Resources.
2) U.S. Census Bureau.
3) U.S. Geological Survey.

4 2 0 4 Miles

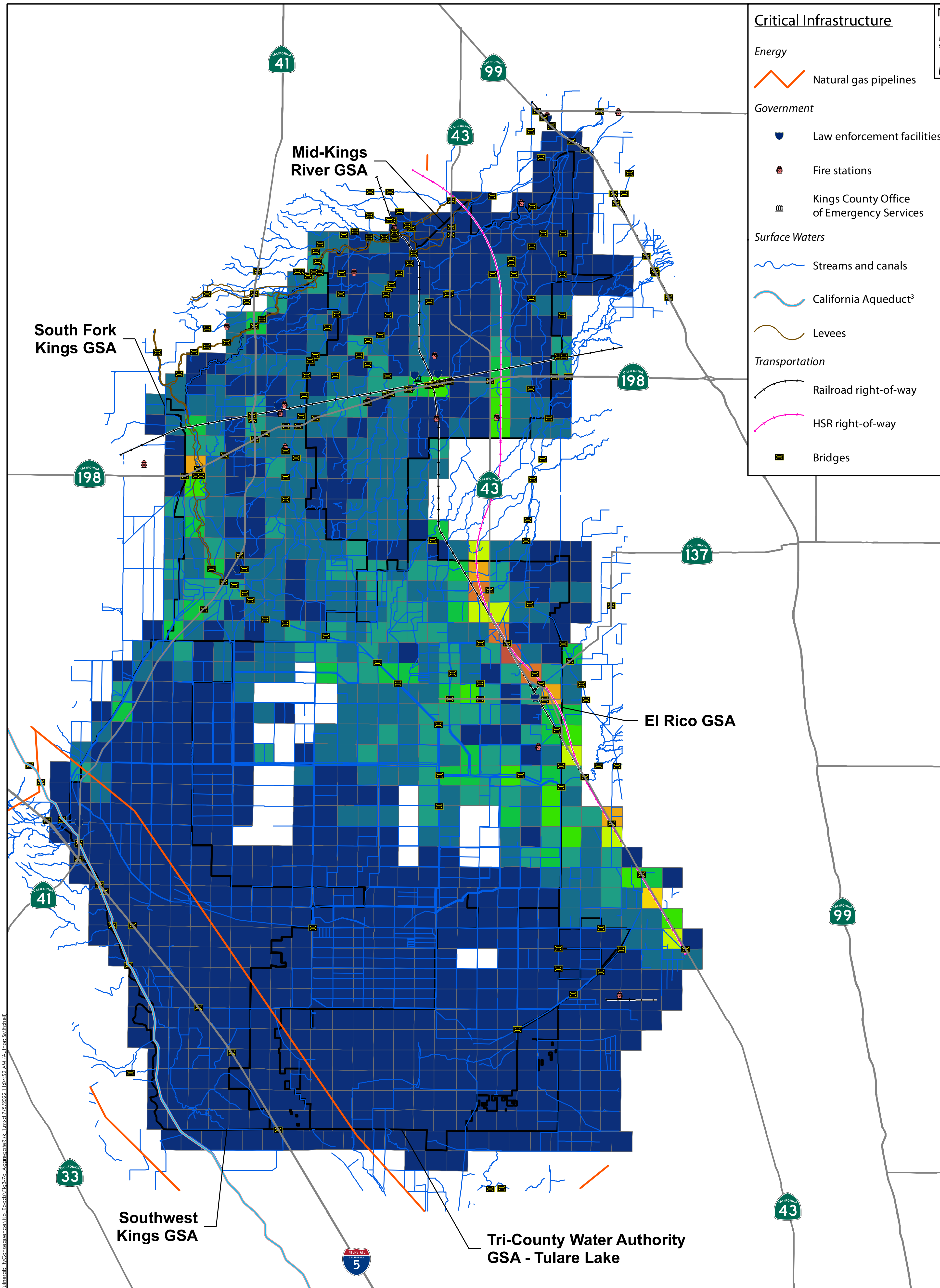
TRS Aggregate Infrastructure Vulnerability Map
Differential Subsidence: V-Map (2)
Tulare Lake Subbasin

Geosyntec consultants

Figure
3-6

Project No.: SFO138 | June 2022

P:\GIS\SFO138 - Tulare Lake GSP Update 2022\Projects\20220531_CriticalInfrastructure_VulnerabilityConsequence\Fig3-6_AggregateVulnerability.mxd 6/30/2022 4:42:03 PM (Author: SMitchell)



Legend

Aggregate risk score per section

- -0.021115 - -0.018942
- -0.018941 - -0.016768
- -0.016767 - -0.014594
- -0.014593 - -0.012421
- -0.012420 - -0.010247
- -0.010246 - -0.008073
- -0.008072 - -0.005900
- -0.005899 - -0.003726
- -0.003725 - -0.001552
- -0.001551 - 0.000622

Groundwater Sustainability Agency (GSA) boundary[1]

Highways[2]

California Aqueduct[3]

Notes:
- Risk score per section calculated as: H-Map (1) x V-Map (1) = R-Map (1)
- White areas represent areas with no data.

References:
1) California Department of Water Resources.
2) U.S. Census Bureau.
3) U.S. Geological Survey.

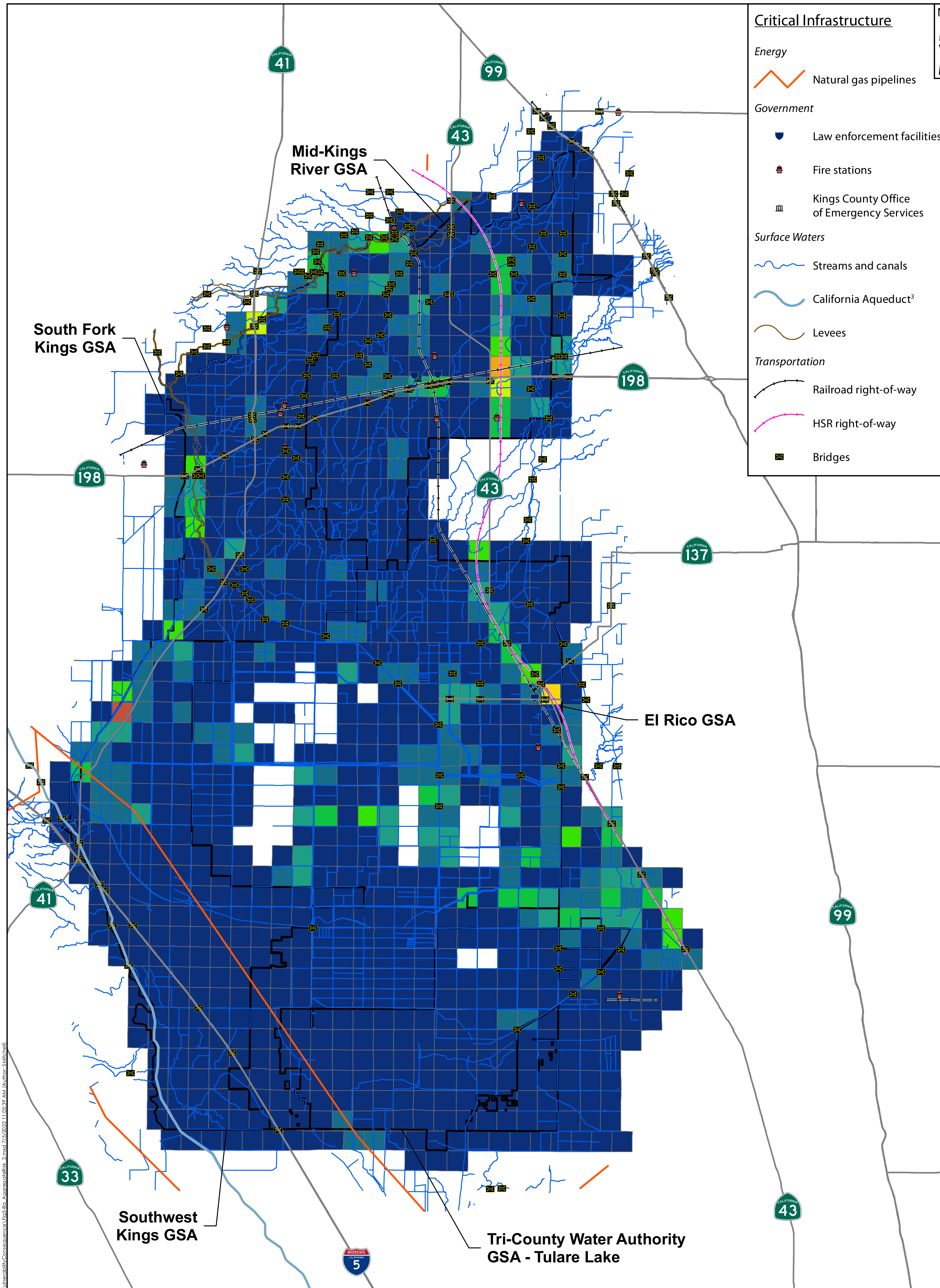
4 2 0 4 Miles

TRS Aggregate Total Subsidence Risk Map
R-Map (1)
Tulare Lake Subbasin

Geosyntec consultants

Project No.: SFO138 | July 2022

Figure 3-7



Legend

Aggregate risk score per section, based on differential ground surface vertical displacement

- 0.00000 - 0.00002
- 0.00003 - 0.00005
- 0.00006 - 0.00007
- 0.00008 - 0.00009
- 0.00010 - 0.00012
- 0.00013 - 0.00014
- 0.00015 - 0.00016
- 0.00017 - 0.00019
- 0.00020 - 0.00021
- 0.00022 - 0.00024

Groundwater Sustainability Agency (GSA) boundary[1]

Highways[2]

California Aqueduct[3]

Notes:
- Risk score per section calculated as: H-Map (2) x V-Map (2) = R-Map (2)
- White areas represent areas with no data.

References:
1) California Department of Water Resources.
2) U.S. Census Bureau.
3) U.S. Geological Survey.

4 2 0 4 Miles

TRS Aggregate Differential Subsidence Risk Map
R-Map (2)
Tulare Lake Subbasin

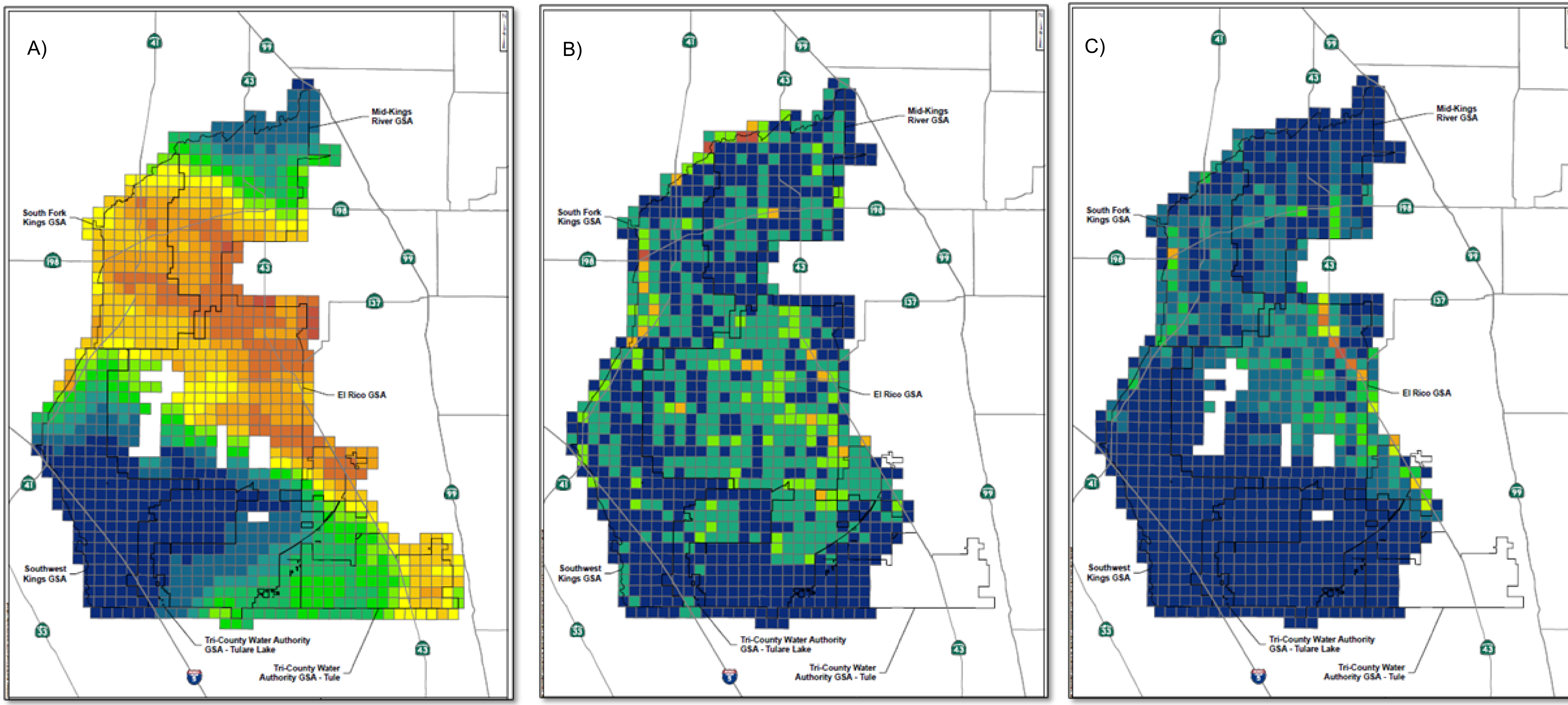
Geosyntec consultants

Figure 3-8

Project No.: SFO138

July 2022

P:\GIS\SFO138 - Tulare Lake GSP Update 2022\Projects\20220531_CriticalInfrastructure_VulnerabilityConsequence\Fig3-8a_AggregateRisk_2.mxd 7/5/2022 11:05:39 AM (Author: SMitchell)



Notes:
Total subsidence risk for the Tulare Lake Subbasin.

H = Hazard
R = Risk
V = Vulnerability

TRS = Township Range Section

Series of maps displayed:

a) Figure 3-2: TRS Average Total Subsidence (2021-2022): H-Map (1)
b) Figure 3-5: TRS Total Infrastructure Density Map Excluding Roads
c) Figure 3-7: TRS H-Map (1) x Total Infrastructure Density Excluding Roads: R-Map (1)

Total Subsidence Risk Series Map: H(1) x V(1) = R(1)
Groundwater Sustainability Plan - Addendum
Tulare Lake Subbasin, Kings County

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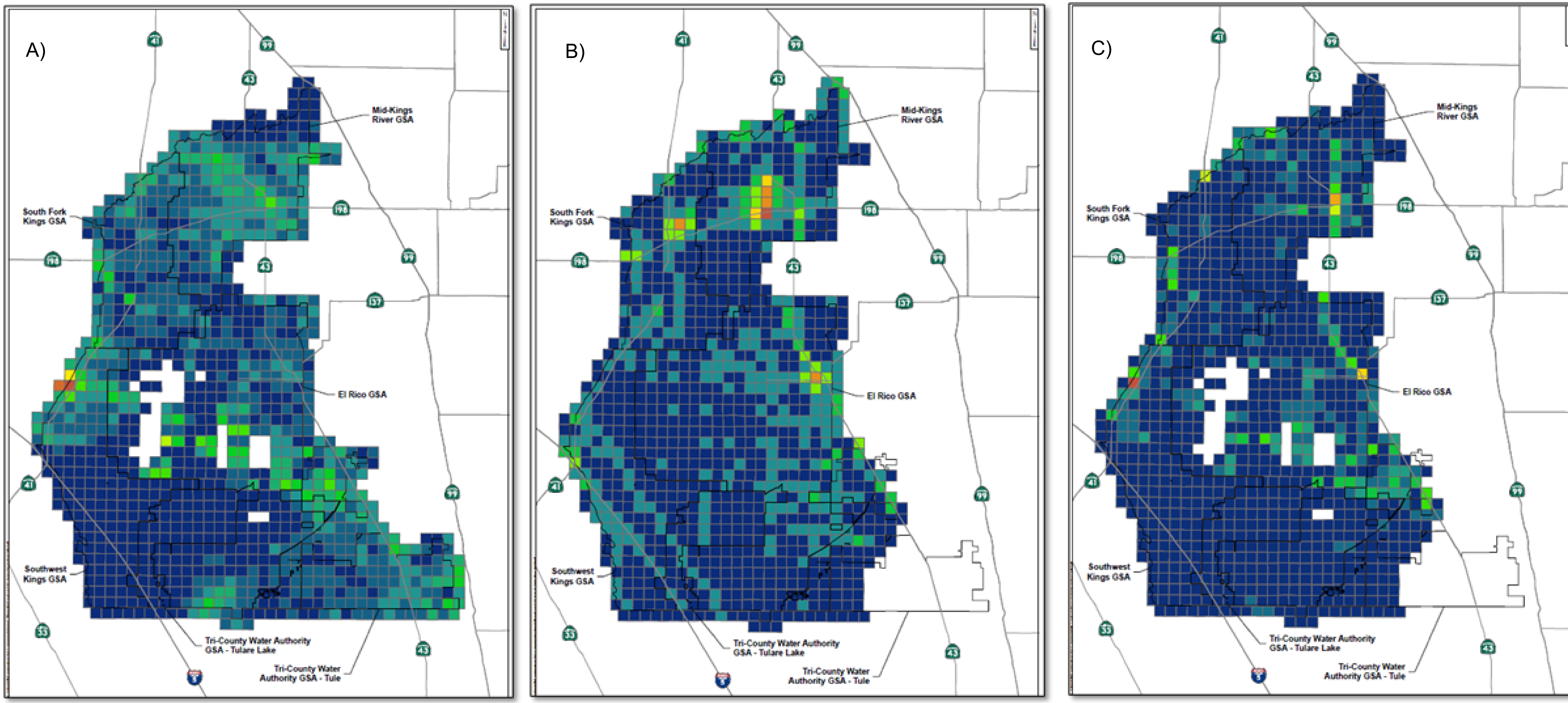
Project No.: SFO138 | June 2022

Figure 3-9



Notes:
Differential Subsidence risk for the Tulare Lake Subbasin. Local Minimum Thresholds (LMT) are considered by infrastructure types.

H = Hazard
R = Risk
V = Vulnerability
TRS = Township Range Section

Series of maps displayed:

a) Figure 3-3: TRS Average Differential Subsidence (2021-2022): H-Map (2)
b) Figure 3-6: TRS Infrastructure Density x LMT: V-Map
c) Figure 3-8: TRS H-Map (2) x V-Map: R-Map (2)

Differential Subsidence Risk Series
Map: H(2) x V(2) = R(2)
Groundwater Sustainability Plan - Addendum
Tulare Lake Subbasin, Kings County

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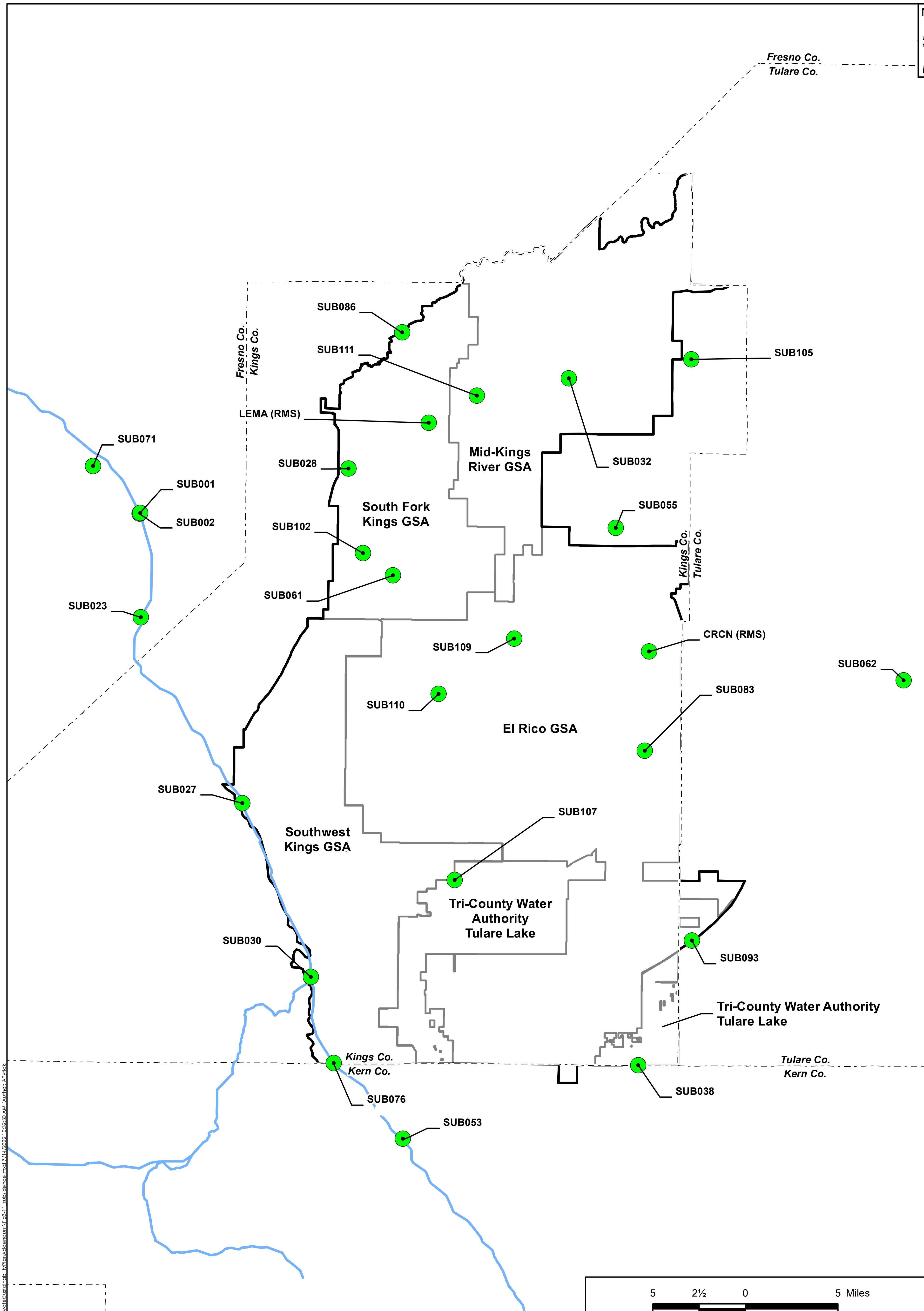
Project No.: SFO138 | June 2022

Figure **3-10**



Legend

- County lines
- Subbasin
- California Aqueduct
- Subsidence RMS Locations

Subsidence RMS Locations

Groundwater Sustainability Plan - Addendum
Tulare Lake Subbasin, Kings County

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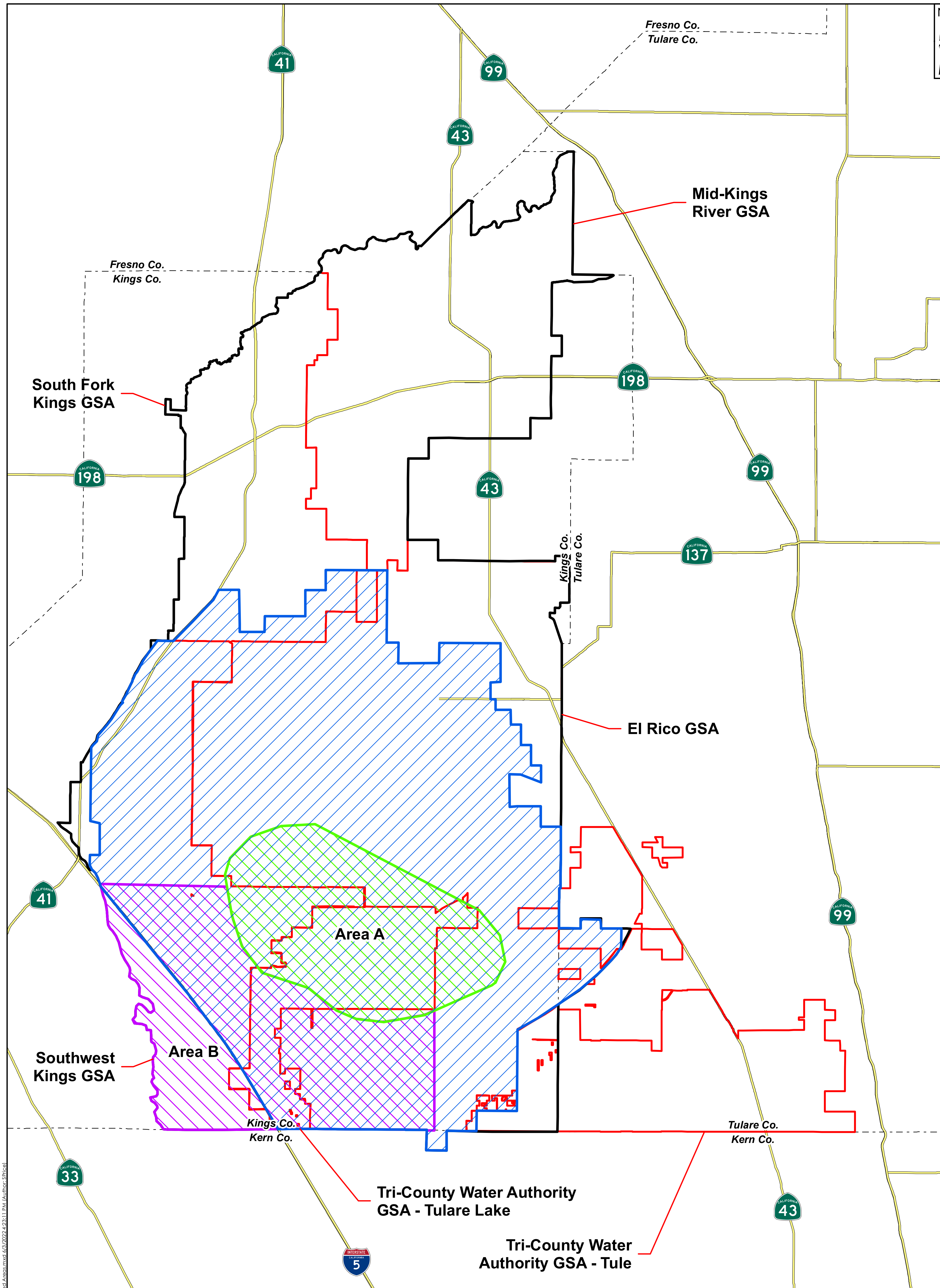
Project No.: SFO128

July 2022

Figure

3-11



Legend

- Tulare Lake Subbasin 5-022.12
- Groundwater Sustainability Agency (GSA) boundary
- De-designated Area
- Management Area A
- Management Area B
- Highways
- County lines

Notes:
De-designated and Management Areas are depicted in Figures 5-1, 5-2, and 5-5 of the Tulare Lake Subbasin GSP. The de-designated Area is recognized in the Basin Plan (SWRCB R5-2017-0032).

5 2½ 0 5 Miles

Management and De-designated Areas
Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County, California

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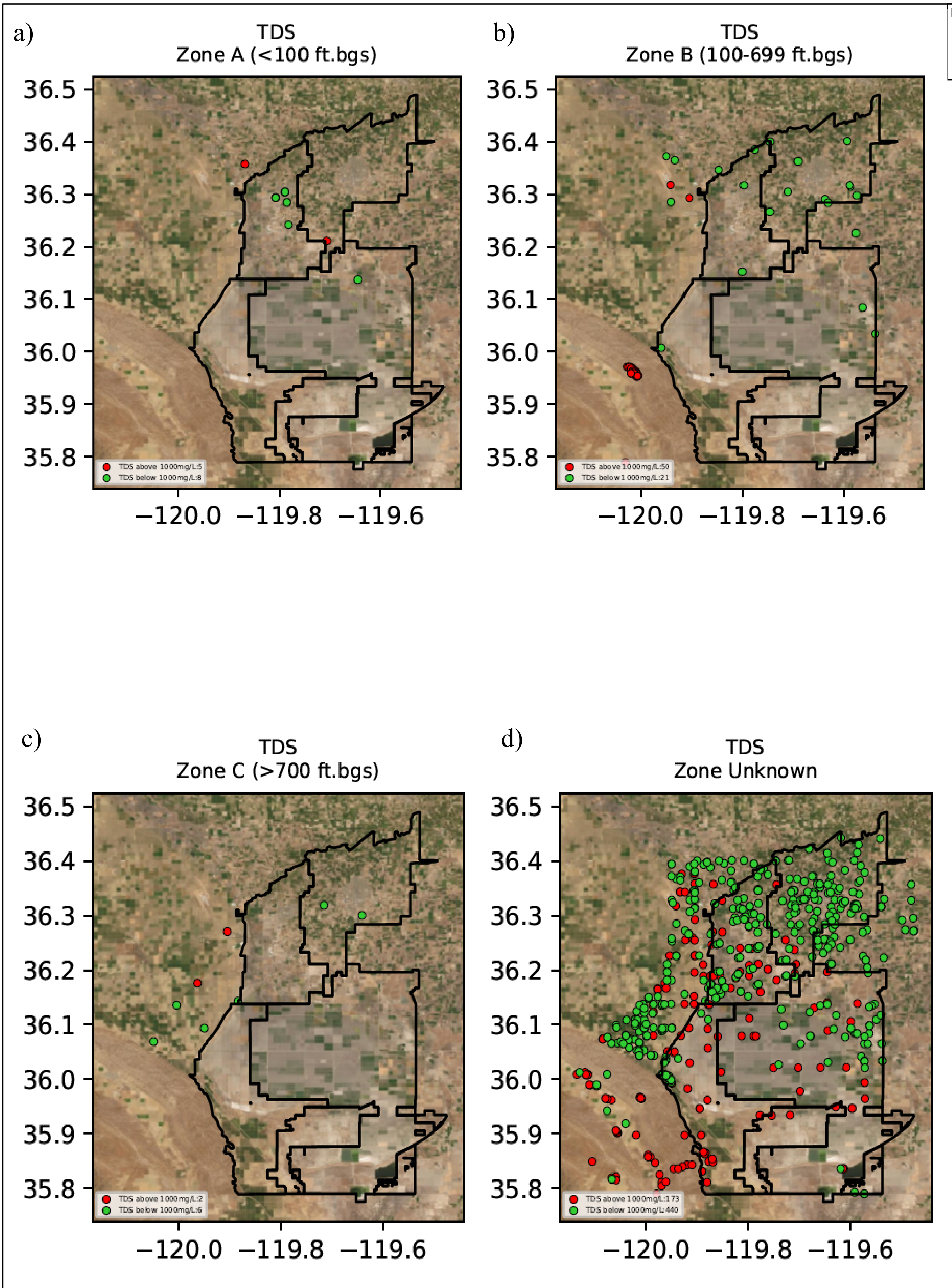
Figure 4-1

Project No.: SFO138 | June 2022



Legend

- TDS above 1000 mg/L:Well Count
- TDS below 1000 mg/L:Well Count

a) Wells screened above 100 ft bgs
b) Wells screened between 100-699 ft bgs
c) Wells screened below 700 ft bgs
d) Wells with unknown screen interval

Notes

ft. bgs = Feet Below Ground Surface
TDS = Total Dissolved Solids
mg/L = milligrams per liter
Data retrieved from State Water Resources Control Board GAMA database.

Historic Distribution of TDS Within Tulare Lake Subbasin

Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County

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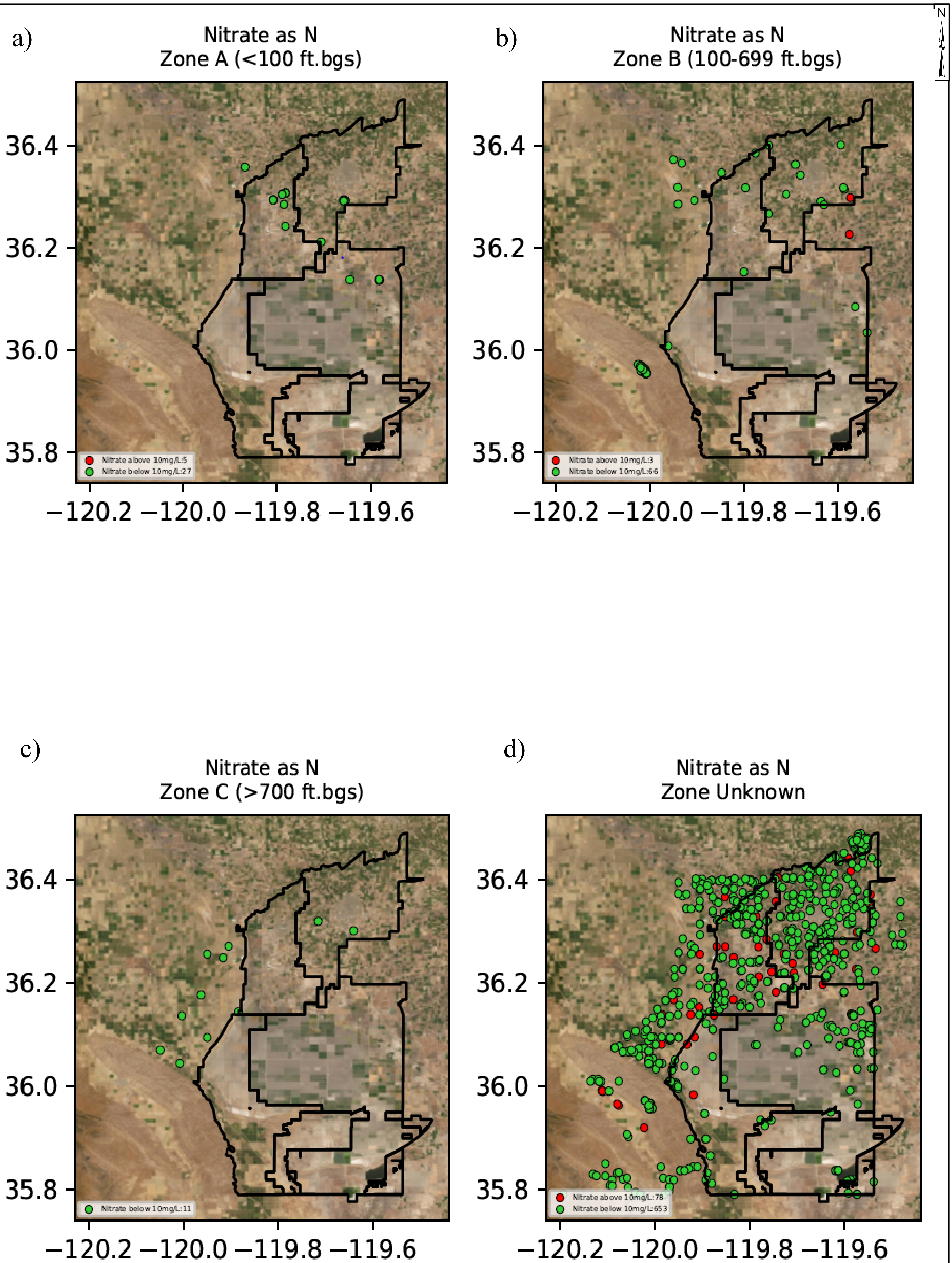
Project No.: SFO138 | June 2022

Figure 4-2



Legend

- Nitrate above 10 mg/L:Well Count
- Nitrate below 10 mg/L:Well Count

a) Wells screened above 100 ft bgs
b) Wells screened between 100-699 ft bgs
c) Wells screened below 700 ft bgs
d) Wells with unknown screen interval

Notes

ft. bgs = Feet Below Ground Surface
N = Nitrogen
mg/L = milligrams per liter
Data retrieved from State Water Resources Control Board GAMA database.

Historic Distribution of Nitrate Within Tulare Lake Subbasin

Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County

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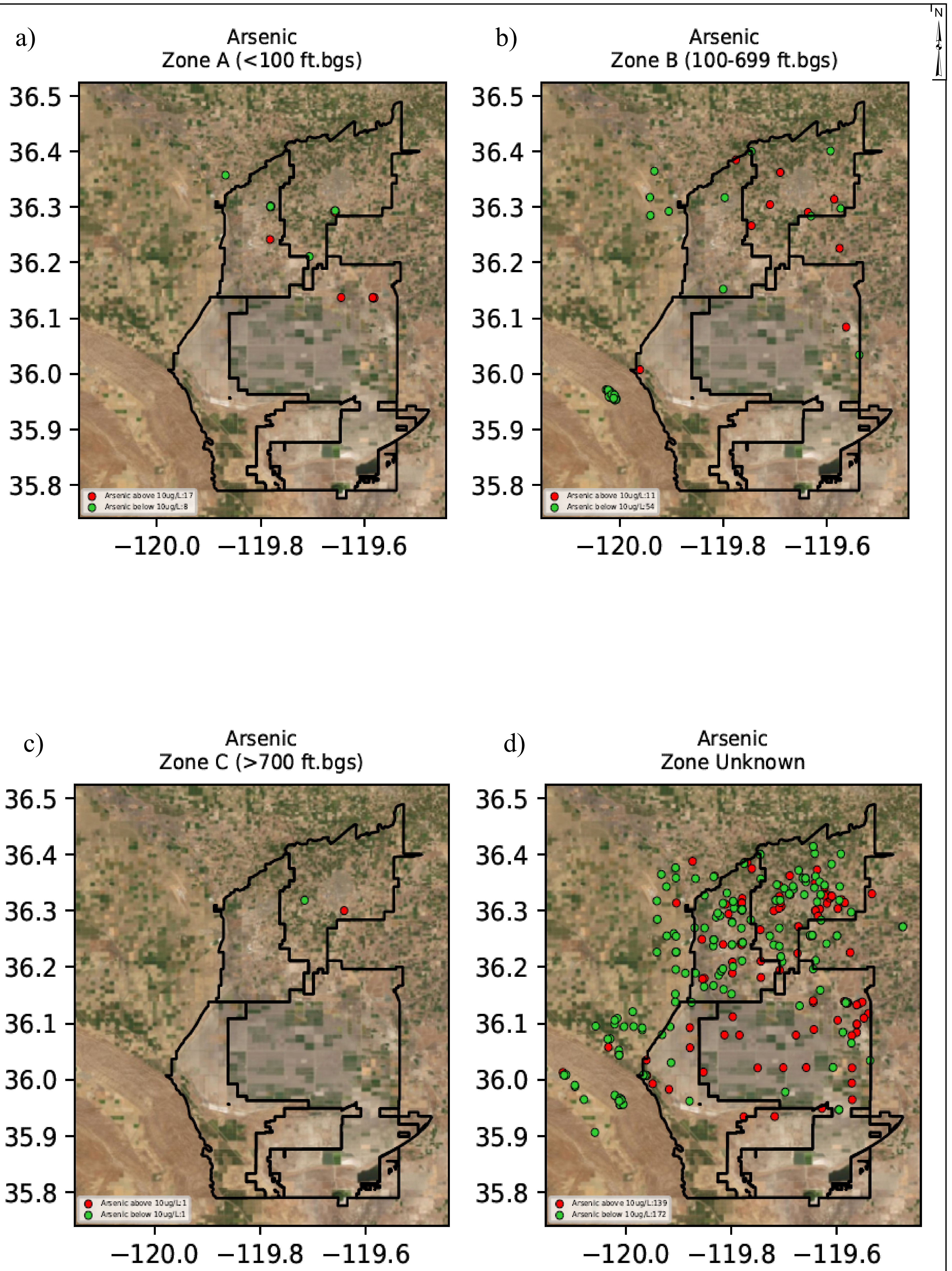
Figure 4-3



Legend

- Arsenic above 10 ug/L:Well Count
- Arsenic below 10 ug/L:Well Count

a) Wells screened above 100 ft bgs
b) Wells screened between 100-699 ft bgs
c) Wells screened below 700 ft bgs
d) Wells with unknown screen interval

Notes

ft. bgs = Feet Below Ground Surface
ug/L = micrograms per liter
Data retrieved from State Water Resources Control Board GAMA database.

Historic Distribution of Arsenic Within Tulare Lake Subbasin

Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County

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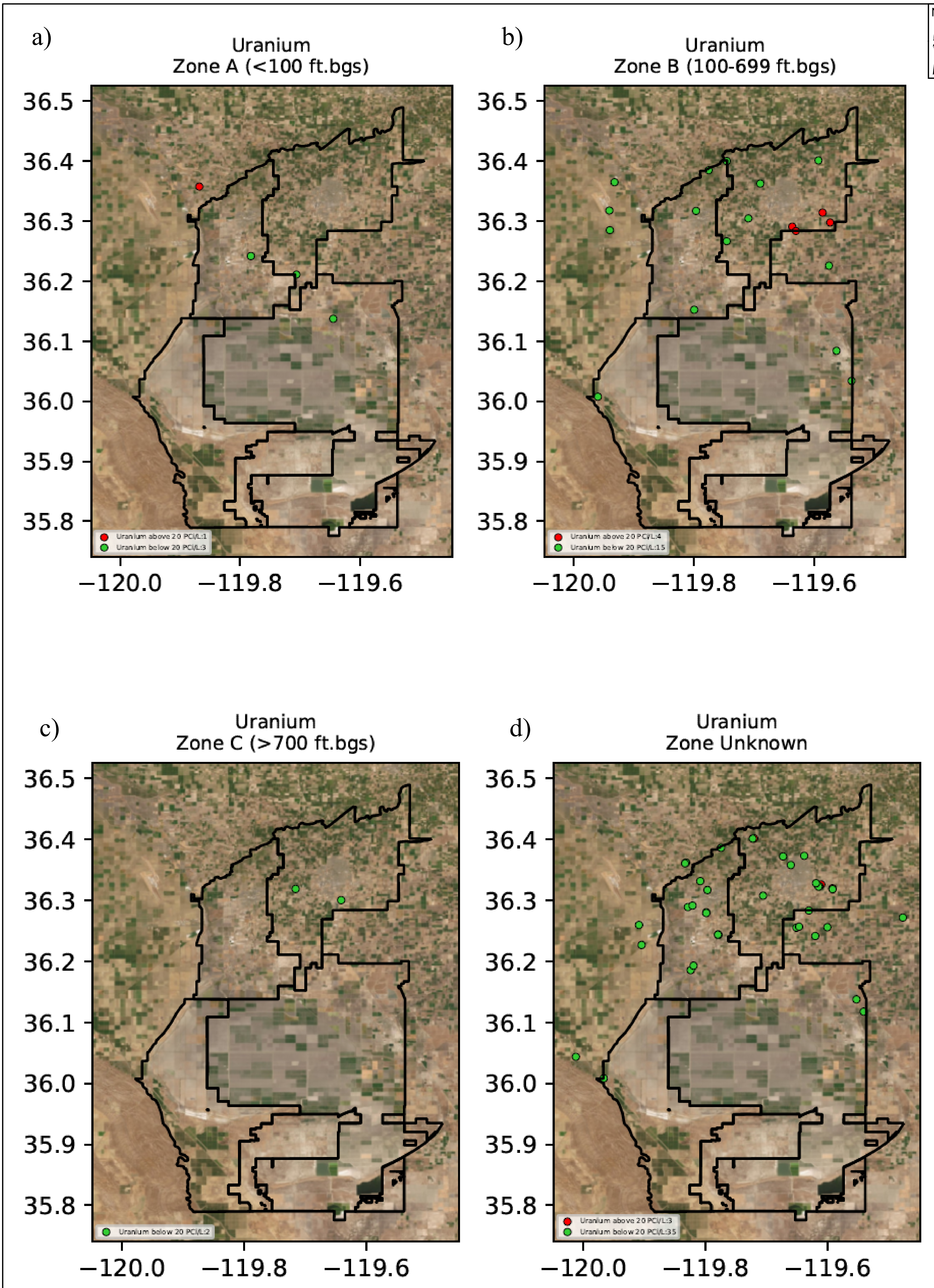
Figure 4-4



Legend

- Uranium above 20 pCi/L:Well Count
- Uranium below 20 pCi/L:Well Count

a) Wells screened above 100 ft bgs
b) Wells screened between 100-699 ft bgs
c) Wells screened below 700 ft bgs
d) Wells with unknown screen interval

Notes

ft. bgs = Feet Below Ground Surface
pCi/L = picocuries per liter
Data retrieved from State Water Resources Control Board GAMA database.

Historic Distribution of Uranium Within Tulare Lake Subbasin

Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County

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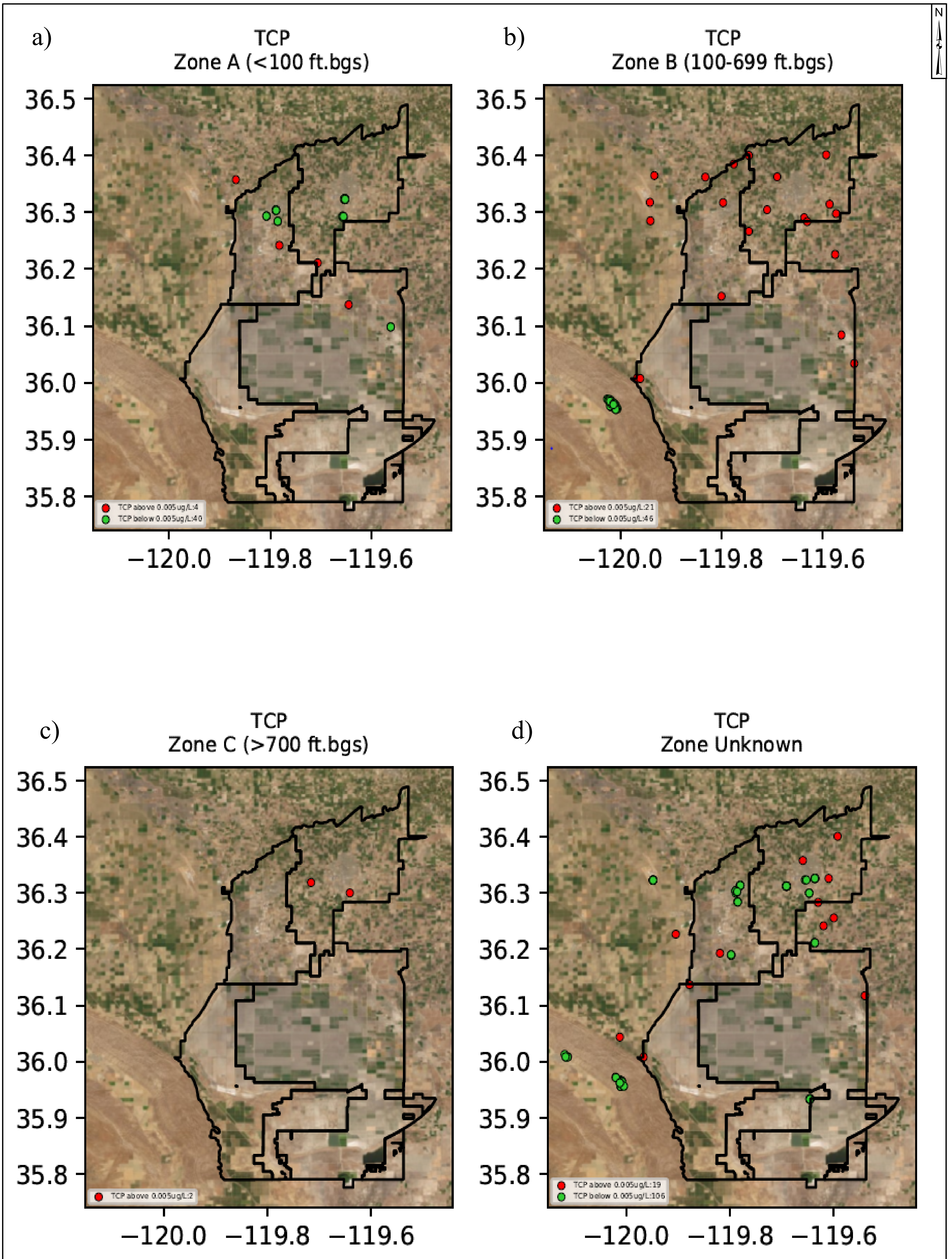
Project No.: SFO138 | June 2022

Figure 4-5



Legend

- TCP above 0.005 ug/L:Well Count
- TCP below 0.005 ug/L:Well Count

a) Wells screened above 100 ft bgs
b) Wells screened between 100-699 ft bgs
c) Wells screened below 700 ft bgs
d) Wells with unknown screen interval

Notes

ft. bgs = Feet Below Ground Surface
TCP = 1,2,3-Trichloropropane
ug/L = micrograms per liter
Data retrieved from State Water Resources Control Board GAMA database.

Historic Distribution of TCP Within Tulare Lake Subbasin

Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County

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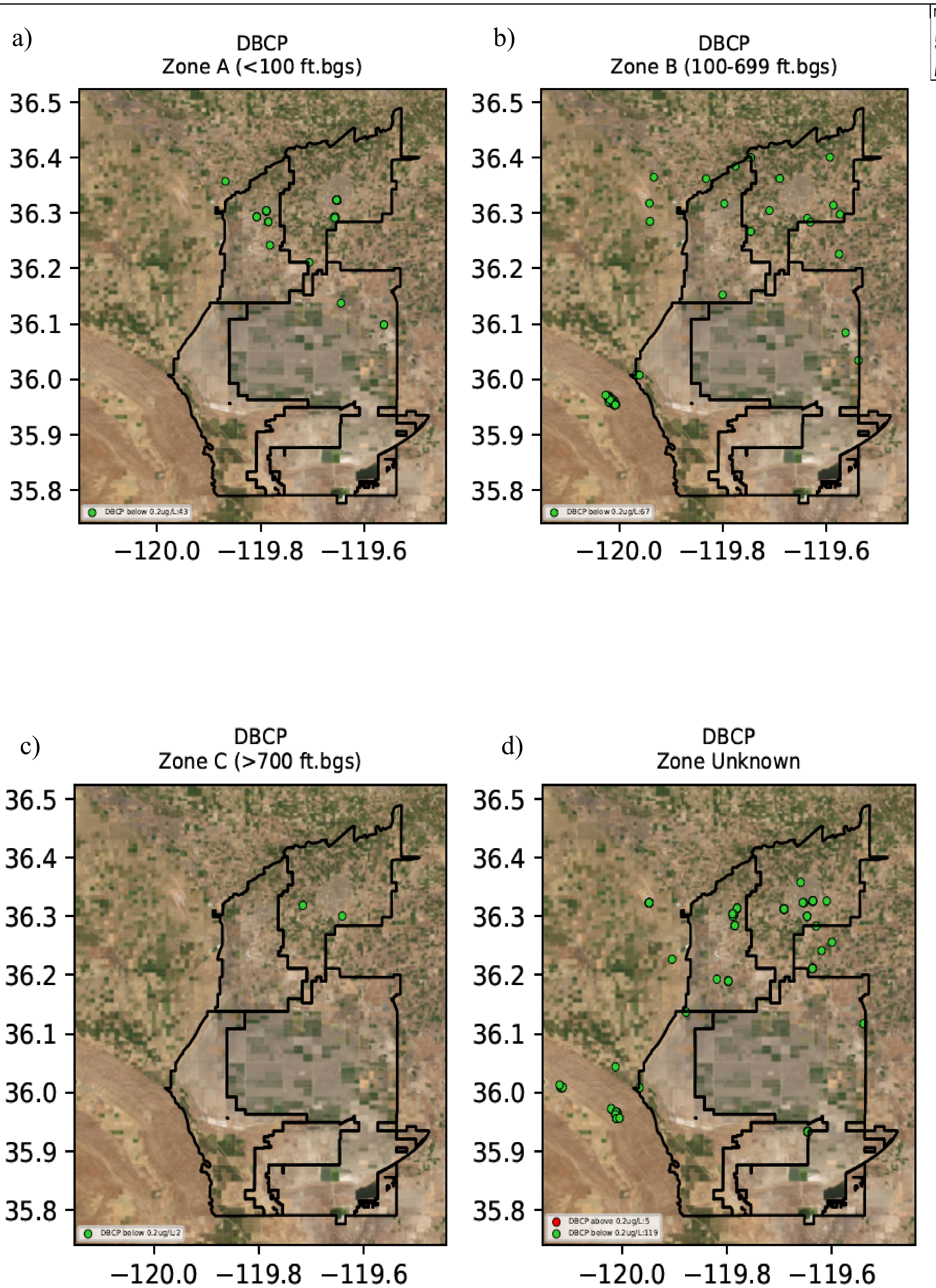
Figure 4-6



Legend

- DBCP above 0.2 ug/L:Well Count
- DBCP below 0.2 ug/L:Well Count

a) Wells screened above 100 ft bgs
b) Wells screened between 100-699 ft bgs
c) Wells screened below 700 ft bgs
d) Wells with unknown screen interval

Notes

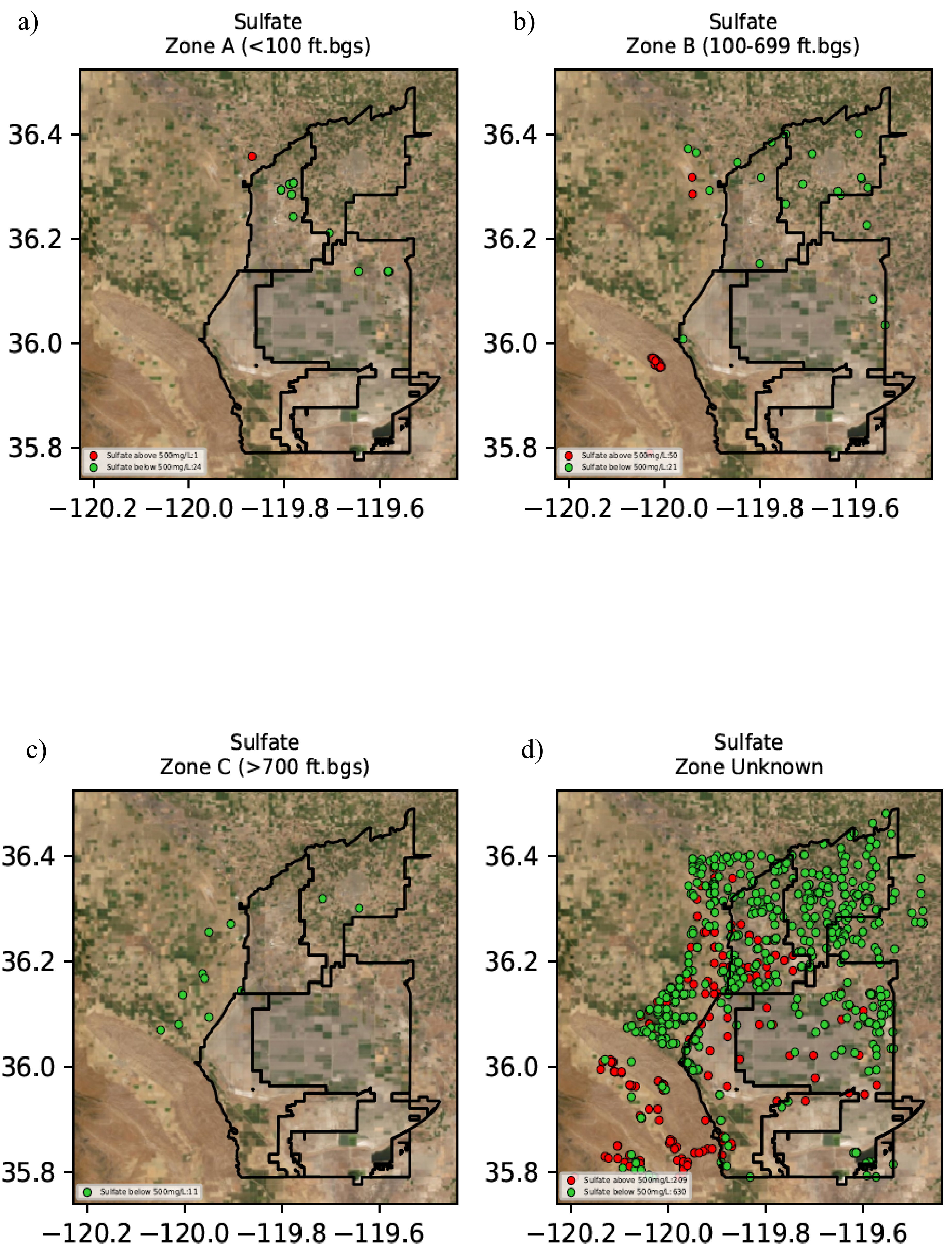
ft. bgs = Feet Below Ground Surface
DBCP = 1,2-Dibromo-3-chloropropane
ug/L = micrograms per liter
Data retrieved from State Water Resources Control Board GAMA database.

Historic Distribution of DBCP Within Tulare Lake Subbasin

Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County

Geosyntec consultants

Project No.: SFO138	June 2022	Figure 4-7



Legend
- Sulfate above 500 mg/L:Well Count
- Sulfate below 500 mg/L:Well Count

a) Wells screened above 100 ft bgs
b) Wells screened between 100-699 ft bgs
c) Wells screened below 700 ft bgs
d) Wells with unknown screen interval

Notes
ft. bgs = Feet Below Ground Surface
mg/L = milligram per liter
Data retrieved from State Water Resources Control Board GAMA database.

Historic Distribution of Sulfate Within Tulare Lake Subbasin

Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County

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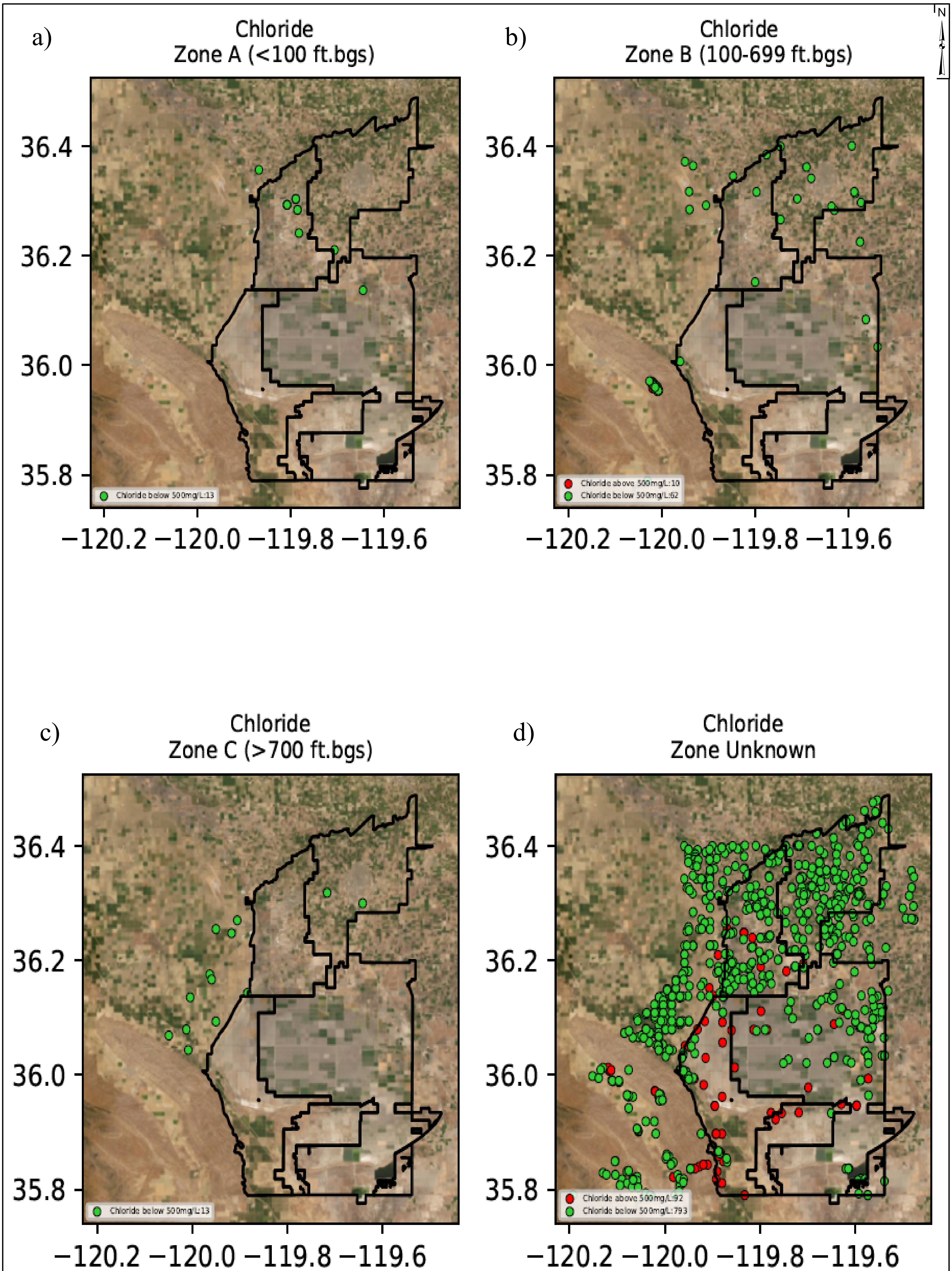
Project No.: SFO138 | June 2022

Figure 4-8



Legend

- Chloride above 500 mg/L: Well Count
- Chloride below 500 mg/L:Well Count

a) Wells screened above 100 ft bgs
b) Wells screened between 100-699 ft bgs
c) Wells screened below 700 ft bgs
d) Wells with unknown screen interval

Notes

ft. bgs = Feet Below Ground Surface
mg/L = milligram per liter
Data retrieved from State Water Resources Control Board GAMA database.

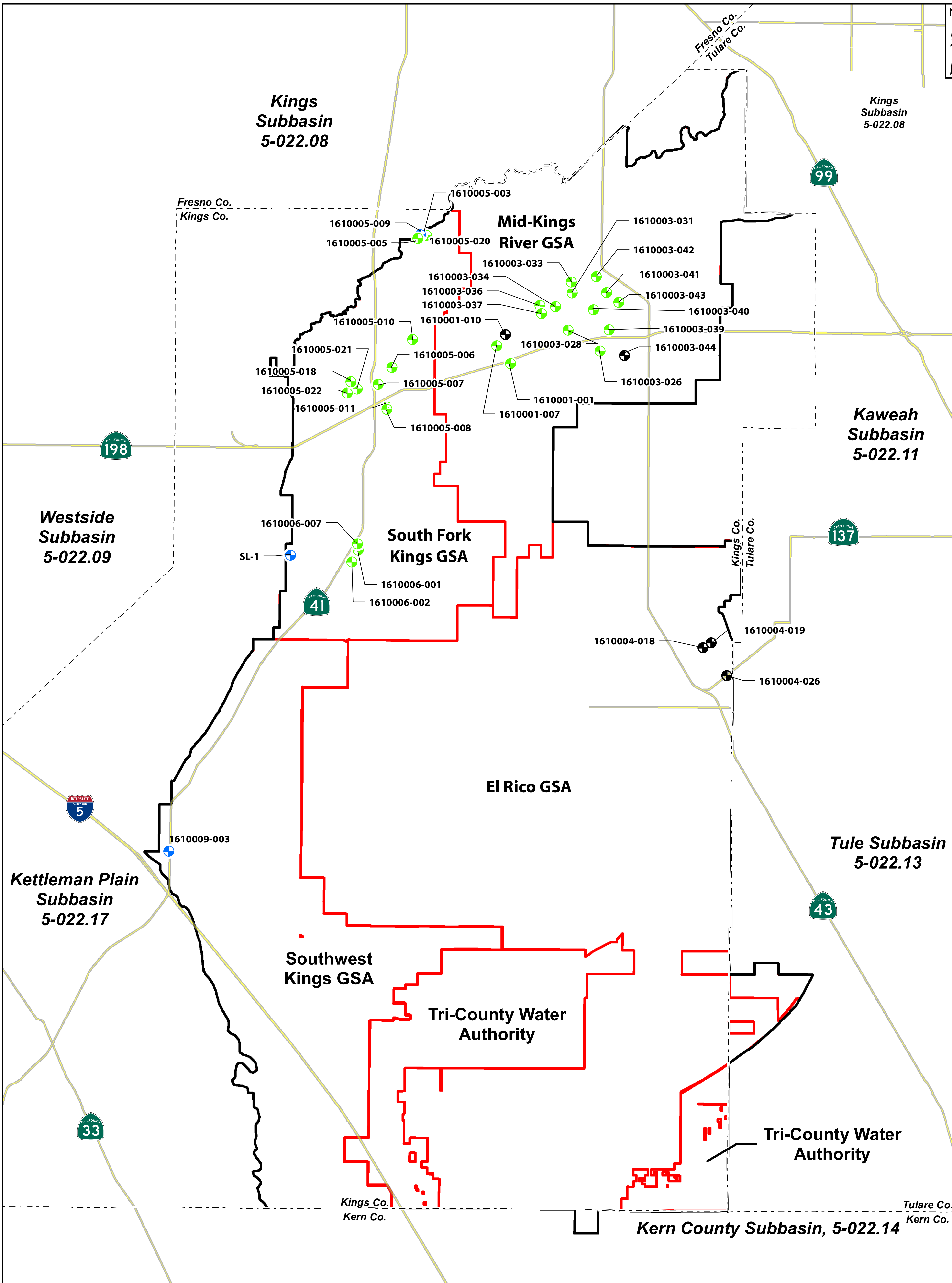
Historic Distribution of Chloride Within Tulare Lake Subbasin

Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County

Geosyntec consultants

Project No.: SFO138 | June 2022

Figure 4-9



Legend

- Tulare Lake Subbasin 5-022.12
- GSA_Master
- Highways
- County lines

Aquifer Zone

- Unknown
- B Zone
- C Zone

6 3 0 6 Miles

Groundwater Quality Monitoring Points
Groundwater Sustainability Plan Addendum
Tulare Lake Subbasin, Kings County, California

Geosyntec consultants

Project No.: SFO138 | June 2022

Figure 4-10

P:\GIS\SFO138 - Tulare Lake GSP Update 2022\Projects\RMS WQ monitoring points\Fig4-10_RMS WQ Monitoring Points.mxd 6/3/2022 12:18:57 PM (Author: SPrice)

TABLES

Table 2-1
Summary of Map Zones Based on E-Clay Elevation
Tulare Lake Subbasin GSP Addendum

E-Clay Elevation				
Map Color Zone		Upper Elev	Mid Point	Lower Elev
E-zone 1	Brown	100	150	200
E-Zone 2	Red	0	50	100
E-Zone 3	Orange	-100	-50	0
E-Zone 4	Lime	-200	-150	-100
E-Zone 5	Green	-300	-250	-200
E-Zone 6	Turquiose	-400	-350	-300
E-zone 7	Blue	-500	-450	-400
E-Zone 8	Purple	-600	-550	-500
E-zone 9	Magenta	-700	-650	-600

Notes:
E- Clay = Corcoran Clay
Elev = Elevation
Elevation is in mean sea level.

Table 2-2

Summary of OSCWR Database Query for Public, Domestic, Agricultural, and Industrial Purpose of Use

Tulare Lake Subbasin GSP Addendum

E-Clay Zone		Domestic/Public Well Count	Ag/Industrial Well Count	Total By E-Zone
Brown	E-zone 1	43	48	91
Red	E-Zone 2	178	248	426
Orange	E-Zone 3	528	488	1016
Lime	E-Zone 4	561	417	978
Green	E-Zone 5	970	1113	2083
Turquiose	E-Zone 6	191	371	562
Blue	E-zone 7	12	107	119
Purple	E-Zone 8	3	14	17
Magenta	E-zone 9	3	4	7
TOTAL		2489	2810	5299
Aquifer		**Domestic/Public Well Count**	**Ag/Industrial Well Count**	**Total By Aquifer**
A-Zone	<100' Depth	377	579	956
B-Zone	100'-700' Depth	2048	1593	3641
C-Zone	> 700' Depth	64	638	702
		2489	2810	5299

Notes:

Ag = Agricultural

E- Clay = Corcoran Clay

OSCWR = Online System of Well Completion Reports

Table 2-3
Summary of Well Completion Depths for Public/Domestic Wells in the C-Zone
Tulare Lake Subbasin GSP Addendum

E-Clay Zone		Dom/Public Well Count	Avg. Completion Elevation	Max Completion Elevation	Min Completion Elevation
Brown	E-zone 1	0	NA	NA	NA
Red	E-Zone 2	0	NA	NA	NA
Orange	E-Zone 3	4	4	-885	-471
Lime	E-Zone 4	15	15	-1223	-564
Green	E-Zone 5	24	24	-1007	-495
Turquiose	E-Zone 6	20	20	-679	-489
Blue	E-zone 7	1	1	-879	-879
Purple	E-Zone 8	0	NA	NA	NA
Magenta	E-zone 9	0	NA	NA	NA
TOTAL		64			

Notes:
Avg = Average
Dom = Domestic
E- Clay = Corcoran Clay
Max = Maximum
Min = Minimum
NA = Not Available
Elevation is in mean sea level.

Table 2-4
Summary of Well Completion Depths for Public/Domestic Wells in the B-Zone
Tulare Lake Subbasin GSP Addendum

E-Clay Zone		Dom/Public Well Count	Avg. Completion Elevation	Max Completion Elevation	Min Completion Elevation
Brown	E-zone 1	39	98	187	-115
Red	E-Zone 2	170	56	182	-335
Orange	E-Zone 3	510	6	158	-333
Lime	E-Zone 4	509	-5	150	-434
Green	E-Zone 5	697	-18	142	-473
Turquiose	E-Zone 6	110	-182	120	-491
Blue	E-zone 7	8	-349	-228	-476
Purple	E-Zone 8	3	-106	-37	-216
Magenta	E-zone 9	2	-60	13	-134
TOTAL		2048			

Notes:
Avg = Average
Dom = Domestic
E- Clay = Corcoran Clay
Max = Maximum
Min = Minimum
Elevation is in mean sea level.

Table 2-5
Summary of Well Completion Depths for Public/Domestic Wells in the A-Zone
Tulare Lake Subbasin GSP Addendum

E-Clay Zone		Dom/Public Well Count	Avg. Completion Elevation	Max Completion Elevation	Min Completion Elevation
Brown	E-zone 1	4	222	242	195
Red	E-Zone 2	8	211	272	165
Orange	E-Zone 3	14	180	217	157
Lime	E-Zone 4	37	169	200	146
Green	E-Zone 5	249	173	238	125
Turquiose	E-Zone 6	61	169	200	99
Blue	E-zone 7	3	129	147	96
Purple	E-Zone 8	0	NA	NA	NA
Magenta	E-zone 9	1	133	133	133
TOTAL		377			

Notes:
Avg = Average
Dom = Domestic
E- Clay = Corcoran Clay
Max = Maximum
Min = Minimum
NA = Not Available
Elevation is in mean sea level.

Table 2-6
Summary of Well Completion Percentiles for Public/Domestic Wells in the B-Zone
Tulare Lake Subbasin GSP Addendum

E-Clay Zone		Dom/Public Well Count	**MT Elevation Percentile Level**				
			50%	60%	70%	80%	90%
Brown	E-zone 1	16	99	115	118	123	127
Red	E-Zone 2	68	56	67	85	88	104
Orange	E-Zone 3	358	18	34	47	53	56
Lime	E-Zone 4	384	11	28	39	43	48
Green	E-Zone 5	586	15	30	39	44	46
Turquiose	E-Zone 6	98	-210	-109	-37	-16	-1
Blue	E-zone 7	8	-336	-333	-275	-241	-233
Purple	E-Zone 8	3	-60	-54	-48	-45	-42
Magenta	E-zone 9	2	-46	-31	-16	-9	-2
TOTAL		1523					

Kings River Area		Dom/Public Well Count	**MT Depth Percentile Level**				
			50%	60%	70%	80%	90%
River Zone	R-Zone	61	60	60	70	76.8	85.5

Notes:
Dom = Domestic
E- Clay = Corcoran Clay
MT = Minimum Threshold
R-Zone = River Zone
Elevation is in mean sea level.

Table 2-7
Summary of Potential Well Failures in the B-Zone by Percentile
Tulare Lake Subbasin GSP Addendum

E-Clay Zone		Dom/Public Well Count	MT Elevation Potential Well Fails				
			50%	60%	70%	80%	90%
Brown	E-zone 1	16	6	5	3	2	2
Red	E-Zone 2	68	27	20	14	10	7
Orange	E-Zone 3	358	143	107	72	54	36
Lime	E-Zone 4	384	154	115	77	58	38
Green	E-Zone 5	586	234	176	117	88	59
Turquiose	E-Zone 6	98	39	29	20	15	10
Blue	E-zone 7	8	3	2	2	1	1
Purple	E-Zone 8	3	1	1	1	0	0
Magenta	E-zone 9	2	1	1	0	0	0
TOTAL		1523	609	457	305	228	152

Notes:
Dom = Domestic
E- Clay = Corcoran Clay
MT = Minimum Threshold
Elevation is in mean sea level.

Table 2-8
Summary of Available Saturated Thickness in the B-Zone by Percentile
Tulare Lake Subbasin GSP Addendum

E-Clay Zone		Dom/Public Well Count	MT Elevation Available Drawdown				
			50%	60%	70%	80%	90%
Brown	E-zone 1	16	99	115	118	123	127
Red	E-Zone 2	68	56	67	85	88	104
Orange	E-Zone 3	358	18	34	47	53	56
Lime	E-Zone 4	384	111	128	139	143	148
Green	E-Zone 5	586	215	230	239	244	246
Turquiose	E-Zone 6	98	90	191	263	284	299
Blue	E-zone 7	8	64	67	125	159	167
Purple	E-Zone 8	3	440	446	452	455	458
Magenta	E-zone 9	2	554	569	584	591	598
TOTAL		1523					

Notes:
Dom = Domestic
E- Clay = Corcoran Clay
MT = Minimum Threshold
Elevation is in mean sea level.

Table 2-9
Summary of Interim Minimum Thresholds (MT) for All Aquifers
Tulare Lake Subbasin GSP Addendum

E-Clay Zone		Dom/Public Well Count	Interim MT Elevation			
			A Zone	B-Zone Elev (90th Percentile)	C-Zone Elev (E-Clay + 50)	R-Zone (Depth)
Brown	E-zone 1	39	Base of A-Clay	127	150	60
Red	E-Zone 2	170		104	50	
Orange	E-Zone 3	510		56	-50	
Lime	E-Zone 4	509		48	-150	
Green	E-Zone 5	697		46	-250	
Turquiose	E-Zone 6	110		-1	-350	
Blue	E-zone 7	8		-233	-450	
Purple	E-Zone 8	3		-42	-550	
Magenta	E-zone 9	2		-2	-650	
TOTAL		2048				

Notes:
Dom = Domestic
E- Clay = Corcoran Clay
MT = Minimum Threshold
R-Zone = River Zone
Elevation is in mean sea level.

Table 2-10
Summary of Interim MTs for All RMS Locations
Tulare Lake Subbasin GSP Addendum

Well ID	Alternative Well ID	GSA	GSP (January 2020) GWL SMC Elevations		SMC Addendum (June 2022)					B-Zone		
			MO Elev	MT Elev	Aquifer	E-Clay Elevation Zone		# of Public/DomWells in Section	MT Elev (A-Zone)	MT Elev (80%)	MT Elev (90%)	MT Elev (C-Zone)
18S20E23E003M	KRCDAC1S	SFK	198.4	148.4	A	--	--	5	148.4			
19S20E29E002M		SFK	183.63	133.63	A	--	--	2	133.63			
20S19E25A003M		SFK	199.21	149.21	A	--	--	0	149.21			
AG-1		SFK	--	--	A	--	--	3	--			
18S21E17N001M		MKR	213.38	163.38	A	--	--	6	163.38			
MW-A		MKR	253.5	203.5	B	E-Zone 1	Brown	6		84	86	
18S22E24D001M		MKR	95.97	45.97	B	E-Zone 1	Brown	3		84	86	
18S22E03B001M		MKR	134.48	84.48	B	E-Zone 1	Brown	4		84	86	
17S22E28A001M	KRCDKCWD01	MKR	156.77	106.77	B	E-Zone 1	Brown	6		84	86	
MWG INT		MKR	181.23	131.23	B	E-Zone 1	Brown	1		84	86	
MWD INT		MKR	191.22	141.22	B	E-Zone 1	Brown	4		84	86	
MW-C		MKR	186.02	136.02	B	E-Zone 1	Brown	3		84	86	
MWD DEEP		MKR	158.78	108.78	B	E-Zone 3	Orange	1		41	53	
MWG DEEP		MKR	132.82	82.82	B	E-Zone 3	Orange	1		41	53	
18S22E34R001M*		MKR	144.38	94.38	B	E-Zone 3	Orange	13		--	101	
MWH INT		MKR	110.17	60.17	B	E-Zone 3	Orange	13		41	53	
18S22E28A001M	KRCDKCWD08	MKR	95.97	45.97	B	E-Zone 3	Orange	5		41	53	
1610005-009*	18S20E11C002M	SFK	31.3	-18.7	B	E-Zone 5	Green	2		--	24	
18S20E23E001M*	KRCDAC1D	SFK	26.39	-23.61	B	E-Zone 5	Green	5		--	-43	
18S20E23E002M*	KRCDAC1M	SFK	28.42	-21.58	B	E-Zone 5	Green	5		--	-26	
18S20E34N001M		SFK	68.17	18.17	B	E-Zone 5	Green	8		34	44	
19S20E06D004M*		SFK	--	--	B	E-Zone 5	Green	0		--	8	
LR-19		SFK	--	--	B	E-Zone 5	Green	3		34	44	
LR-18		SFK	--	--	B	E-Zone 5	Green	4		34	44	
LR-4		SFK	--	--	B	E-Zone 5	Green	3		34	44	
ER_CID_05		El Rico	--	--	B	E-Zone 5	Green	0		34	44	
18S21E07R003M		MKR	195.06	145.06	B	E-Zone 5	Green	5		34	44	
18S21E31B001M		MKR	67.13	17.13	B	E-Zone 5	Green	7		34	44	
18S21E27B001M	KRCDKCWD05	MKR	70	20	B	E-Zone 5	Green	13		34	44	
19S20E32D002M*	KRCDAC3M	SFK	-26.91	-76.91	B	E-Zone 6	Turquiose	0		--	-91	
20S20E26L001M*	KRCDAC5M	SFK	45.75	-4.25	B	E-Zone 6	Turquiose	3		--	-57	
CID-071		El Rico	--	--	B	E-Zone 6	Turquiose	0		-41	-5	
19S20E26N002M*	CU ELEMENTARY SCHOOL	SFK	-3.81	-53.81	B	E-Zone 6	Turquiose	1		--	-99.78	
SL-1		SFK	--	--	B	E-Zone 7	Blue	0		-275	-233	
1610009-003	Becky Pease Well	SWK	70.58	20.58	B	E-Zone 7	Blue	1		-275	-233	
MWH DEEP		MKR	38.47	-11.53	C	E-Zone 3	Orange	13				-50
FB 35-2*		TCWA	--	--	C	E-Zone 4	Lime	0				-214
ER_CID-01		El Rico	--	--	C	E-Zone 4	Lime	2				-150
19S22E08D002M		MKR	-39.5	-89.5	C	E-Zone 4	Lime	13				-150
1610005-020	18S20E11C003M	SFK	7.21	-42.79	C	E-Zone 5	Green	2				-250
19S20E06D005M		SFK	--	--	C	E-Zone 5	Green	0				-250
1610005-011	1610005-011	SFK	-91.02	-141.02	C	E-Zone 5	Green	0				-250
ZE 33-4		TCWA	--	--	C	E-Zone 5	Green	0				-250
ER_CID-081		El Rico	--	--	C	E-Zone 5	Green	1				-250
KRCDTL002		El Rico	7.43	-42.57	C	E-Zone 5	Green	0				-250
19S21E30A001M	KRCDKCWD06	MKR	185.18	135.18	C	E-Zone 5	Green	2				-250
19S20E32D003M	KRCDAC3D	SFK	-26.91	-76.91	C	E-Zone 6	Turquiose	0				-350
20S20E26L002M	KRCDAC5D	SFK	-19.25	-69.25	C	E-Zone 6	Turquiose	3				-350
20S19E02A001M		SFK	-67.47	-117.47	C	E-Zone 6	Turquiose	0				-350
20S20E07H001M		SFK	-102.74	-152.74	C	E-Zone 6	Turquiose	2				-350
20S20E28E003M		SFK	-41.13	-91.13	C	E-Zone 6	Turquiose	2				-350
ER_S-173		El Rico	-192.36	-242.36	C	E-Zone 6	Turquiose	0				-350
KRCDTL003		El Rico	-153.55	-203.55	C	E-Zone 6	Turquiose	0				-350
ER_S-225*		El Rico	-208.49	-258.49	C	E-Zone 7	Blue	0				-257
Well 16-8		SWK	50.96	0.96	C	E-Zone 7	Blue	0				-450
ER_S-205		El Rico	-280.27	-330.27	C	E-Zone 7	Blue	0				-450
21S22E07J001M		El Rico	-146.77	-196.77	C	E-Zone 7	Blue	1				-450

Notes:
E- Clay = Corcoran Clay
GSA = Groundwater Sustainability Agency
GWL = Groundwater Level
ID = Identification
MO = Measurable Objective
MT = Minimum Threshold
SMC = Sustainable Management Criteria
Elevation is in mean sea level.
* MT is set 20 feet below lowest measurement collected from 2015 to 2021.

Table 3-1
Infrastructure Impacts from Subsidence
Groundwater Sustainability Plan - Addendum
Tulare Lake Subbasin

Type of Infrastructure	Length or Number within 3 miles of TLSB	Possible Impacts to Infrastructure from Subsidence
Canals	1,891 miles	- Decrease in regional or localized slope of the channel that leads to decreased ability to convey flow. - For lined canals, differential vertical movement that causes cracking in lining, which could result in decreased ability to convey flow.
Aqueduct	25.1 miles	
Flood Protection Levees	102 miles	- Decrease in the elevation of the top of the levee with respect to the elevation of the flood water that it is designed to contain
		- Differential vertical movement that causes cracking/break in levee, which could result in decreased ability to contain water.
Pipelines	47 miles	- Differential vertical movement between points that induces axial strain exceeding strain capacity.
High Speed Rail Lines	42 miles	- Differential vertical movement that causes cracking, which could result in unsafe driving conditions.
Buildings (i.e., emergency facilities)	29	- Differential vertical movement between foundation locations that causes distress in structural members or inoperability of equipment housed in the building.
Bridges	222	- Differential vertical movement between piers and abutments that could lead to increased stress in structural members
Roads	4,380 miles	- Differential vertical movement that causes pavement/embankment cracking, which could result in unsafe driving conditions.
Airports	1	
Rail Lines	83 miles	
Water Wells	5,474	- Drag loads that exceed the capacity of the well leading to well failure

Notes:
TLSB = Tulare Lake Subbasin

Table 3-2
Vertical Displacement at RMS Locations
Groundwater Sustainability Plan - Addendum
Tulare Lake Subbasin

Monitoring Station	Baseline (feet)	With GSP Implementation (feet)
CRCN	11.07	4.34
LEMA	8.98	3.70
SUB001 [2]	Limited data	1.60
SUB002 [2]	Limited data	1.60
SUB023	2.41	1.91
SUB027 [2]	Limited data	0.80
SUB028	8.87	4.38
SUB030 [2]	Limited data	0.70
SUB032	9.49	4.25
SUB036	5.88	2.88
SUB037	3.49	2.27
SUB038	2.61	1.83
SUB053 [2]	Limited data	1.10
SUB055	14.07	6.09
SUB061 [1]	6.35	3.37
SUB062	10.49	4.80
SUB071 [2]	Limited data	1.30
SUB076 [2]	Limited data	0.80
SUB083	12.60	5.58
SUB086	8.63	3.96
SUB093	2.87	1.81
SUB102 [1]	4.55	2.41
SUB105	7.34	3.47
SUB107 [2]	Limited data	0.70
SUB109 [1]	4.32	2.28
SUB110	no data	no data
SUB111	11.62	5.08

Notes:

1. InSAR data was incomplete. Subsidence calculations utilized available data.
2. Values for "With GSP implementation" estimated based on nearby sites due to limited data.

Table 3-3

Local Minimum Tolerances (LMT) for Differential Subsidence

Groundwater Sustainability Plan - Addendum

Tulare Lake Subbasin

Type of Infrastructure	Local Minimum Thresholds (LMT) for Differential Subsidence
Canals and Aqueduct	1/600
Flood Protection Levees	1/600
Pipelines	1/100
High Speed Rail Lines	1/80
Buildings	1/300
Bridges	1/400
Embankments for Roads, Airports, and Rail Lines	1/600

Table 4-1
Upper Tolerance Interval, Measurable Objective, and Minimum Thresholds
Groundwater Sustainability Plan - Addendum
Tulare Lake Subbasin

GSA	Well I.D.	Aquifer Zone	Units	Upper Tolerance Interval						
				TDS	Nitrate as N	Arsenic	Uranium	Sulfate	TCP	Chloride
				mg/L	mg/L	µg/L	pCi/L	mg/L	µg/L	mg/L
MKR	1610001-001	C		-	-	13.9	3.1	-	-	20.1
	1610001-007	C		-	-	51.6	-	-	-	58.8
	1610001-010	unk		-	-	23.9	-	-	-	-
	1610003-031	C		421	5	12	-	-	-	172
	1610003-039	C		487	-	10	-	-	-	223
	1610003-036	C		348	-	7	-	-	-	98
	1610003-041	C		599	-	3	-	-	-	-
	1610003-033	C		422	-	10	-	-	-	167
	1610003-040	C		500	-	5	-	4	-	175
	1610003-026	C		461	-	13	-	10	-	-
	1610003-028	C		425	-	21	-	3	-	-
	1610003-043	C		519	-	10	-	-	-	-
	1610003-042	C		616	-	-	-	-	-	243
	1610003-037	C		331	-	5	-	-	-	79
	1610003-044	unk		474.8	-	12.9	-	-	-	-
	1610003-034	C		386	1	30	-	16	-	126
SFK	1610006-001	C		839	3	7	-	-	-	-
	1610006-002	C		2452	-	-	-	436	-	80
	1610006-007	C		-	-	-	-	-	-	-
	1610005-021	C		420	-	2	-	-	-	92
	1610005-010	C		340	2	11	-	-	-	-
	1610005-003	unk		-	-	20	4	3	-	52
	1610005-022	C		449	-	0	5	1	-	98
	1610005-005	C		309	1	16	3	4	-	51
	1610005-018	C		423	-	2	2	-	-	91
	1610005-008	C		401	-	4	8	-	-	-
	1610005-006	C		382	2	7	3	10	-	77
	1610005-009	B		-	-	29	-	-	-	-
	1610005-020	C		286	-	8	4	-	-	31
	1610005-011	C		451	-	5	-	-	-	84
	SL-1	B		-	2.2	-	-	-	-	-
SWK	1610009-003	B		939	1	17	1	-	-	-
El Rico	1610004-026	unk		269	3	20	-	59	-	43
	1610004-018	unk		-	-	28	-	-	-	-
	1610004-019	unk		174	-	33	11	-	-	-

Notes:

269	Has data from 2000 to 2020
250	Data Pre-2000
-/250	No data avalable
250	New Well, <2 samples collected

Table 4-1
Upper Tolerance Interval, Measurable Objective, and Minimum Thresholds
Groundwater Sustainability Plan - Addendum
Tulare Lake Subbasin

GSA	Well I.D.	Aquifer Zone	Units	Measurable Objective						
				TDS	Nitrate as N	Arsenic	Uranium	Sulfate	TCP	Chloride
				mg/L	mg/L	µg/L	pCi/L	mg/L	µg/L	mg/L
MKR	1610001-001	C		500	7	13.9	3.1	250	0.00025	250
	1610001-007	C		500	7	51.6	14	250	0.00025	250
	1610001-010	unk		500	7	23.9	14	250	0.00025	250
	1610003-031	C		500	5	12	14	250	0.00025	250
	1610003-039	C		500	7	10	14	250	0.00025	250
	1610003-036	C		500	2	7	14	250	0.00025	250
	1610003-041	C		599	7	3	14	250	0.00025	250
	1610003-033	C		500	7	10	14	250	0.00025	250
	1610003-040	C		500	7	5	14	250	0.00025	250
	1610003-026	C		500	7	13	14	250	0.00025	250
	1610003-028	C		500	7	21	14	250	0.00025	250
	1610003-043	C		519	7	10	14	250	0.00025	250
	1610003-042	C		616	7	7	14	250	0.00025	250
	1610003-037	C		500	7	5	14	250	0.00025	250
	1610003-044	unk		474.8	7	12.9	14	250	0.00025	250
	1610003-034	C		500	1	30	14	250	0.00025	250
SFK	1610006-001	C		839	3	7	14	250	0.00025	250
	1610006-002	C		2452	7	7	14	436	0.00025	250
	1610006-007	C		500	7	7	14	250	0.00025	250
	1610005-021	C		500	7	2	14	250	0.00025	250
	1610005-010	C		500	2	11	14	250	0.00025	250
	1610005-003	unk		500	7	20	4	250	0.00025	250
	1610005-022	C		500	7	0.5	5	250	0.00025	250
	1610005-005	C		500	1	16	3	250	0.00025	250
	1610005-018	C		500	7	2	2	250	0.00025	250
	1610005-008	C		500	7	4	8	250	0.00025	250
	1610005-006	C		500	2	7	3	250	0.00025	250
	1610005-009	B		500	7	29	14	250	0.00025	250
	1610005-020	C		500	7	8	4	250	0.00025	250
	1610005-011	C		500	7	5	14	250	0.00025	250
	SL-1	B		1500	2.2	7	14	1000	0.00025	250
SWK	1610009-003	B		939	1	17	1	250	0.00025	250
El Rico	1610004-026	unk		500	3	20	14	250	0.00025	250
	1610004-018	unk		500	7	28	14	250	0.00025	250
	1610004-019	unk		500	7	33	11	250	0.00025	250

Notes:

269	Has data from 2000 to 2020
250	Data Pre-2000
-/250	No data avalable
250	New Well, <2 samples collected

Table 4-1

Upper Tolerance Interval, Measurable Objective, and Minimum Thresholds

Groundwater Sustainability Plan - Addendum

Tulare Lake Subbasin

GSA	Well I.D.	Aquifer Zone	Units	Minimum Threshold						
				TDS	Nitrate as N	Arsenic	Uranium	Sulfate	TCP	Chloride
				mg/L	mg/L	µg/L	pCi/L	mg/L	µg/L	mg/L
MKR	1610001-001	C		1000	10	13.9	20	500	0.0005	500
	1610001-007	C		1000	10	51.6	20	500	0.0005	500
	1610001-010	unk		1000	10	23.9	20	500	0.0005	500
	1610003-031	C		1000	10	56	20	500	0.0005	500
	1610003-039	C		1000	10	10	20	500	0.0005	500
	1610003-036	C		1000	10	10	20	500	0.0005	500
	1610003-041	C		1000	10	10	20	500	0.0005	500
	1610003-033	C		1000	10	69	20	500	0.0005	500
	1610003-040	C		1000	10	10	20	500	0.0005	500
	1610003-026	C		1000	19	23	20	500	0.0005	500
	1610003-028	C		1000	10	35	20	500	0.0005	500
	1610003-043	C		1000	10	10	20	500	0.0005	500
	1610003-042	C		1000	10	10	20	500	0.0005	500
	1610003-037	C		1000	10	10	20	500	0.0005	500
	1610003-044	unk		1000	10	10	20	500	0.0005	500
	1610003-034	C		1000	10	78	20	500	0.0005	500
SFK	1610006-001	C		1000	10	13	20	500	0.0005	500
	1610006-002	C		4500	10	10	20	800	0.0005	500
	1610006-007	C		1000	10	10	20	500	0.0005	500
	1610005-021	C		1000	10	10	20	500	0.0005	500
	1610005-010	C		1000	10	29	20	500	0.0005	500
	1610005-003	unk		1000	10	23	20	500	0.0005	500
	1610005-022	C		1000	10	10	20	500	0.0005	500
	1610005-005	C		1000	10	25	20	500	0.0005	500
	1610005-018	C		1000	10	10	20	500	0.0005	500
	1610005-008	C		1000	10	10	20	500	0.0005	500
	1610005-006	C		1000	10	19	20	500	0.0005	500
	1610005-009	B		1000	10	46	20	500	0.0005	500
	1610005-020	C		1000	10	11	20	500	0.0005	500
	1610005-011	C		1000	10	14	20	500	0.0005	500
	SL-1	B		1500	10	10	20	1000	0.0005	500
SWK	1610009-003	B		1000	10	23	20	500	0.0005	500
El Rico	1610004-026	unk		1000	10	32	20	500	0.0005	500
	1610004-018	unk		1000	10	38	20	500	0.0005	500
	1610004-019	unk		1000	10	33	20	500	0.0005	500

Notes:

269	Has data from 2000 to 2020
250	Data Pre-2000
-/250	No data avalable
250	New Well, <2 samples collected

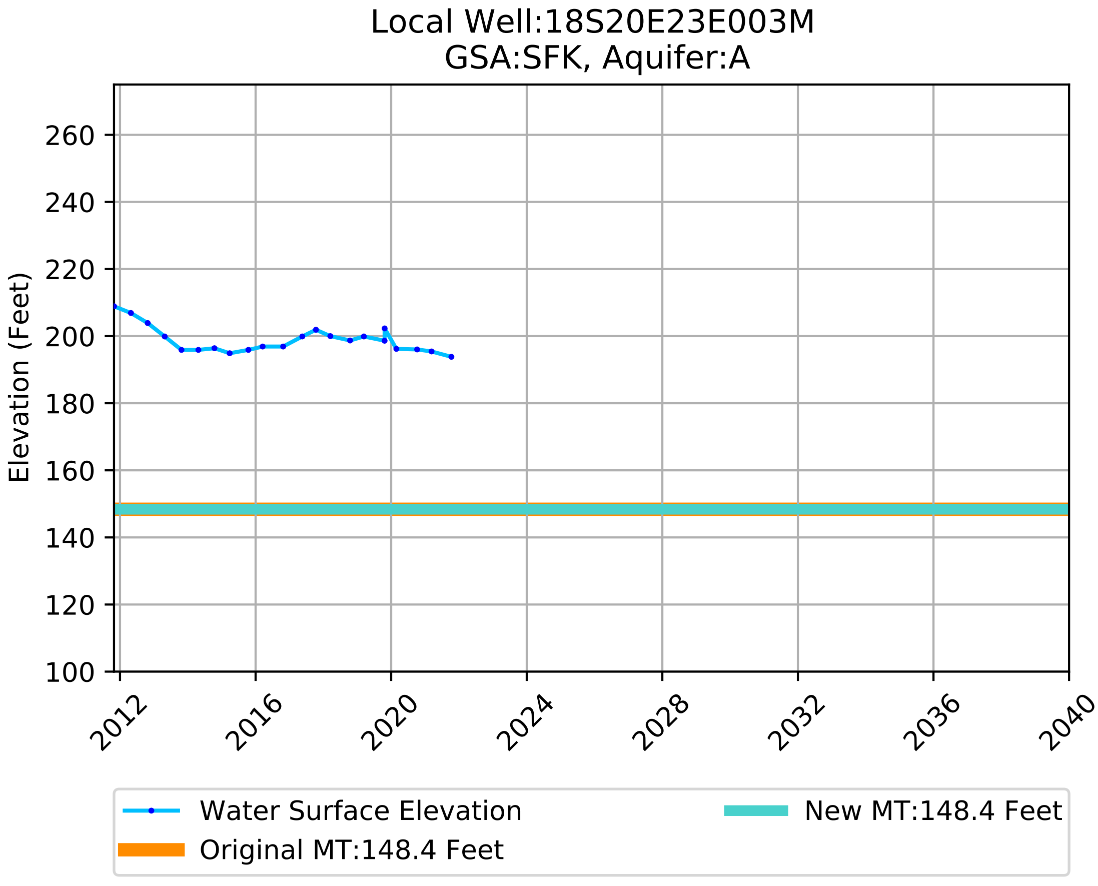
Table 4-2
Groundwater Quality Network - Sampling Frequency
Groundwater Sustainability Plan - Addendum
Tulare Lake Subbasin

Well Name	GSA	Aquifer Zone	TDS	Nitrate as N	Arsenic	Uranium	Sulfate	TCP	Chloride
1610001-001	MKR	C	NA	9	9	NA	NA	9	NA
1610001-007	MKR	C	NA	9	9	NA	NA	9	NA
1610001-010	MKR	Unk	NA	1	0.25	NA	3	3	3
1610003-031	MKR	C	3	1	3	NA	3	3	3
1610003-039	MKR	C	3	1	3	NA	3	3	3
1610003-036	MKR	C	3	2	3	NA	3	3	3
1610003-041	MKR	C	3	1	3	NA	3	3	3
1610003-033	MKR	C	3	1	3	NA	3	3	3
1610003-040	MKR	C	3	1	3	NA	3	3	3
1610003-026	MKR	C	NA	9	3	NA	NA	9	NA
1610003-028	MKR	C	NA	1	3	NA	3	3	3
1610003-043	MKR	C	3	1	3	NA	3	3	3
1610003-042	MKR	C	3	1	3	NA	3	3	3
1610003-037	MKR	C	3	1	3	NA	3	3	3
1610003-044	MKR	Unk	3	1	3	NA	3	3	3
1610003-034	MKR	C	3	1	3	NA	3	3	3
1610006-001	SFK	C	1	1	3	3	3	3	3
1610006-002	SFK	C	NA	DUE	9	NA	NA	9	NA
1610006-007	SFK	C	1	1	3	NA	3	0.25	3
1610005-021	SFK	C	3	1	0.25	NA	3	3	3
1610005-010	SFK	C	3	1	0.25	NA	3	3	3
1610005-003	SFK	unk	NA	9	9	NA	NA	9	NA
1610005-022	SFK	C	3	1	0.25	NA	3	3	3
1610005-005	SFK	C	3	1	0.25	NA	3	3	3
1610005-018	SFK	C	3	1	0.25	NA	3	3	3
1610005-008	SFK	C	NA	9	0.25	NA	NA	9	NA
1610005-006	SFK	C	3	1	0.25	NA	3	3	3
1610005-009	SFK	B	3	1	0.25	NA	3	3	3
1610005-020	SFK	C	3	1	0.25	NA	3	3	3
1610005-011	SFK	C	3	1	0.25	NA	3	3	3
SL-1	SFK	B	2	2	2	2	2	2	2
1610009-003	SWK	B	NA	9	9	9	NA	9	NA
1610004-026	ELR	Unk	3	1	0.25	NA	3	3	3
1610004-018	ELR	Unk	3	1	0.25	NA	3	3	3
1610004-019	ELR	Unk	3	1	3	NA	3	3	3

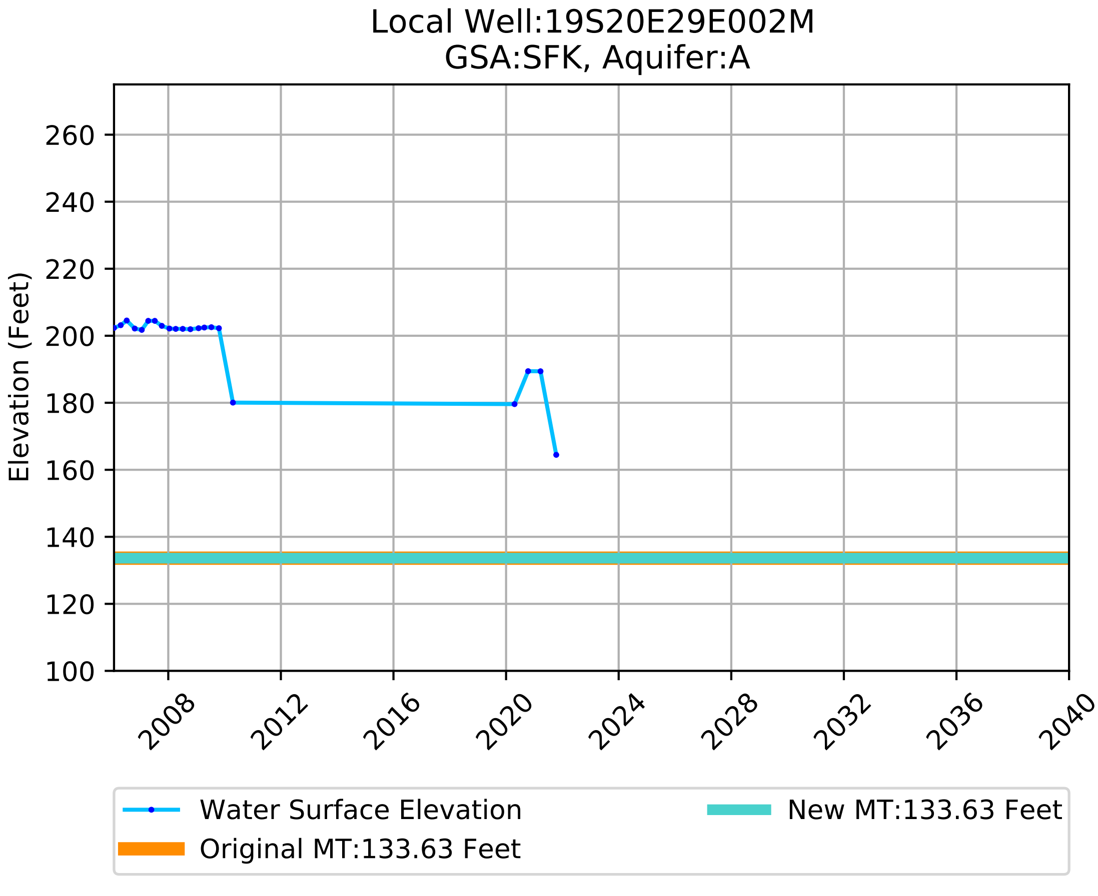
Notes:
DUE = Sampling Event due
GSA = Groundwater Sustainability Agency
MKR = Mid-Kings River GSA
NA = Not Available
SFK = South Fork Kings GSA
SWK = Southwest Kings GSA
Unk = Unknown Aquifer Zone.
All Numbers are reported in years.
Bold well names are newly added to the Groundwater Quality Monitoring Network.
Wells no longer monitored by existing regulatory agencies have been removed from the monitoring network.

APPENDIX A

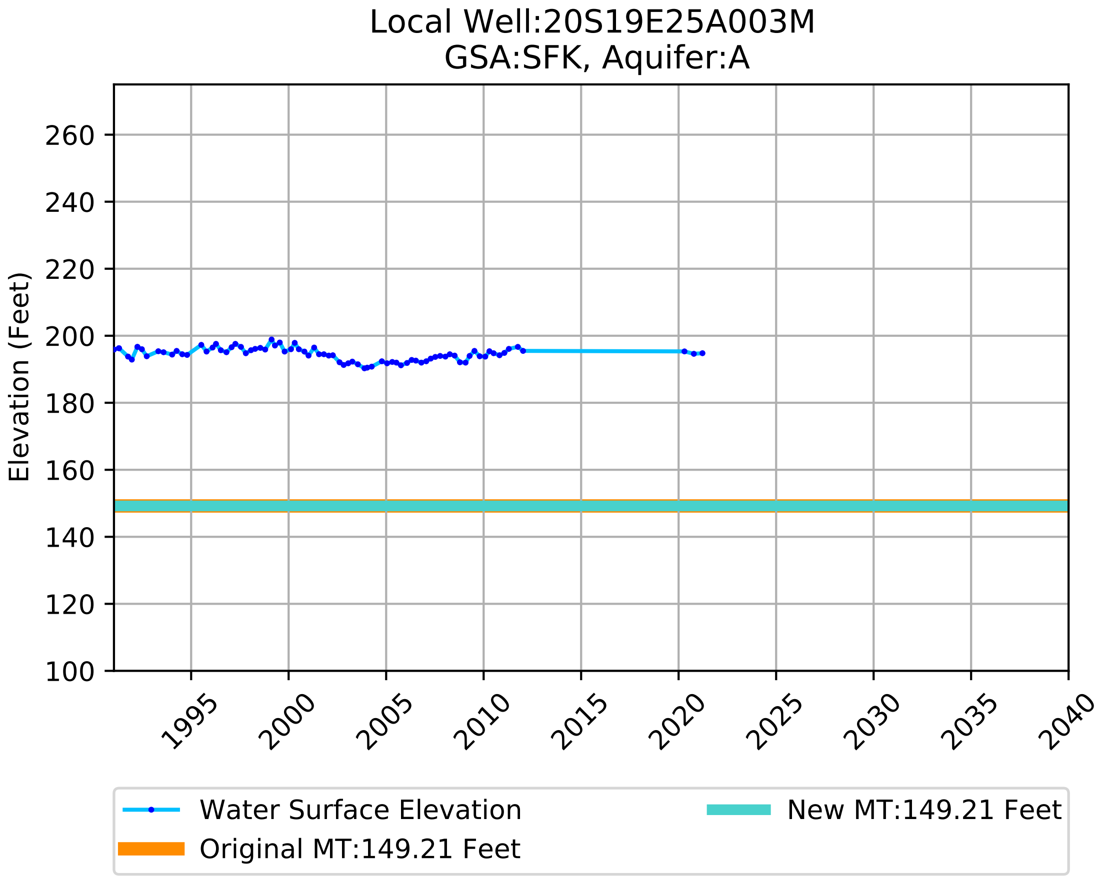
GROUNDWATER LEVEL SMC SUPPORTING INFORMATION



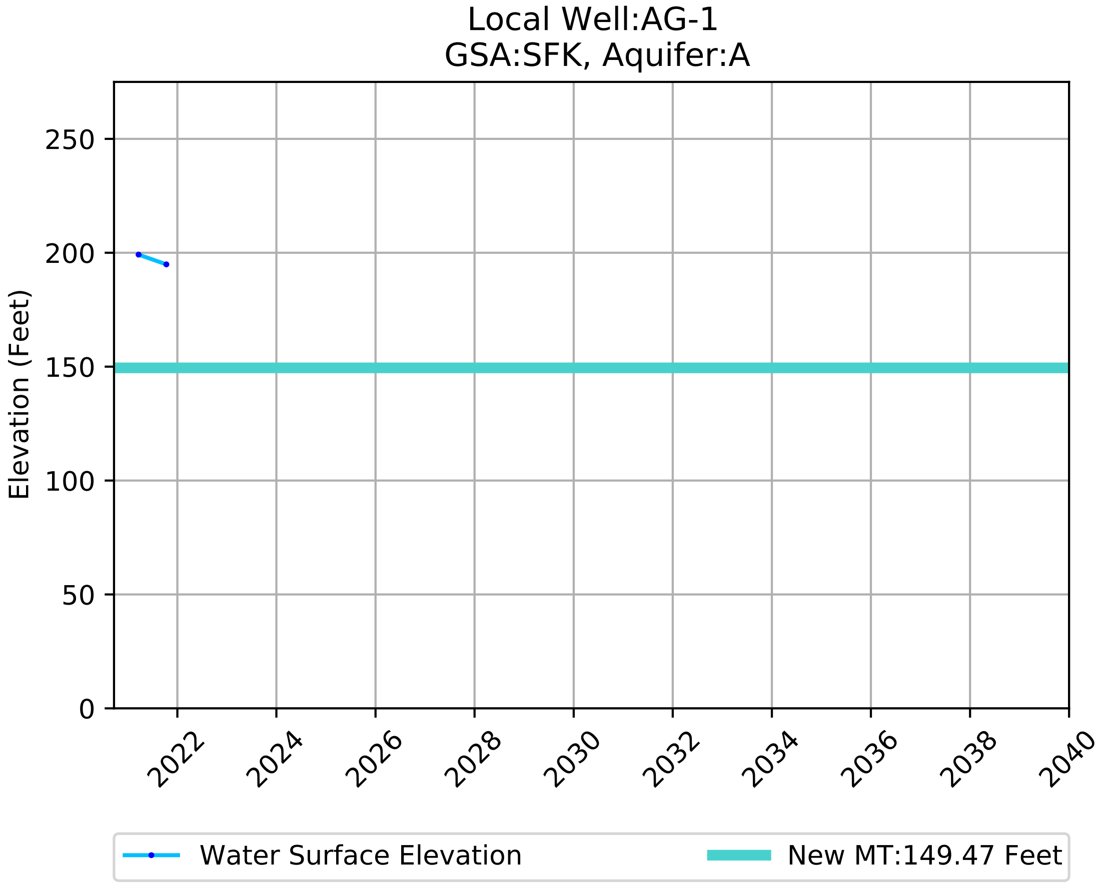
Local Well:18S20E23E003M
GSA:SFK, Aquifer:A
Elevation (Feet)
260
240
220
200
180
160
140
120
100
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
Original MT:148.4 Feet
New MT:148.4 Feet



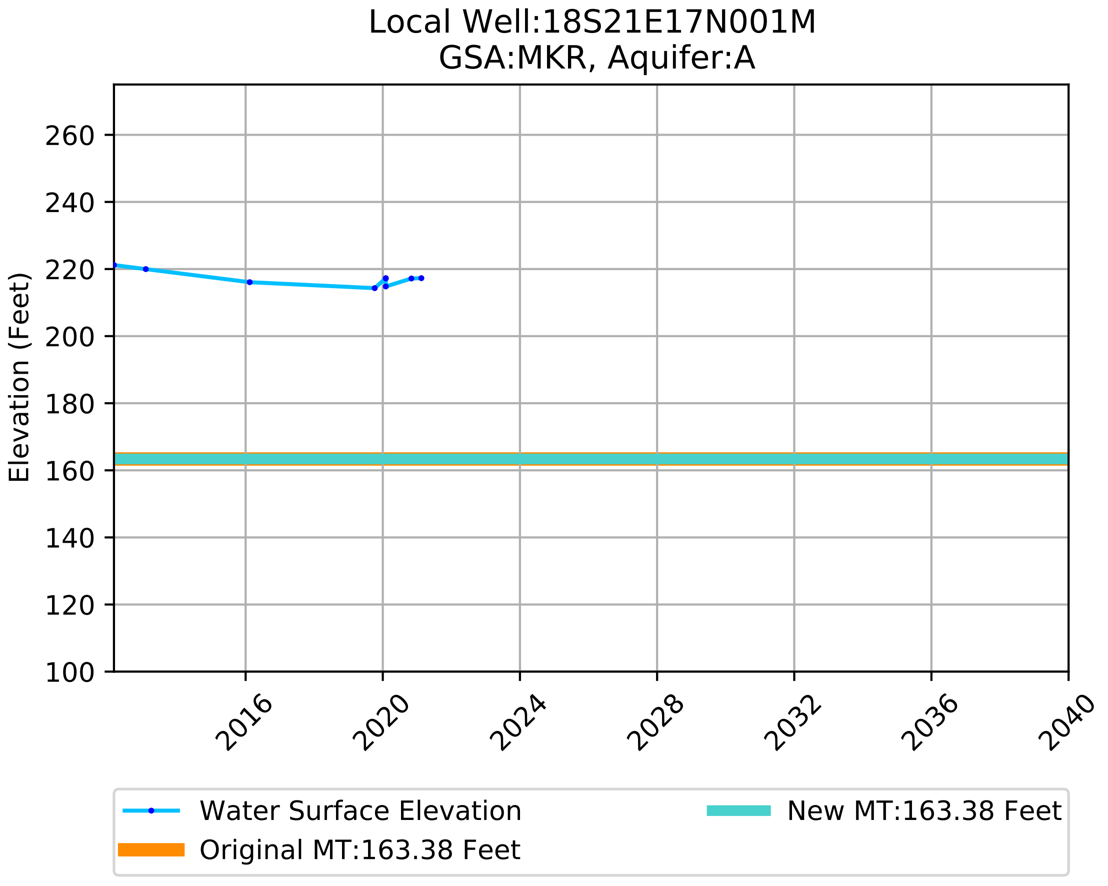
Local Well:19S20E29E002M
GSA:SFK, Aquifer:A
Elevation (Feet)
260
240
220
200
180
160
140
120
100
2008
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:133.63 Feet
Original MT:133.63 Feet



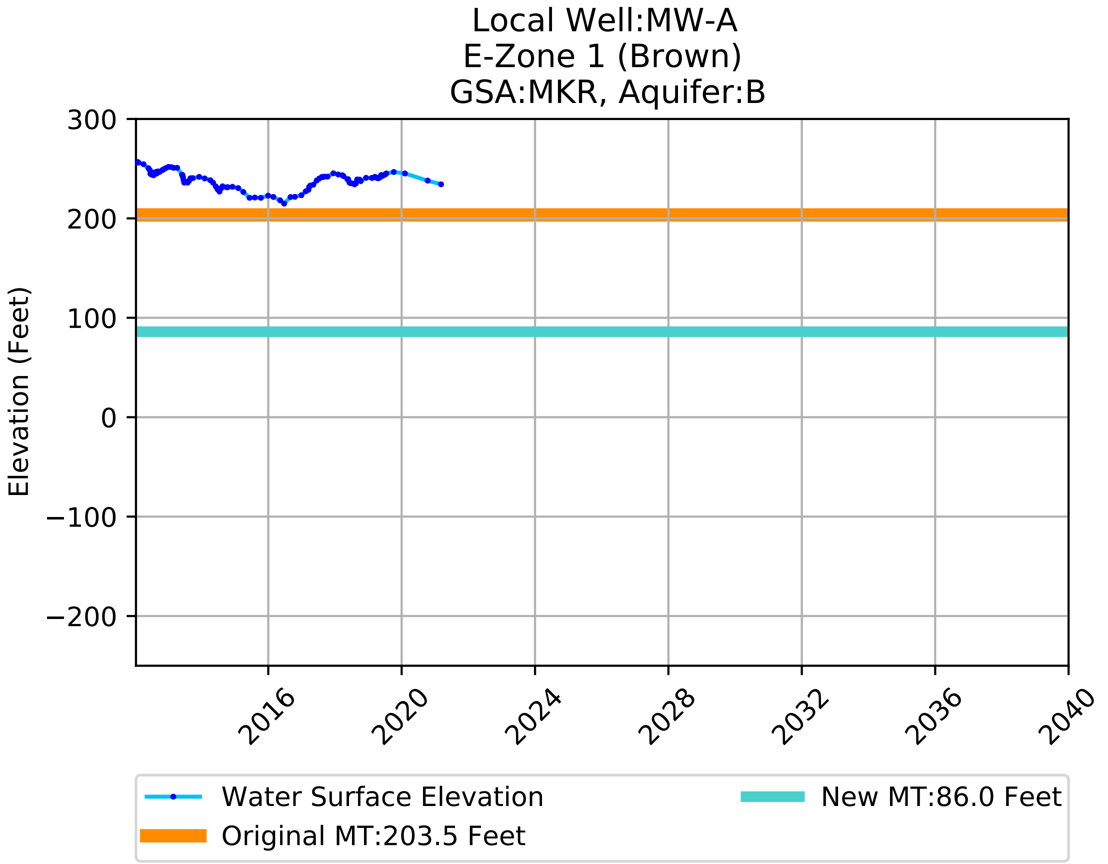
Local Well:20S19E25A003M
GSA:SFK, Aquifer:A
Elevation (Feet)
260
240
220
200
180
160
140
120
100
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
Water Surface Elevation
New MT:149.21 Feet
Original MT:149.21 Feet

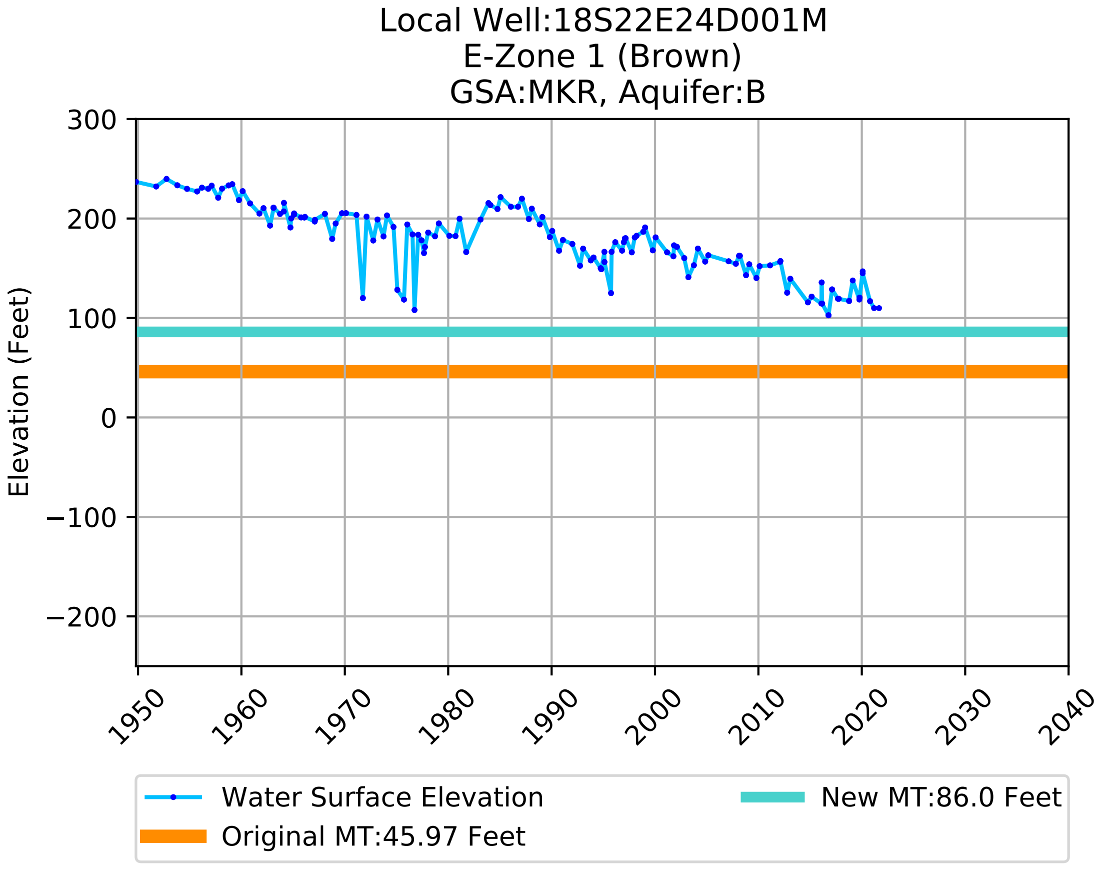


Local Well:AG-1
GSA:SFK, Aquifer:A
Elevation (Feet)
250
200
150
100
50
0
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Water Surface Elevation
New MT:149.47 Feet

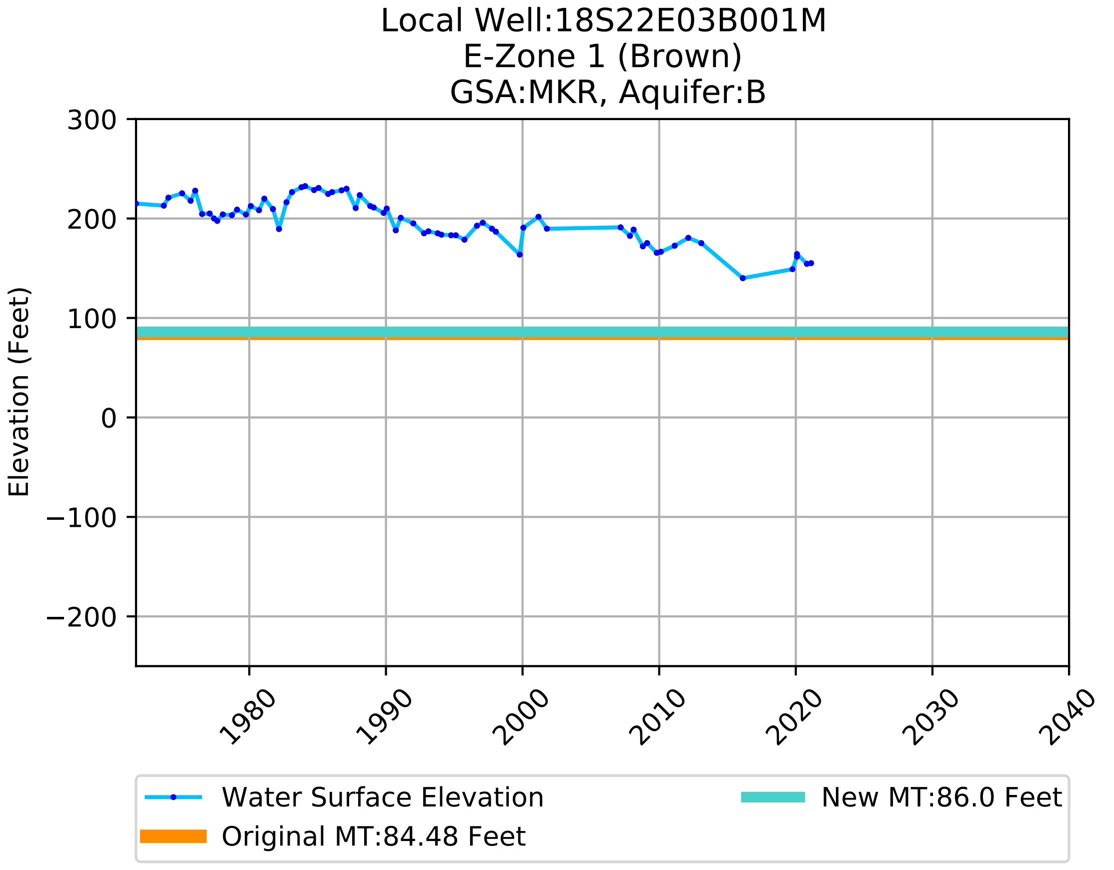


Local Well:18S21E17N001M
GSA:MKR, Aquifer:A
Elevation (Feet)
260
240
220
200
180
160
140
120
100
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:163.38 Feet
Original MT:163.38 Feet

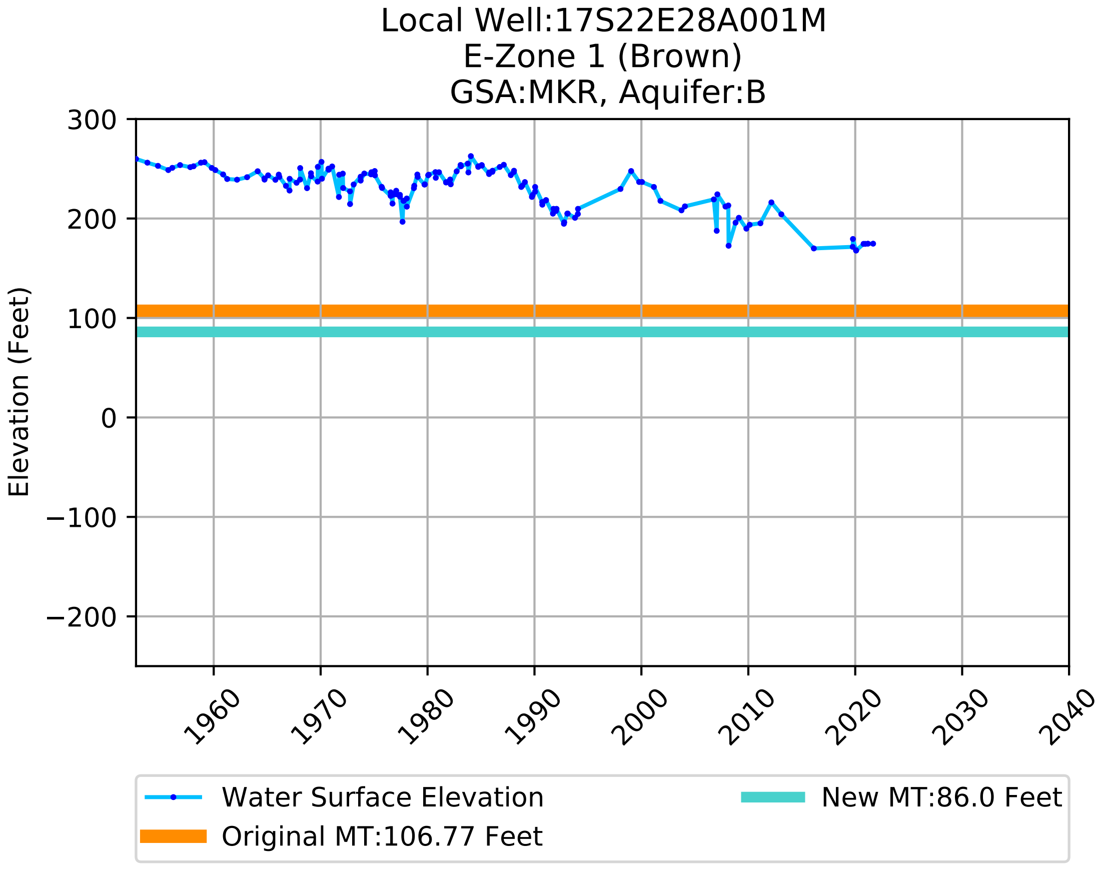

Local Well:MW-A
E-Zone 1 (Brown)
GSA:MKR, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
Original MT:203.5 Feet
New MT:86.0 Feet

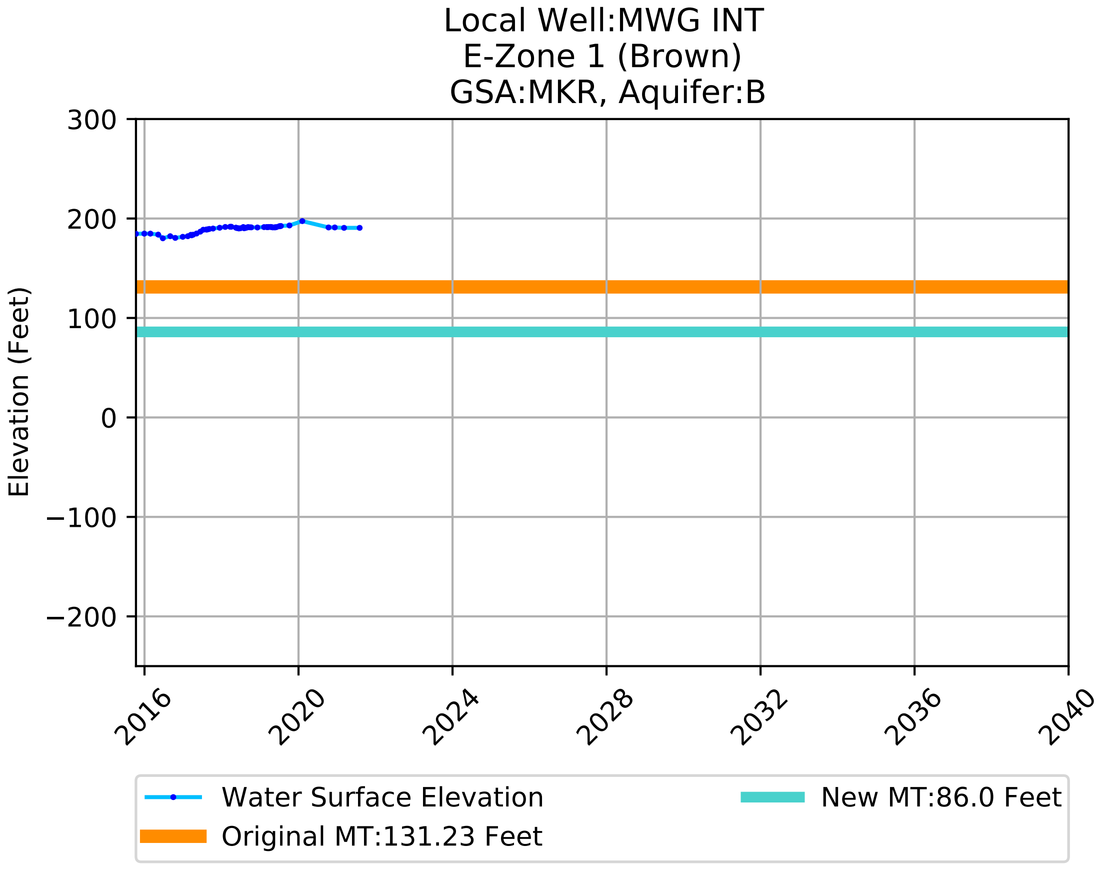


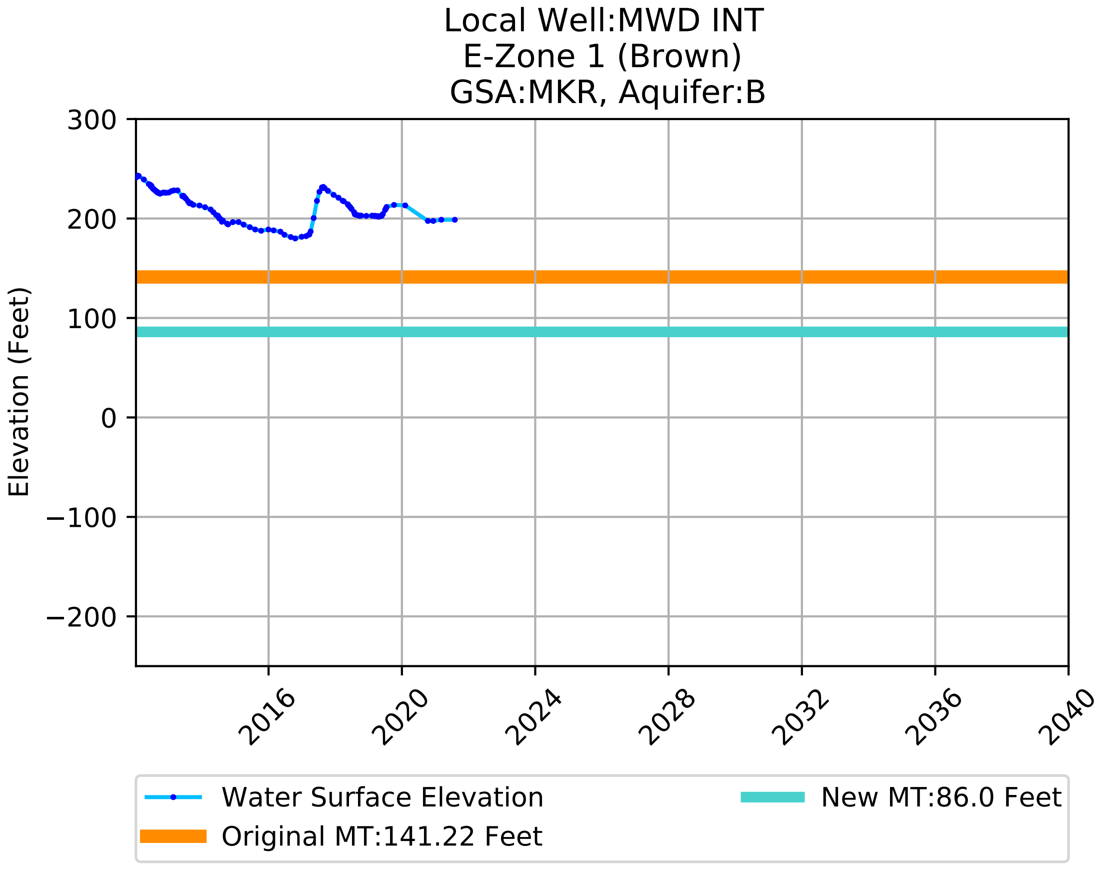
Local Well:18S22E24D001M
E-Zone 1 (Brown)
GSA:MKR, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
Water Surface Elevation
Original MT:45.97 Feet
New MT:86.0 Feet



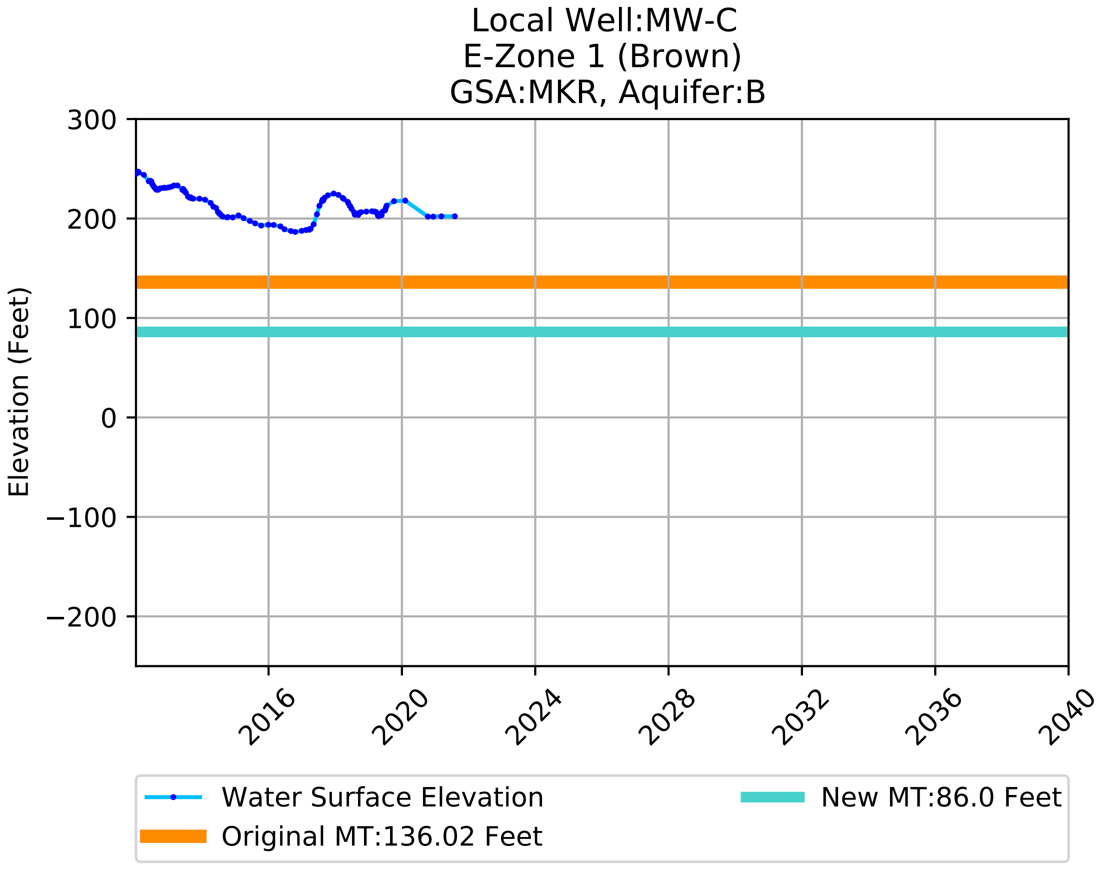
Local Well:18S22E03B001M
E-Zone 1 (Brown)
GSA:MKR, Aquifer:B
300
200
100
0
−100
−200
Elevation (Feet)
1980
1990
2000
2010
2020
2030
2040
Water Surface Elevation
New MT:86.0 Feet
Original MT:84.48 Feet


Local Well:17S22E28A001M
E-Zone 1 (Brown)
GSA:MKR, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
1960
1970
1980
1990
2000
2010
2020
2030
2040
Water Surface Elevation
Original MT:106.77 Feet
New MT:86.0 Feet

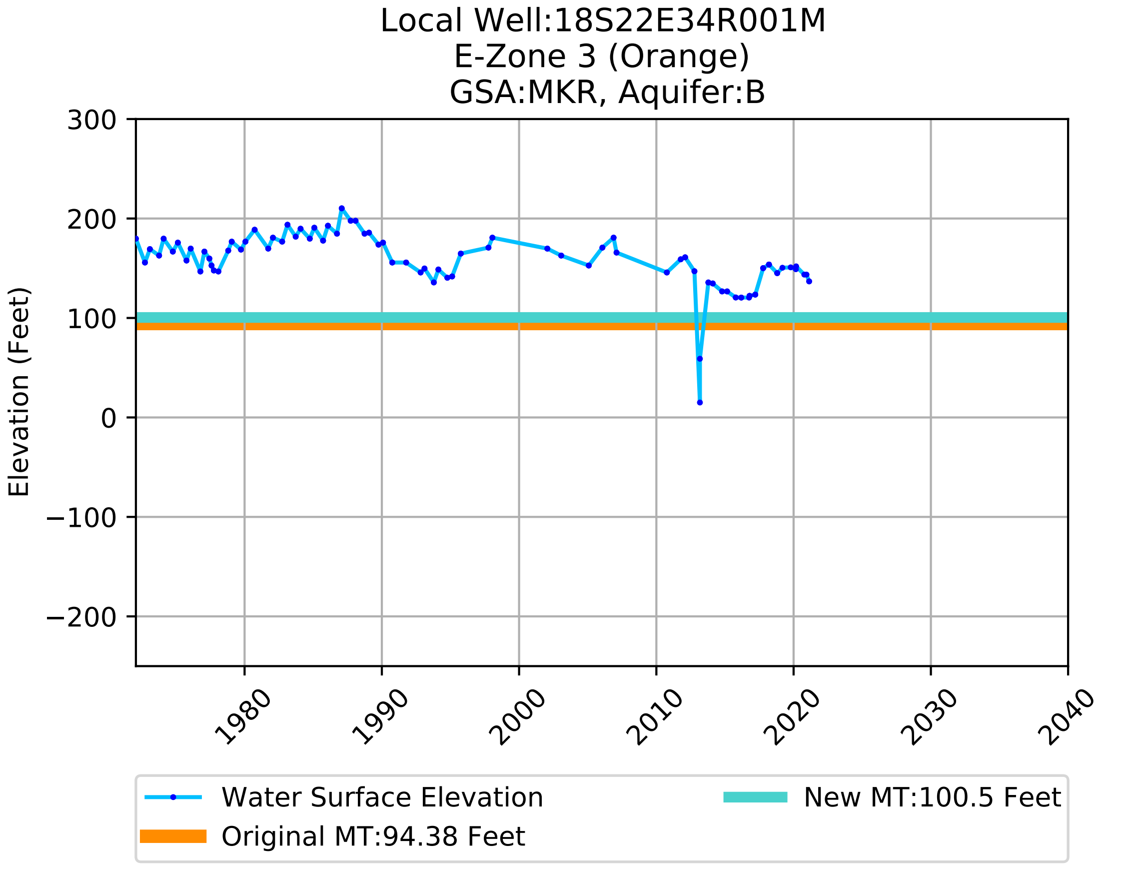

Local Well:MWG INT
E-Zone 1 (Brown)
GSA:MKR, Aquifer:B
300
200
100
0
−100
−200
Elevation (Feet)
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
Original MT:131.23 Feet
New MT:86.0 Feet



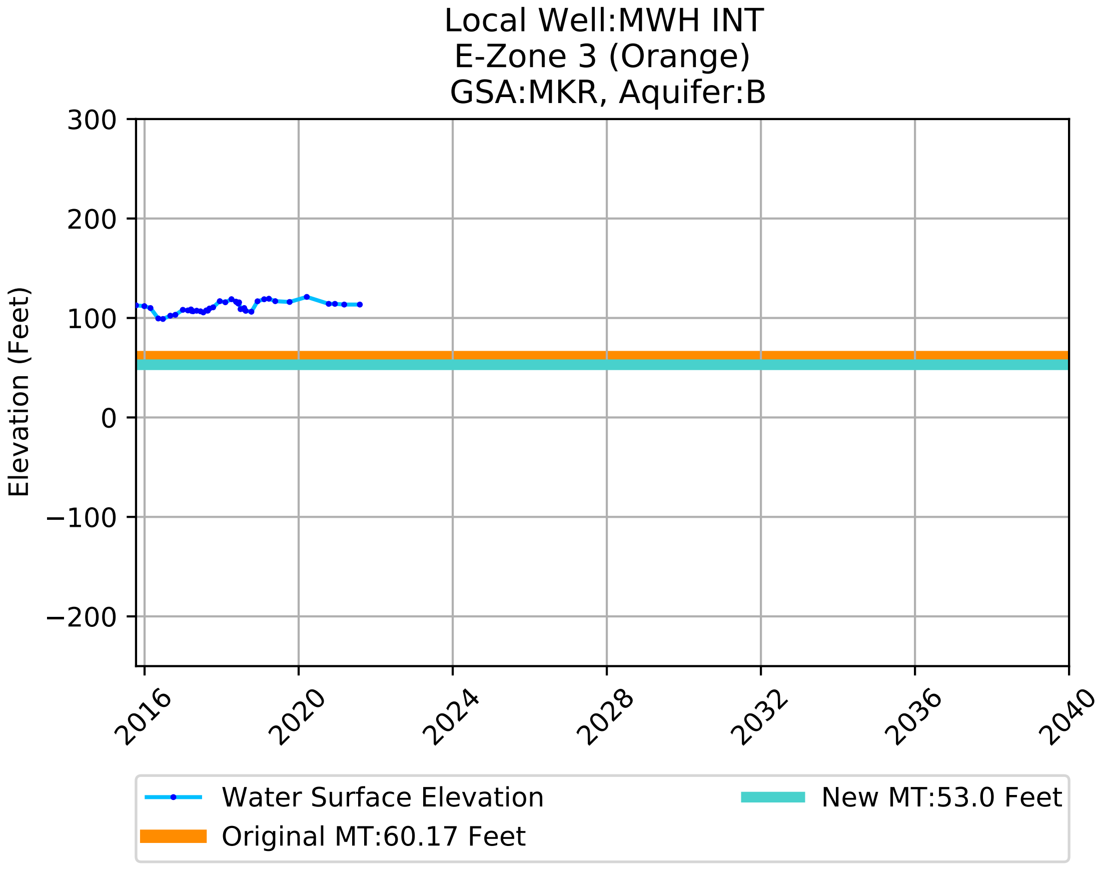
Local Well:MWD INT
E-Zone 1 (Brown)
GSA:MKR, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
Original MT:141.22 Feet
New MT:86.0 Feet



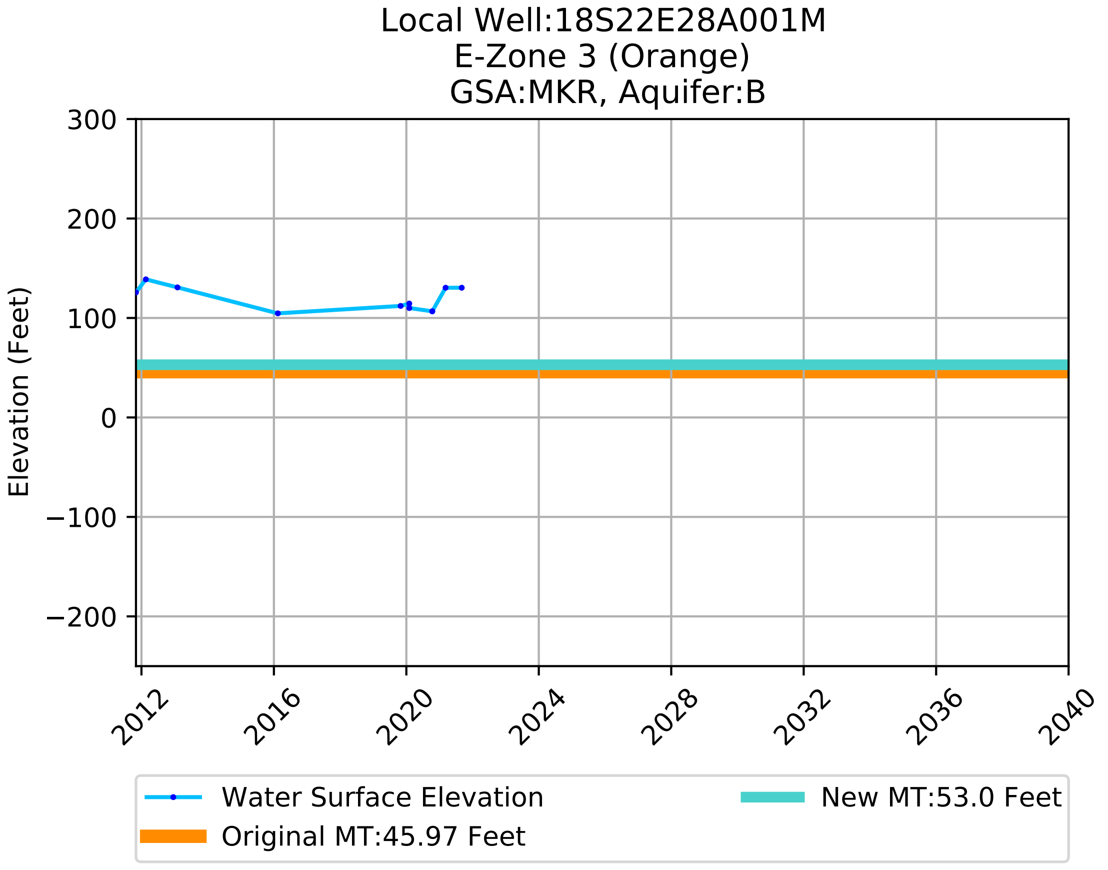
Local Well:MW-C
E-Zone 1 (Brown)
GSA:MKR, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
Original MT:136.02 Feet
New MT:86.0 Feet



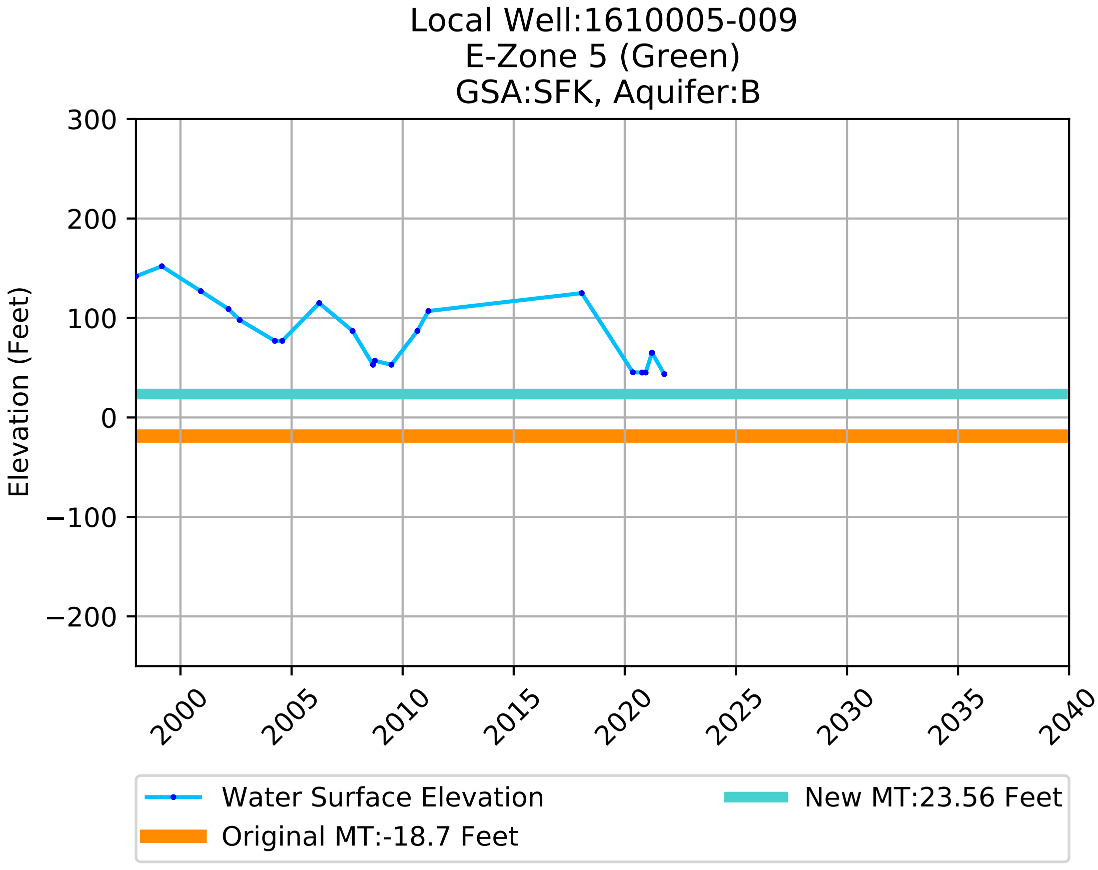
Local Well:18S22E34R001M
E-Zone 3 (Orange)
GSA:MKR, Aquifer:B
300
200
100
0
−100
−200
Elevation (Feet)
1980
1990
2000
2010
2020
2030
2040
Water Surface Elevation
New MT:100.5 Feet
Original MT:94.38 Feet

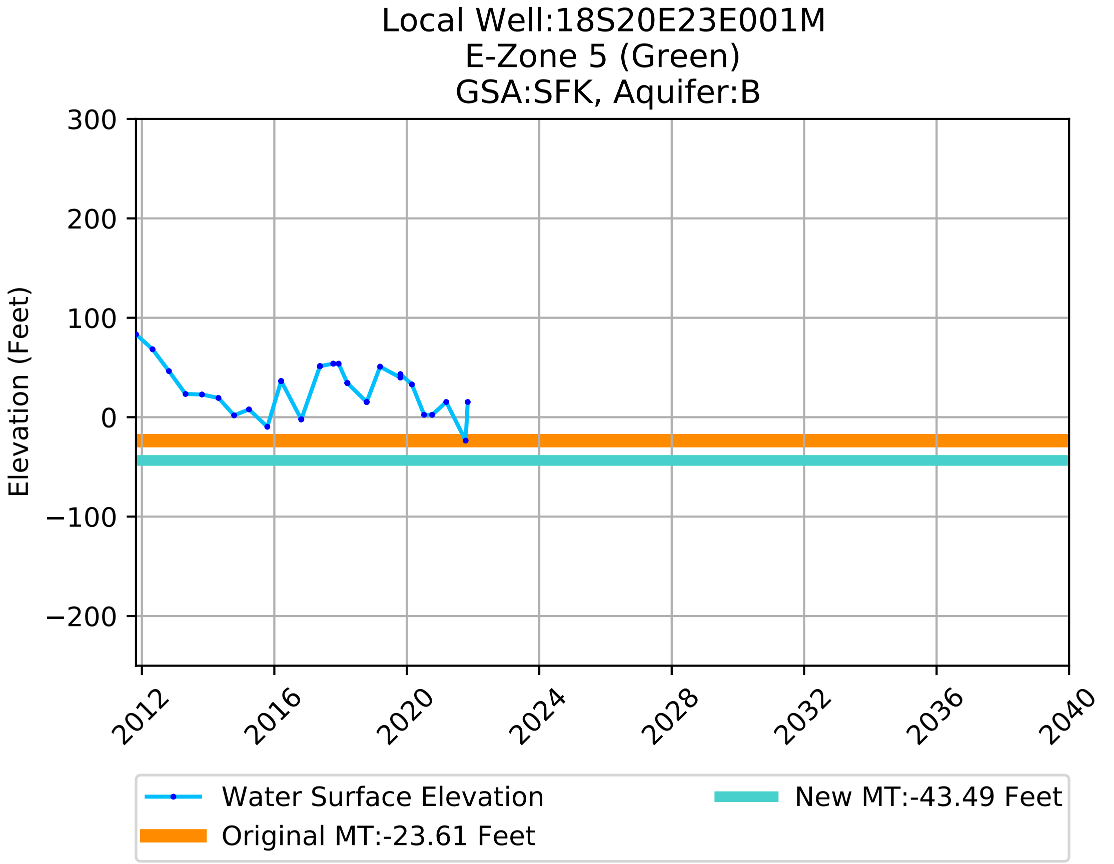


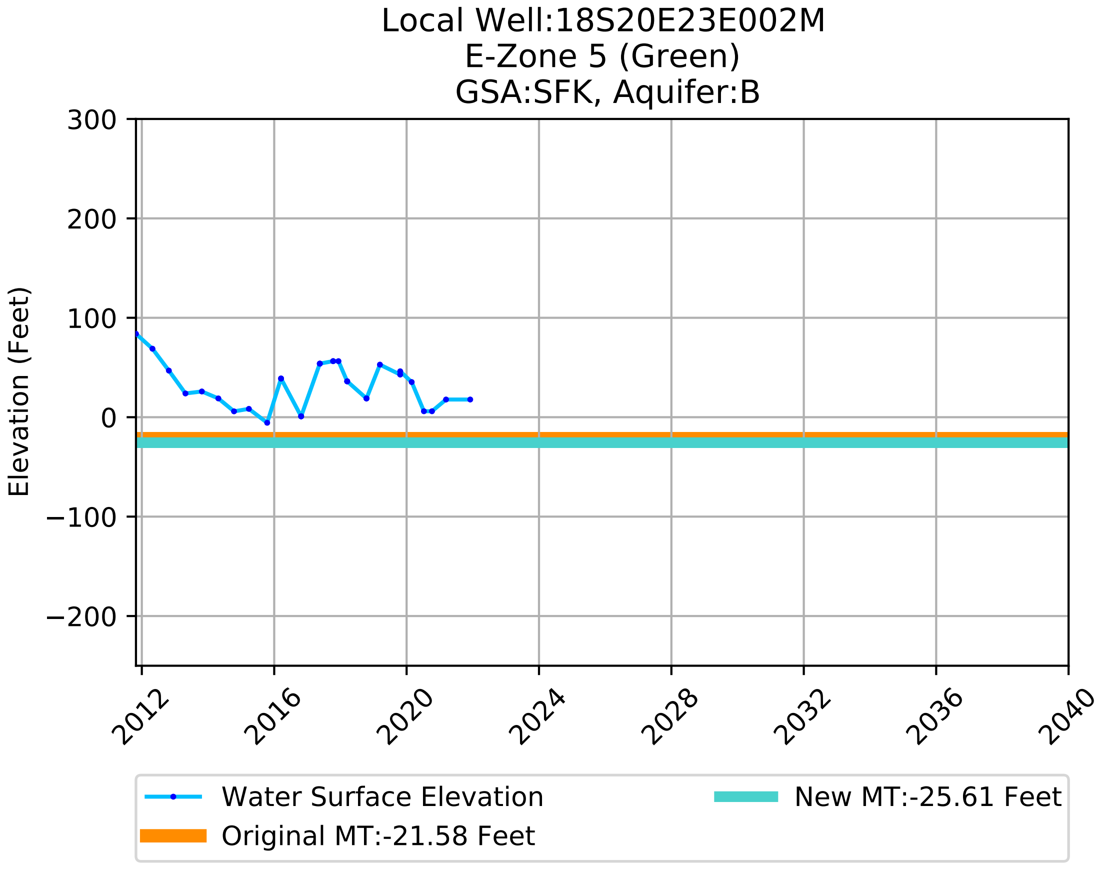
Local Well:MWH INT
E-Zone 3 (Orange)
GSA:MKR, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:53.0 Feet
Original MT:60.17 Feet



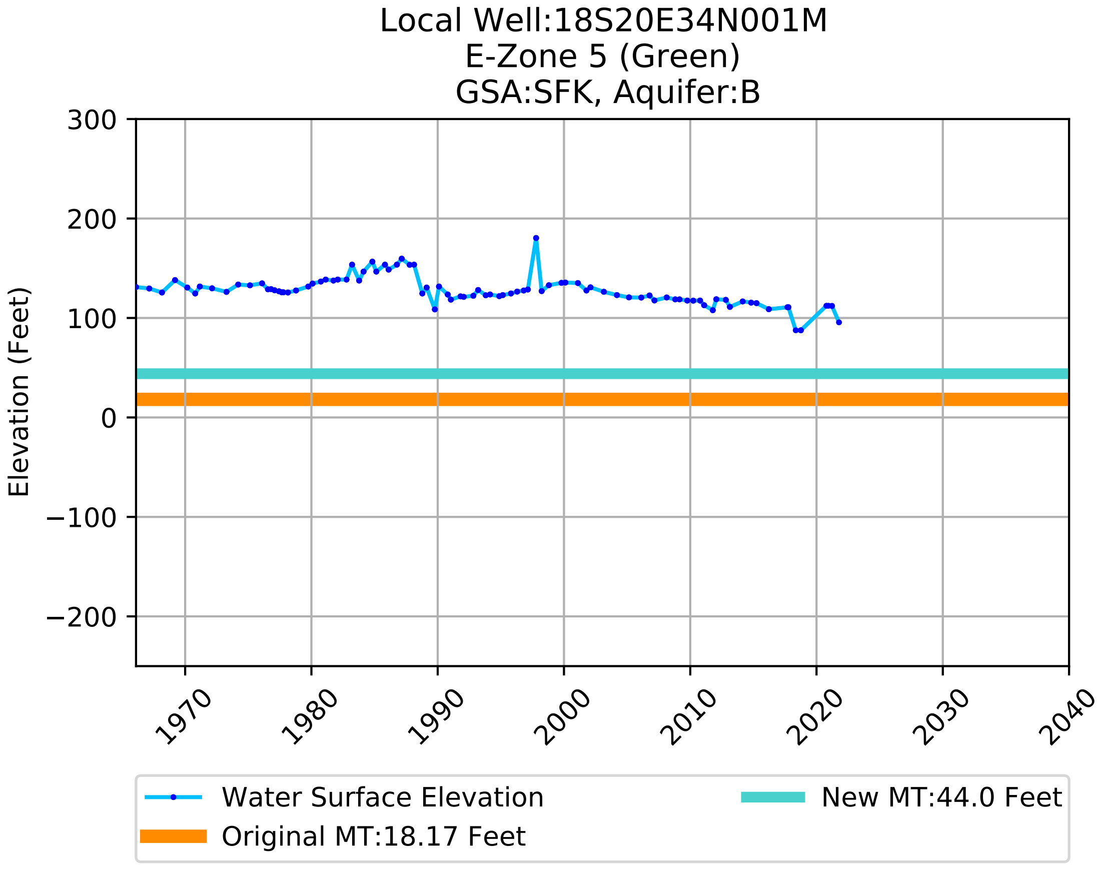
Local Well:18S22E28A001M
E-Zone 3 (Orange)
GSA:MKR, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:53.0 Feet
Original MT:45.97 Feet


Local Well:1610005-009
E-Zone 5 (Green)
GSA:SFK, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2000
2005
2010
2015
2020
2025
2030
2035
2040
Water Surface Elevation
New MT:23.56 Feet
Original MT:-18.7 Feet

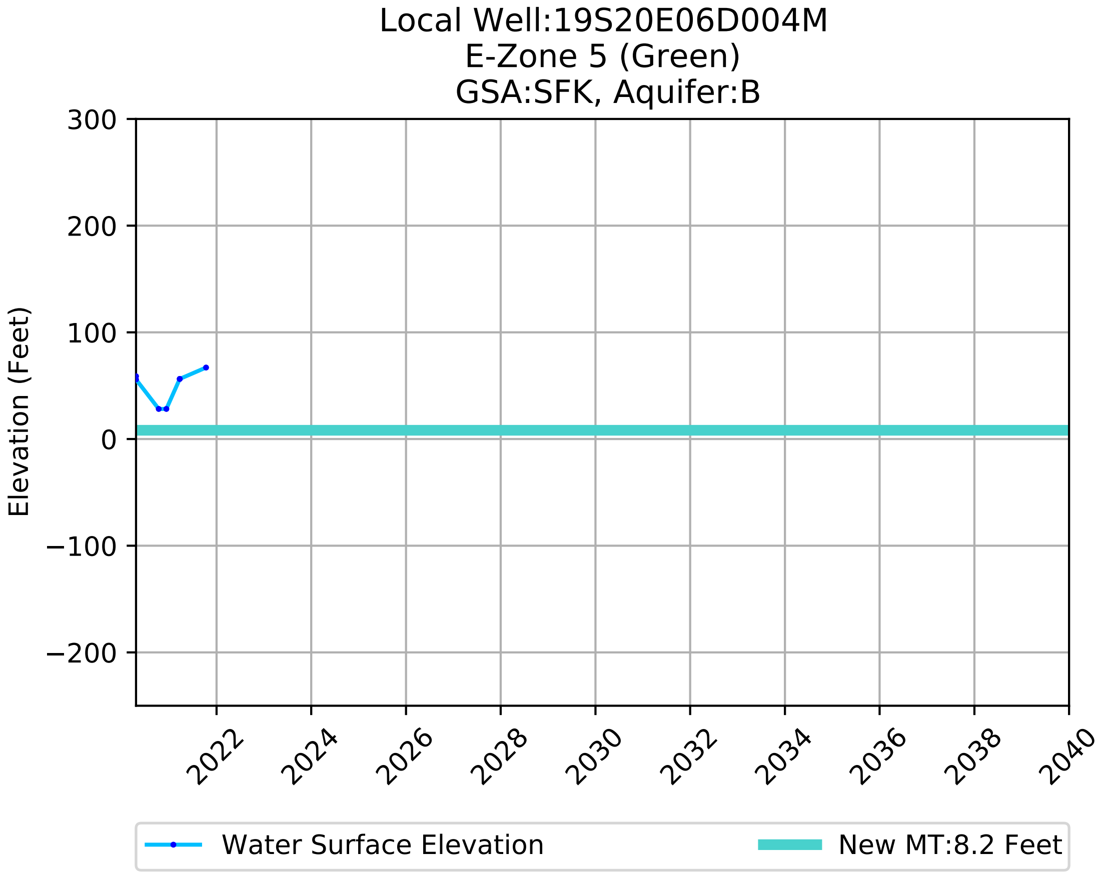

Local Well:18S20E23E001M
E-Zone 5 (Green)
GSA:SFK, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
Original MT:-23.61 Feet
New MT:-43.49 Feet



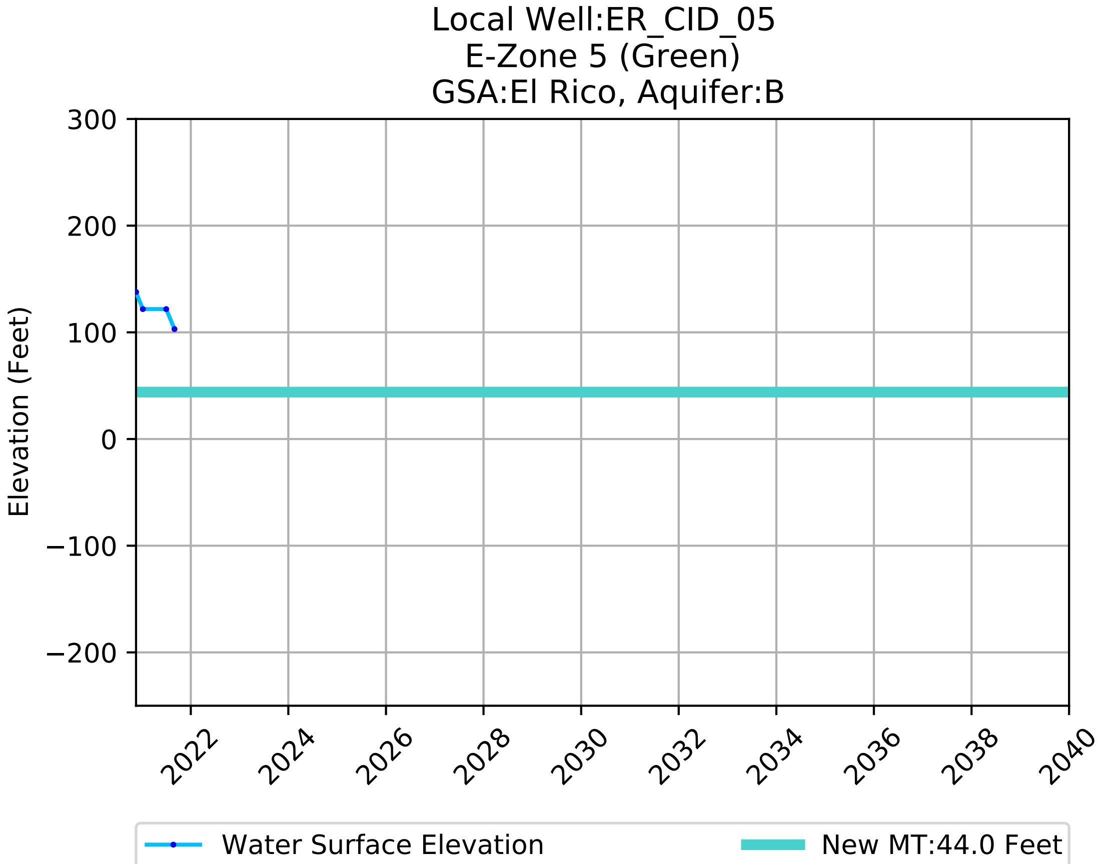
Local Well:18S20E23E002M
E-Zone 5 (Green)
GSA:SFK, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
Original MT:-21.58 Feet
New MT:-25.61 Feet



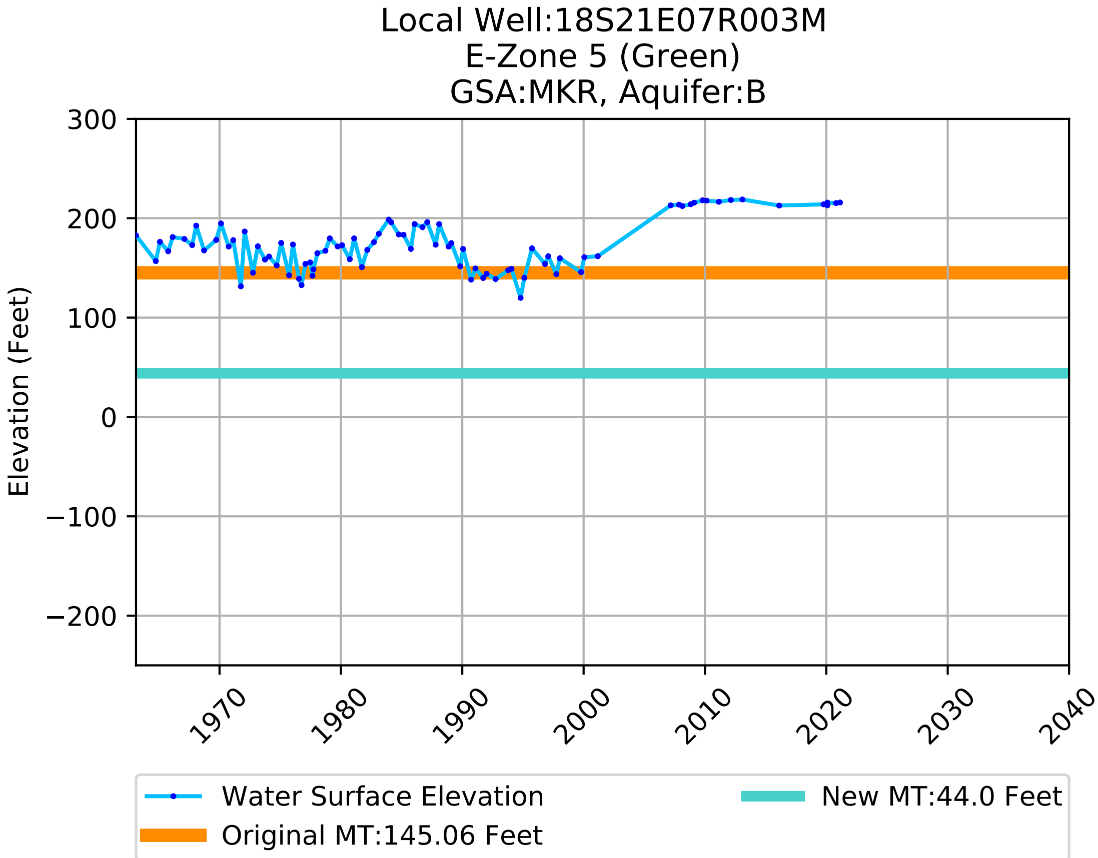
Local Well:18S20E34N001M
E-Zone 5 (Green)
GSA:SFK, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
1970
1980
1990
2000
2010
2020
2030
2040
Water Surface Elevation
New MT:44.0 Feet
Original MT:18.17 Feet



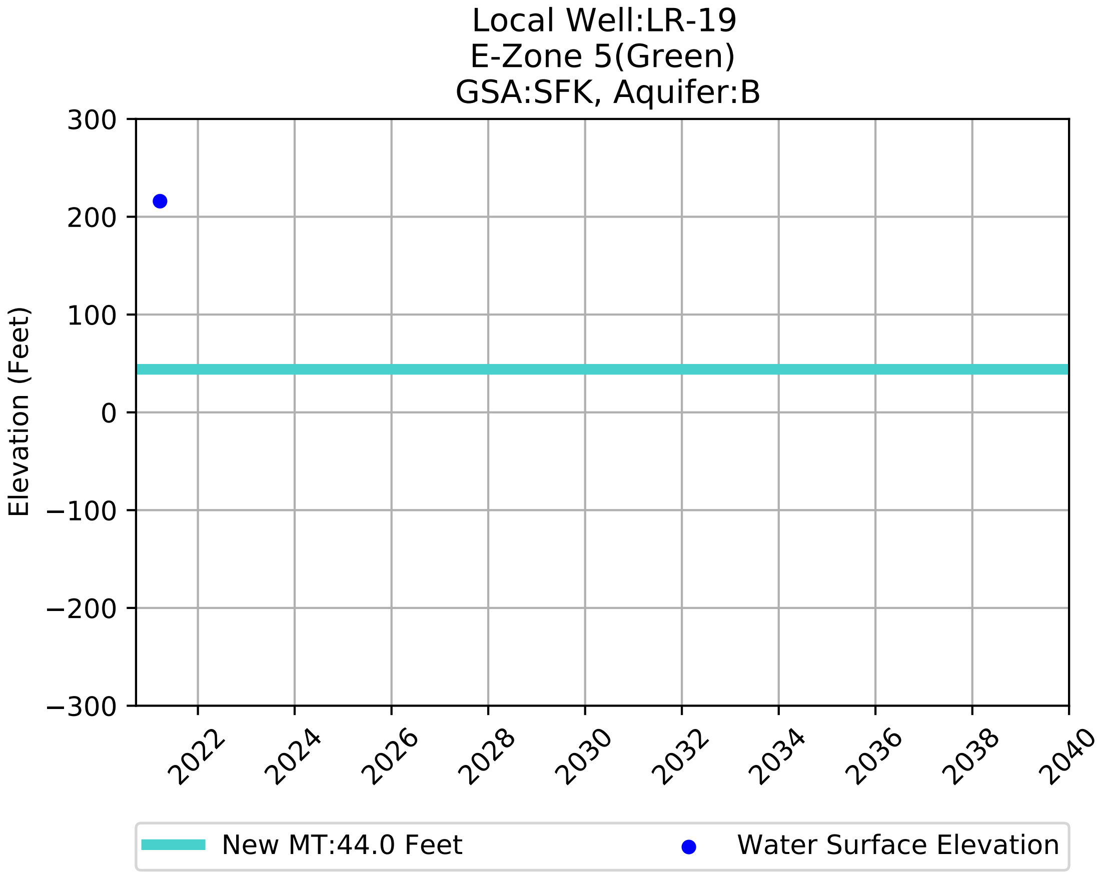
Local Well:19S20E06D004M
E-Zone 5 (Green)
GSA:SFK, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Water Surface Elevation
New MT:8.2 Feet

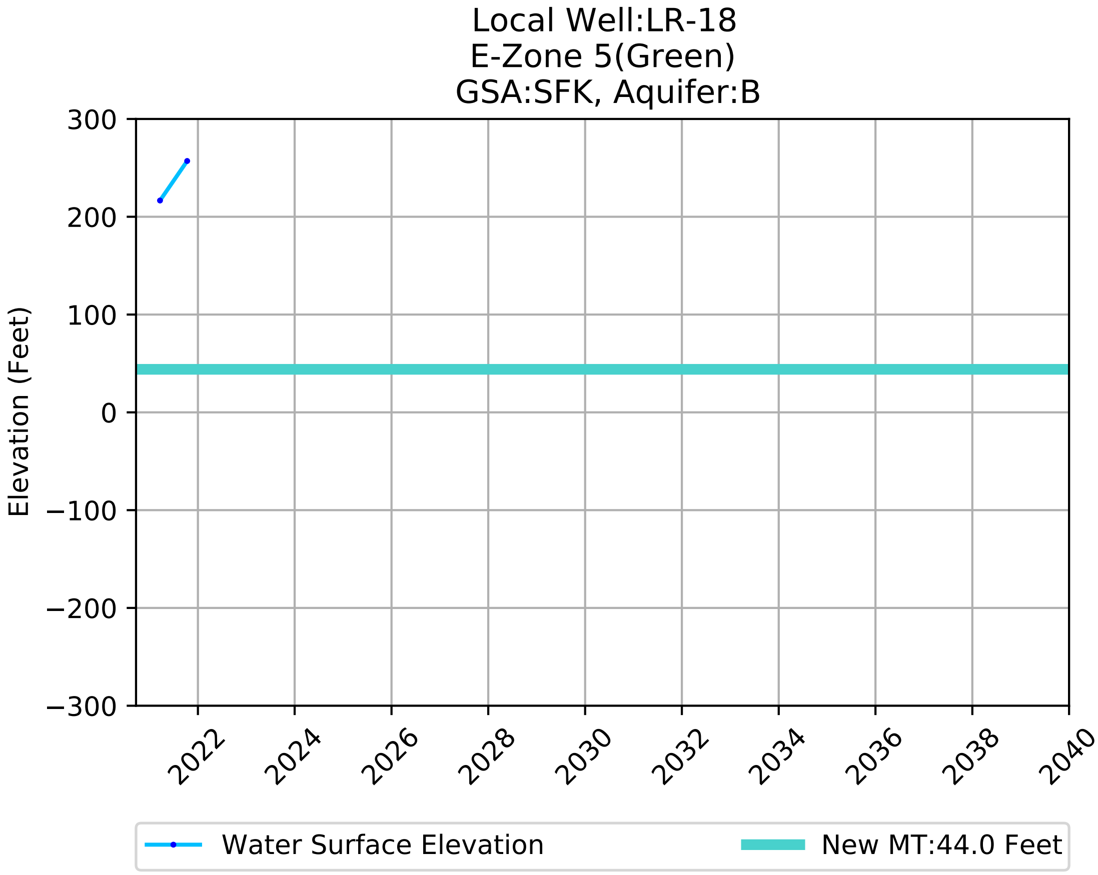


Local Well:ER_CID_05
E-Zone 5 (Green)
GSA:El Rico, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Water Surface Elevation
New MT:44.0 Feet

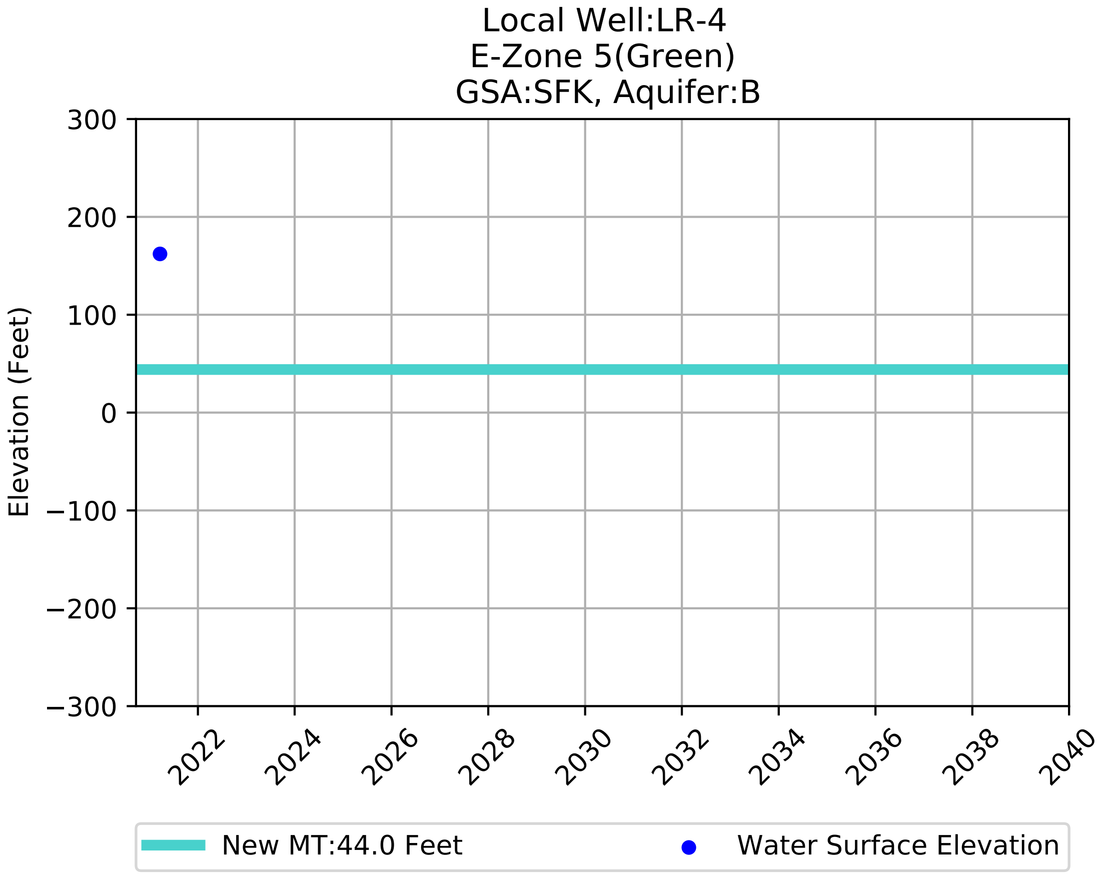


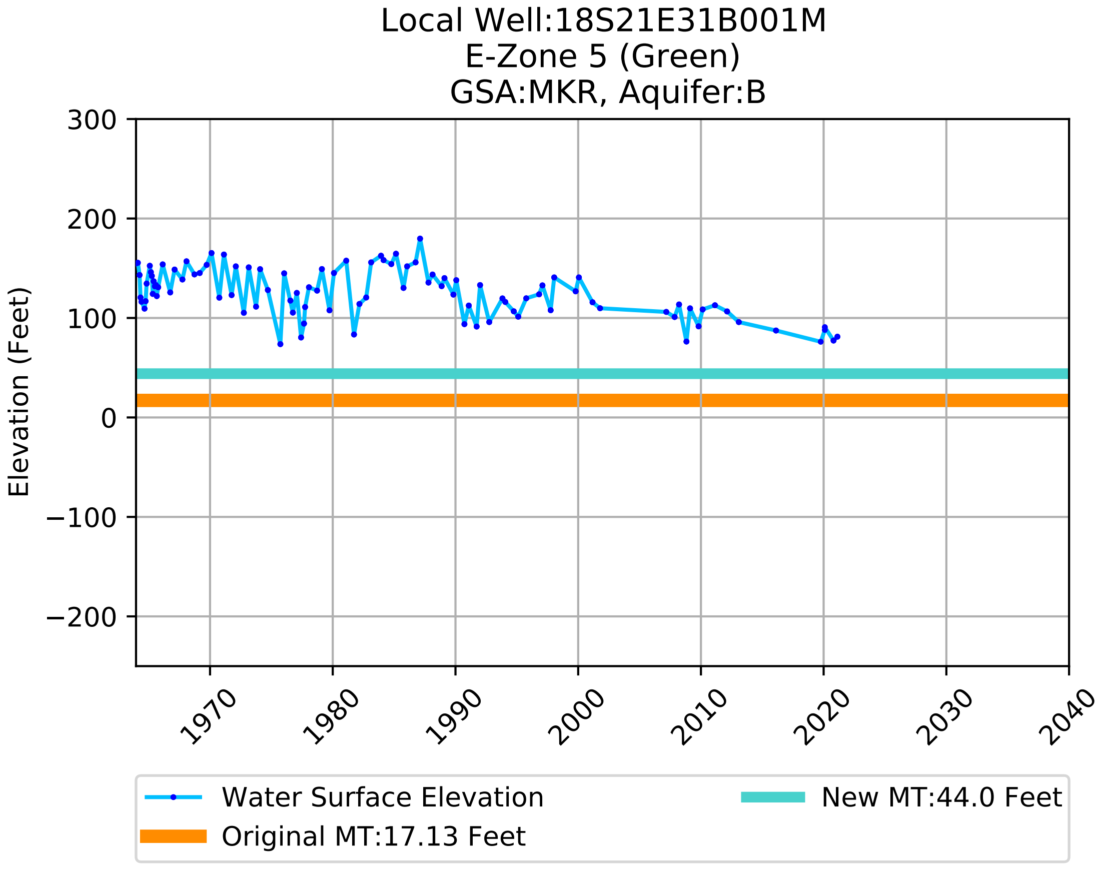
Local Well:18S21E07R003M
E-Zone 5 (Green)
GSA:MKR, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
1970
1980
1990
2000
2010
2020
2030
2040
Water Surface Elevation
Original MT:145.06 Feet
New MT:44.0 Feet


Local Well:LR-19
E-Zone 5(Green)
GSA:SFK, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
−300
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
New MT:44.0 Feet
Water Surface Elevation

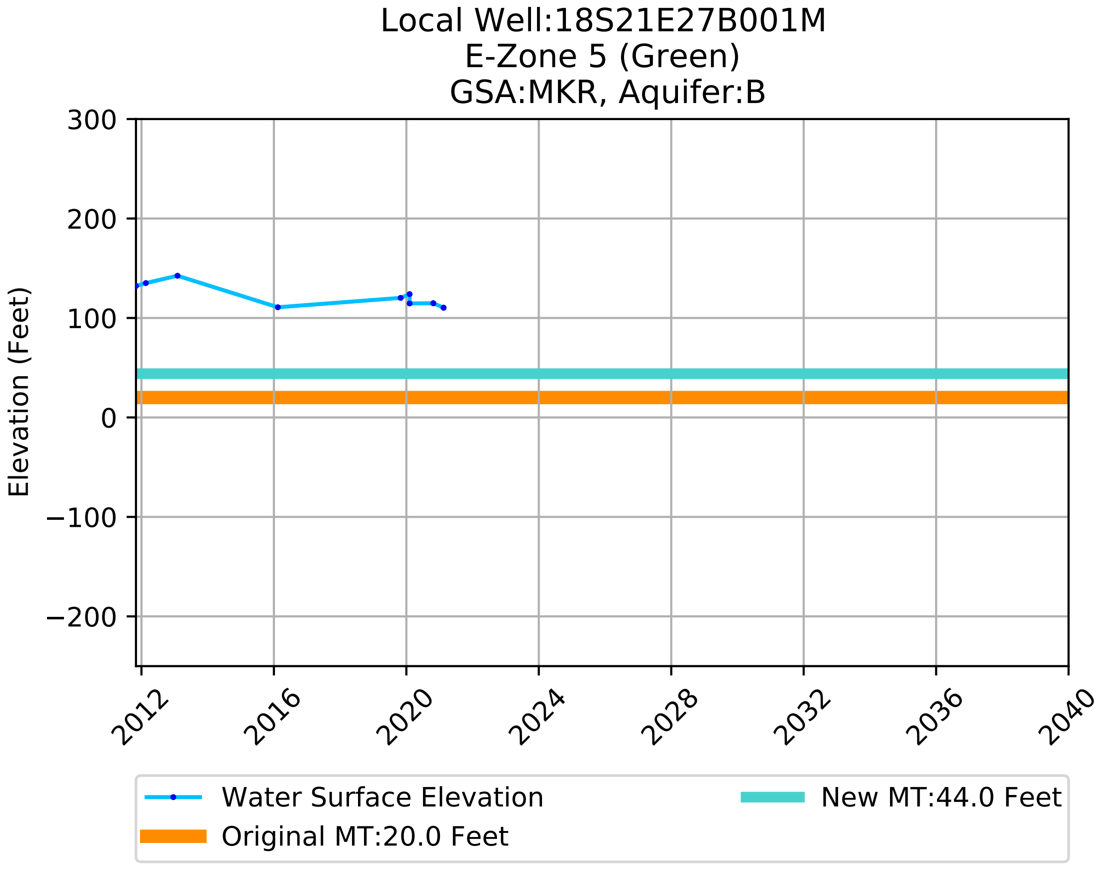


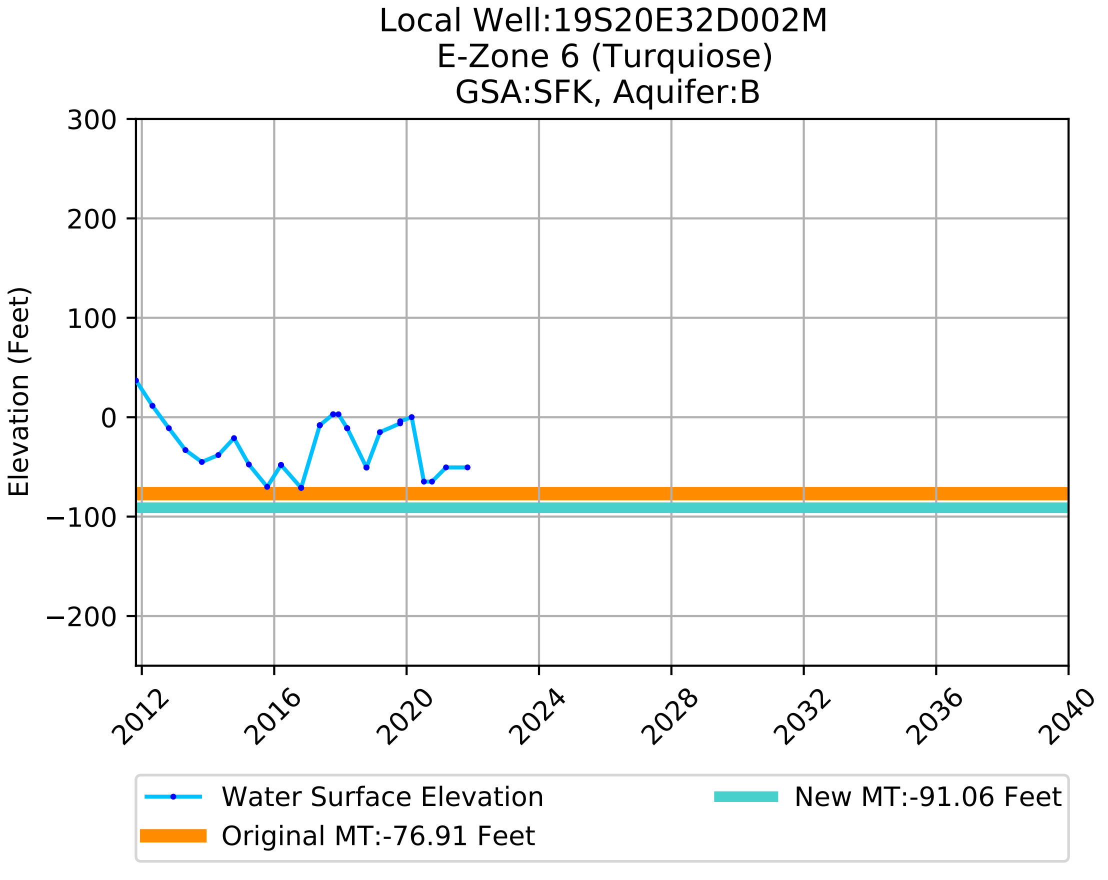
Local Well:LR-18
E-Zone 5(Green)
GSA:SFK, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
−300
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Water Surface Elevation
New MT:44.0 Feet

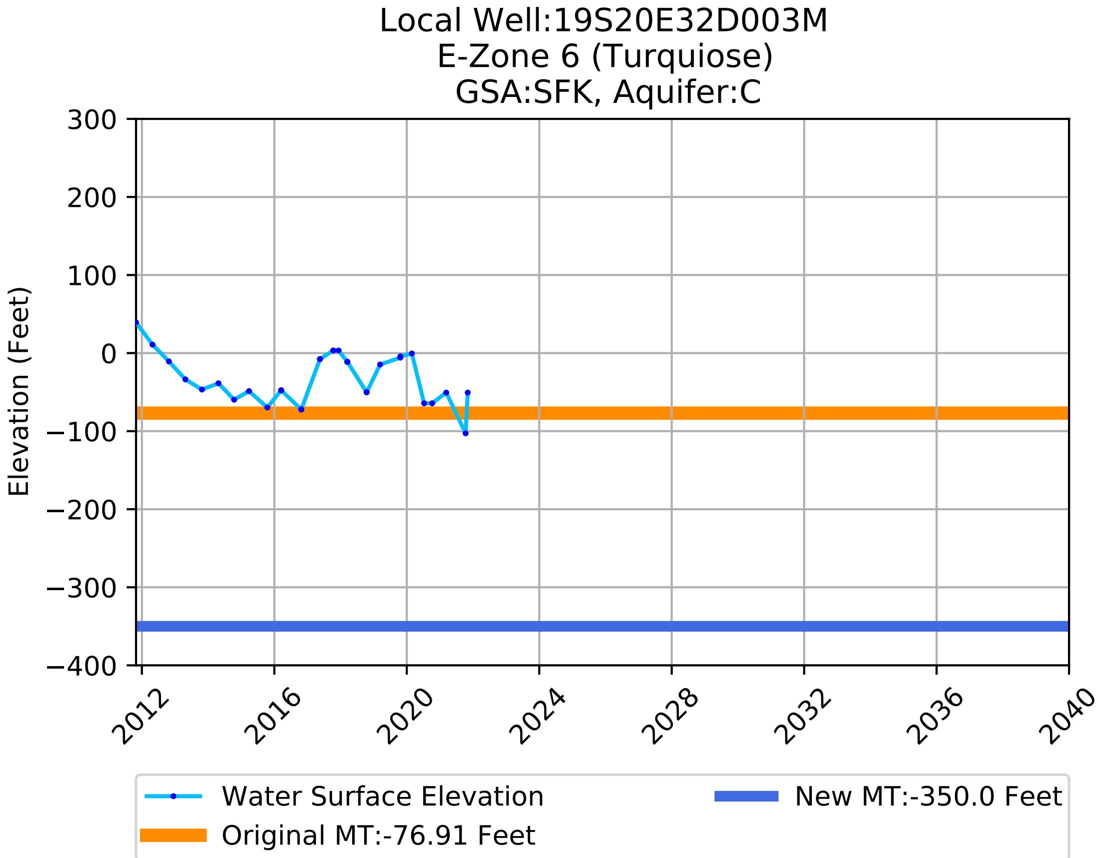

Local Well:LR-4
E-Zone 5(Green)
GSA:SFK, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
−300
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
New MT:44.0 Feet
Water Surface Elevation



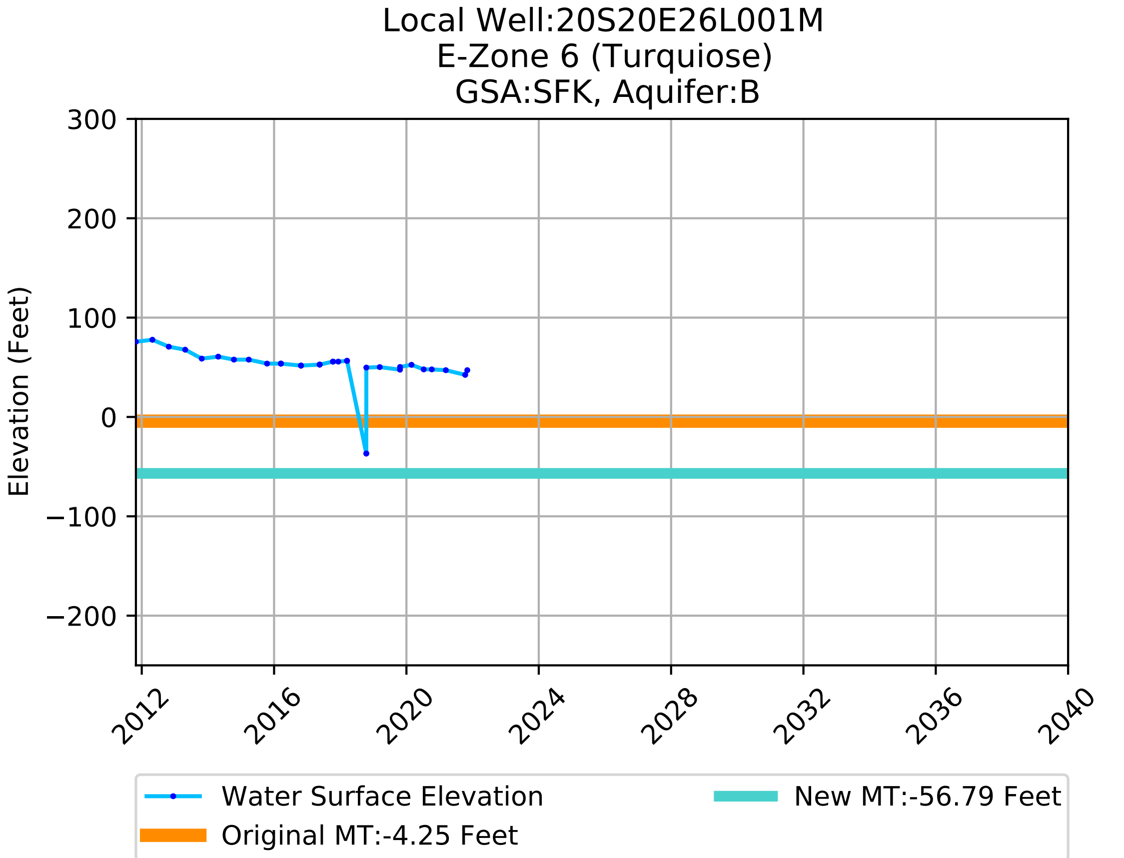
Local Well:18S21E31B001M
E-Zone 5 (Green)
GSA:MKR, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
1970
1980
1990
2000
2010
2020
2030
2040
Water Surface Elevation
New MT:44.0 Feet
Original MT:17.13 Feet


Local Well:18S21E27B001M
E-Zone 5 (Green)
GSA:MKR, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:44.0 Feet
Original MT:20.0 Feet

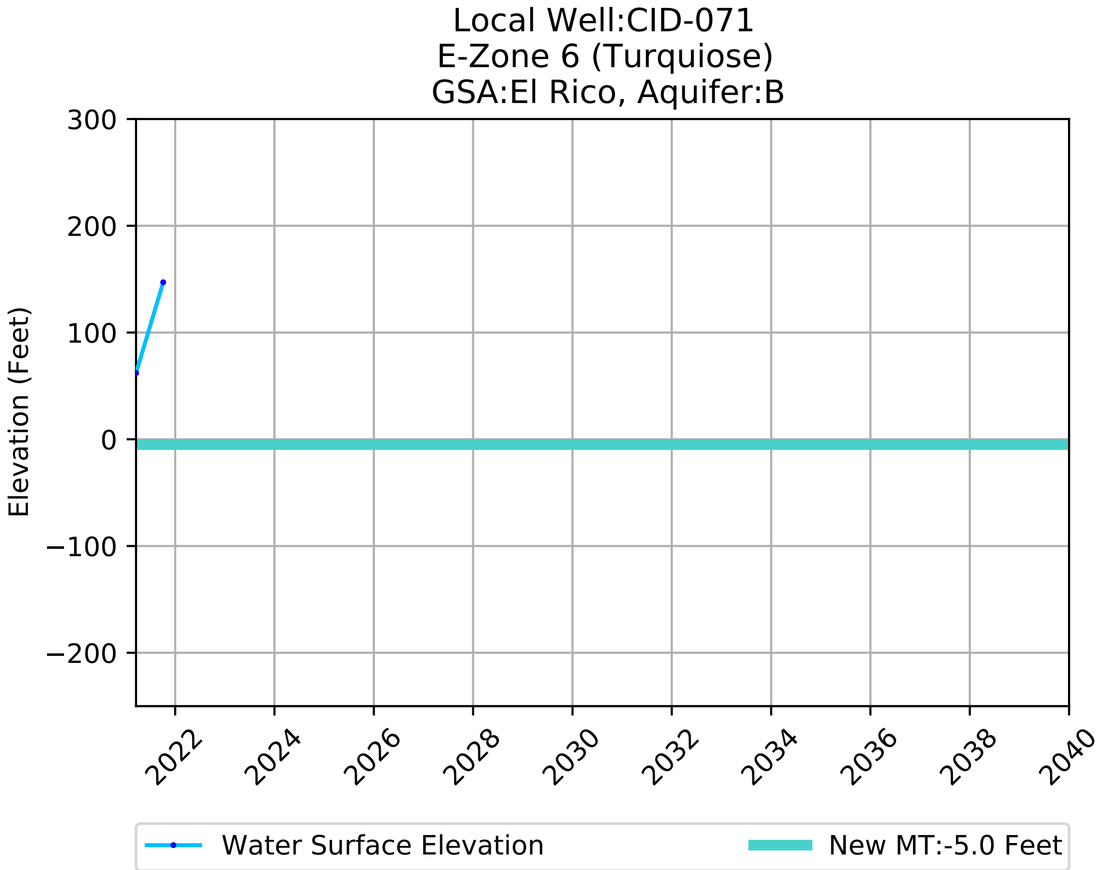

Local Well:19S20E32D002M
E-Zone 6 (Turquiose)
GSA:SFK, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
Original MT:-76.91 Feet
New MT:-91.06 Feet



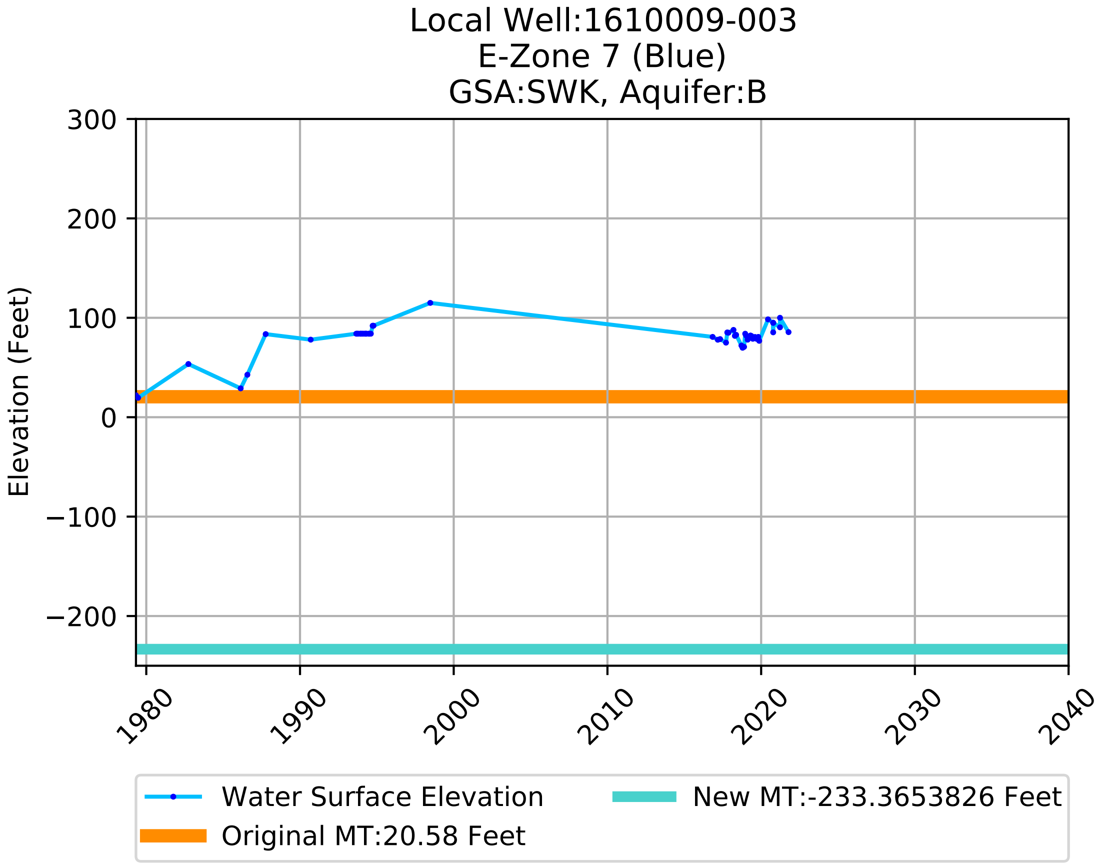
Local Well:19S20E32D003M
E-Zone 6 (Turquiose)
GSA:SFK, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
Original MT:-76.91 Feet
New MT:-350.0 Feet



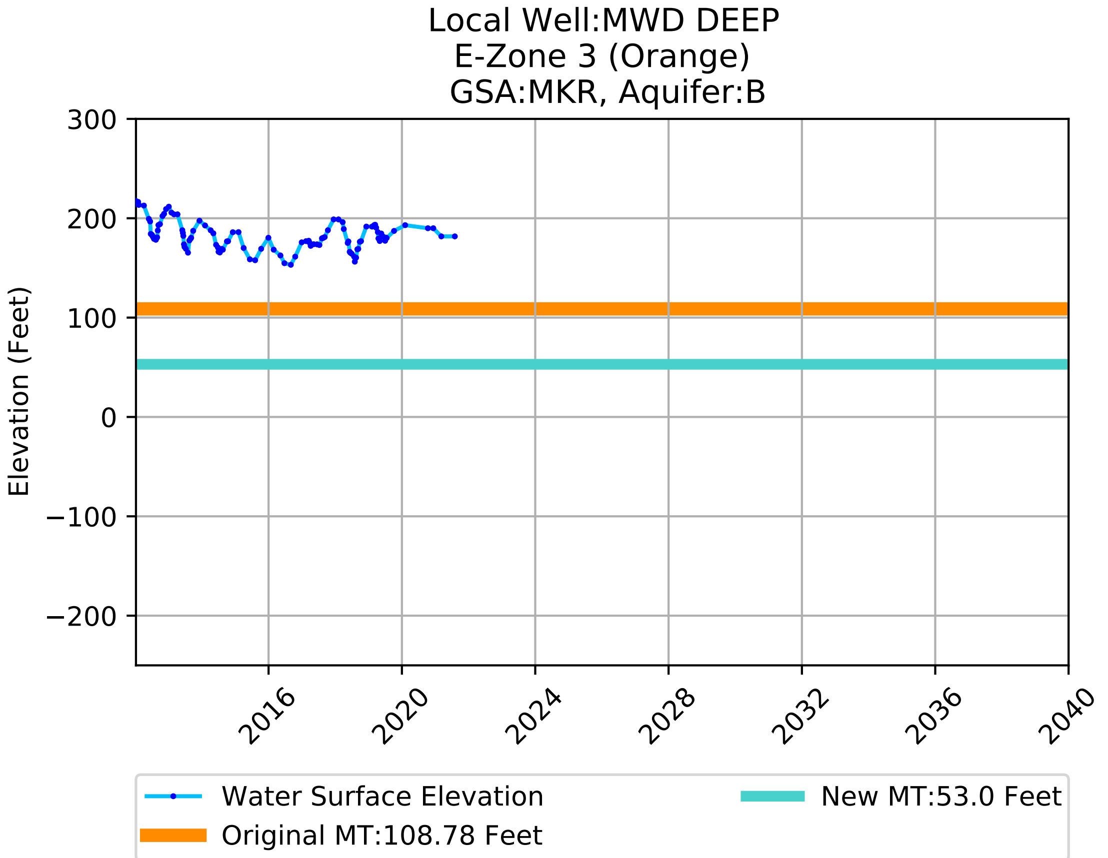
Local Well:20S20E26L001M
E-Zone 6 (Turquiose)
GSA:SFK, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:-56.79 Feet
Original MT:-4.25 Feet

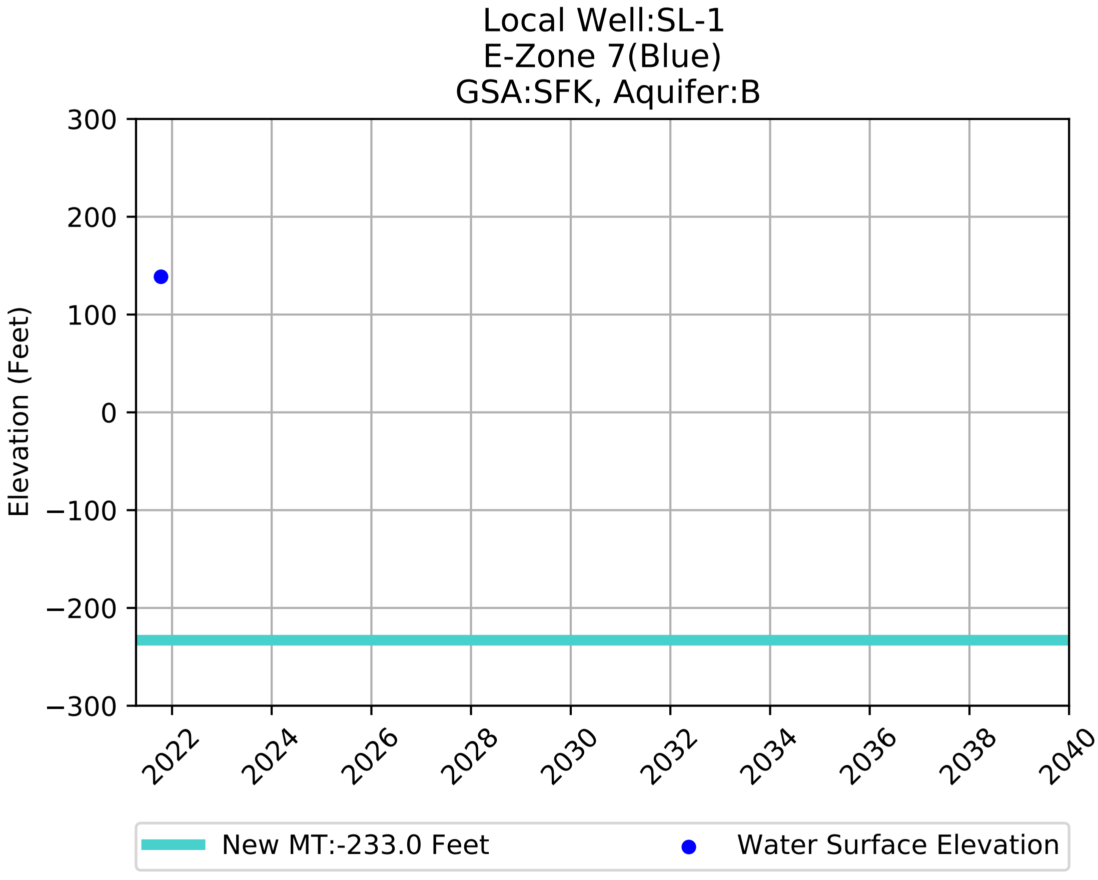


Local Well:CID-071
E-Zone 6 (Turquiose)
GSA:El Rico, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Water Surface Elevation
New MT:-5.0 Feet

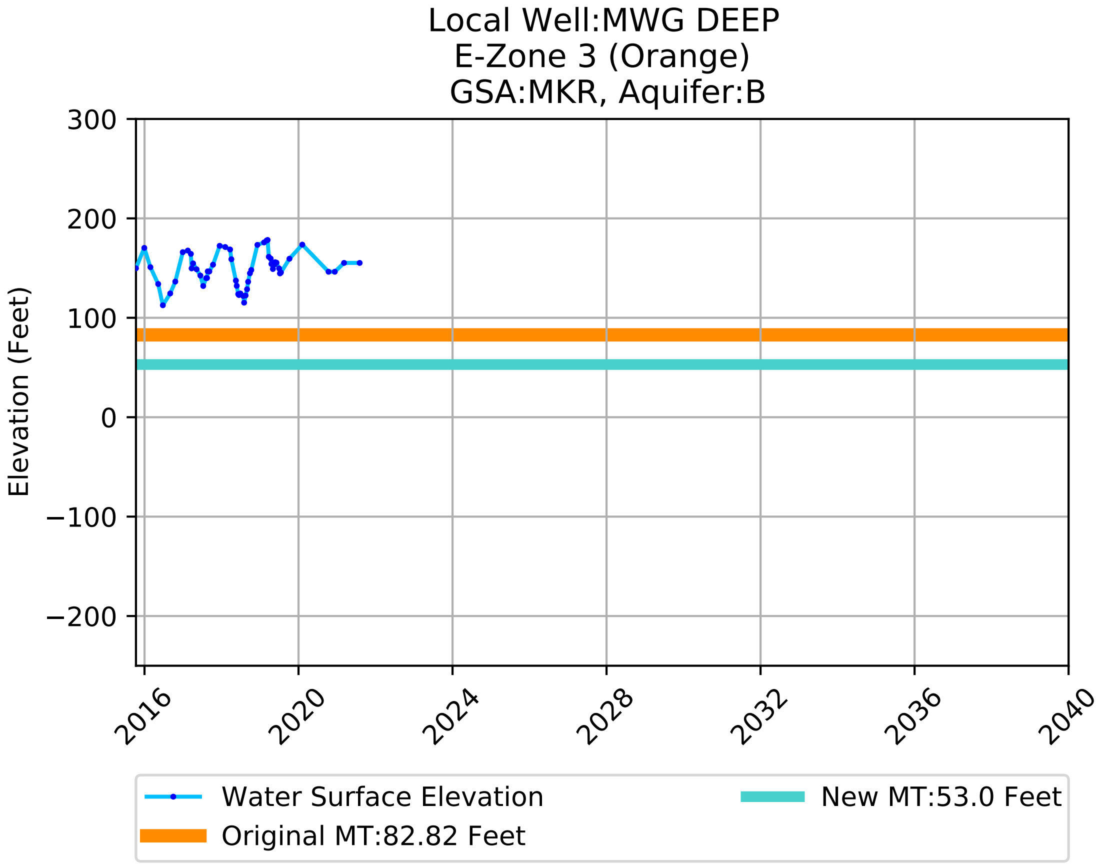


Local Well:1610009-003
E-Zone 7 (Blue)
GSA:SWK, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
1980
1990
2000
2010
2020
2030
2040
Water Surface Elevation
Original MT:20.58 Feet
New MT:-233.3653826 Feet

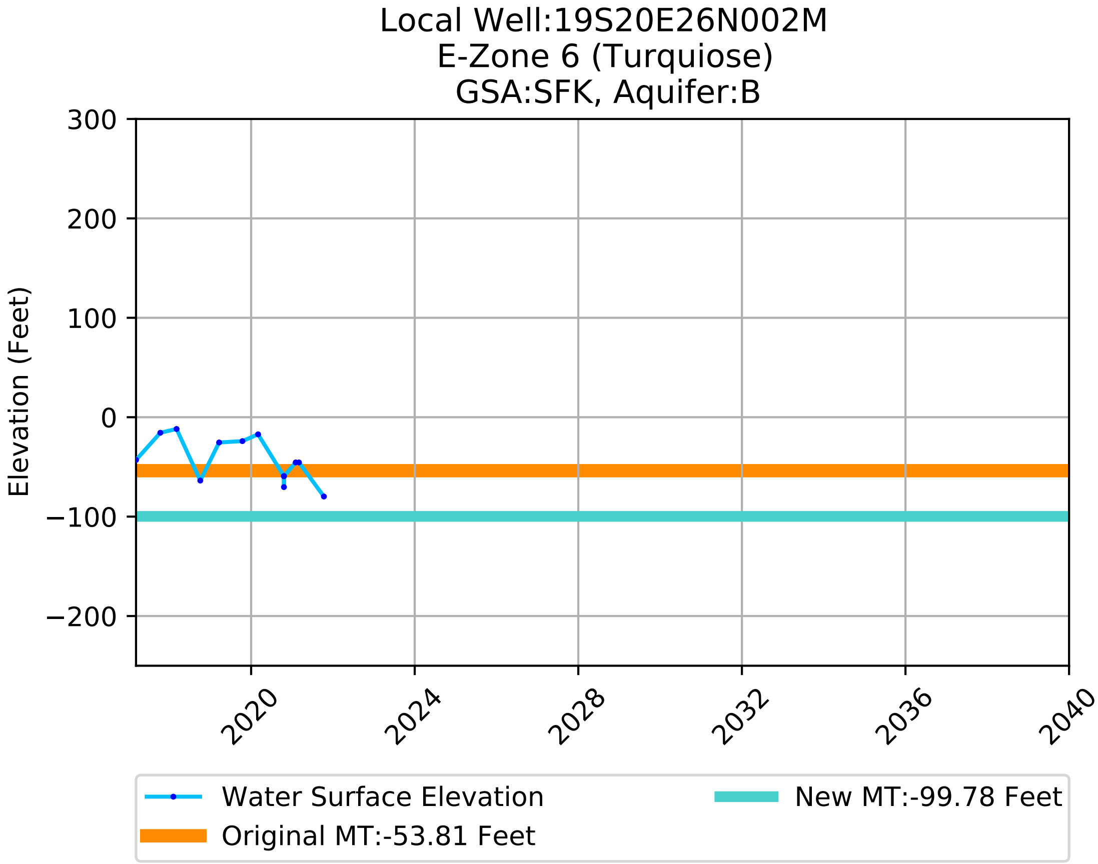

Local Well:MWD DEEP
E-Zone 3 (Orange)
GSA:MKR, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
Original MT:108.78 Feet
New MT:53.0 Feet



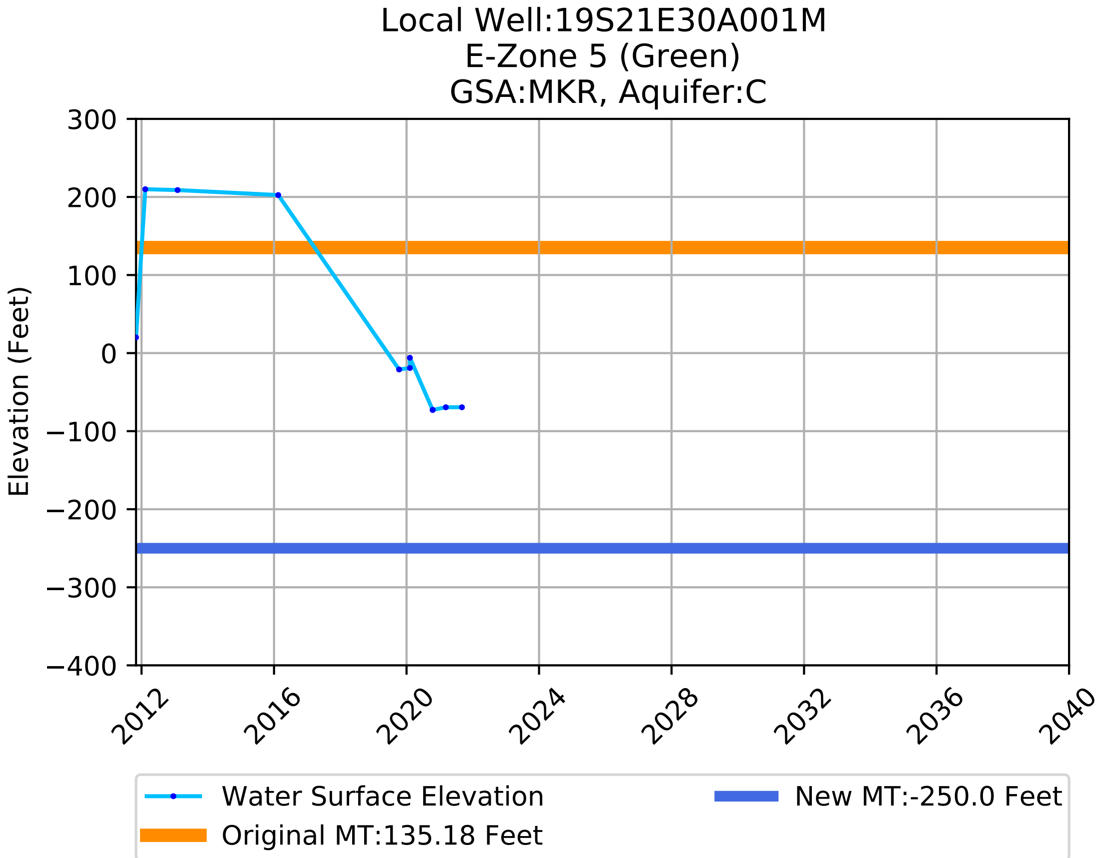
Local Well:SL-1
E-Zone 7(Blue)
GSA:SFK, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
−300
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
New MT:-233.0 Feet
Water Surface Elevation



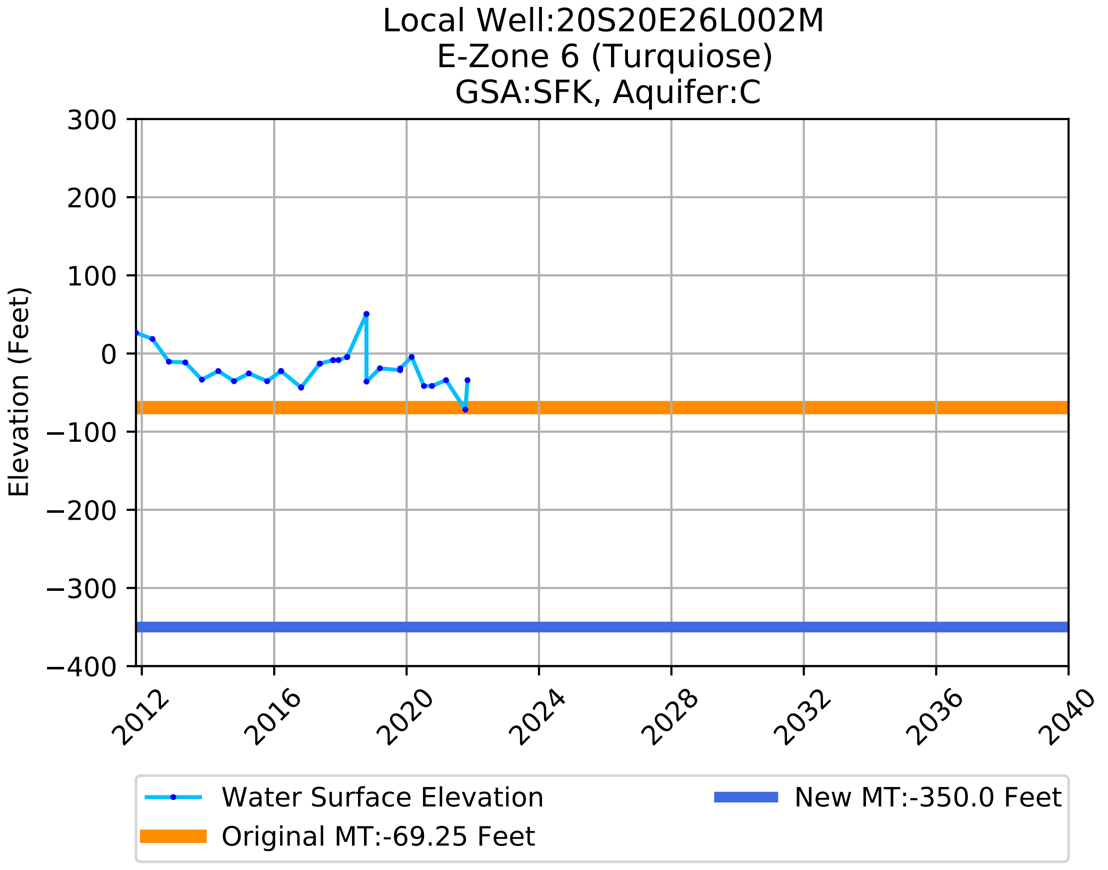
Local Well:MWG DEEP
E-Zone 3 (Orange)
GSA:MKR, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:53.0 Feet
Original MT:82.82 Feet



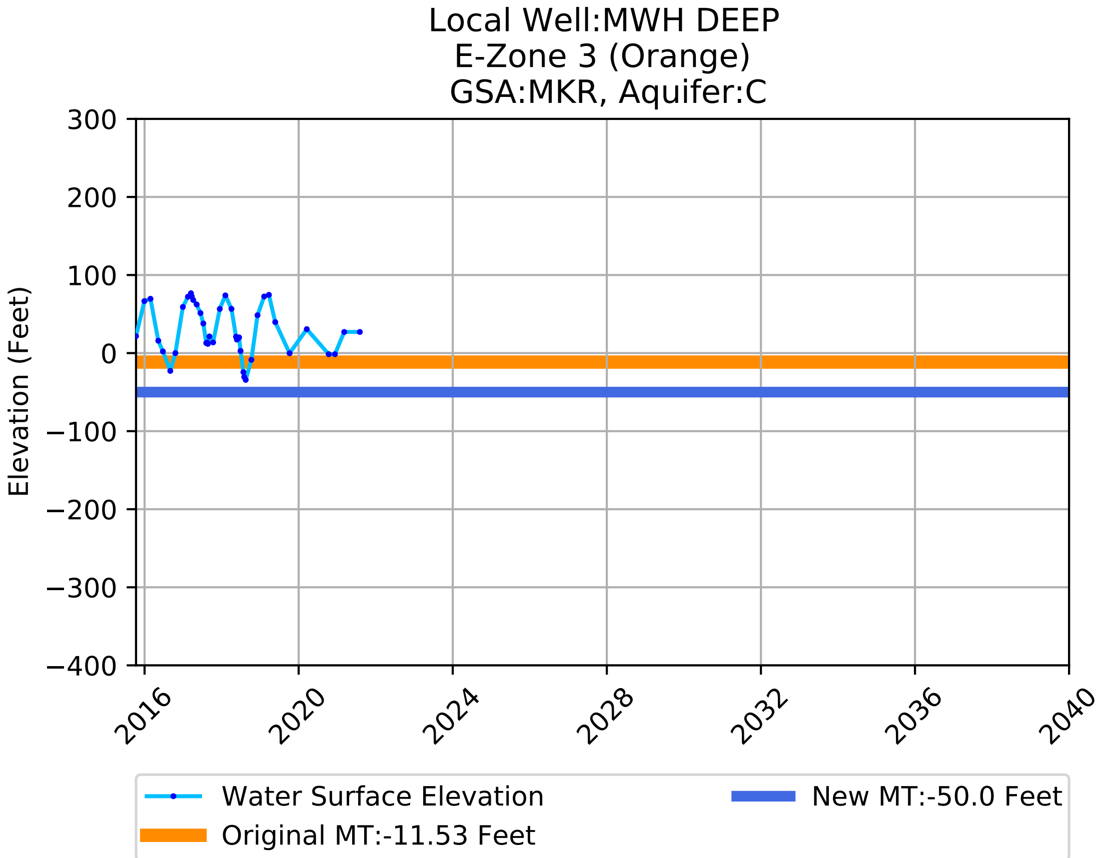
Local Well:19S20E26N002M
E-Zone 6 (Turquiose)
GSA:SFK, Aquifer:B
Elevation (Feet)
300
200
100
0
−100
−200
2020
2024
2028
2032
2036
2040
Water Surface Elevation
Original MT:-53.81 Feet
New MT:-99.78 Feet

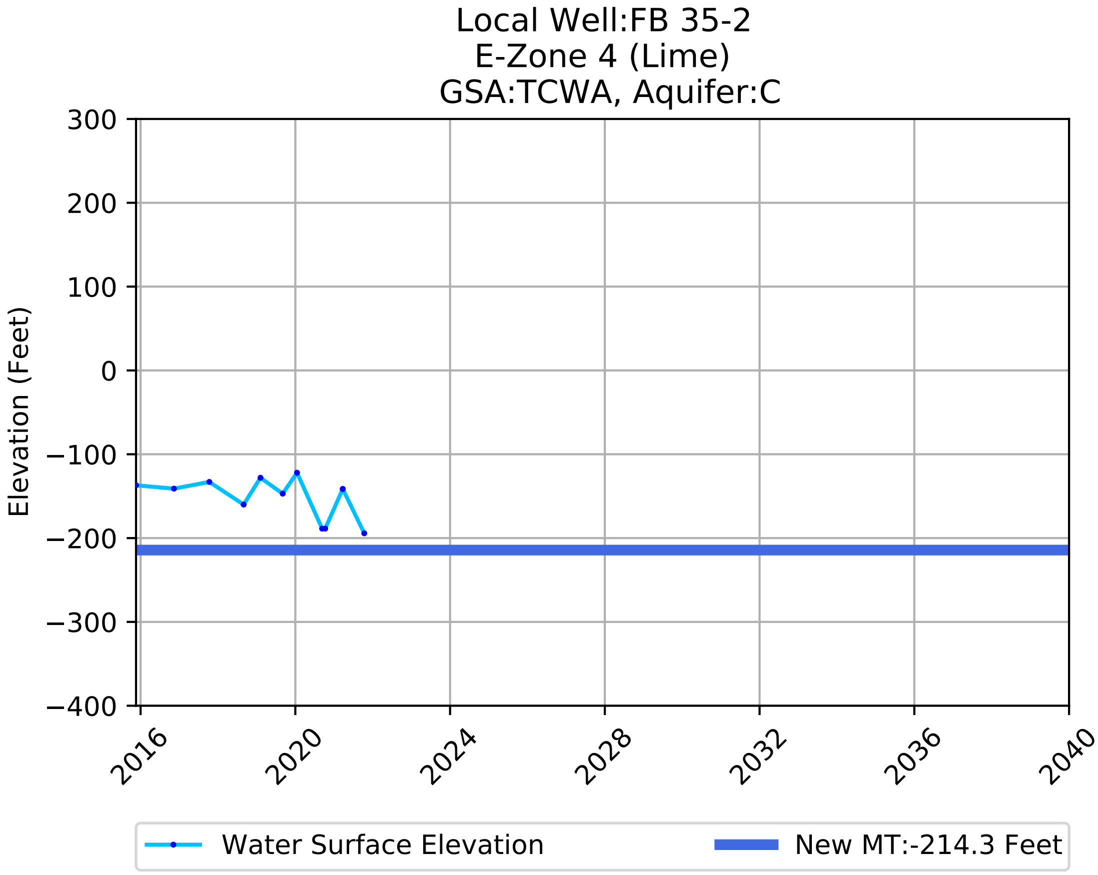


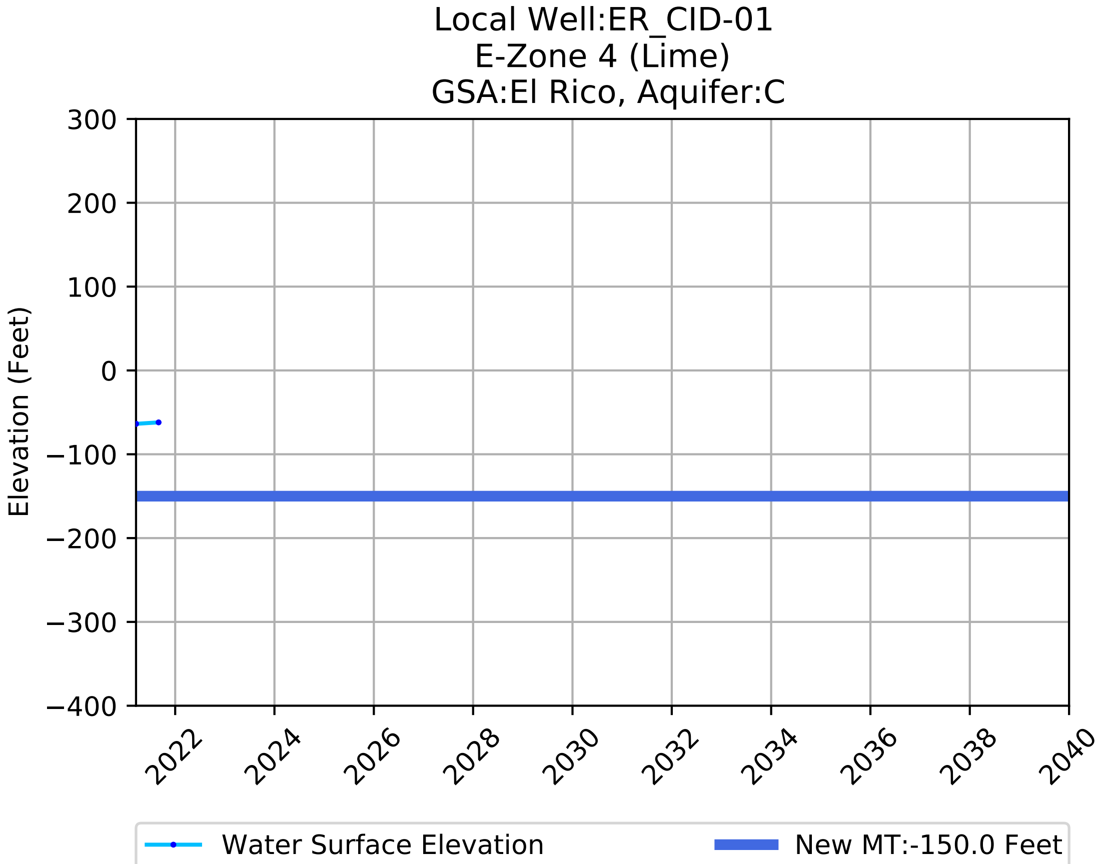
Local Well:19S21E30A001M
E-Zone 5 (Green)
GSA:MKR, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:-250.0 Feet
Original MT:135.18 Feet



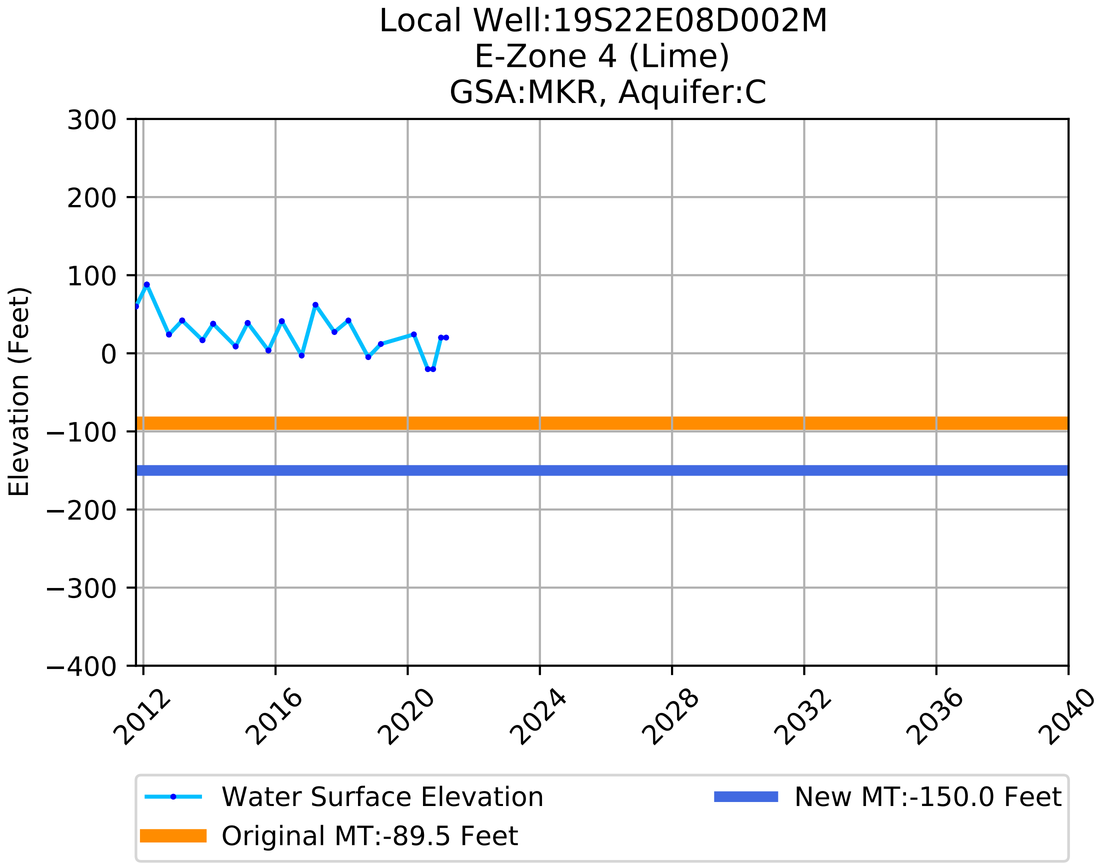
Local Well:20S20E26L002M
E-Zone 6 (Turquiose)
GSA:SFK, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:-350.0 Feet
Original MT:-69.25 Feet

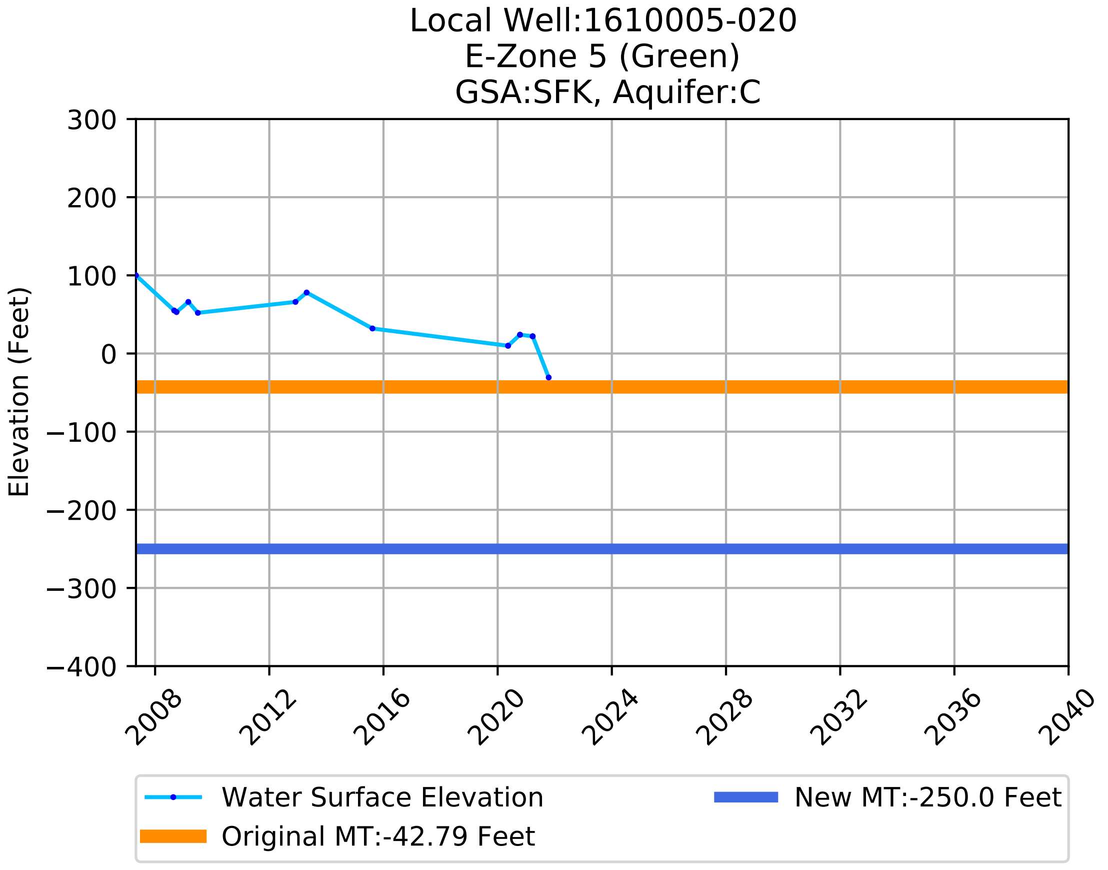

Local Well:MWH DEEP
E-Zone 3 (Orange)
GSA:MKR, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:-50.0 Feet
Original MT:-11.53 Feet


Local Well:FB 35-2
E-Zone 4 (Lime)
GSA:TCWA, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:-214.3 Feet

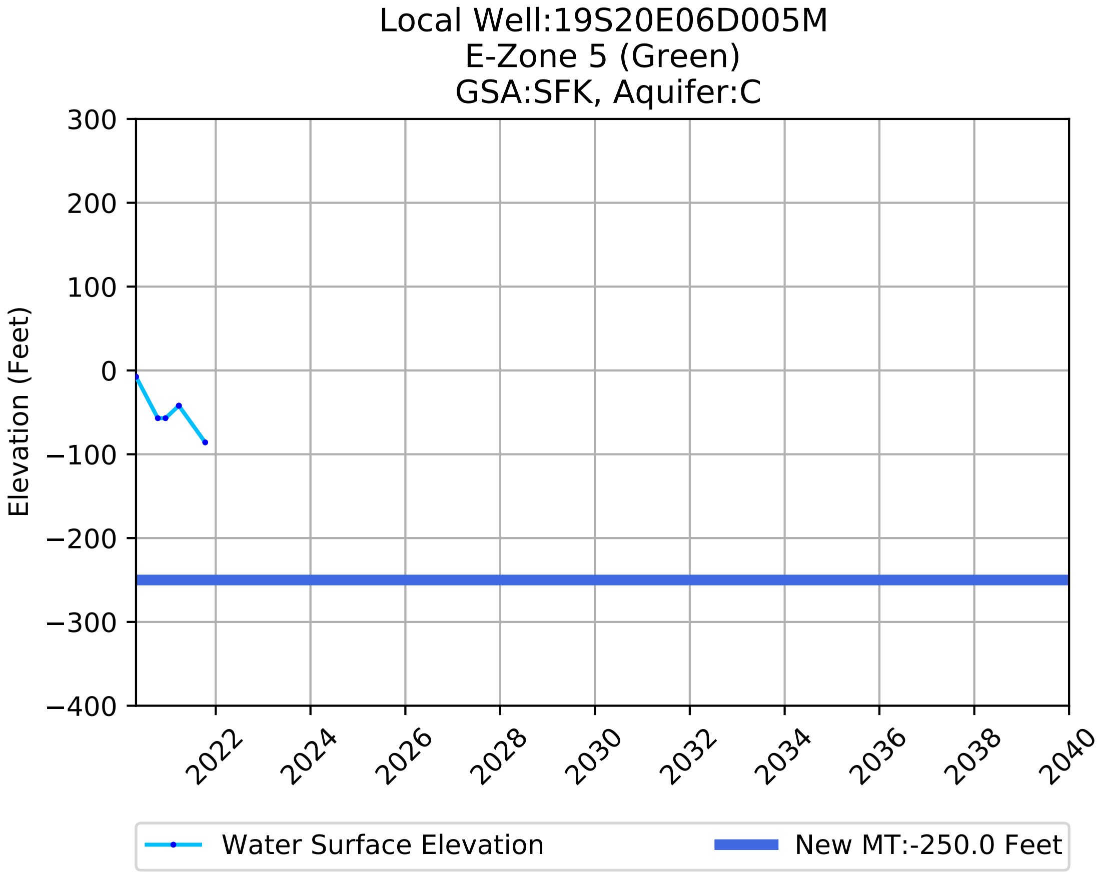


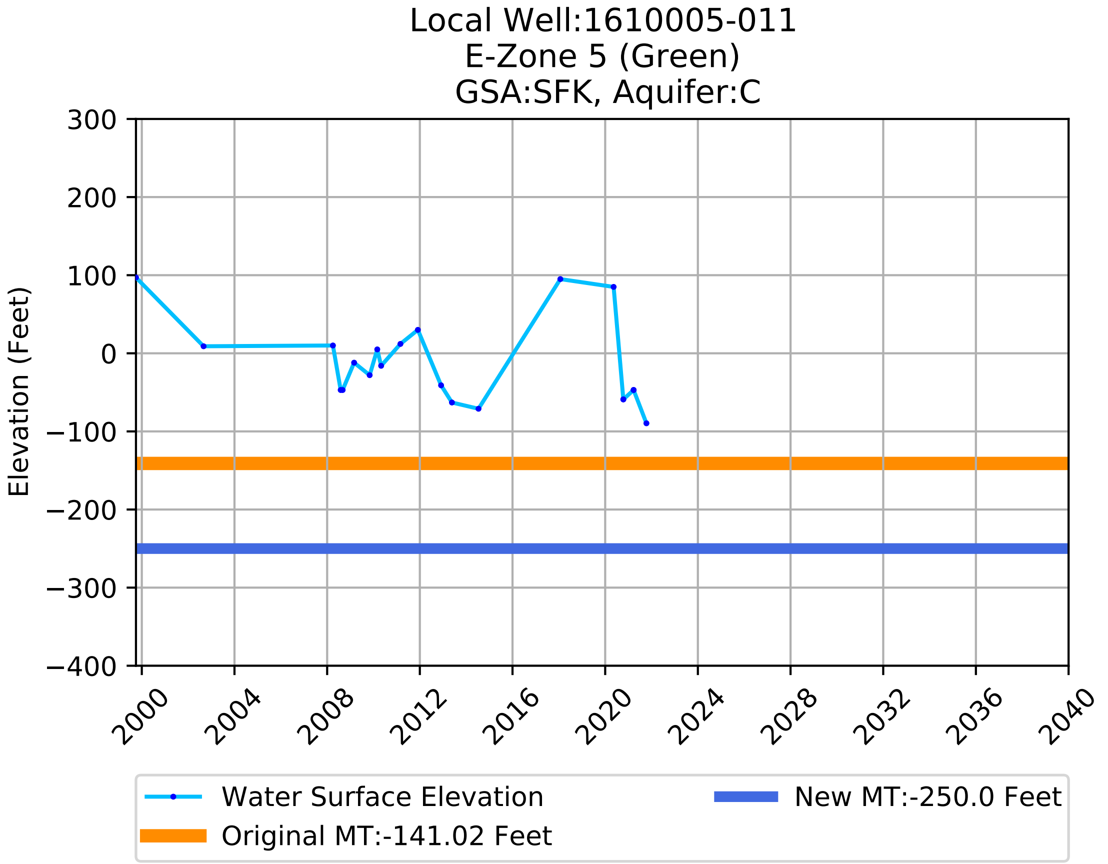
Local Well:ER_CID-01
E-Zone 4 (Lime)
GSA:El Rico, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Water Surface Elevation
New MT:-150.0 Feet

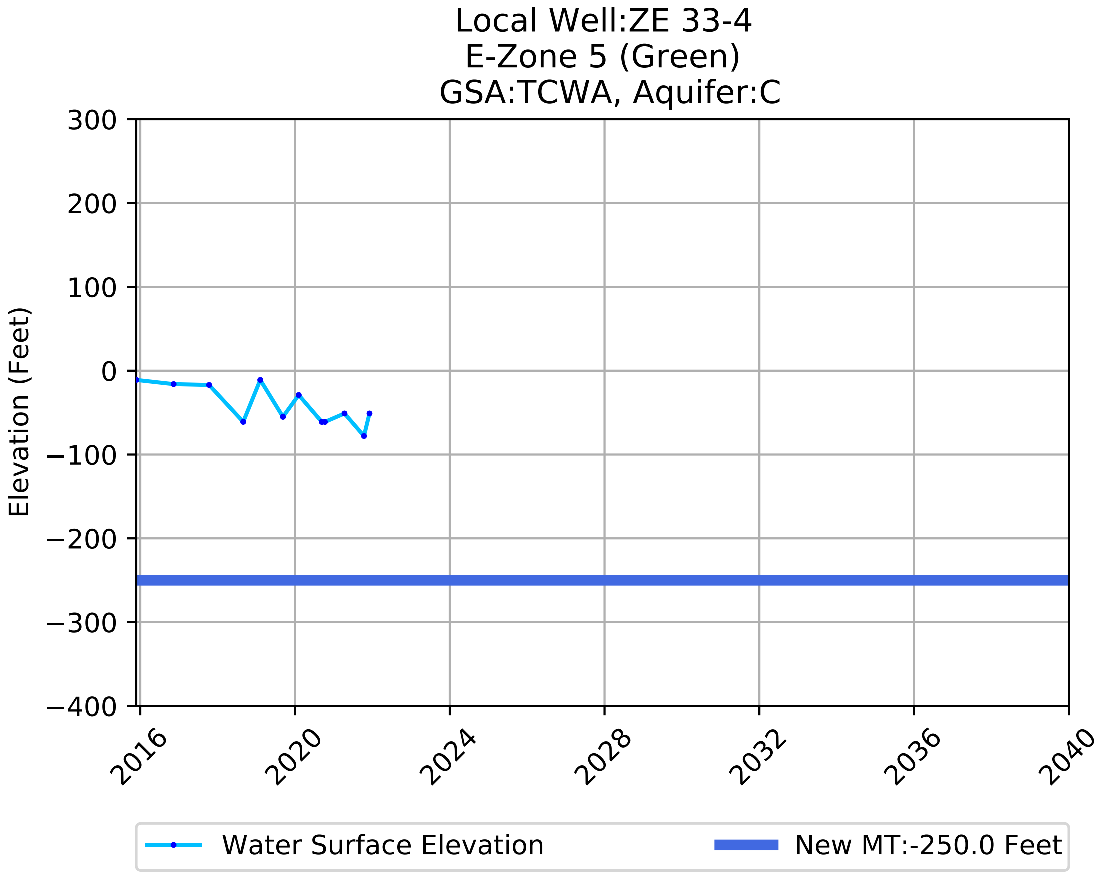

Local Well:19S22E08D002M
E-Zone 4 (Lime)
GSA:MKR, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:-150.0 Feet
Original MT:-89.5 Feet

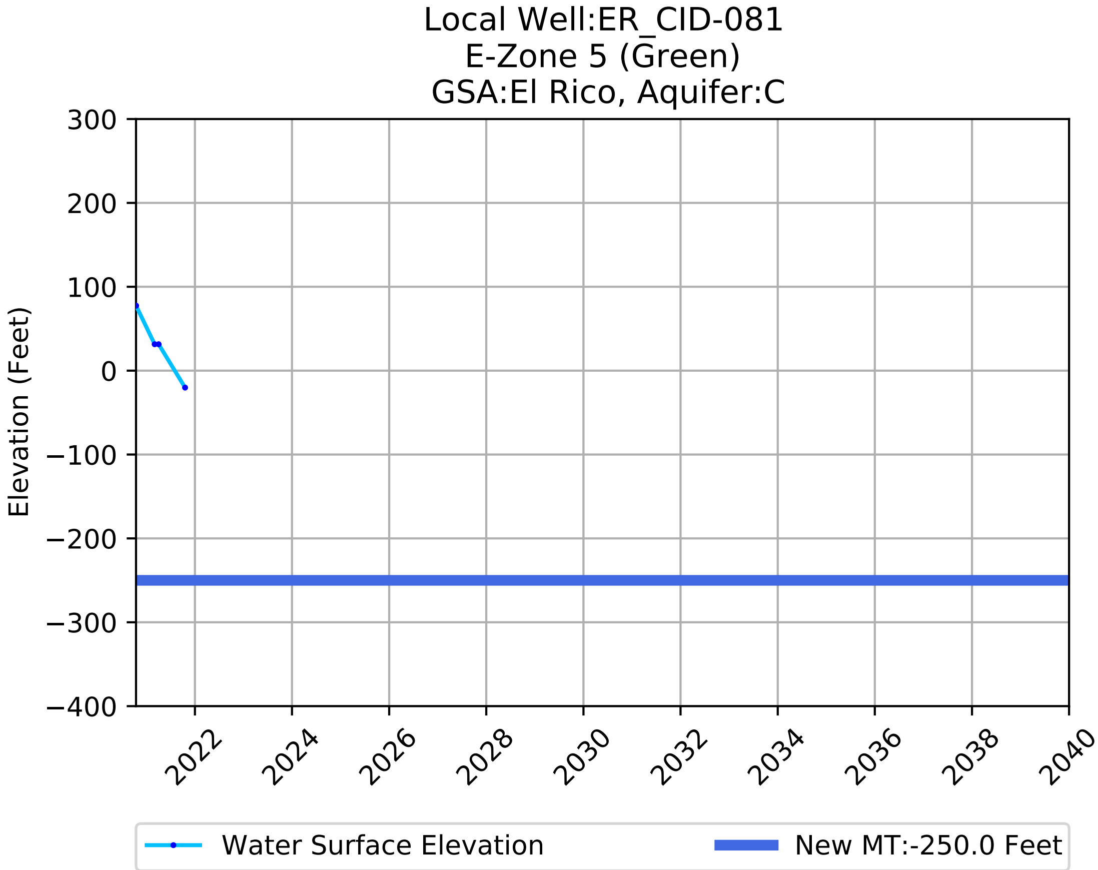


Local Well:1610005-020
E-Zone 5 (Green)
GSA:SFK, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2008
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:-250.0 Feet
Original MT:-42.79 Feet

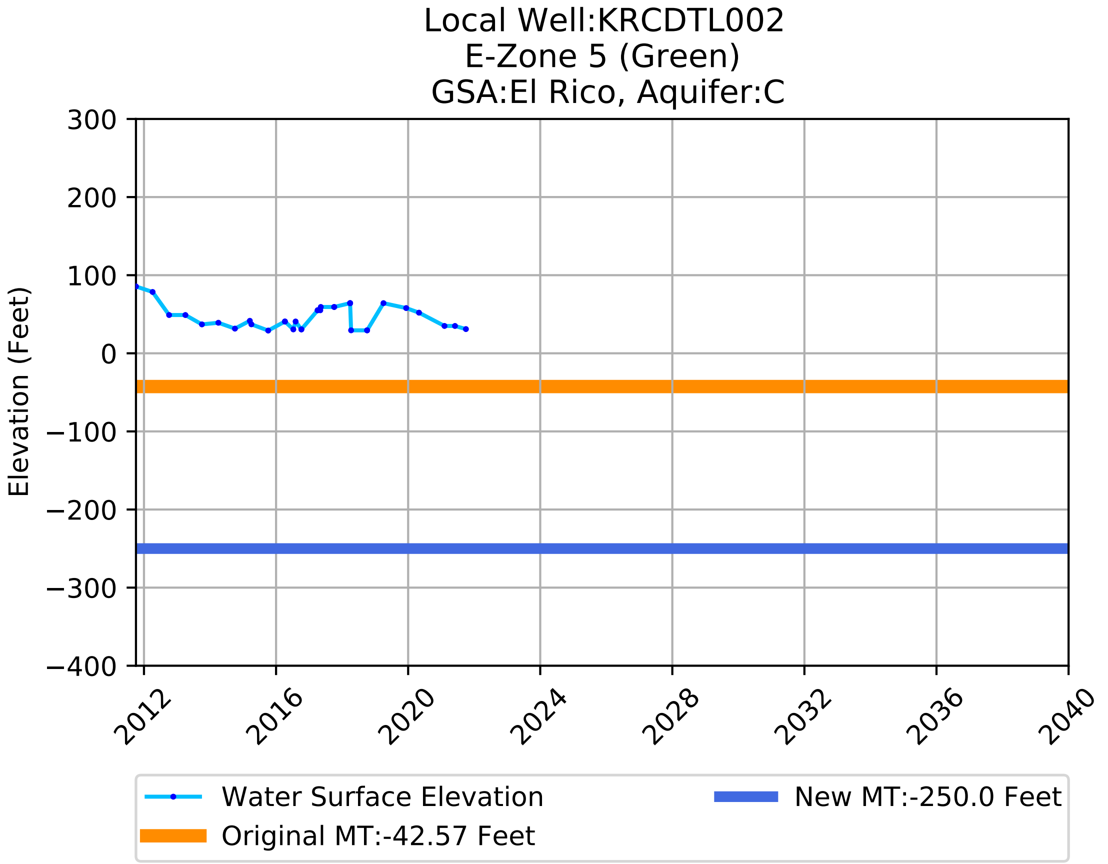

Local Well:19S20E06D005M
E-Zone 5 (Green)
GSA:SFK, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Water Surface Elevation
New MT:-250.0 Feet


Local Well:1610005-011
E-Zone 5 (Green)
GSA:SFK, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2000
2004
2008
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
Original MT:-141.02 Feet
New MT:-250.0 Feet

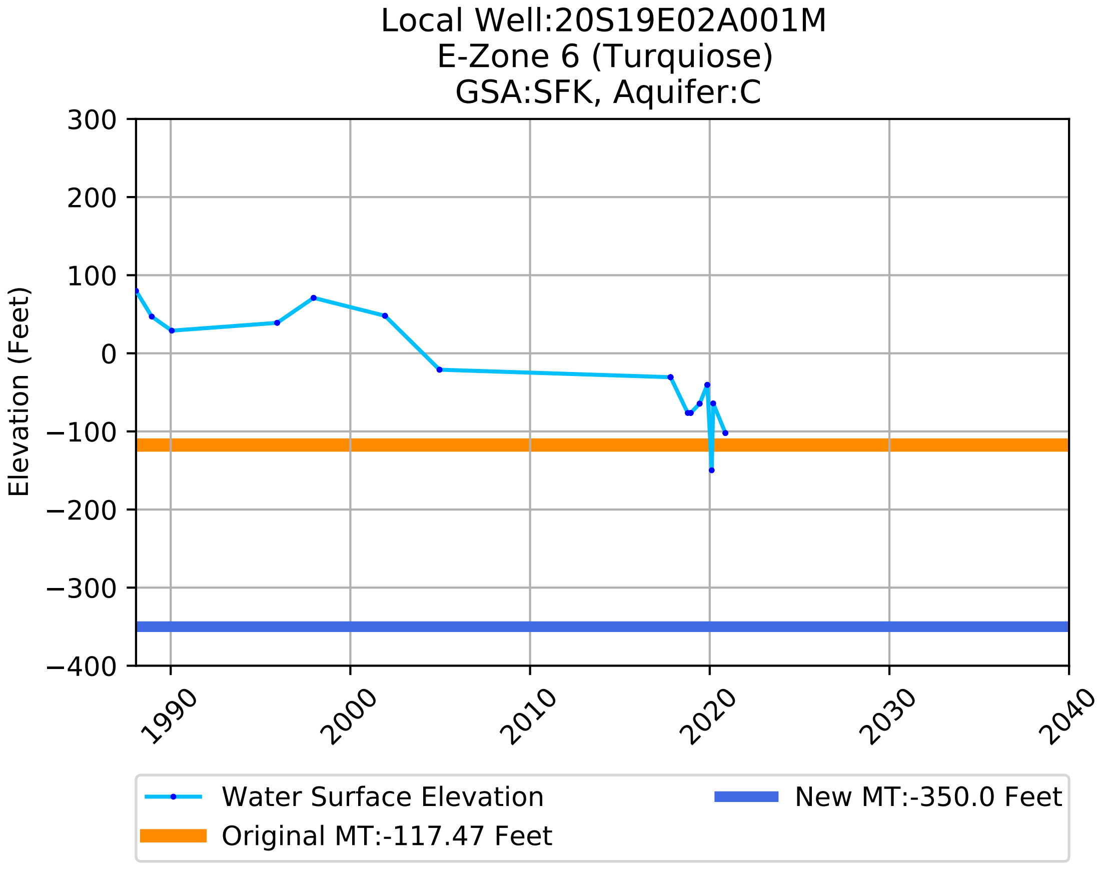

Local Well:ZE 33-4
E-Zone 5 (Green)
GSA:TCWA, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:-250.0 Feet



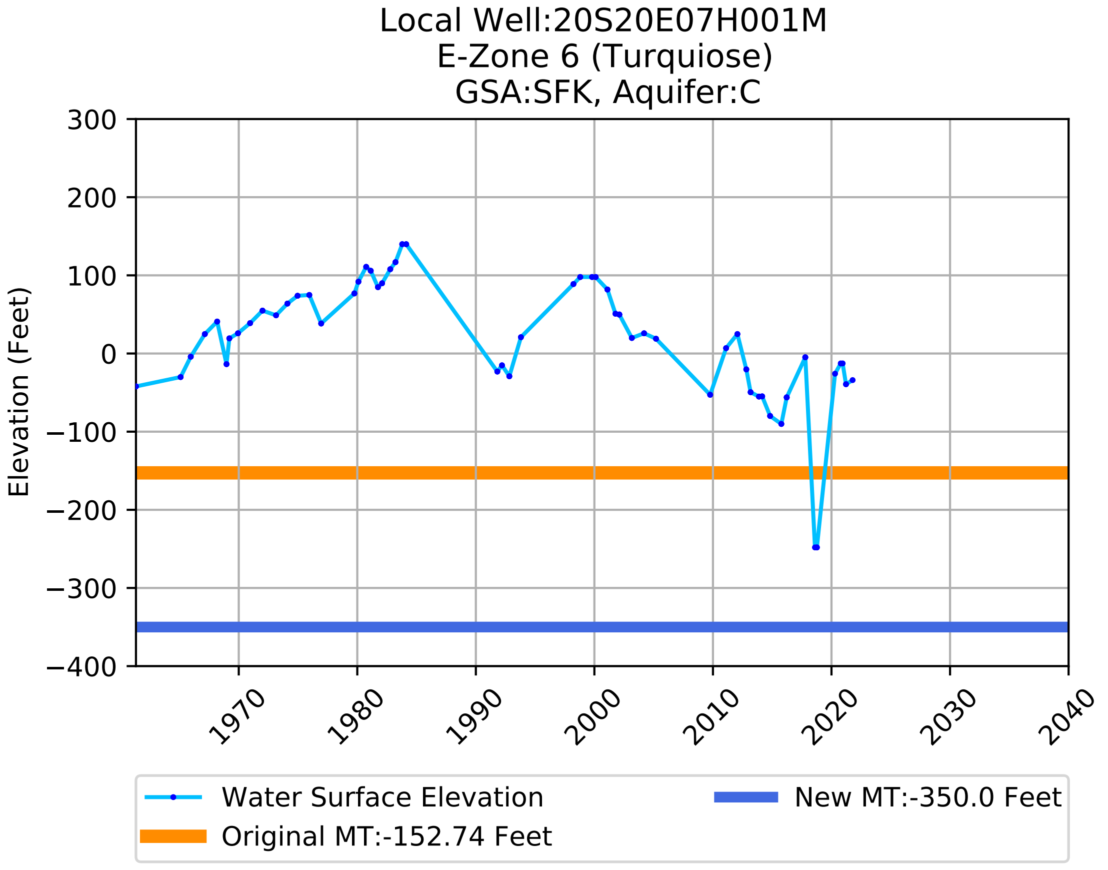
Local Well:ER_CID-081
E-Zone 5 (Green)
GSA:El Rico, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Water Surface Elevation
New MT:-250.0 Feet

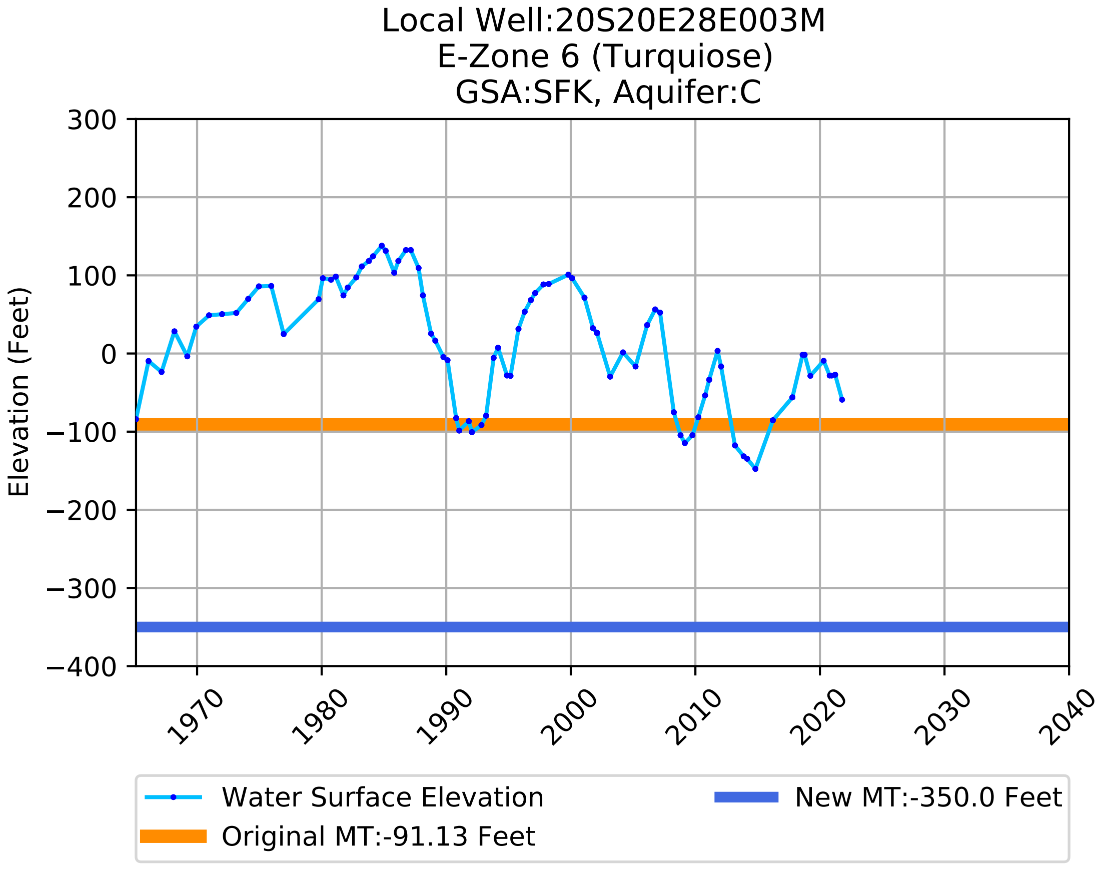


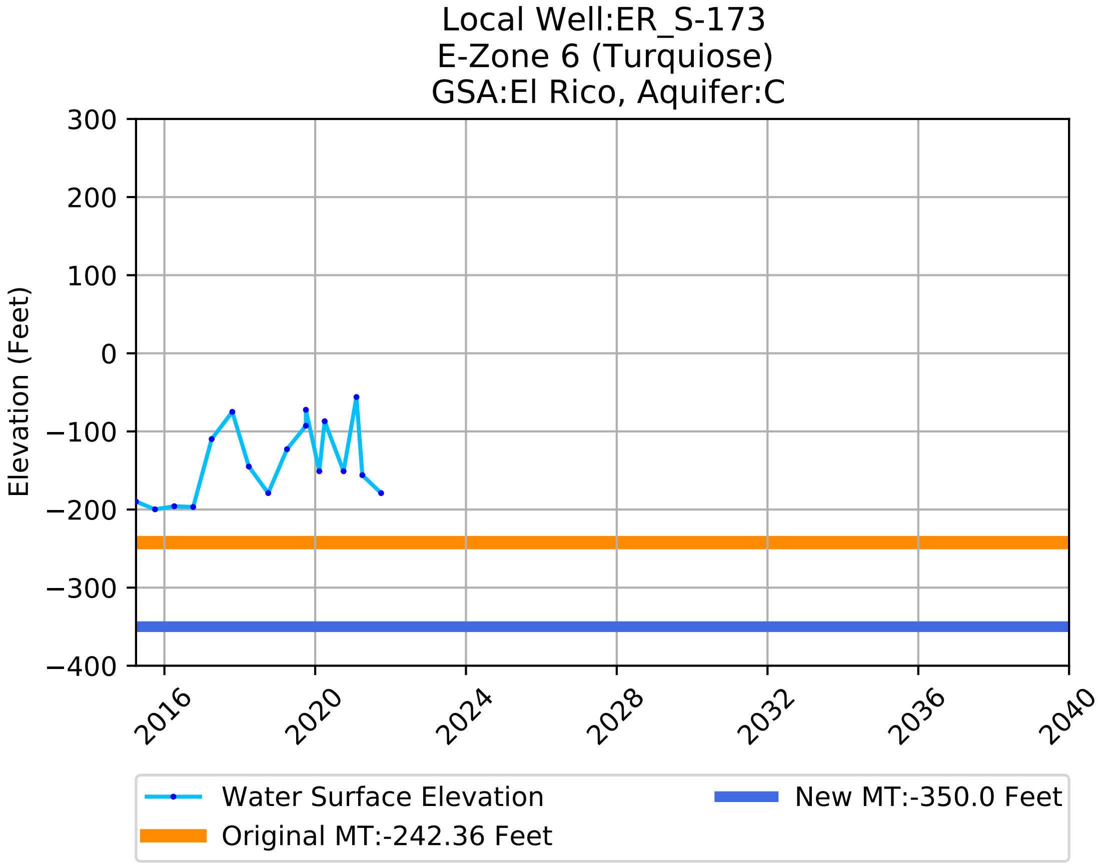
Local Well:KRCDTL002
E-Zone 5 (Green)
GSA:El Rico, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
Original MT:-42.57 Feet
New MT:-250.0 Feet



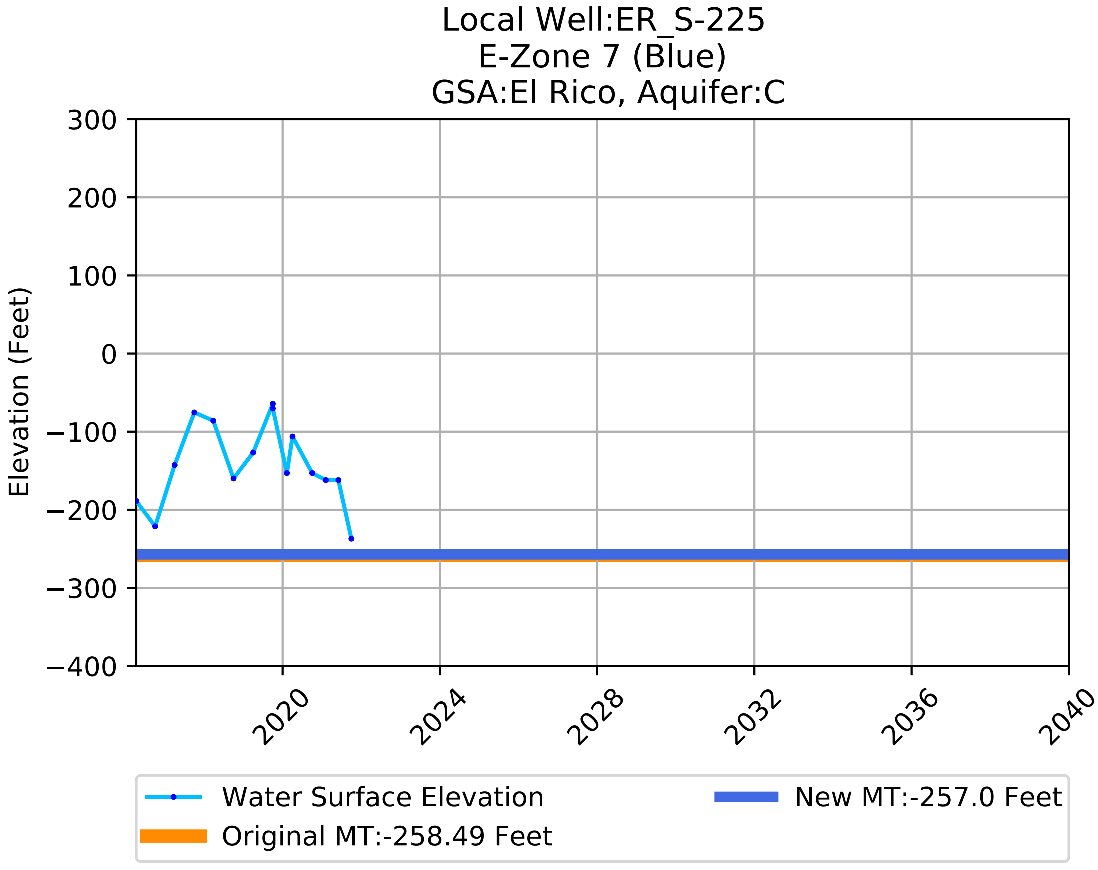
Local Well:20S19E02A001M
E-Zone 6 (Turquiose)
GSA:SFK, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
1990
2000
2010
2020
2030
2040
Water Surface Elevation
New MT:-350.0 Feet
Original MT:-117.47 Feet

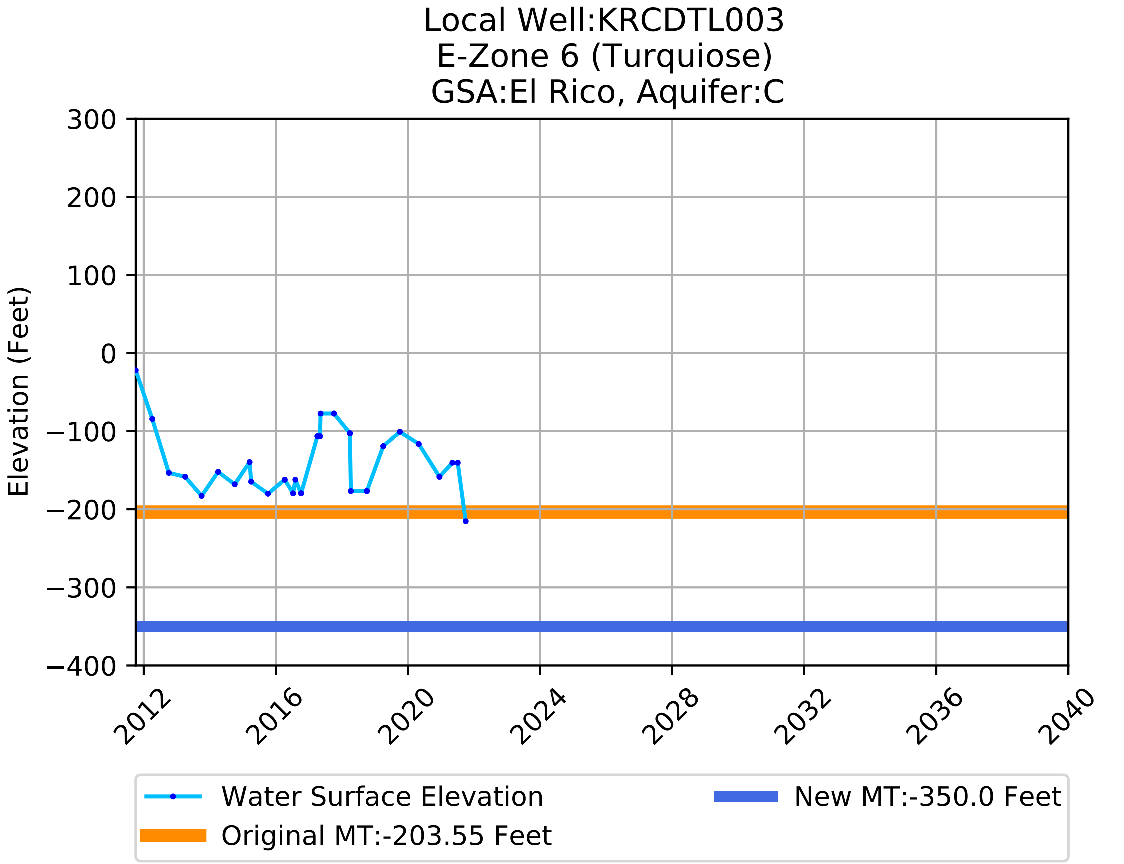

Local Well:20S20E07H001M
E-Zone 6 (Turquiose)
GSA:SFK, Aquifer:C
300
200
100
0
−100
−200
−300
−400
Elevation (Feet)
1970
1980
1990
2000
2010
2020
2030
2040
Water Surface Elevation
New MT:-350.0 Feet
Original MT:-152.74 Feet


Local Well:20S20E28E003M
E-Zone 6 (Turquiose)
GSA:SFK, Aquifer:C
300
200
100
0
−100
−200
−300
−400
Elevation (Feet)
1970
1980
1990
2000
2010
2020
2030
2040
Water Surface Elevation
New MT:-350.0 Feet
Original MT:-91.13 Feet

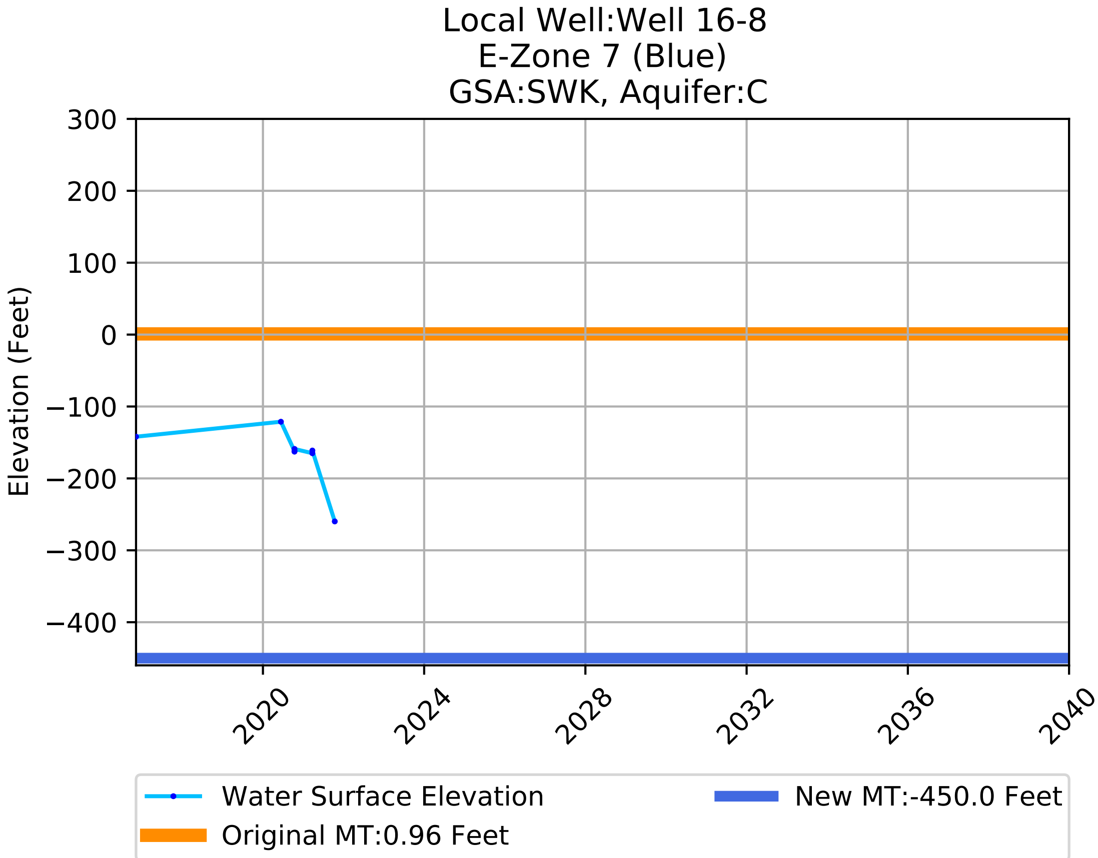


Local Well:ER_S-173
E-Zone 6 (Turquiose)
GSA:El Rico, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:-350.0 Feet
Original MT:-242.36 Feet

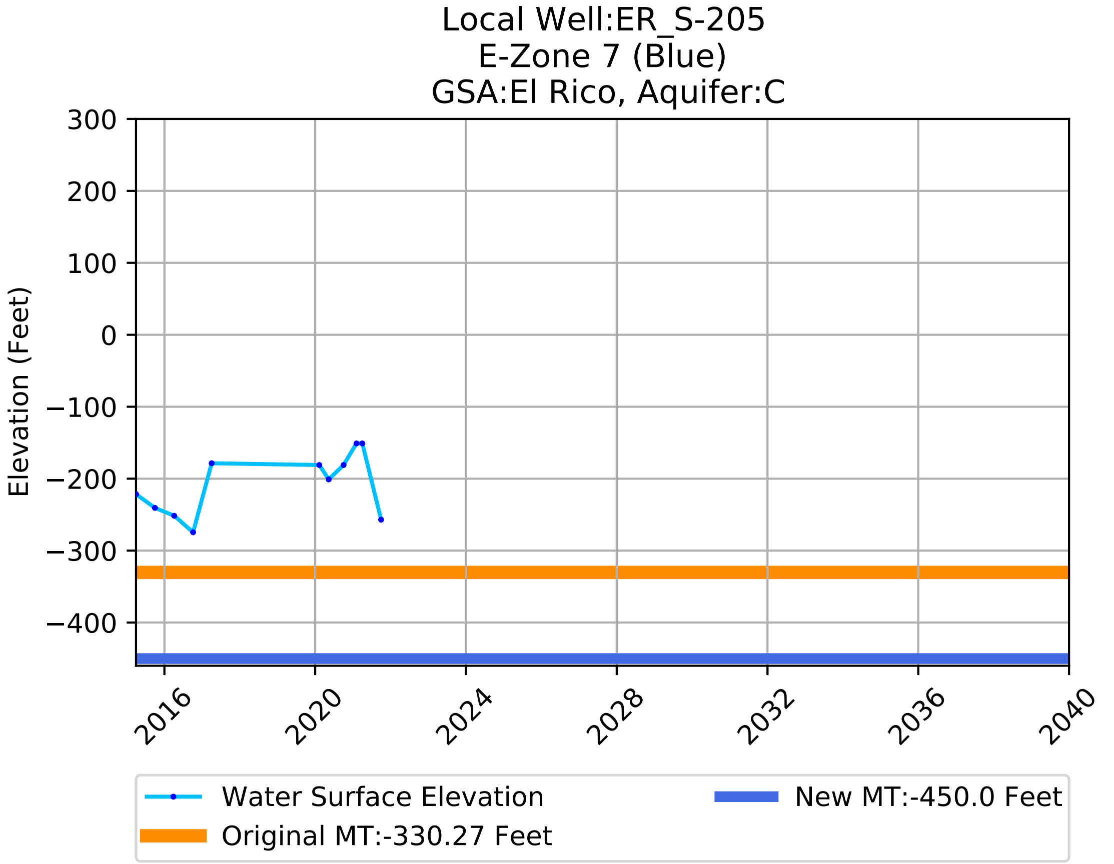

Local Well:ER_S-225
E-Zone 7 (Blue)
GSA:El Rico, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:-257.0 Feet
Original MT:-258.49 Feet

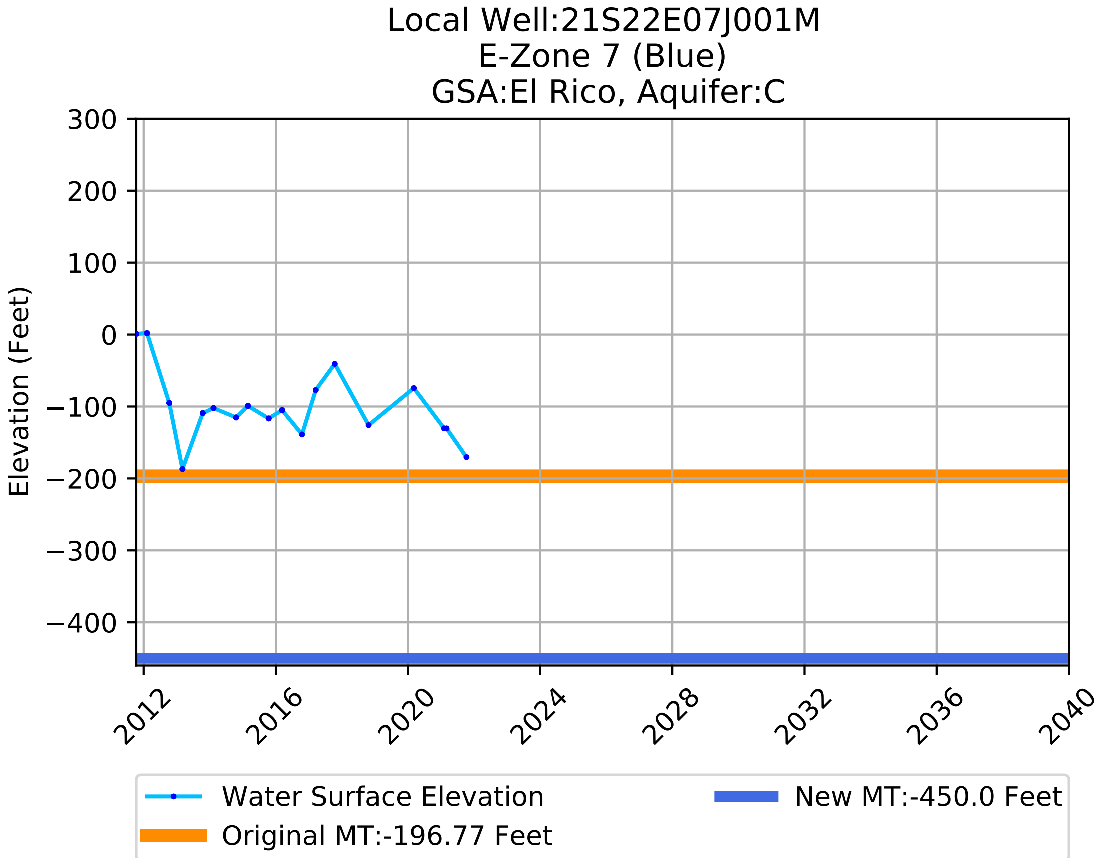


Local Well:KRCDTL003
E-Zone 6 (Turquiose)
GSA:El Rico, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:-350.0 Feet
Original MT:-203.55 Feet



Local Well:Well 16-8
E-Zone 7 (Blue)
GSA:SWK, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:-450.0 Feet
Original MT:0.96 Feet


Local Well:ER_S-205
E-Zone 7 (Blue)
GSA:El Rico, Aquifer:C
300
200
100
0
−100
−200
−300
−400
Elevation (Feet)
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
New MT:-450.0 Feet
Original MT:-330.27 Feet



Local Well:21S22E07J001M
E-Zone 7 (Blue)
GSA:El Rico, Aquifer:C
Elevation (Feet)
300
200
100
0
−100
−200
−300
−400
2012
2016
2020
2024
2028
2032
2036
2040
Water Surface Elevation
Original MT:-196.77 Feet
New MT:-450.0 Feet

APPENDIX B

GROUND SUBSIDENCE SMC SUPPORTING INFORMATION

MITIGATION PLAN FRAMEWORK

The Tulare Lake GSAs have agreed to prepare and implement mitigation programs to offset impacts. However, it should be understood that the conditions and users in each area vary widely. This framework presents the minimum requirements that would be included in each GSA-specific mitigation program. As the GSAs considered what mitigation might entail in their areas, it became clear that the effort has many facets that will require stakeholder input in each area. In particular, funding for these efforts would need to be developed through a Proposition 218 process and election. Also, most rural residential wells are considered *di minimis* under SGMA, and therefore will need to be investigated more fully to understand their location and construction. Due to the tight deadline allowed in GSP Regulations, insufficient time was available to seek stakeholder input into a complete mitigation program. Instead, the GSAs have agreed to this framework and will prepare individual mitigation programs specific to their stakeholder needs by January 2025 for inclusion into the five-year Plan update.

Purpose

The purpose of the mitigation program is to address local landowner issues to the extent feasible. The plan would be that the mitigation program would address local impacts to beneficial users resulting from GSP implementation. However, care must be taken to establish what portion of the impacts are associated with the choices by the landowner or other nearby landowners, rather than GSA actions to implement the GSP. In this regard, the mitigation plan might be viewed to be similar to efforts put in place around groundwater banks, where benefits and impacts from the banking operations are considered along with all available monitoring information by qualified professionals to develop a view of whether mitigation is warranted. The impacts covered by the program would be limited to domestic wells, critical infrastructure, and land uses that are adversely affected by declining groundwater levels, land subsidence, or changes to groundwater quality. The mitigation plan may be revised or expanded based on groundwater conditions in the future.

Minimum Plan Requirements

Each plan will include the following:

1. Stakeholder outreach
2. Well Registration
3. Eligibility Criteria
4. Application process
5. Evaluation process
6. Identification of suitable mitigation
7. Funding Source

Stakeholder Outreach

The program should present the public outreach and education efforts that will be performed during development of the mitigation program and prior to implementation. Prior to implementation, extensive outreach will be needed to notify stakeholders of the Program requirements and how they can apply for assistance. These efforts should be in general accordance with the existing Stakeholder Communication and Engagement Plan. However, one main difference relative to when the 2020 GSP was developed is that through the Governor's Executive Order N-7-22, GSAs are more directly involved in well permitting. So, for impacted parties, contacting their local GSA about the matter should become routine.

Well Registration

As noted above, the information on domestic wells regarding well construction and operation is limited. The Kings County database provides some information on the existing domestic wells where permits were obtained but is not updated regularly for well operational status. A comprehensive database of the domestic wells with construction details would be complied across the Subbasin.

Eligibility Criteria

The program should present the eligibility requirements to qualify for the program based on stakeholder compliance with the GSP, GSA's Rules & Regulations, and other laws or regulations.

Application Process

The program should clearly present the process by which an affected stakeholder can submit a claim. It is anticipated that this process will include requests for information such as a Well Completion Report on the well, monitored depths to water over time, records on how the well was maintained, information on the amount of water used or power consumption records that could be used as a proxy, water quality records for relevant COCs, and information about existing wells within a radius around the well experiencing the perceived impact.

Evaluation

Once a claim of adverse impact has been made to a GSA, the GSA will investigate the claim to evaluate whether it is associated with GSP Implementation. As was stated before, the mitigation program will be designed to address local impacts to beneficial users resulting from GSP implementation. However, care must be taken to establish what part of the impacts may be associated with choices by the landowner, other nearby landowners, or potentially some other issue with the facility, rather than GSA actions to implement the GSP. In this regard the mitigation plan might be viewed to be similar to efforts put in place around Groundwater Banks, where benefits and impacts from the Banks operations are considered along with all available monitoring information by qualified professionals to come to a view of whether mitigation is warranted.

Mitigation

Once contacted about a potential impact, the GSA will begin working with the local landowner. There are various services available to landowners with well issues, such as County programs to provide temporary water service while a new well is drilled. The GSAs will convey available information on these services and work with the landowner to provide information about the facility and its condition to the GSAs so that an evaluation can be undertaken as quickly as possible. Once a claim of impact has been confirmed to be due to GSP implementation, the GSA will pursue suitable mitigation efforts as described in each GSA specific plan. Various factors may reflect the proper mitigation methods for the specific issue. For example, facility age, location, financial impact to the stakeholder as a result of mitigation.

Funding Source

Funding will be needed for the program through the GSA's implementation of assessments, fees, charges, and penalties. All of these funds will have to be developed consistent with Proposition 218 requirements. Also, much work will have to be done to better understand the sources of the impacts and identify landowners involved in developing the identified impacts, so that funds are collected from the appropriate parties. In addition, the GSAs will explore grant funding as County, state and federal assistance will be needed to successfully implement this program. The State has existing grant programs for community water systems and well construction funding. The GSAs will also work with local NGOs that may be able to provide assistance or seek grant monies to help fund the program.

APPENDIX B – GROUND SUBSIDENCE SMC SUPPORTING INFORMATION

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1 MECHANICS OF SUBSIDENCE

Subsidence in the San Joaquin Valley (SJV) and thus in the subbasin is primarily attributed to compaction[1] of subsurface clay layers (i.e., fine-grained soils) in response to groundwater extraction. As sketched in Figure B1-1, groundwater in the SJV occurs in a shallow unconfined or partially confined aquifer and a deep confined aquifer that comprises fine-grained aquitards interbedded with coarser-grained aquifers. The shallow and deep aquifers are separated by a laterally extensive lacustrine clay layer (aquitard) known as the Corcoran Clay (Galloway et al. 1999). Groundwater in the aquifers is replenished primarily by infiltration through stream channels near the valley margins, and secondarily by precipitation.

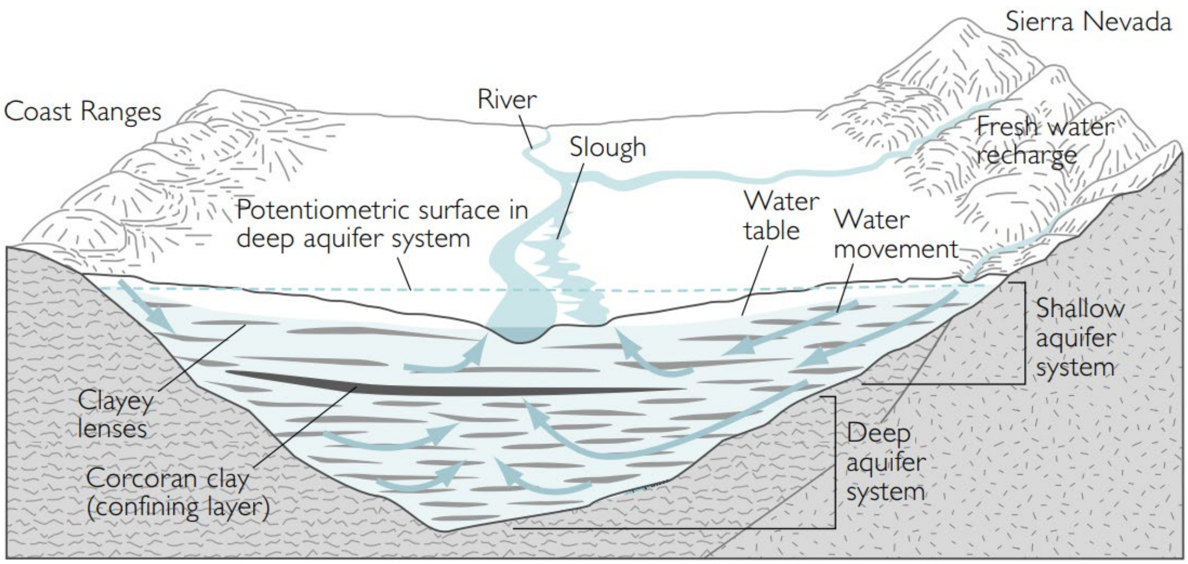

Figure B1-1. Geological sketch of the San Joaquin Valley depicting the shallow and deep aquifer systems separated by the Corcoran Clay layer (figure from Galloway et al. 1999)

Pumping from wells installed in the shallow unconfined aquifer and the deep confined aquifer began over 100 years ago, which led to a decrease in the elevation of the piezometric surface within each aquifer. This led to an increase in the (effective) stress between soil particles, and compression of the soil column which manifested as subsidence at the ground surface.

The concept of effective stress in soil (i.e., the formational material of coarse-grained aquifers and fine-grained aquitards) and the effect of changes in the elevation of the level of the water table (i.e., piezometric surface) is sketched in Figure B1-1. The soil columns are drawn to be somewhat representative of the conditions in the SJV where an upper aquifer is separated from a lower aquifer by a

[1] Geotechnical engineers use the term consolidation to describe the process by which a soil layer dissipates (i.e., expels) pore water pressures and decreases in volume. Geologists use the term compaction to describe consolidation. Compaction is known by geotechnical engineers as the densification of soils by the application of mechanical energy (e.g., Holtz and Kovacs, 1981). The term compaction, together with the term consolidation, will be used herein for consistency with literature on the topic of subsidence in the SJV.

relatively thick aquitard, and the lower aquifer is underlain by bedrock. As shown by Equation B-1, the effective vertical stress (σ'_v) acting between soil particles (or grains) at an arbitrary horizontal plane is equal to the difference between the total stress (σ_t) and the pore-fluid pressure (u).

$$\sigma'_v = \sigma_t - u$$ **Equation B-1**

The total stress is defined as the stress applied by the weight of soil and water above the arbitrary plane, and the pore-fluid pressure is equal to the height of the water column above the arbitrary plane multiplied by the unit weight of water (i.e., 62.4 pounds per cubic foot, pcf). On the column to the left, which is described as the initial condition prior to pumping in the SJV, the pore-fluid pressure at the arbitrary horizontal plane is defined by the height of the water column (z_{w1}). As groundwater is pumped, the elevation of the water table decreases as depicted in the column to the right (final condition) such that the height of the water column above the arbitrary plane decreases and is equal to z_{w2}. The total stress at the arbitrary plane maintains the same value in the initial condition and the final condition, but since the value of the pore-fluid pressure decreases, the effective stress also decreases.

When a soil is loaded, it will compress (i.e., decrease in volume) because of 1) deformation of soil grains, 2) compression of air and water in the voids[2], and/or 3) squeezing out of water and air from the voids between soil particles (Holtz and Kovacs, 1981). At typical loads, the deformation of soil grains is negligible. In soils below the water table, which is most of the soil column in the SJV, water occupies the pore space between soil particles; therefore, compression of the air in the voids is also negligible. Thus, the main component of volume change in the SJV is caused by squeezing of water from the voids.

Changes of the effective stress of the soil lead to changes in the volume that the soil occupies in space. An increase of the effective stress causes a decrease of the volume of the soil and vice-versa. For the columns in Figure B1-2, a change in volume is represented by a change in the elevation of the ground surface, as such an increase in the effective stress causes downward movement of the ground surface (i.e., subsidence). The amount of volume change due to a change in the effective stress depends on the compressibility of the soil material.

In fine-grained soils (i.e., aquitards), volume change is higher than in coarse-grained soils and irreversible when effective stress increases beyond the highest value it has previously experienced[3]. Consequently, a volume reduction is triggered when the piezometric level falls below historically low values.

[2] Soils are an assemblage of individual small particles. Voids refers to the space between particles.
[3] Volume change in fine-grained soils is not linearly correlated with an increment in the effective stress. Instead, volume change increases with the logarithm of the increase of effective stress.

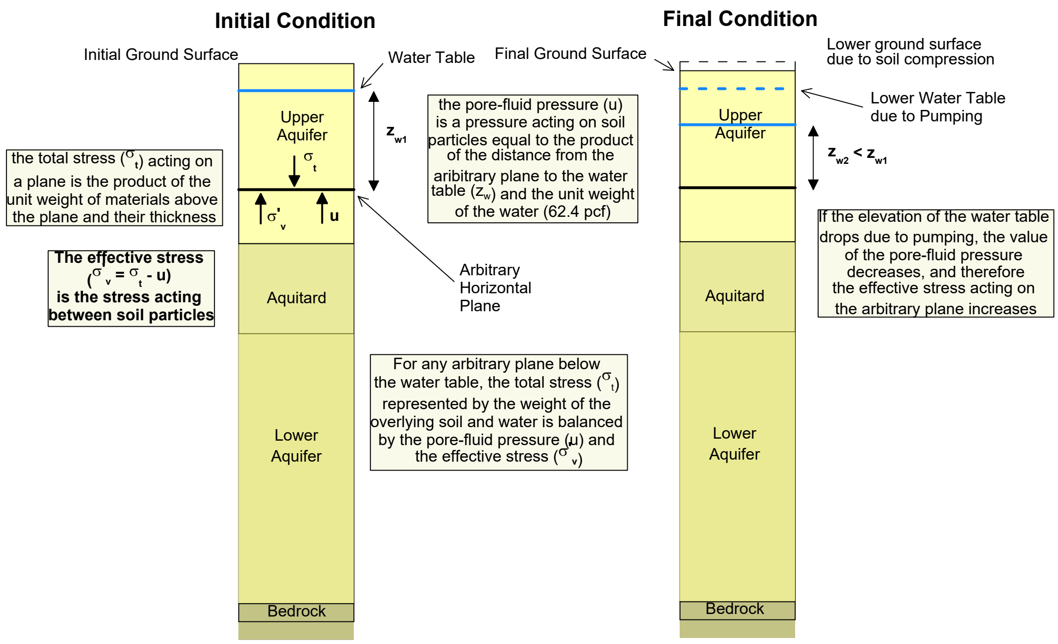

Figure B1-2. The principle of effective stress and the effect of lower water table on effective stress

Subsidence related to groundwater withdrawal generally occurs slowly over a large area, with relatively little differential movement within the subsiding areas. In some instances, scarps, fissures, cracks, and/or sinkholes may form in response to differential movement within subsiding areas, or from rapid surface subsidence.

2 TIME RATE EFFECTS OF SUBSIDENCE

Subsidence in the SJV primarily occurs as water is essentially squeezed out of fine-grained aquitards (i.e., consolidation) due to effective stress increases induced by decreased piezometric levels. The fine-grained nature of the aquitards (i.e., clayey soil units) causes the outflow of water to be relatively slow. As such, subsidence resulting from groundwater extraction does not all occur instantaneously, but rather can occur over extended periods of time (e.g., Lees et al. 2021, Borchers and Carpenter 2014, Lofgren and Klausing 1969). It is important to understand this time lag in evaluating current and projected subsidence, in that current/ongoing subsidence is likely in part related to historical activities. The time-dependent process of subsidence caused by consolidation is as follows:

1. As the piezometric level decreases due to pumping below previous established values, (in Figure B1-1, the previous established value is the water table elevation described as the initial condition), water in the pores of coarse-grained soils drains out relatively quickly causing a change in the pore-fluid pressure and an increase in the vertical effective stress. However, given that fine-grained soils have much lower permeability[4] than coarse-grained soils, the change in the pore-fluid pressure, and thus the change in effective stress, is relatively slow. If the time period during

[4] Herein the term "permeability" is used to describe the coefficient in Darcy's law of flow through porous media, which is also known as "hydraulic conductivity" or "coefficient of permeability".

which the water table is lowered due to pumping is shorter than the time period required for the fine-grained soil to fully drain, and the initial water table elevation is reestablished, then only a portion of the fine-grained layer is affected by the temporarily reduced pore-fluid pressure and the effective stresses only increase in that portion of the soil layer. The portion of the fine-grained layer affected by the increase in effective stress consolidates (compresses and decreases in volume), which is manifested at ground surface as subsidence. The magnitude of subsidence is affected by the portion of the soil layer that drained (or partially drained) and was affected, albeit temporarily, by the higher value of effective stress.

2. If the time period during which the water table is lowered due to pumping is long enough to allow the fine-grained soils to fully drain, then the entire layer is subjected to increased vertical effective stress and the magnitude of subsidence at ground surface is larger. Completion of "primary consolidation" is said to have occurred in the fine-grained layer when the pore-fluid pressure in the entire layer is consistent with the new elevation of the water table and the effective stress at an arbitrary plane is constant over time.
3. After primary consolidation and at constant effective stress, clayey soil units continue to decrease in volume due to a process known as "secondary compression." The magnitude of the decrease in volume over time due to secondary compression is greatest when the applied effective stress is equivalent to the maximum effective stress applied to the soil unit in the past. Using the sketch of Figure B1-1, the magnitude of secondary compression will be highest if the final water elevation condition is maintained. However, secondary compression will decrease if the water elevation rises back to the initial condition and the effective stress in the soil decreases from its maximum value.

The sketch in Figure B2-1 shows how settlement (vertical axis) of a clayey soil unit, which manifests at the ground surface as subsidence, develops over time (horizontal axis in logarithmic units of time). Once a stress change is applied at time = 0, the pore-fluid is slowly squeezed out until primary consolidation is complete and the pore-fluid pressure is stable across the soil unit. Subsequently, secondary compression begins and leads to additional settlement at an approximately constant rate (when plotted against the log of time).

The main purpose of Figure B2-1 is to show that subsidence cannot be completely stopped once a stress change has been applied and maintained for a period of time. Areas of the SJV that have experienced subsidence will continue to exhibit subsidence for some time, albeit at a lower rate, even if piezometric levels are returned to levels preceding groundwater pumping in the SJV.

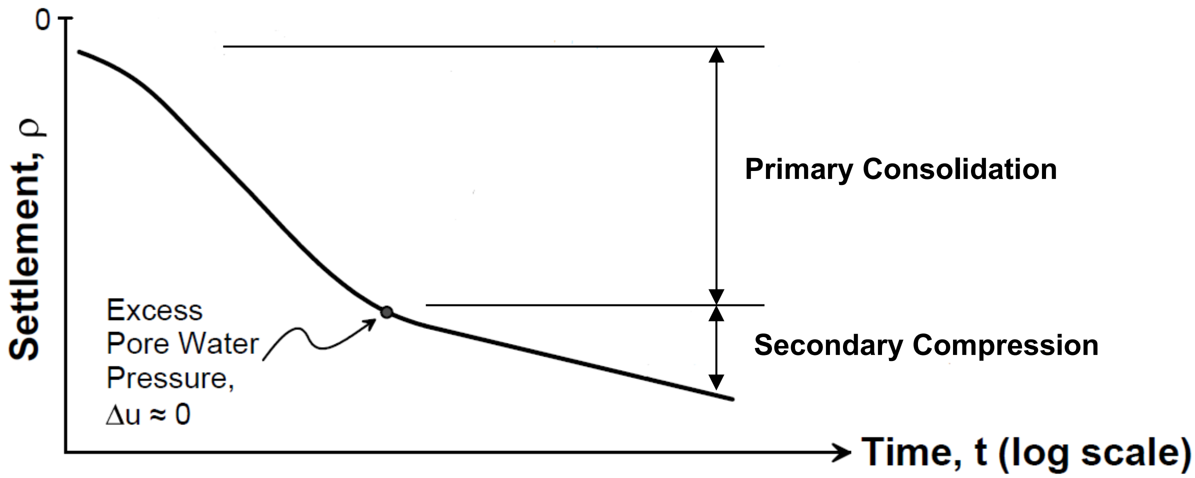

Figure B2-1. Time rate of settlement due to consolidation and compression

3 DEVELOPMENT OF LOCAL MINIMUM TOLERANCES (LMT)

The following sections describe the ways in which subsidence can damage critical infrastructure. Critical infrastructure includes infrastructure that covers a large area, is intended for multiple beneficial uses and multiple beneficial users (e.g., not localized infrastructure which is maintained locally).

3.1 Overview of Critical Infrastructure

3.1.1 Canals and Aqueducts

Canals are structures with a rectangular or trapezoidal shape that convey water by gravity (i.e., they rely on a positive downward slope from upstream to downstream). Canals can be lined with concrete, as is typical for those that are designed to convey water for distribution purposes (e.g., the California Aqueduct), or they can be unlined and vegetated as is typical for local irrigation canals and drainage ditches.

If subsidence occurs uniformly across the length of the canal, then the total amount of subsidence does not have a significant effect on the performance of the canal because the slope of the canal does not change. However, the performance of the canal (i.e., its ability to convey water in the quantities for which it was designed) will be affected by differential subsidence in two ways:

- Case A: A greater magnitude of subsidence at an upstream point on the canal (Point A) than a downstream point on the canal (Point B) will lead to a reduction of the slope of the canal. This will cause a reduction in the velocity of the water flow and an increase in the depth of water in the canal (and less freeboard) to convey the same volume of water. If subsidence at Point A is significantly higher than at Point B, then the slope of the canal may be reversed leading to a loss of conveyance.

- Case B: A lower magnitude of subsidence at an upstream point on the canal (Point A) than a downstream point on the canal (Point B) will lead to an increase of the slope of the canal. This will cause an increase in the energy gradient of the water flow and a reduction of the depth of water in the canal to convey the same volume of water. If a portion of a canal increases its slope, it is likely that another portion of the canal will experience a decrease in its slope.

Additionally, differential subsidence can damage the concrete lining of the canal.

Subsidence causing a reduction of water conveyance capacity of canals has been reported for the California Aqueduct (Aqueduct) (DWR, 2017), the Delta-Mendota Canal (DMC) (Sneed et al. 2013[5]), and canals of the San Luis Canal Company and the Central California Irrigation District (Amec, 2017). The effect of subsidence on water conveyance in canals can be mitigated if the amount and location of subsidence is incorporated in the design. For example, the Aqueduct was built with extra freeboard ranging from 1 to 9 feet (DWR, 2017) so that the canal could accommodate an increase in water depth due to a reduction of the slope of the canal. If differential subsidence is not incorporated in the design, and the slope of the canal decreases (Case B), then the effect of differential subsidence can be mitigated by raising the freeboard, as was done for the Aqueduct (DWR, 2017) and the DMC, or by installing lift stations, as has been done, for example, to canals owned by the Angiola Water District (AWD) and the Homewood Canal (Amec, 2017). In a letter commenting on the GSP previously delivered by the subbasin, AWD described that the Angiola Ditch, Utica Canal, and Blakely Canal have been negatively affected by subsidence (AWD, 2020).

Canals are perhaps the type of infrastructure most susceptible to subsidence given their significant length within the SJV (e.g., the Aqueduct extends hundreds of miles through the SJV) and the fact that their ability to convey water depends on gravity. As described above, differential subsidence along the length of a canal will have an impact on the flow through the canal; therefore, differential subsidence along the length of the canal should be monitored and its magnitude used to evaluate the effect on performance.

The change in performance of each canal will depend on the canal’s design and purpose. Each canal will be affected differently depending on the magnitude of differential subsidence. In lieu of guidance that can be applied to all canals, a maximum differential subsidence tolerance of 1/600 (i.e., equivalent to 2 inches of differential settlement over 100 ft) measured anywhere along the canal’s alignment as well as between points that are 500 ft, 1,000 ft, and 2,000 ft apart, is suggested herein. Regarding the Aqueduct, DWR (2020) indicated that subsidence along the alignment of the Aqueduct should be limited to less than 0.01 ft per year (i.e., essentially zero) by 2040 and a goal of no subsidence thereafter.

3.1.2 Flood Protection Levees

Flood protection levees are earthen embankments that are built along rivers to protect areas of interest from seasonally high flood water levels. Engineered levees are typically designed following guidance from the US Army Corps of Engineers (USACE, 2000). Accordingly, levees typically fail due to one or more of the

[5] Sneed, M., Brandt, J., and Solt, M. 2013. Land subsidence along the Delta-Mendota Canal in the northern part of the San Joaquin Valley, California, 2003–10: U.S. Geological Survey Scientific Investigations Report 2013–5142, 87 p. A

following conditions:

- Overtopping: flood water elevation exceeds the elevation of the crown of the levee
- Surface erosion: water flowing over the levee erodes the embankment and reduces its section
- Piping: water flowing through the levee develops into a spring which causes internal erosion that in turn causes more flow through the levee and more erosion, eventually leading to a breach of the levee
- Slides: movement within the levee or the foundation soils due to insufficient strength in the soils.

The Urban Levee Design Criteria (DWR, 2012) indicate that levees should be designed to protect against the 200-year return period flood event and that the crown of the levees (i.e., top of levee) should have a minimum 3-foot freeboard. Downward movement (i.e., settlement) of the crown of a levee with respect to the floodplain can reduce the freeboard. This amount of settlement should be incorporated in the design as additional freeboard, or the levee should be topped off as settlement accumulates over time.

The effect of subsidence on the performance of levees is not addressed in USACE (2000) or DWR (2012). The performance of levees is considered to be potentially affected by the regional subsidence in two ways:

- Case 1: By lowering the elevation of the crown of the levee with respect to the elevation of the flood area.
- Case 2: By inducing differential amounts of subsidence along the longitudinal axis of the levee that can lead to longitudinal cracking and other types of distress to the earthen embankment.

When considering Case 1, given that subsidence is a regional phenomenon, the elevation of the flood protection levees and the elevation of the flood-prone areas (i.e., floodplain) generally decrease uniformly. With little or no differential movement between the crown of the levee and the floodplain, the performance of the levee is unaffected.

Regarding Case 2, in general, levees are flexible earthen structures that can tolerate typical differential longitudinal settlement that occurs due to variability of soils in their foundation. As such, there is very little literature on performance limits of levees affected by differential settlement along their longitudinal axis. In their Geotechnical Design Manual, the South Carolina Department of Transportation (SCDOT, 2019) imposes a limit for settlement of paved road embankments, i.e., embankments with a brittle layer on their crown, of 1 inch measured over a distance of 50 ft, which is equivalent to a slope of 1/600. This is considered to be a conservative value for levees given that levees do not typically have paved roads on their crown. Therefore, in lieu of any other applicable guidance, a value of 1/600 should be used to increase awareness by infrastructure managers (i.e., alert level) and trigger actions such as visual inspections to identify cracks that may be detrimental to the performance of the embankments.

3.1.3 Pipelines

Differential subsidence may cause strain on buried hydrocarbon or water pipelines. In regard to steel pipelines carrying hydrocarbons, PRCI (2009) indicates that the lateral component of displacement that may accompany subsidence is responsible for greater potential damage because it can cause large compressive forces in the pipeline and lead to upheaval buckling. General rules cannot be applied to the estimation of the effect of differential subsidence on the integrity of pipelines given that many factors such as pipe material type, diameter, wall thickness, internal operating pressure, weld strength, burial depth, and burial material, need to be considered. Instead, analysis and modeling on a case-by-case basis is required.

As described in Amec (2017), PG&E has not reported any impacts to their pipelines due to subsidence.

3.1.4 Buildings

The performance of individual buildings subjected to differential settlement across supports has been documented with general guidance developed by Bjerrum (1963). Table B3-1 lists tolerance and performance criteria for buildings that can be used to evaluate the effect of local differential subsidence. Given the range of performance criteria for buildings listed in Table B3-1 between 1/50 and 1/1000, a value of 1/300 is recommended since it is described as the limit that leads to cracking of panels and thus evident manifestation of the deleterious effect of settlement (subsidence).

Table B3-1. Tolerable settlements for buildings (Bjerrum, 1963 and Fang, 1990)

Tolerance Differential Settlement	Performance Criteria
1/1000	Limit where difficulties with machinery sensitive to settlements are to be feared
1/750	Multistory concrete rigid frame on mat foundation 4 ft ± thick
1/600	Limit of danger for frames with diagonals
1/500	Safe limit for buildings where cracking is not permissible. Rigid circular mat or ring footing for tall and slender rigid structures.
1/300	Limit where first cracking in panel walls is to be expected. Limit where difficulties with overhead cranes are to be expected.
1/250	Limit where tilting of high, rigid buildings might become visible.
1/150	Limit where structural damage of buildings is to be feared.

3.1.5 Bridges

In Caltrans (2015), total settlement guidance is provided for bridges supported on footings. Those tolerances are for load-induced settlement and not subsidence. As such, Caltrans does not appear to provide specific guidance on tolerable differential subsidence (or settlement) across a bridge. Instead, a case-by-case approach is suggested in Caltrans (2014) with reference to documents from Washington DOT (WSDOT). In their foundation design manual, WSDOT (2010) provides the settlement criteria reproduced in Table B3-2. If the highest total settlement is selected (i.e., $\Delta H > 4$ inches), then with approval from the State Geotechnical Engineer, a maximum of 3 or more inches (in) can be allowed. Differential settlement of 3 inches over a distance 100 ft, is equivalent to a slope of 0.25%, or 1/400.

Table B3-2. WSDOT settlement criteria for bridges (WSDOT, 2010)

Total Settlement at Pier or Abutment	Differential Settlement over 100 ft within Pier or Abutment, and Differential Settlement between Piers	Action
$\Delta H \leq 1$ inch (in)	$\Delta H_{100} \leq 0.75$ in	Design and Construct
1 in < $\Delta H \leq 4$ in	0.75 in < $\Delta H_{100} \leq 3$ in	Ensure structure can tolerate settlement
$\Delta H > 4$ in	$\Delta H_{100} > 3$ in	Obtain approval* prior to proceeding with design and construction

Note: * Approval of WSDOT State Geotechnical Engineer and WSDOT Bridge Design Engineer required

3.1.6 Embankments for Roads, Rail Lines, and Airports

Similar to flood protection levees, embankments for roads, rail lines, and airports are earthen structures that can be affected by subsidence. Perhaps the main difference between embankments for levees and those for roads, rail lines, and airports is that the latter have been typically built with higher engineering standards such as soil placement following specifications and construction quality control. If the amount of differential subsidence along the longitudinal access of the road or runway is excessive, it can cause the development of cracks on the surface pavement or dips and bumps on the road that can pose a hazard to vehicles (cars and planes).

In their Geotechnical Manual, Caltrans (2014) does not limit the amount of differential settlement that can be tolerated by a road embankment. Instead, Caltrans (2014) indicates that applicable design criteria should be determined on a project-by-project basis. In lieu of guidance specific to California, the 1/600 criteria cited by SCDOT and described as a criterion for levees can be applied to road embankments.

Amec (2017) describe that representatives of Burlington Northern-Santa Fe and Union Pacific Railroad were interviewed regarding subsidence impacts to their infrastructure. These representatives indicated that periodic rail track maintenance is carried out as part of the operations and maintenance program and that they have not noticed any increases or changes to maintenance that can be attributed to subsidence. Similarly, Amec (2017) discusses interviews with officers at Caltrans Office of Structure Investigations – North, Caltrans District 6, and Caltrans District 10, which have jurisdiction over areas subjected to subsidence. Accordingly, all Caltrans representatives indicated that they were not aware of any subsidence that has impacted bridges or roadways.

In regard to the proposed high speed rail (HSR) through the area, Amec (2017) indicated that the maximum induced slope change should not exceed 1.25% (1/80).

3.1.7 Water Wells

Subsidence-induced damage to wells is caused by yielding of the well casing under the drag load applied by the soil around the casing. Drag load is a force, typically calculated for the design of foundation piles (e.g., Fellenius, 1989), that develops along the surface area of a well casing when the soil surrounding the casing moves downward relative to the casing.

Drag load is illustrated in B3-1, which shows a relatively shallow well that terminates in the upper aquifer above the Corcoran Clay (Well #1) and a relatively deep well that terminates in the lower aquifer that is confined by the Corcoran Clay (Well #2). Along their length, both wells are in contact with the surrounding soil, which allows friction to develop along the well casing. Reduction of the piezometric surface in the lower aquifer causes an increase in the effective stress within the Corcoran Clay, which induces consolidation (i.e., the process of dissipation of excess pore water pressure in the soil) and leads to settlement of this clay layer, which manifests as subsidence at the ground surface. As the Corcoran Clay settles, the soil above this layer also settles. Well #1, which terminates above the Corcoran Clay, will move downward with the soil above the Corcoran Clay and no significant amount of relative movement is expected between the well and the soil. However, as the Corcoran Clay consolidates and settles, the soil within and above this layer will drag on the casing of Well #2, which is not moving uniformly at the same rate because the lower portion of the well within the lower aquifer is providing resistance due to friction along the casing. If the drag load applied on the casing exceeds the structural capacity of the well casing, then the well casing will yield and fail. Yielding of a well casing is an undesirable effect of subsidence because it renders the well inoperable.

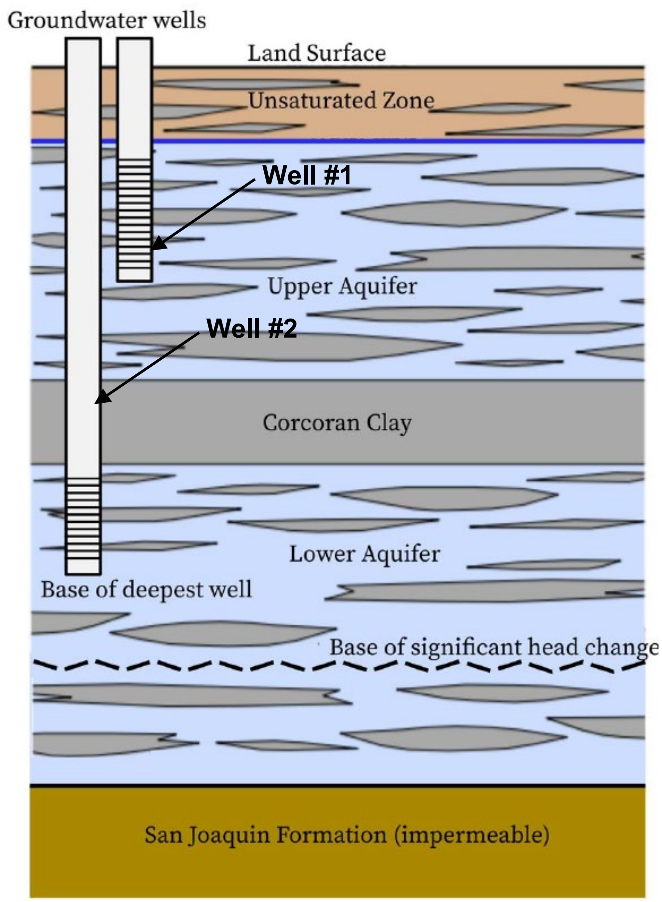

Figure B3-1. Schematic of two typical water wells in the subbasin (background figure from Lees and Knight, 2021)

3.2 Summary of Impacts to Infrastructure from Subsidence

The tables below provide a summary of impacts to infrastructure from subsidence.

Table B3-3. Differential subsidence minimum tolerances for impacts

Type of Infrastructure	Minimum Differential Subsidence for Impacts to Occur	Considerations	Possible Mitigation Measures
Canals (excludes Aqueduct)	Case-by-Case, 1/600	Depends on the construction details of the canal, capacity, water needs, and direction of flow relative to differential subsidence. In general, differential subsidence should be minimized to less than 1/600.	Dredging/filling portions of canals to reestablish desired slopes; repairing concrete cracks; installation of pumps
Aqueduct	Case-by-Case, 1/600	Depends on the local construction details, capacity, water needs, and direction of flow relative to differential subsidence.	Repairing concrete cracks; installation of pumps or lifts
Flood Protection Levees	1/600	Minimum tolerance may not lead to cracking. As such, some levees may be subjected to much higher magnitude of differential subsidence without damage.	Fill/cover/repair cracks; top levee off with additional material to increase height
Pipelines	Case-by-Case	Depends on pipe material, diameter, wall thickness, weld capacity, burial depth, type of soil in the pipe trench, etc.	Stress relief excavations; installation of pipe sleeves; replacement of pipe sections
Buildings	1/300	Equal amounts of subsidence typically happen over areas larger than the footprint of a single building.	Releveling building foundations
Bridges	1/400		Releveling bridge foundations
Embankments for Roads, Airports, and Rail Lines	1/600	Minimum tolerance may not lead to cracking. As such, some embankments may be subjected to much higher magnitude of differential subsidence without damage.	Repave roads and runways; reset railroad ties
High Speed Rail Lines	1/80		
Water Wells	Case-by-Case Evaluation is Necessary	Depends on well construction details. Wells terminated in the deep aquifer are more likely to be subjected to drag load. New wells should be designed for predicted drag load.	Decrease pumping rates; well repairs; well replacement

Table B3-4. Regional (total) subsidence minimum tolerance for impacts

Type of Infrastructure	Minimum Subsidence for Impacts to Occur	Considerations	Possible Mitigation Measures
Water Wells	N/A	Regional subsidence does not affect the performance of individual wells	N/A
Flood Protection Levees	Change in elevation between the floodplain and the levee > 3 ft	Elevation between the crown of the levee and the floodplain should not change. Given that levees are typically designed with a 3-ft freeboard, a reasonable tolerance would be that the change in elevation between the floodplain and the levee does not exceed 3 ft.	Top levee off with additional material to increase height
Embankments for Roads, Airports, and Rail Lines	N/A	The performance of these structures is not affected by a total amount of subsidence	N/A
High Speed Rail Lines	N/A	The performance of these structures is not affected by a total amount of subsidence	N/A
Canals (excludes Aqueduct)	N/A	Regional subsidence does not affect the performance of canals.	N/A
Aqueduct	Case-by-Case	Depends on regional subsidence north and south of TLSB.	Installation of lifts or pumps
Pipelines	N/A	Not applicable because regional subsidence does not affect the performance of pipelines	N/A
Buildings	N/A	Not applicable because regional subsidence does not affect the performance of buildings	N/A
Bridges	N/A	Not applicable because regional subsidence does not affect the performance of bridges	N/A

4 RISK ASSESSMENT INPUTS

The information presented in Section 3 was ultimately used to develop input values for the risk assessment for vulnerability for differential subsidence.

4.1 Definition of Vulnerability (V)

Section 3 describes each type of critical infrastructure in the TLSB, the types and mechanisms of subsidence that can impact each type of infrastructure, and the estimated amount of subsidence necessary for impacts to start to occur. Note that the primary form of subsidence that is a concern for most types of infrastructure is differential subsidence, and thus, these are the primary tolerances used in the risk calculations. Table B3-5 below provides a summary of subsidence values by infrastructure type that may initially result in impacts. The tolerance values were multiplied by the amount of respective infrastructure in each TRS (e.g., number of buildings or miles of roads) and then summed to come up with an aggregate V value for each TRS, which was ultimately used in the risk calculations when considering risk related to differential subsidence.

Table B3-5. Tolerance by Infrastructure Type

Type of Infrastructure	Vulnerability (V) Tolerance Factor (i.e., Differential Subsidence Tolerance for Potential Impacts to Occur)
Flood Protection Levees	1/600
Embankments for Roads, Airports, and Rail Lines	1/600
High Speed Rail Lines	1/80
Canals and Aqueduct	1/600
Pipelines	1/100*
Buildings	1/300
Bridges	1/400

Note: *Vulnerability for pipelines is case-by-case; as such, 1/100 is selected as a conservative tolerance.

4.2 Definition of Consequence (C)

As described Section 3, subsidence impacts each type of critical infrastructure differently, both in terms of the amount of subsidence necessary to cause impacts, as well as the severity of those impacts and the types of actions required to mitigate each. In many risk assessment, a consequence factor ("C") is included in the calculation, where R = H x V x C. C represents the consequence of damage to a given piece of infrastructure subjected to the hazard. Subsidence affects some types of infrastructure more severely than others. For example, cracks in a road caused by subsidence are not necessarily a severe or high consequence impact and are already addressed through routine maintenance. Reduction in canal transmission capacity or increases in canal seepage caused by subsidence are more severe or higher consequence impacts. We did not include consequence in this risk assessment, as we did not have the quantitative data (e.g., monetary values for repair or replacement of infrastructure, secondary economic impacts due to impacted infrastructure, etc.) necessary to accurately represent consequence for each type of infrastructure. However, this could be included if such information is developed, to better define high risk areas within the TLSB.

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APPENDIX C

WATER QUALITY SMC SUPPORTING INFORMATION

Appendix C
Upper Tolerance Limit Data
Groundwater Sustainability Plan - Addendum
Tulare Lake Subbasin

Well ID	Analyte	Units	95% Upper Tolerance Limit	Count	Minimum Value	Maximum Value	Mean	Standard Error	Standard Deviation	Date (Minimum)	Date (Maximum)
1610003-031	Arsenic	µg/L	11.575	64	3.0	56.0	9.038	1.270	10.157	10/6/1994	12/18/2018
1610003-039	Arsenic	µg/L	9.637	8	8.4	9.9	9.238	0.169	0.478	7/1/2008	5/9/2019
1610003-036	Arsenic	µg/L	6.610	39	3.9	10.0	6.195	0.205	1.280	1/29/2002	12/20/2018
1610003-041	Arsenic	µg/L	3.125	4	0.0	2.3	1.100	0.636	1.273	5/5/2009	2/9/2010
1610003-033	Arsenic	µg/L	10.339	66	5.7	69.0	8.465	0.938	7.623	11/5/1998	12/18/2018
1610003-040	Arsenic	µg/L	4.698	7	0.0	4.7	3.257	0.589	1.558	4/10/2009	12/20/2018
1610003-026	Arsenic	µg/L	16.014	69	4.7	60.0	13.861	1.079	8.962	2/11/1986	12/15/2015
1610003-038	Arsenic	µg/L	4.972	4	3.4	4.7	4.100	0.274	0.548	5/9/2008	12/14/2015
1610003-028	Arsenic	µg/L	22.943	75	4.9	70.0	20.792	1.079	9.347	7/1/1991	12/20/2018
1610003-043	Arsenic	µg/L	9.889	7	7.4	10.0	8.914	0.398	1.054	3/10/2010	12/18/2018
1610003-042	Arsenic	µg/L	2.879	6	0.0	3.0	1.333	0.601	1.473	3/10/2010	12/18/2018
1610003-037	Arsenic	µg/L	4.678	5	2.2	4.6	3.580	0.395	0.884	5/9/2006	12/20/2018
1610003-034	Arsenic	µg/L	30.348	68	0.0	78.0	25.876	2.240	18.474	5/11/1998	12/20/2018
1610006-001	Arsenic	µg/L	9.796	20	0.0	30.0	6.515	1.568	7.010	3/19/1987	11/6/2017
1610006-002	Arsenic	µg/L	8.584	10	0.0	13.0	5.500	1.363	4.311	1/9/1985	4/10/2019
1610006-005	Arsenic	µg/L	0.883	8	0.0	2.1	0.263	0.263	0.742	12/13/2005	11/11/2011
1610005-021	Arsenic	µg/L	2.078	46	0.0	4.2	1.705	0.185	1.257	1/15/2010	11/5/2019
1610005-007	Arsenic	µg/L	7.695	20	3.0	11.0	6.780	0.437	1.955	10/5/1995	8/13/2013
1610005-010	Arsenic	µg/L	11.043	69	5.2	29.0	9.932	0.557	4.626	8/7/1999	12/20/2019
1610005-003	Arsenic	µg/L	19.863	51	15.0	27.0	19.216	0.322	2.301	3/26/1987	8/25/2015
1610005-022	Arsenic	µg/L	0.348	35	0.0	2.3	0.158	0.093	0.552	5/27/2010	11/5/2019
1610005-005	Arsenic	µg/L	15.795	89	8.2	25.0	14.982	0.409	3.858	3/28/1990	12/20/2019
1610005-018	Arsenic	µg/L	2.174	55	0.0	4.0	1.850	0.162	1.201	12/6/2004	11/5/2019
1610005-008	Arsenic	µg/L	3.632	39	0.0	8.0	3.074	0.276	1.721	10/5/1995	7/2/2019
1610005-006	Arsenic	µg/L	6.424	61	0.0	19.0	5.808	0.308	2.404	10/5/1995	12/4/2018
1610005-009	Arsenic	µg/L	28.770	60	23.0	46.0	27.833	0.468	3.627	2/28/2011	11/5/2019
1610005-020	Arsenic	µg/L	8.200	63	4.0	11.0	7.900	0.150	1.190	4/26/2007	11/5/2019
1610005-011	Arsenic	µg/L	4.541	111	0.0	14.0	3.866	0.341	3.588	2/24/2012	12/10/2019
1610009-003	Arsenic	µg/L	16.651	55	6.8	23.2	15.869	0.390	2.891	11/26/1986	10/2/2019
1610004-026	Arsenic	µg/L	20.289	94	12.0	32.0	19.702	0.296	2.866	7/11/2006	12/11/2019
1610004-018	Arsenic	µg/L	27.545	53	22.0	38.0	26.830	0.356	2.592	3/4/2013	12/23/2019
1610004-019	Arsenic	µg/L	32.634	5	28.0	33.0	30.000	0.949	2.121	12/22/2014	1/8/2019
1610001-001	Arsenic	µg/L	13.935	36	4.1	41.0	11.106	1.394	8.362	2/16/2011	5/1/2019
1610001-007	Arsenic	µg/L	51.609	38	3.0	110.0	37.753	6.839	42.156	2/16/2011	5/1/2019
1610001-010	Arsenic	µg/L	23.917	10	18.0	27.0	21.600	1.024	3.239	8/30/2017	11/6/2019
1610003-039	Arsenic	µg/L	9.877	4	8.4	9.6	9.050	0.260	0.520	8/19/2011	5/9/2019
1610006-001	Arsenic	µg/L	6.606	5	-10.0	3.4	-2.220	3.179	7.108	6/24/2011	11/6/2017
1610005-010	Arsenic	µg/L	11.305	51	5.2	29.0	9.898	0.701	5.003	2/24/2012	12/20/2019
1610005-003	Arsenic	µg/L	22.007	13	17.0	23.0	20.769	0.568	2.048	2/28/2011	8/25/2015

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Well ID	Analyte	Units	95% Upper Tolerance Limit	Count	Minimum Value	Maximum Value	Mean	Standard Error	Standard Deviation	Date (Minimum)	Date (Maximum)
1610005-005	Arsenic	µg/L	16.438	60	8.8	25.0	15.480	0.479	3.709	2/28/2011	12/20/2019
1610005-018	Arsenic	µg/L	0.786	49	-10.0	3.4	-0.818	0.798	5.584	9/20/2011	11/5/2019
1610005-008	Arsenic	µg/L	4.253	16	2.2	5.0	3.750	0.236	0.944	4/15/2013	7/2/2019
1610005-006	Arsenic	µg/L	6.975	38	3.1	19.0	6.129	0.417	2.573	5/11/2012	12/4/2018
1610005-009	Arsenic	µg/L	28.770	60	23.0	46.0	27.833	0.468	3.627	2/28/2011	11/5/2019
1610005-020	Arsenic	µg/L	8.279	55	4.0	11.0	7.949	0.165	1.222	2/28/2011	11/5/2019
1610005-011	Arsenic	µg/L	2.846	115	-10.0	14.0	1.540	0.659	7.069	2/24/2012	12/10/2019
1610009-003	Arsenic	µg/L	15.927	36	6.8	19.0	15.247	0.335	2.010	1/5/2011	10/2/2019
1610004-026	Arsenic	µg/L	20.425	76	12.0	32.0	19.789	0.319	2.782	1/27/2011	12/11/2019
1610004-018	Arsenic	µg/L	27.545	53	22.0	38.0	26.830	0.356	2.592	3/4/2013	12/23/2019
1610004-019	Arsenic	µg/L	32.634	5	28.0	33.0	30.000	0.949	2.121	12/22/2014	1/8/2019
1610003-031	Chloride	mg/L	171.562	7	160.0	180.0	164.286	2.974	7.868	10/6/1994	12/18/2018
1610003-039	Chloride	mg/L	222.801	5	210.0	220.0	216.000	2.449	5.477	7/1/2008	5/9/2019
1610003-036	Chloride	mg/L	97.899	7	83.0	100.0	91.429	2.644	6.997	1/29/2002	12/20/2018
1610003-033	Chloride	mg/L	173.457	8	140.0	190.0	157.500	6.748	19.086	11/5/1998	12/18/2018
1610003-040	Chloride	mg/L	175.456	4	160.0	170.0	167.500	2.500	5.000	4/10/2009	12/20/2018
1610003-026	Chloride	mg/L	141.637	10	60.0	152.0	124.200	7.708	24.376	2/11/1986	12/15/2015
1610003-028	Chloride	mg/L	161.909	9	90.0	170.0	142.778	8.296	24.889	7/1/1991	12/20/2018
1610003-042	Chloride	mg/L	242.992	4	220.0	240.0	230.000	4.082	8.165	3/10/2010	12/18/2018
1610003-037	Chloride	mg/L	79.356	5	72.0	80.0	75.800	1.281	2.864	5/9/2006	12/20/2018
1610003-034	Chloride	mg/L	118.709	8	40.0	120.0	89.625	12.300	34.789	5/11/1998	12/20/2018
1610006-001	Chloride	mg/L	86.701	11	32.0	100.0	71.818	6.679	22.153	3/19/1987	11/6/2017
1610006-002	Chloride	mg/L	80.165	10	28.0	160.0	50.800	12.981	41.050	1/9/1985	4/10/2019
1610006-005	Chloride	mg/L	79.222	5	29.0	83.0	53.000	9.445	21.119	12/13/2005	11/6/2017
1610005-021	Chloride	mg/L	91.792	5	87.0	93.1	88.620	1.142	2.554	1/15/2010	10/30/2018
1610005-007	Chloride	mg/L	40.707	7	8.1	64.0	22.629	7.388	19.548	10/5/1995	4/15/2013
1610005-010	Chloride	mg/L	40.747	7	17.0	40.0	33.429	2.991	7.913	8/7/1999	12/20/2019
1610005-003	Chloride	mg/L	51.619	10	26.0	68.0	42.900	3.854	12.188	3/26/1987	5/14/2013
1610005-022	Chloride	mg/L	98.014	4	92.0	96.7	94.414	1.131	2.263	5/27/2010	2/6/2018
1610005-005	Chloride	mg/L	51.051	12	26.0	58.0	43.167	3.582	12.408	3/28/1990	12/20/2019
1610005-018	Chloride	mg/L	90.662	8	84.0	91.0	88.325	0.988	2.796	12/6/2004	2/6/2018
1610005-008	Chloride	mg/L	32.581	8	9.2	46.0	21.325	4.760	13.464	10/5/1995	4/18/2016
1610005-006	Chloride	mg/L	77.052	7	58.0	81.0	69.429	3.116	8.243	10/5/1995	5/3/2016
1610005-020	Chloride	mg/L	31.009	7	20.0	32.0	27.143	1.580	4.180	4/26/2007	5/14/2019
1610005-011	Chloride	mg/L	84.251	4	13.0	65.0	44.750	12.412	24.824	4/15/2013	5/14/2019
1610009-003	Chloride	mg/L	342.781	8	27.6	450.0	229.512	47.901	135.485	11/26/1986	4/5/2017
1610004-026	Chloride	mg/L	42.662	8	26.0	52.0	35.000	3.240	9.165	7/11/2006	2/8/2017
1610003-039	Chloride	mg/L	224.187	4	210.0	220.0	215.000	2.887	5.774	8/19/2011	5/9/2019
1610005-021	Chloride	mg/L	88.419	4	87.0	88.0	87.500	0.289	0.577	10/18/2011	10/30/2018

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1610005-005	Chloride	mg/L	58.279	4	28.0	51.0	42.000	5.115	10.231	4/15/2013	12/20/2019
1610005-011	Chloride	mg/L	84.251	4	13.0	65.0	44.750	12.412	24.824	4/15/2013	5/14/2019
1610003-031	Nitrate as Nitrogen	mg/L	5.030	4	0.0	4.0	1.750	1.031	2.062	10/6/1994	12/18/2018
1610003-036	Nitrate as Nitrogen	mg/L	2.462	7	0.0	5.0	0.714	0.714	1.890	1/29/2002	7/16/2008
1610003-033	Nitrate as Nitrogen	mg/L	3.939	7	0.0	8.0	1.143	1.143	3.024	11/5/1998	12/12/2019
1610003-026	Nitrate as Nitrogen	mg/L	2.541	10	0.0	7.0	0.960	0.699	2.211	2/11/1986	5/2/2018
1610003-028	Nitrate as Nitrogen	mg/L	0.367	9	0.0	1.0	0.111	0.111	0.333	7/1/1991	12/12/2019
1610003-034	Nitrate as Nitrogen	mg/L	1.013	14	0.0	4.0	0.379	0.294	1.098	5/11/1998	12/11/2019
1610006-001	Nitrate as Nitrogen	mg/L	2.546	39	0.0	25.0	1.154	0.688	4.295	3/19/1987	10/16/2019
1610005-010	Nitrate as Nitrogen	mg/L	2.103	8	0.0	5.0	0.625	0.625	1.768	8/7/1999	5/31/2019
1610005-003	Nitrate as Nitrogen	mg/L	0.020	30	0.0	0.1	0.009	0.005	0.029	3/26/1987	11/29/2018
1610005-005	Nitrate as Nitrogen	mg/L	1.324	14	0.0	4.4	0.533	0.366	1.370	1/28/1993	12/20/2019
1610005-008	Nitrate as Nitrogen	mg/L	1.785	6	0.0	3.0	0.500	0.500	1.225	8/21/2001	8/3/2017
1610005-006	Nitrate as Nitrogen	mg/L	2.042	15	0.0	8.0	0.800	0.579	2.242	10/5/1995	5/1/2018
1610009-003	Nitrate as Nitrogen	mg/L	1.407	37	0.0	8.0	0.902	0.249	1.514	11/26/1986	1/2/2019
1610004-026	Nitrate as Nitrogen	mg/L	2.942	131	0.7	19.0	2.354	0.298	3.407	7/11/2006	12/11/2019
1610004-026	Nitrate as Nitrogen	mg/L	6.151	12	2.7	8.3	5.133	0.462	1.601	12/20/2011	8/10/2015
1610003-040	Sulfate	mg/L	4.182	4	0.0	4.0	1.000	1.000	2.000	4/10/2009	12/20/2018
1610003-026	Sulfate	mg/L	9.769	7	0.0	14.0	5.557	1.721	4.554	2/11/1986	12/15/2015
1610003-028	Sulfate	mg/L	3.478	5	0.0	4.0	1.400	0.748	1.673	7/1/1991	12/15/2015
1610003-034	Sulfate	mg/L	16.362	5	3.7	19.0	8.140	2.961	6.622	5/11/1998	11/9/2009
1610006-001	Sulfate	mg/L	292.323	11	15.0	300.0	231.818	27.155	90.063	3/19/1987	11/6/2017
1610006-002	Sulfate	mg/L	436.010	10	200.0	800.0	305.400	57.737	182.580	1/9/1985	4/10/2019
1610006-005	Sulfate	mg/L	94.036	5	2.0	120.0	31.760	22.430	50.156	12/13/2005	11/6/2017
1610005-003	Sulfate	mg/L	3.045	10	0.0	4.0	1.980	0.471	1.488	3/26/1987	5/14/2013
1610005-022	Sulfate	mg/L	0.823	4	0.0	0.8	0.197	0.197	0.394	5/27/2010	2/6/2018
1610005-005	Sulfate	mg/L	3.735	10	0.0	6.0	2.350	0.612	1.936	3/28/1990	12/20/2019
1610005-018	Sulfate	mg/L	2.848	6	0.0	4.0	1.050	0.699	1.713	12/6/2004	2/6/2018
1610005-006	Sulfate	mg/L	10.226	6	0.0	16.0	3.667	2.552	6.250	10/5/1995	5/3/2016
1610009-003	Sulfate	mg/L	191.946	8	97.0	260.0	148.000	18.585	52.566	11/26/1986	4/5/2017
1610004-026	Sulfate	mg/L	58.780	8	28.0	77.0	44.750	5.933	16.782	7/11/2006	2/8/2017
1610005-005	Sulfate	mg/L	7.252	4	-10.0	2.6	-3.925	3.512	7.024	4/15/2013	12/20/2019
1610005-011	Sulfate	mg/L	11.185	4	-10.0	6.8	-2.625	4.339	8.679	4/15/2013	5/14/2019
1610003-031	TDS	mg/L	421.735	11	370.0	440.0	405.455	7.307	24.234	10/6/1994	12/18/2018
1610003-039	TDS	mg/L	487.016	9	460.0	500.0	477.778	4.006	12.019	7/1/2008	5/9/2019
1610003-036	TDS	mg/L	348.432	9	300.0	360.0	330.000	7.993	23.979	1/29/2002	12/20/2018
1610003-041	TDS	mg/L	598.637	7	560.0	600.0	585.714	5.281	13.973	5/5/2009	12/20/2018
1610003-033	TDS	mg/L	425.003	11	360.0	450.0	404.545	9.181	30.451	11/5/1998	12/18/2018
1610003-040	TDS	mg/L	500.242	7	450.0	520.0	477.143	9.440	24.976	4/10/2009	12/20/2018

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1610003-026	TDS	mg/L	415.825	13	310.0	520.0	372.308	19.973	72.013	2/11/1986	12/15/2015
1610003-038	TDS	mg/L	889.010	4	450.0	870.0	567.500	101.026	202.052	5/9/2008	12/14/2015
1610003-028	TDS	mg/L	417.571	14	310.0	430.0	394.286	10.778	40.328	7/1/1991	12/20/2018
1610003-043	TDS	mg/L	519.229	7	510.0	520.0	514.286	2.020	5.345	3/10/2010	12/18/2018
1610003-042	TDS	mg/L	616.159	7	570.0	630.0	590.000	10.690	28.284	3/10/2010	12/18/2018
1610003-037	TDS	mg/L	331.050	7	300.0	340.0	314.286	6.851	18.127	5/9/2006	12/20/2018
1610003-034	TDS	mg/L	376.121	11	190.0	390.0	330.909	20.291	67.299	5/11/1998	12/20/2018
1610006-001	TDS	mg/L	824.065	14	636.0	860.0	775.429	22.513	84.236	3/19/1987	11/6/2017
1610006-002	TDS	mg/L	2451.918	11	650.0	4500.0	1431.455	457.989	1518.978	1/9/1985	4/10/2019
1610006-005	TDS	mg/L	639.688	5	490.0	640.0	570.000	25.100	56.125	12/13/2005	11/6/2017
1610005-021	TDS	mg/L	420.336	9	390.0	443.0	407.000	5.783	17.349	1/15/2010	10/30/2018
1610005-007	TDS	mg/L	513.138	7	320.0	630.0	412.857	40.983	108.430	10/5/1995	4/15/2013
1610005-010	TDS	mg/L	338.628	9	320.0	340.0	332.222	2.778	8.333	8/7/1999	12/20/2019
1610005-003	TDS	mg/L	259.553	11	220.0	270.0	246.364	5.920	19.633	3/26/1987	5/14/2013
1610005-022	TDS	mg/L	449.086	7	400.0	457.0	425.286	9.727	25.734	5/27/2010	2/6/2018
1610005-005	TDS	mg/L	302.176	12	230.0	330.0	280.000	10.075	34.902	3/28/1990	12/20/2019
1610005-018	TDS	mg/L	422.989	11	410.0	430.0	417.091	2.647	8.780	12/6/2004	2/6/2018
1610005-008	TDS	mg/L	400.503	11	360.0	420.0	388.182	5.530	18.340	8/24/1995	4/18/2016
1610005-006	TDS	mg/L	377.730	10	330.0	400.0	365.000	5.627	17.795	10/5/1995	5/3/2016
1610005-020	TDS	mg/L	285.804	9	250.0	290.0	275.556	4.444	13.333	4/26/2007	5/14/2019
1610005-011	TDS	mg/L	451.368	4	410.0	440.0	427.500	7.500	15.000	4/15/2013	5/14/2019
1610009-003	TDS	mg/L	881.480	12	545.0	1000.0	780.750	45.766	158.537	11/26/1986	4/5/2017
1610004-026	TDS	mg/L	269.001	11	200.0	320.0	243.636	11.384	37.755	7/11/2006	2/8/2017
1610004-018	TDS	mg/L	296.297	6	230.0	300.0	263.333	12.824	31.411	3/4/2013	4/19/2017
1610004-019	TDS	mg/L	174.187	4	160.0	170.0	165.000	2.887	5.774	12/22/2014	12/20/2017
1610003-039	TDS	mg/L	490.912	4	460.0	480.0	475.000	5.000	10.000	8/19/2011	5/9/2019
1610005-021	TDS	mg/L	422.522	4	390.0	420.0	402.500	6.292	12.583	10/18/2011	10/30/2018
1610005-005	TDS	mg/L	329.348	4	250.0	310.0	287.500	13.150	26.300	4/15/2013	12/20/2019
1610005-011	TDS	mg/L	451.368	4	410.0	440.0	427.500	7.500	15.000	4/15/2013	5/14/2019
1610005-021	Uranium	pCi/L	6.833	6	2.6	6.6	4.877	0.761	1.864	10/27/2011	5/16/2012
1610005-007	Uranium	pCi/L	6.312	16	0.5	13.0	4.386	0.904	3.615	12/12/1994	11/22/2011
1610005-003	Uranium	pCi/L	3.632	16	0.0	7.4	2.181	0.681	2.722	3/28/1990	8/29/2005
1610005-022	Uranium	pCi/L	5.275	8	1.9	6.0	3.933	0.568	1.606	1/30/2012	11/27/2012
1610005-005	Uranium	pCi/L	2.786	13	0.0	7.6	1.519	0.581	2.096	12/12/1994	11/19/2002
1610005-018	Uranium	pCi/L	2.419	5	0.0	2.0	1.350	0.385	0.861	8/31/2005	5/9/2007
1610005-008	Uranium	pCi/L	7.774	17	0.9	19.7	5.331	1.152	4.751	12/12/1994	1/30/2015
1610005-006	Uranium	pCi/L	3.320	11	0.0	5.7	1.930	0.624	2.069	4/4/1995	11/19/2002
1610005-020	Uranium	pCi/L	3.632	4	2.5	3.6	2.910	0.227	0.454	2/27/2009	7/30/2010
1610009-003	Uranium	pCi/L	1.161	5	0.0	1.0	0.533	0.226	0.506	9/8/2005	10/7/2015

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1610004-019	Uranium	pCi/L	10.703	4	5.6	9.2	7.405	1.036	2.073	12/22/2014	12/26/2019
1610005-003	Uranium	pCi/L	2.825	17	-10.0	7.4	-0.286	1.468	6.052	3/28/1990	8/29/2005
1610005-022	Uranium	pCi/L	6.693	4	1.9	6.0	3.933	0.868	1.735	1/30/2012	11/27/2012
1610005-005	Uranium	pCi/L	1.692	16	-10.0	7.6	-1.252	1.381	5.524	3/28/1990	11/19/2002
1610005-018	Uranium	pCi/L	5.860	5	-10.0	2.0	-0.650	2.345	5.243	8/31/2005	5/9/2007
1610005-006	Uranium	pCi/L	2.886	14	-10.0	5.7	0.764	0.982	3.676	12/12/1994	11/19/2002
1610005-020	Uranium	pCi/L	3.632	4	2.5	3.6	2.910	0.227	0.454	2/27/2009	7/30/2010
1610005-011	Uranium	pCi/L	8.658	4	3.6	7.9	5.613	0.957	1.914	3/21/2002	11/19/2002

Abbreviations:
µg/L = microgram per liter
mg/L = milligrams per liter
pCi/L = picocuries per liter
TDS = Total Dissolved Solids

APPENDIX D

MITIGATION PLAN FRAMEWORK

MITIGATION PLAN FRAMEWORK

The Tulare Lake GSAs have agreed to prepare and implement mitigation programs to offset impacts. However, it should be understood that the conditions and users in each area vary widely. This framework presents the minimum requirements that would be included in each GSA-specific mitigation program. As the GSAs considered what mitigation might entail in their areas, it became clear that the effort has many facets that will require stakeholder input in each area. In particular, funding for these efforts would need to be developed through a Proposition 218 process and election. Also, most rural residential wells are considered *di minimis* under SGMA, and therefore will need to be investigated more fully to understand their location and construction. Due to the tight deadline allowed in GSP Regulations, insufficient time was available to seek stakeholder input into a complete mitigation program. Instead, the GSAs have agreed to this framework and will prepare individual mitigation programs specific to their stakeholder needs by January 2025 for inclusion into the five-year Plan update.

Purpose

The purpose of the mitigation program is to address local landowner issues to the extent feasible. The plan would be that the mitigation program would address local impacts to beneficial users resulting from GSP implementation. However, care must be taken to establish what portion of the impacts are associated with the choices by the landowner or other nearby landowners, rather than GSA actions to implement the GSP. In this regard, the mitigation plan might be viewed to be similar to efforts put in place around groundwater banks, where benefits and impacts from the banking operations are considered along with all available monitoring information by qualified professionals to develop a view of whether mitigation is warranted. The impacts covered by the program would be limited to domestic wells, critical infrastructure, and land uses that are adversely affected by declining groundwater levels, land subsidence, or changes to groundwater quality. The mitigation plan may be revised or expanded based on groundwater conditions in the future.

Minimum Plan Requirements

Each plan will include the following:

1. Stakeholder outreach
2. Well Registration
3. Eligibility Criteria
4. Application process
5. Evaluation process
6. Identification of suitable mitigation
7. Funding Source

Stakeholder Outreach

The program should present the public outreach and education efforts that will be performed during development of the mitigation program and prior to implementation. Prior to implementation, extensive outreach will be needed to notify stakeholders of the Program requirements and how they can apply for assistance. These efforts should be in general accordance with the existing Stakeholder Communication and Engagement Plan. However, one main difference relative to when the 2020 GSP was developed is that through the Governor's Executive Order N-7-22, GSAs are more directly involved in well permitting. So, for impacted parties, contacting their local GSA about the matter should become routine.

Well Registration

As noted above, the information on domestic wells regarding well construction and operation is limited. The Kings County database provides some information on the existing domestic wells where permits were obtained but is not updated regularly for well operational status. A comprehensive database of the domestic wells with construction details would be complied across the Subbasin.

Eligibility Criteria

The program should present the eligibility requirements to qualify for the program based on stakeholder compliance with the GSP, GSA's Rules & Regulations, and other laws or regulations.

Application Process

The program should clearly present the process by which an affected stakeholder can submit a claim. It is anticipated that this process will include requests for information such as a Well Completion Report on the well, monitored depths to water over time, records on how the well was maintained, information on the amount of water used or power consumption records that could be used as a proxy, water quality records for relevant COCs, and information about existing wells within a radius around the well experiencing the perceived impact.

Evaluation

Once a claim of adverse impact has been made to a GSA, the GSA will investigate the claim to evaluate whether it is associated with GSP Implementation. As was stated before, the mitigation program will be designed to address local impacts to beneficial users resulting from GSP implementation. However, care must be taken to establish what part of the impacts may be associated with choices by the landowner, other nearby landowners, or potentially some other issue with the facility, rather than GSA actions to implement the GSP. In this regard the mitigation plan might be viewed to be similar to efforts put in place around Groundwater Banks, where benefits and impacts from the Banks operations are considered along with all available monitoring information by qualified professionals to come to a view of whether mitigation is warranted.

Mitigation

Once contacted about a potential impact, the GSA will begin working with the local landowner. There are various services available to landowners with well issues, such as County programs to provide temporary water service while a new well is drilled. The GSAs will convey available information on these services and work with the landowner to provide information about the facility and its condition to the GSAs so that an evaluation can be undertaken as quickly as possible. Once a claim of impact has been confirmed to be due to GSP implementation, the GSA will pursue suitable mitigation efforts as described in each GSA specific plan. Various factors may reflect the proper mitigation methods for the specific issue. For example, facility age, location, financial impact to the stakeholder as a result of mitigation.

Funding Source

Funding will be needed for the program through the GSA's implementation of assessments, fees, charges, and penalties. All of these funds will have to be developed consistent with Proposition 218 requirements. Also, much work will have to be done to better understand the sources of the impacts and identify landowners involved in developing the identified impacts, so that funds are collected from the appropriate parties. In addition, the GSAs will explore grant funding as County, state and federal assistance will be needed to successfully implement this program. The State has existing grant programs for community water systems and well construction funding. The GSAs will also work with local NGOs that may be able to provide assistance or seek grant monies to help fund the program.