Sustainable Management Criteria

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3.1 Introduction § 354.22

This Section defines the process for determining the Sustainable Management Criteria ("SMCs"), specific to the Agency, in order to achieve the sustainability goal of the Tule Subbasin and the portion of the Subbasin that is within the jurisdiction of the Agency. This Section characterizes and defines the minimum thresholds and measurable objectives with interim milestones for each applicable sustainability indicator.

SGMA requires the establishment of SMCs to serve both as a means for measuring success of Management Actions and as triggers for specific Agency actions within a Management Action. For example, the Measurable Objectives (MOs) for the chronic lowering of groundwater level sustainability indicator represents a target groundwater surface elevation that acts as a quantitative measure of the sustainability goal. These MOs will be utilized by the Groundwater Accounting Management Action described in Section 5 to guide management of, among other things, the Transitional Groundwater Allocations. Interim milestones (IMs) were developed to illustrate a reasonable path to achieve the sustainability goal for the Subbasin within 20 years of Plan implementation, and to guide allocation decisions under the Groundwater Accounting Management Action described in Section 5 of this Plan. In this way, the Agency can adaptively manage its portion of the Tule Subbasin while ensuring that the sustainability objectives are met.

Four attachments to this GSP contain supplemental information on the process, analyses, and results that informed the current version of the SMCs for this 2nd Amended GSP. These attachments are considered extensions of this chapter:

1. **Attachment 4** – Technical Support for Addressing Department of Water Resources Comments Regarding Sustainable Management Criteria for Upper Aquifer Groundwater Levels in the Tule Subbasin
2. **Attachment 5** – Addressing SWRCB Staffs Degraded Groundwater Quality Sustainable Management Criteria Deficiencies
3. **Attachment 6** - Technical Support for Land Subsidence Sustainable Management Criteria in the Tule Subbasin
4. **Attachment 7** –Technical Support for Addressing State Water Resources Control Board Comments Regarding Interconnected Surface Water in the Tule Subbasin

The process and analyses vary for each sustainability indicator's SMC development; however, the general methodology remains consistent with the goal of avoiding significant and unreasonable effects to beneficial uses and users of groundwater in the subbasin.

3.2 Sustainability Goal § 354.24

The Sustainability Goal of the Tule Subbasin is defined as the absence of undesirable results, accomplished by 2040 and achieved through a collaborative, subbasin-wide program of sustainable groundwater management by the various Tule Subbasin GSAs.

It is further the goal of the Tule Subbasin GSAs that coordinated implementation of their respective GSPs will achieve sustainability in a manner that facilitates the highest degree of collective economic, societal, environmental, cultural, and communal welfare and provides all beneficial uses and users the ability to manage the groundwater resource at least cost. Moreover, this coordinated implementation is anticipated to ensure that the sustainability goal, once achieved, is also maintained through the remainder of the 50-year planning and implementation horizon, and thereafter.

In achieving the Sustainability Goal, these GSPs are intended to balance average annual inflows and outflows of water by 2040 so that long term negative change in storage does not occur after 2040, with the ultimate goal being avoidance of undesirable results caused by groundwater overdraft. The stabilization of change in storage should stabilize groundwater elevations, which, in turn, will inhibit water quality degradation and arrest land subsidence.

This Section 3 establishes the specific measurable Sustainable Management Criteria (SMCs) that the Vandalia Water District (VWD) GSA will use as management targets, set at levels that basinwide modeling has determined will result in meeting the Sustainability Goal of the Tule Subbasin. Section 5 of this GSP integrates the SMCs established in this Section with the Management Actions that are being implemented by the Agency.

3.3 Process for Establishing Sustainable Management Criteria

The Sustainable Management Criteria (hereafter “SMCs”) discussed and established in this Section were developed in consultation with the Agency’s member agencies, local stakeholders, Tule Subbasin GSA counterparts, technical leads, regional partners, interbasin stakeholders, and other interested parties. The process for setting SMCs related to undesirable results and measurement methodology is consistent among the various GSAs within the Tule Subbasin, while the quantifiable process for setting measurable objectives, interim milestones, and minimum thresholds for RMS in each GSA individually was determined by that Agency and its consultants to address the diverse conditions that occur throughout the Tule Subbasin.

The process leading up to the development and establishment of these Sustainable Management Criteria included:

- Regular agenda items, material reviews, and presentations at the Agency regular Groundwater Planning Commission Meetings wherein information relevant pertinent to the development of Sustainable Management Criteria was discussed with recommendations provided;
- Holding public outreach landowner and stakeholder meetings within the Agency and throughout the Tule Subbasin outlining the process for Plan development, discussing Sustainable Management Criteria, and providing data and context related to local groundwater-related issues; and
- Reviewing existing hydrologic data, current and historical groundwater information assembled in the *Tule Subbasin Setting* (**Attachment 2**), and modeling various groundwater management scenarios in order to determine whether the model outcomes predicted that the selected SMC would avoid undesirable results.

3.4 Undesirable Results § 354.26(a)

Undesirable Results are caused by groundwater conditions occurring throughout the subbasin that, for any sustainability indicator, become significant and unreasonable. The sustainability indicators include:

- Chronic lowering of groundwater levels indicating a depletion of supply if continued over the planning and implementation horizon;
- Reduction of groundwater storage;
- Seawater intrusion;
- Degraded water quality, including the migration of contaminant plumes that impair water supplies;
- Land subsidence that substantially interferes with surface land uses; and
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

The Tule Subbasin GSAs have evaluated the conditions under which significant and unreasonable groundwater conditions, specific to each sustainability indicator, could occur within the subbasin and have established common criteria to define when such conditions constitute an undesirable result. The process to identify the conditions that constitute undesirable results in the Tule Subbasin was informed through:

- Research and documentation of the hydrogeological setting and conceptual model of the subbasin (see **Attachment 2**);
- Identification of beneficial uses and users of groundwater;
- Definition of the basin-wide conditions that are significant and unreasonable as it relates to each sustainability indicator;
- Development of sustainable management criteria (minimum thresholds) that define the point at which significant and unreasonable conditions occur and which the GSAs seek to avoid.

Based on analysis of the hydrogeological conceptual model, five sustainability indicators were identified with potential to cause significant and unreasonable effects within the Tule Subbasin. These indicators are:

- Chronic lowering of groundwater levels indicating a depletion of supply if continued over the planning and implementation horizon;
- Reduction of groundwater storage;
- Degraded water quality, including the migration of contaminant plumes that impair groundwater supplies;
- Land subsidence that substantially impacts critical infrastructure; and
- Depletions of interconnected surface water.

One sustainability indicator, seawater intrusion, does not apply within the Tule Subbasin (defined in the Tule Subbasin Setting, **Attachment 2)**.

Significant and unreasonable conditions were defined as the point at which groundwater conditions cause impacts to beneficial uses and users that cannot be mitigated. These conditions were defined for each sustainability indicator. Sustainable management criteria were identified to avoid significant and unreasonable conditions. Undesirable results were defined, for each sustainability indicator, as the combination of minimum threshold exceedances that were considered significant and unreasonable.

The Sustainable Management Criteria identified to avoid undesirable results were vetted through a public process that included multiple stakeholder workshops, meetings, and document review. While the sustainable management criteria are protective of undesirable results for most beneficial uses and users, during the transition period between 2020 and 2040, if impacts occur, a mitigation program has been developed to address these impacts. The Tule Subbasin Mitigation Plan can be found as **Attachment 8** of this GSP.

3.5 Minimum Thresholds, Interim Milestones, and Measurable Objectives for Sustainability Indicators **§ 354.28(a); § 354.30(a)**

The Agency has developed numerical minimum thresholds, interim milestones, and measurable objectives for four of the five sustainability indicators applicable to the Tule Subbasin, including:

- Chronic Lowering of Groundwater Levels
- Reduction of Groundwater Storage
- Degraded Water Quality
- Land Subsidence
- Interconnected Surface Water

Each sustainability indicator is evaluated at the various RMS within the Agency, defined in the Tule Subbasin Monitoring Plan, to establish the numerical minimum threshold, interim milestones and measurable to achieve sustainability within 20 years. The locations of the various RMS for each Sustainability Indicator are identified in **Attachment 1, Figures A1-2, A1-4 and A1-7.**

In addition, for each Sustainability Indicator in the Agency, the metrics for quantifying the measurable objective and minimum threshold are summarized in **Table 3-1: Metrics for Quantifying Sustainability** Indicators**.**

Table 3-1: Metrics for Quantifying Sustainability Indicators

Sustainability Indicator	Metric for Quantifying
Chronic Lowering of Groundwater Levels	Depth to Groundwater
Reduction in Groundwater Storage	Depth to Groundwater

Seawater Intrusion	Not Applicable to Tule Subbasin
Degraded Water Quality	Measured Groundwater Quality
Land Subsidence	Measured Land Subsidence Rate and Extent
Depletion of Interconnected Surface Waters	Depth to Groundwater

3.5.1 Chronic Lowering of Groundwater Levels

3.5.1.1 Groundwater Beneficial Uses and Users §354.26(b)(3)

Beneficial uses and users of groundwater in the Agency include domestic supply, municipal supply, agricultural supply, industrial supply and environmental. Potential effects of chronic lowering of groundwater levels are addressed in the following sections.

3.5.1.2 Chronic Lowering of Groundwater Levels Undesirable Result §354.26(a)

3.5.1.2.1 Definition of Significant and Unreasonable Groundwater Level Conditions §354.26(b)(2)

A key driver of the analysis presented herein to address CDWR comments is protection of the basic human right to water. As stated in the California Water Code Section 106.3, "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes." In the Tule Subbasin, many private residences in the small communities of the area rely on private wells to meet their domestic water supply needs. As these wells are typically shallow, they are vulnerable to, among other things, lowered groundwater levels from overdraft conditions. While seasonal conditions can influence groundwater levels, the Tule Subbasin has been shown to be in long-term overdraft, primarily from agricultural pumping. A primary objective of the Tule Subbasin GSAs is the sustainable management of groundwater levels to avoid impacts to all beneficial uses and users in the Tule Subbasin, including private domestic wells. While the Sustainable Groundwater Management Act (SGMA) provides for achieving groundwater sustainability by 2040, it is recognized that this access to water must be protected during that transitional time if additional overdraft occurs.

In consideration of the above, the Tule Subbasin GSAs have revised their definition of significant and unreasonable conditions, as it relates to Upper Aquifer groundwater levels, as follows:

Lowering of groundwater levels from groundwater pumping that results in unmitigated impacts to beneficial uses and users.

While this definition applies to all beneficial uses and users of groundwater (including municipal, domestic, agricultural and industrial types), a primary focus of the Tule Subbasin GSAs is protection of the most vulnerable populations, which are residents who rely on individual domestic wells for their water supply.

3.5.1.2.2 Criteria for Defining Undesirable Results for Chronic Lowering of Upper Aquifer Groundwater Levels §354.26(b)(2)

Groundwater levels in the Tule Subbasin have shown a general chronic lowering since approximately 1987. The primary cause of groundwater conditions that have led to chronic lowering of groundwater levels is groundwater production in excess of natural and artificial recharge over a multi-year period that includes both wetter than average and drier than average conditions. This condition has been exacerbated during natural drought-cycles when access to imported water supplies is restricted and groundwater production increases. Restricted access to imported surface water can occur due to a variety of factors, including but not limited to, increased requirements in the Delta, which may increase the likelihood imported supplies from Millerton Lake will be delivered outside the Tule Subbasin. Climate change may also affect the availability and rate upon which natural and artificial recharge is available.

As per SGMA, an undesirable result is quantified through minimum threshold (MT) exceedances. For the Tule Subbasin, the criteria for determining groundwater level conditions that represent an undesirable result are either the occurrence of (1) or (2) as follows:

1a. Groundwater levels drop below the MT in any three RMS wells in any given year.

AND

1b. More than 38 domestic wells require mitigation in any given year. If 38 wells require mitigation for multiple years, no more than 257 wells shall be impacted cumulatively by 2040.

OR

2. If a GSA is unable to meet mitigation needs

Three RMS wells correlates to the number of potentially impacted domestic wells that a GSA can afford to mitigate in a single year, including the Porterville area which has the highest density of potentially impacted private domestic wells (approximately 30). The number of potentially impacted domestic wells per RMS if groundwater levels are at the minimum threshold is approximately 11, based on the spatial distribution of wells (258 total potentially impacted wells divided by 23 RMS wells). If the maximum annual number of impacted domestic wells requiring mitigation is approximately 38 (see **Attachment 4**), then this would correlate to three RMS minimum threshold exceedances. If either metric for criterion 1 (including both 1a and 1b) or 2 is exceeded or is not otherwise met, it would indicate that sustainability planning and implementation is not sufficient and therefore is an undesirable result.

3.5.1.2.2 Criteria for Defining Undesirable Results for Chronic Lowering of Lower Aquifer Groundwater Levels §354.26(b)(2)

Land subsidence is the only potential significant and unreasonable effect for chronic lowering of Lower Aquifer groundwater levels. The definition of undesirable results for Lower Aquifer groundwater levels is an exceedance of the cumulative subsidence at any given RMS that is not attributable to elastic conditions or measurement error (see Section 3.5.4.2.2 of this GSP).

3.5.1.3 Chronic Lowering of Groundwater Levels Minimum Thresholds § 354.28(c)(1)(A)(B)

3.5.1.3.1 Process for Determining Minimum Thresholds § 354.28(b)

Upper Aquifer

The process to determine MTs for Upper Aquifer groundwater levels focused on avoiding impacts to domestic wells. Starting with the groundwater level MTs previously published in the 2022 GSP revision, a series of analyses were conducted to estimate the number of wells potentially impacted in the Tule Subbasin at progressively shallow groundwater levels. During various iterations of the analysis, the results were presented to stakeholders, including the GSA managers, GSA Boards and stakeholder committees, non-governmental organization (NGO) groups, and State Water Resources Control Board (SWRCB) staff for review and comment. Key goals of the exercise were to:

- Minimize potential domestic well impacts from groundwater pumping,
- Ensure the financial feasibility of funding the mitigation of wells that could potentially be impacted, and
- Ensure the feasibility of projects and management actions necessary to maintain groundwater levels to avoid impacts.

The financial feasibility of funding mitigation of potentially impacted wells was evaluated in the context of the Tule Subbasin Mitigation Plan (**Attachment 8**). The Mitigation Plan ensures that funds will be available to address wells potentially impacted as a result of groundwater pumping and that impacted parties will not be without water.

The coordinated methodology to develop MTs included the following steps:

1. Historical groundwater level hydrographs were prepared for each of the Upper Aquifer Representative Monitoring Site (RMS) wells in the subbasin (see Figure 3-1 for example).
2. The groundwater level measured at each RMS well in Fall 2022 was selected as representative of recent low groundwater conditions (see Table 3-2).

3. An updated version of the calibrated groundwater flow model of the Tule Subbasin[1] was used to estimate the model-predicted change in groundwater levels forecast at each
4. Representative Monitoring Site (RMS) well between 2022 and 2040. The forecast incorporated each GSA's project and management actions, as outlined in the 2022 GSPs.
5. The revised coordinated MT at each RMS well was established as the difference between the 2022 measured groundwater elevation at that well and the model-forecasted groundwater elevation in 2040 (see Figure 3-1; Table 3-2).
6. The MTs for the RMS wells were contoured via kriging in Geographic Information System (GIS) to develop a MT surface across the subbasin (see Figure 3-2).

Table 3-2: Revised Coordinated Upper Aquifer Groundwater Level Minimum Thresholds

		A	B	C[2]	D	E[3]
GSA	RMS Well	Fall 2022 GWL (ft asml)	Model-Predicted 2020 to 2040 Change in GWL[1] (ft)	Revised Coordinated MT (ft asml)	Previous 2022 GSP MT (ft asml)	Difference (ft)
Vandalia WD	VID #21	434	13	421	N/A	N/A
Vandalia WD	22S/28E-18H001	397	11	386	N/A	N/A

Notes:
[1] TH&Co, 2021. Update to the Groundwater Flow Model of the Tule Subbasin. Technical Memorandum Dated 7/30/21.
[2] C = A - B
[3] E = C - D

The MT contour map was used to estimate the number of wells potentially impacted if groundwater levels were lowered to the MTs (see **Attachment 4**, **Section 6.2**).

While it is not possible at this time to identify exactly how many wells in the Tule Subbasin would be impacted by lowering groundwater levels to the MTs, it is possible, using the best available data provided by the CDWR and United States Geological Survey (USGS), to estimate the number of wells that would be potentially impacted. Further, the available databases have been used to assess the beneficial uses served by the impacted wells, whether agricultural, domestic, industrial, or municipal supply. Sources of data used in the analysis of potentially impacted wells are described in **Attachment 4**.

[1] TH&Co, 2021. Update to the Groundwater Flow Model of the Tule Subbasin. Prepared for the Tule Subbasin Technical Advisory Committee. Dated July 29, 2021. Attachment 3 to the Tule Subbasin Coordination Agreement.

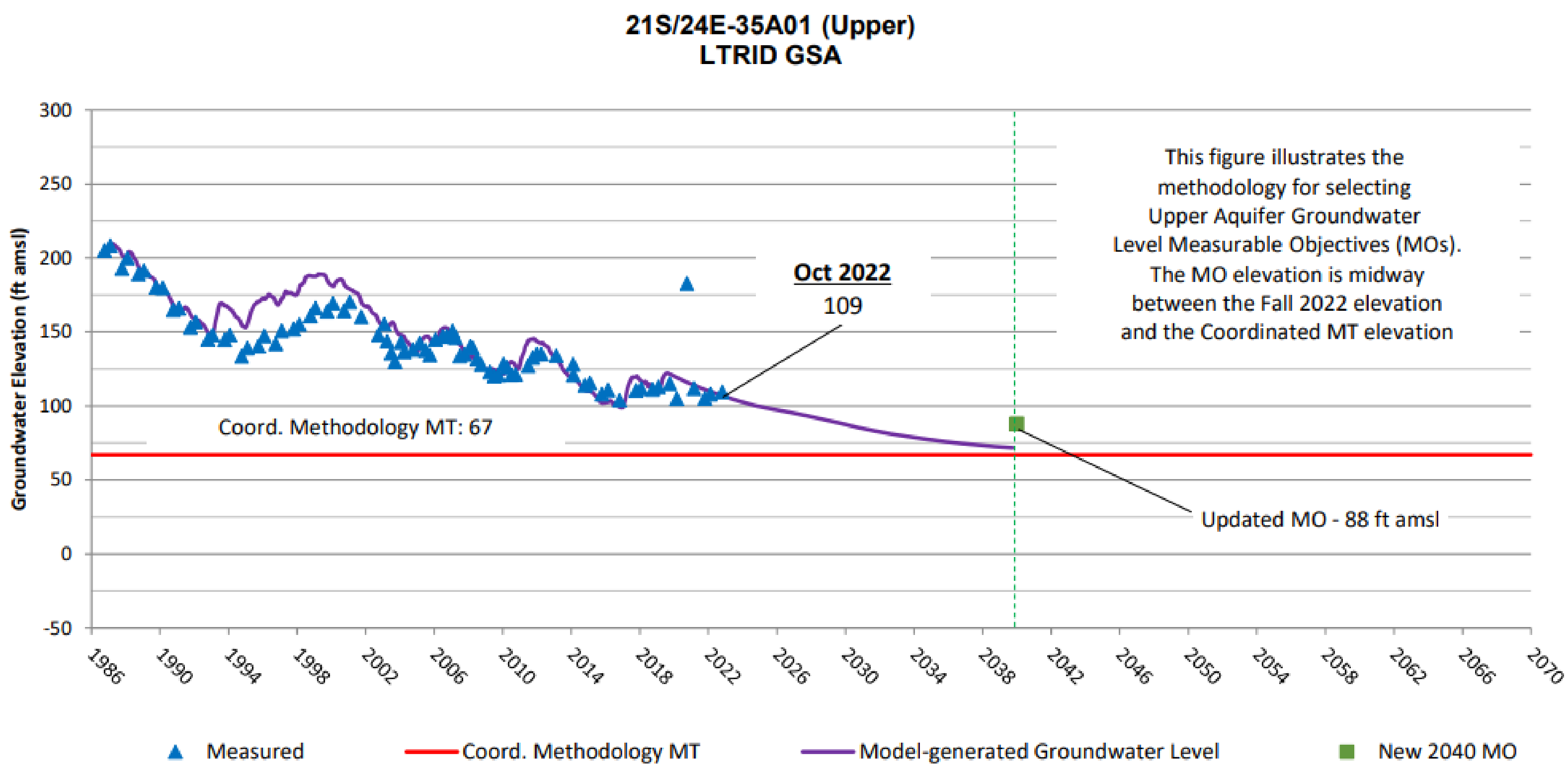


Figure 3-1. Illustration of methodology to select the upper aquifer minimum threshold and measurable objectives.

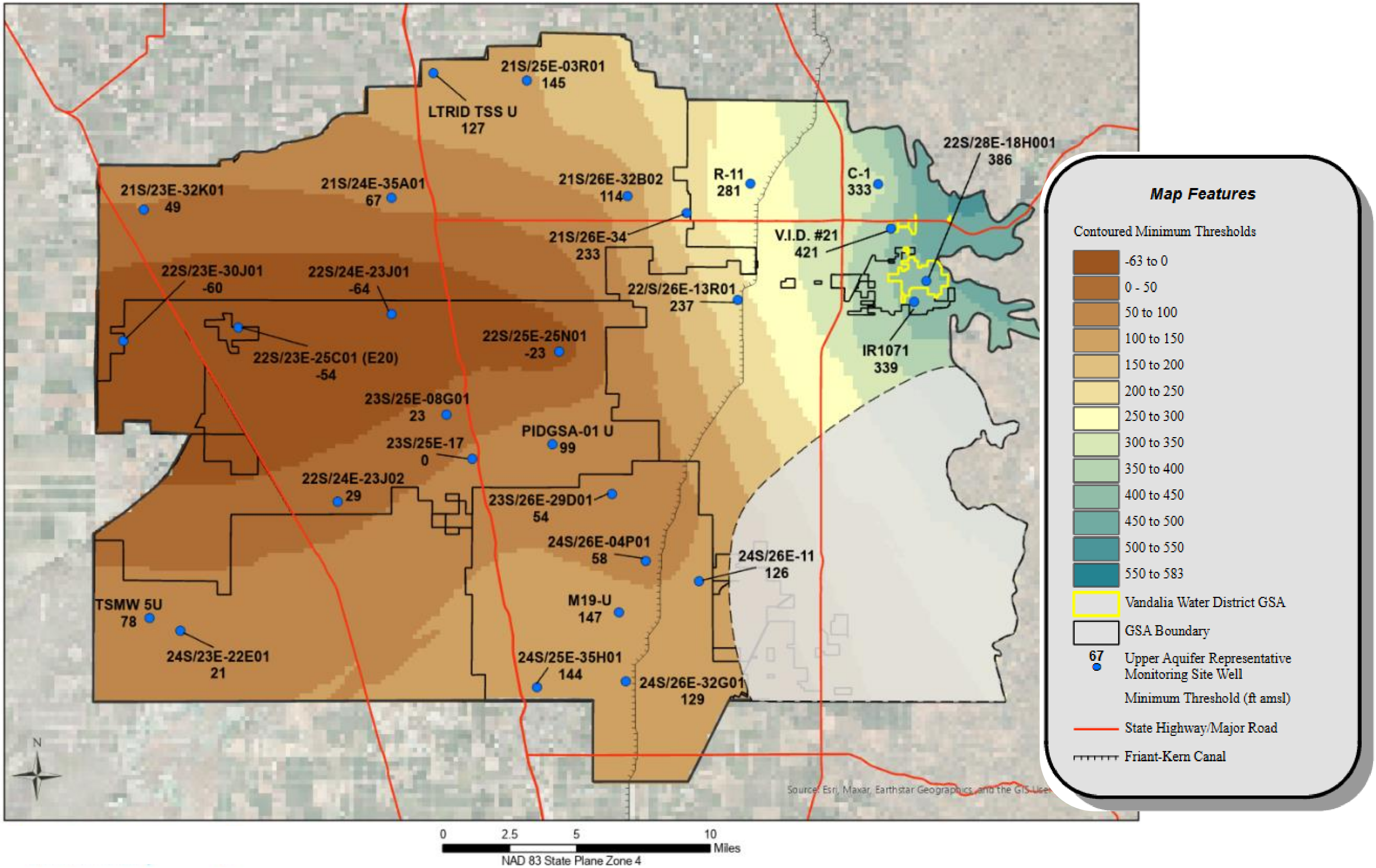


Figure 3-2. Upper aquifer minimum thresholds.

The methodology to estimate the number of wells potentially impacted by lowering Upper Aquifer groundwater levels to the MTs included the following steps and assumptions:

- The MTs for each aquifer, as designated at representative monitoring sites, were contoured via kriging in Geographic Information System (GIS) to develop a MT surface across the subbasin (see Figure 3-2).
- There are a total of 8,996 Tule Subbasin wells in the combined OSWCR/USGS well databases. Of the total wells in these databases, 4,476 wells were removed from the analysis because the records did not include total depth information, they were non-pumping wells or wells documented for uses other than agricultural, private domestic, industrial, or municipal, (e.g., contaminant remediation, injection, monitoring), or they were destroyed.
- 42 wells were added to the database based on records from the City of Porterville and KTWD GSA.
- Within the City of Porterville Urban Development Boundary, the city has implemented a program to connect homes to the municipal water supply system that previously relied on domestic wells for water supply. As a requirement of connecting to the public water supply, domestic well owners are required to destroy their wells. By correlating homes with water supply connections to well locations in the USGS database, 18 wells were removed from consideration in the analysis of potentially impacted wells as they have likely been destroyed.
- A total of 4,544 wells were used in the analysis. The wells were plotted according to the location information in the USGS database (see **Attachment 4, Figure 6**). For wells with only township, range and section information, the well was plotted in the middle of the section.
- As per SGMA[2] GSPs are not required to address wells potentially impacted at groundwater conditions that existed prior to January 1, 2015. Thus, 486 wells that would have been impacted prior to this time were removed from the analysis. The Upper Aquifer groundwater surface used as a basis for removing wells prior to January 1, 2015, was developed based on a manually contoured groundwater elevation contour map using groundwater levels measured in Spring 2015 (see **Attachment 4, Figure 8**). Only wells constructed within the Upper Aquifer, as defined in the Tule Subbasin groundwater flow model, were used to develop the contour map.

Wells at which the total depth or bottom of perforations were above the MT or where the total depth/bottom of perforations were below the MT but could not support pumping with a static groundwater level at the MT were considered “potentially impacted” (see Figure 3-3). Criteria for determining whether a well could support pumping when the static groundwater level was at the MT were the following:

- The pumps in all wells were assumed to be installed, or capable of being installed, within 10 feet of the bottom of the wells.

[2] California Water Code Part 2.74, Ch. 6, Section 10727.2 (b) (4)

- It was assumed that the pumping groundwater level would need to be at least 20 feet above the pump intake to avoid cavitation or entrained air.
- In addition to the pumping support assumptions above, allowance was given to support pumping drawdown based on specific capacity data from available wells and pumping rates reported in the USGS updated version of the OSWCR database.
- For each GSA, TH&Co used an average specific capacity from wells with available data in that GSA. The pumping drawdown allowance for agricultural wells was assigned based on average pumping rates from agricultural wells in each mile square section. The pumping drawdown allowance for domestic wells was assigned based on average pumping rates for domestic wells in each mile square section.

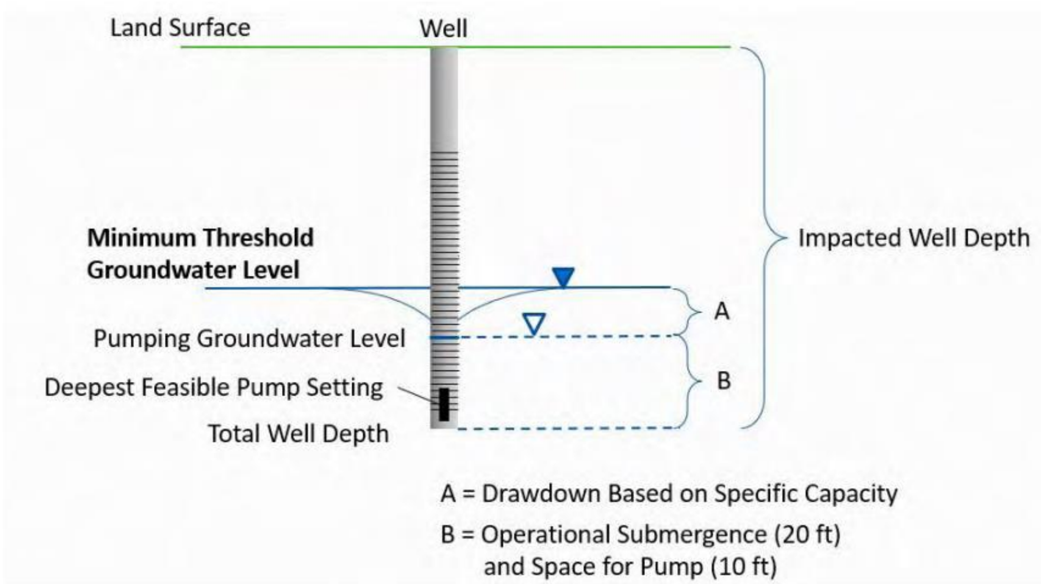


Figure 3-3. To be counted as potentially impacted, any given well in the databases had to be shallower than the groundwater level minimum threshold plus the sum of estimated well drawdown, operational submergence, and space for the pump.

Revised Upper Aquifer groundwater level MTs are shown on Figure 3-2 and summarized in Table 3-2. As a result of the revised methodology, MTs throughout most of the Subbasin were raised relative to those published in the 2022 GSPs (see Table 3-2). The Tule Subbasin GSAs determined that it was feasible to raise the funds necessary to mitigate the wells potentially impacted at the revised MTs developed based on the above methodology and shown in Table 3-2 (see **Attachment 4**, **Sections 6.2 and 7.0**). As such, the updated Upper Aquifer MT surface represents the level at which significant and unreasonable conditions occur that the GSAs seek to avoid.

Lower Aquifer

Lower Aquifer groundwater level MTs were established in connection with minimizing and avoiding land subsidence (see Section 3.5.4 of this GSP). The Lower Aquifer MTs are shown on Figure 3-4. Based on the analysis of potentially impacted wells described above, no wells perforated in the Lower Aquifer were predicted to be impacted as a result of lowering groundwater

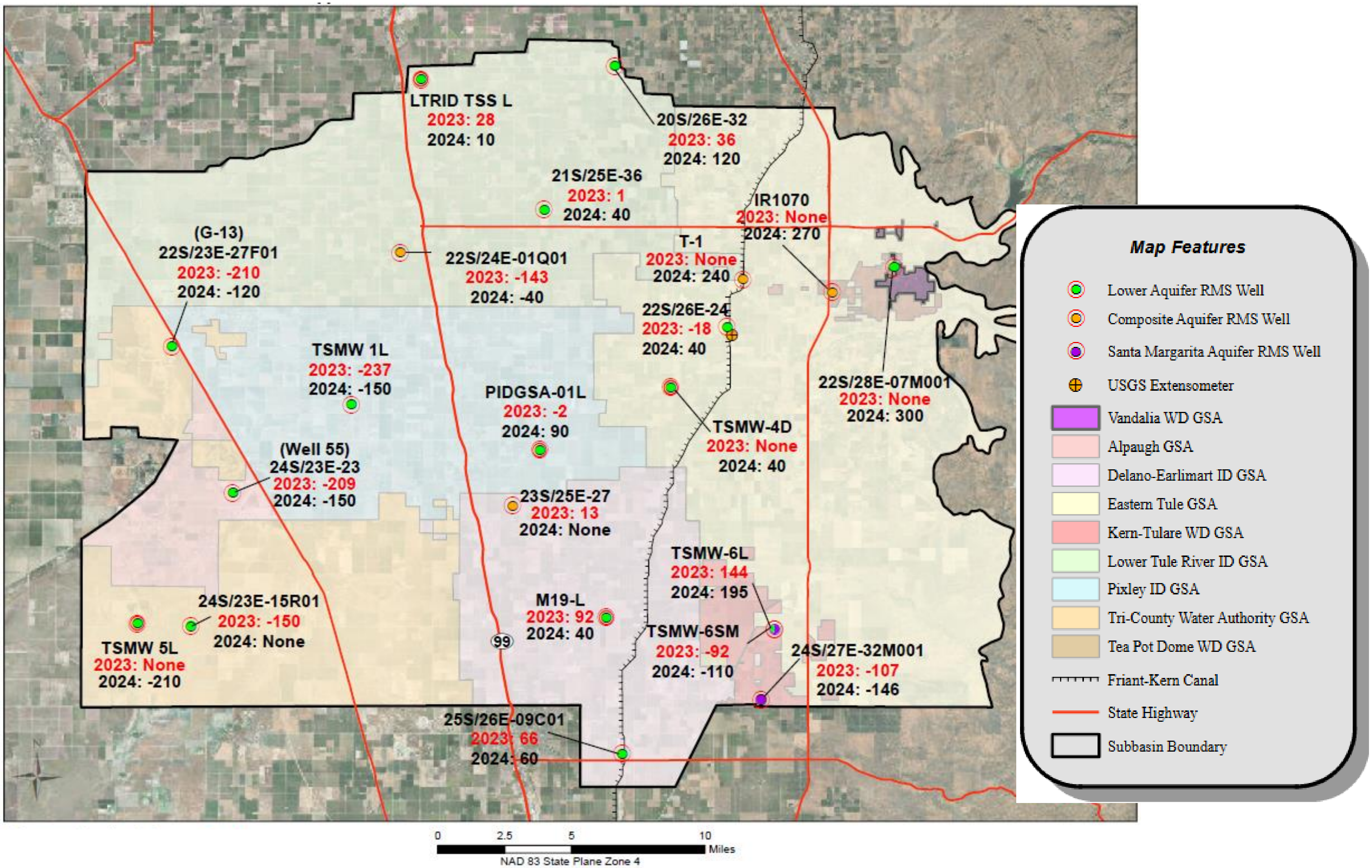


Figure 3-4. Lower aquifer minimum thresholds (Feet above sea level).

levels to the Lower Aquifer MTs. As such, Lower Aquifer MTs were established to avoid land subsidence, as described in Section 3.5.4 of this GSP.

3.5.1.3.2 Relationship of Groundwater Level Minimum Thresholds to Other Sustainability Indicators § 354.28(b)(2)

The upper aquifer groundwater level MTs were developed using current and historical groundwater level measurements across the Subbasin, based on the best available data. The groundwater level data were evaluated to ensure hydrogeologic plausibility and reasonable continuity of MT values between RMS locations for other sustainability indicators. For the lower aquifer, the subsidence analysis was used to inform MTs. The MTs for the land subsidence sustainability indicator were used to define the lower aquifer MTs (Section 3.5.4 of this GSP). Therefore, the land subsidence and lower aquifer groundwater level MTs are aligned.

Land subsidence. The MTs for the land subsidence sustainability indicator were used to define the lower aquifer MTs (Section 3.5.4 of this GSP). Therefore, the land subsidence and lower aquifer groundwater level MTs are aligned, and there is no impact of one on the other.

Reduction in groundwater storage. The reduction of groundwater storage sustainability indicator minimum thresholds are identical to those developed for the chronic lowering of groundwater levels sustainability indicator, since groundwater levels are used as a proxy for the reduction of groundwater storage SMC (Section 3.5.2 of this GSP).

Degraded water quality. Legacy and natural groundwater quality issues are present in the Tule Subbasin. SGMA requires GSAs to account for the degradation of groundwater quality induced by a GSA's management of groundwater. This may include degradation of groundwater quality or migration of contaminant plumes caused by recharge activities or changes in groundwater levels and flow directions induced by overdraft pumping. The Tule Subbasin GSAs are committed to expanding the groundwater quality monitoring network, especially near areas with domestic wells, community groundwater supply systems, and adjacent groundwater recharge facilities.

Depletion of interconnected surface water. In the future, interconnected surface water (ISW) will be evaluated using a rate of surface water depletion in interconnected channels; however, surface water flow data is limited and is a data gap that the Tule Subbasin GSAs are actively working to address. In the interim, groundwater level data is being collected near potentially interconnected streams in ETGSA and monitored in conjunction with the upper aquifer groundwater level monitoring network. At this time, the DWR's Guidance Document for evaluation of ISW has not been released by DWR. In the future, groundwater levels may be used as a proxy for establishing SMC for depletions of interconnected surface water pending recommendations from DWR's Guidance Document.

3.5.1.3.3 Effect of Minimum Thresholds on Neighboring Basins and Subbasins §354.28(b)(3)

The Tule Subbasin is bound by three other subbasins of the San Joaquin Valley Basin:

- Kaweah Subbasin to the north
- Kern Subbasin to the south
- Tulare Lake Subbasin to the west

The Tule Subbasin GSAs have coordinated with neighboring Subbasins to compare the revised MTs for groundwater levels and land subsidence and are generally consistent across GSA Boundaries. The regular monitoring and review of results for annual reporting will provide more information on whether interbasin policies are needed to avoid impacts to beneficial uses and users of groundwater. Because land subsidence SMC are the limiting factor for assigning lower aquifer groundwater level SMC, it is expected that the lower aquifer MTs will be at or above the lower aquifer MTs in neighboring GSAs.

3.5.1.3.4 Method for Quantitative Measurement of Minimum Thresholds §354.28(b)(6)

Groundwater level measurements will be assessed annually using the monitoring network described in **Section 4** of this GSP. The relationship between groundwater levels at each Representative Monitoring Site (RMS) to the MTs described herein will be evaluated annually as well. Groundwater level monitoring will be conducted in accordance with the Tule Subbasin Monitoring Plan outlined in **Attachment 1** to this GSP . Groundwater level data will be collected at the RMS sites bi-annually to capture the seasonal high (spring) and seasonal low (fall) water table conditions. This data will be reported to DWR bi-annually via the SGMA Data Portal and reported in the Annual Reports, as has been completed since the submittal of the first GSP in 2020. During Annual Report development, the GSAs and their respective stakeholder committees review monitoring results and consider if management and policy changes are needed to achieve basin management goals.

3.5.1.4 Chronic Lowering of Groundwater Levels Measurable Objectives and Interim Milestones §354.30(a)(b)(c)(d)(e)(f)(g)

SGMA requires the establishment of Measurable Objectives (MOs) and Interim Milestones (IMs) to serve both as a means for measuring success of Management Actions and as triggers for specific Agency actions within a Management Action. The MOs for the chronic lowering of groundwater level sustainability indicator represents a target groundwater surface elevation that acts as a quantitative measure of the sustainability goal. These MOs will be utilized by the Groundwater Accounting Management Action described in Section 5 to guide management of, among other things, the Transitional Groundwater Allocations. The MOs were selected to provide a reasonable margin of operational flexibility under varying seasonal and long-term conditions (GSP Emergency Regulations §354.30(c)) while avoiding the MTs. Interim milestones (IM) were developed to illustrate a reasonable path to achieve the sustainability goal for the Subbasin within

20 years of Plan implementation, and to guide allocation decisions under the Groundwater Accounting Management Action described in Section 5 of this Plan.

During each year of the plan implementation period, the Agency will evaluate the data collected from the monitoring program during each Spring monitoring event and compare them to the target values established. The Agency will use adaptive management to adjust management actions based on the data collected.

3.5.1.4.1 Process for Determining Measurable Objectives and Interim Milestones

Measurable objectives (MOs) for upper aquifer groundwater levels at each RMS well were established as the midpoint between the 2022 groundwater level and the revised MT. The MOs are designed such that sustainably managed groundwater levels provide operational flexibility above the MT. Revised Upper Aquifer MOs are shown on Figure 3-5. The interim milestones (IMs) represent target groundwater levels at the RMS to demonstrate progress towards the MOs and are based on incrementally (net) decreasing groundwater level changes over time.

The lower aquifer MOs are established based on the land subsidence SMC methodology, described in Section 3.5.4 and are also presented in Table 3-3 and shown on Figure 3-6.

3.5.1.4.2 Quantifiable Measurable Objectives and Interim Milestones

Using the process described, a hydrograph was established at each RMS well location (**Appendix 3-A: RMS Groundwater Level Hydrographs**), and from the hydrograph, the quantifiable interim milestones and measurable objectives were established, summarized in **Table 3-3: Chronic Lowering of Groundwater Levels Interim Milestones and Measurable Objective by RMS Well.**

Table 3-3: Chronic Lowering of Groundwater Levels Interim Milestones and Measurable Objective by RMS Well

RMS ID	Agency Management Area	Aquifer	Interim Milestone GWE (ft amsl)			Measurable Objective GWE (ft amsl)
			2025	2030	2035	2040
VID #21	Vandalia W.D.	Upper	433	431	429	428
22S/28E-18H001	Vandalia W.D.	Upper	397	395	393	392
22S/28E-07M001	Vandalia W.D.	Lower	345	350	355	360

3.5.2 Reduction of Groundwater Storage

Any reduction in groundwater storage in the subbasin is directly correlated with declining groundwater levels. As such, groundwater levels will be used as a proxy for the reduction of groundwater storage sustainable management criteria (see Section 3.5.1.3.2).

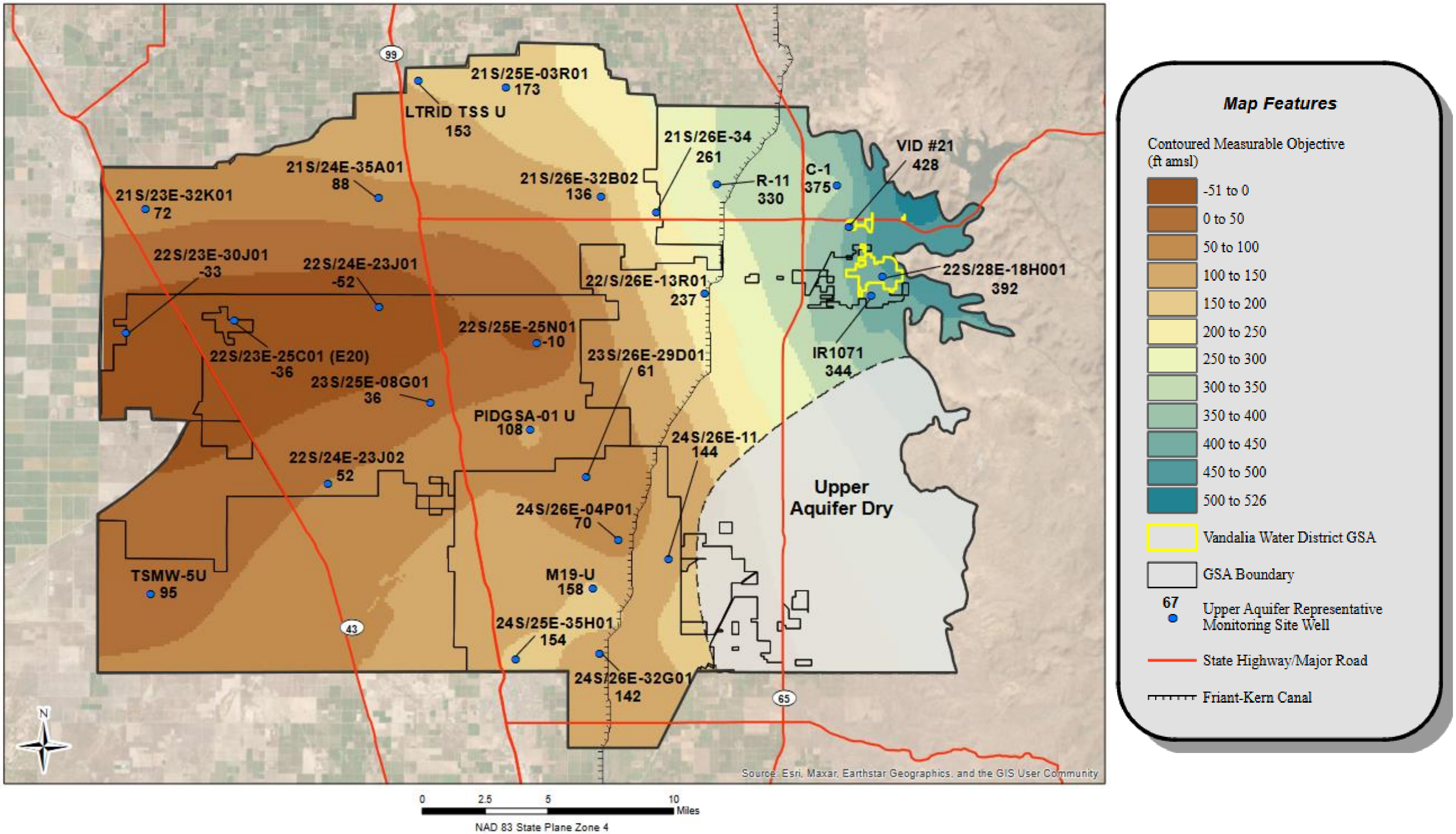


Figure 3-5. Upper aquifer measurable objectives (feet above sea level).

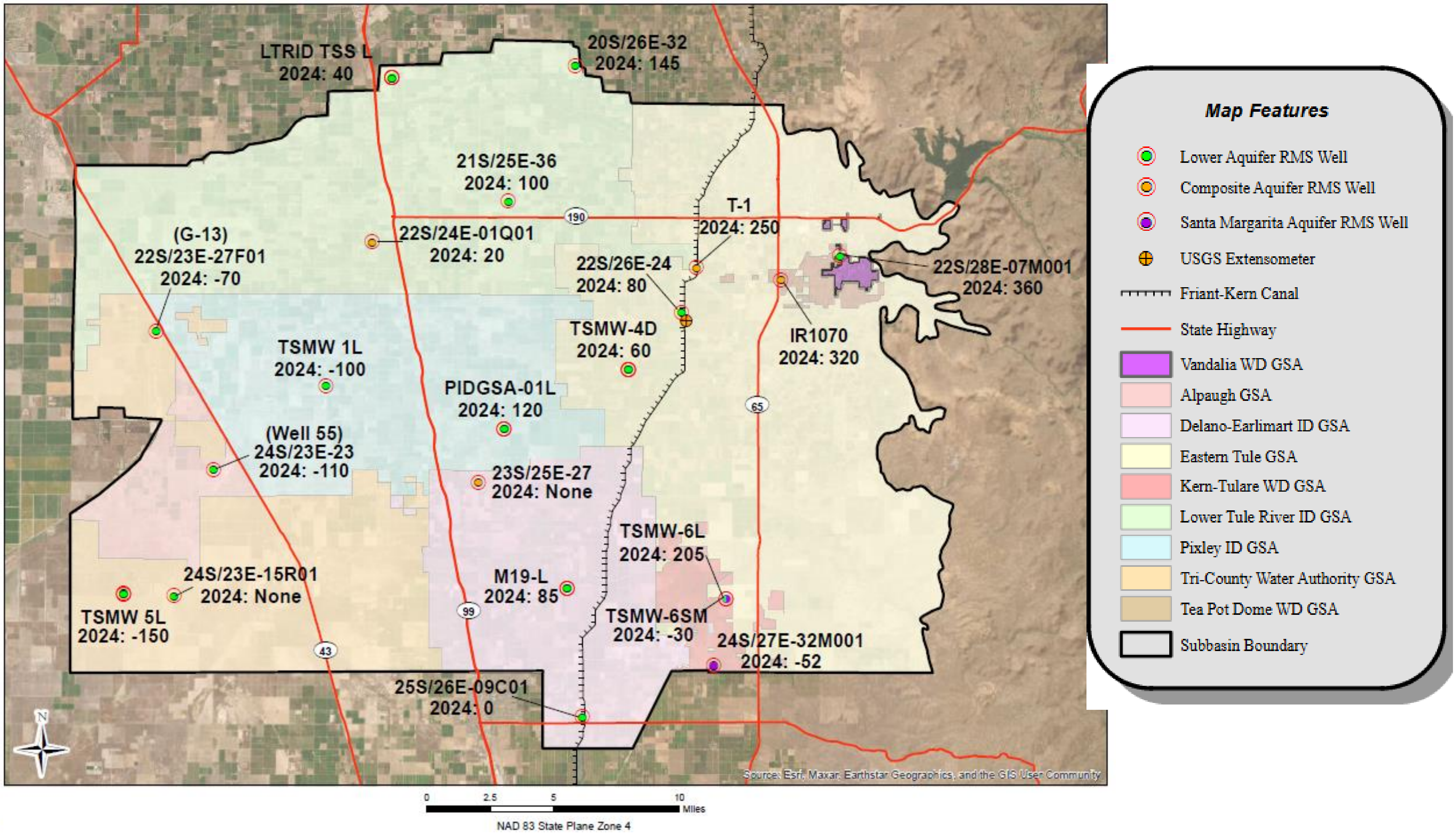


Figure 3-6. Lower aquifer measurable objectives (feet above sea level).

3.5.2.1 Reduction of Groundwater Storage Undesirable Result §354.28(c)(2)

The process relied on to define undesirable results for the reduction of groundwater storage sustainability indicator is the same as that for chronic lowering of groundwater levels as described in Section 3.5.1. The evaluation of potential effects on beneficial uses and users, land uses, and property interests for the reduction of groundwater storage sustainability indicator is also the same as for chronic lowering of groundwater levels. Thus, the combination of minimum threshold exceedances that cause undesirable results for the reduction of groundwater storage sustainability indicator is the same as the combination of exceedances that cause undesirable results for the chronic lowering of groundwater levels sustainability indicator (see Section 3.5.1.2 of this GSP).

3.5.2.2 Reduction in Groundwater Storage Sustainable Management Criteria

Pursuant to GSP Emergency Regulations §354.28(d), groundwater levels may be used as a proxy for other sustainability indicators if a significant correlation between groundwater levels and the other sustainability indicators can be demonstrated. Groundwater levels are directly correlated to groundwater storage (i.e, rising groundwater levels indicate an increase in groundwater storage and vice versa). While groundwater storage can be estimated using measured or model-generated groundwater levels and assumptions regarding the aquifer parameters, the estimates contain significant uncertainty such that monitoring of changes in storage are not practical. Furthermore, groundwater levels are a more direct and reliable measure of sustainability as compared to estimated storage changes. For these reasons, the SMC for the chronic lowering of groundwater levels (Table 3-2) will be used as a proxy for the reduction of groundwater storage sustainability indicator. Accordingly, the SMC for reduction of groundwater storage sustainability indicators are described in the chronic lowering of groundwater levels section above (Section 3.5.1).

3.5.3 Degraded Groundwater Quality

A key driver of the Tule Subbasin GSAs' approach to addressing degraded groundwater quality is protection of the basic human right to water. As stated in the California Water Code Section 106.3, "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes." In the Tule Subbasin, most private rural residences and residents of the small severely disadvantaged communities rely on private domestic wells or municipal wells to meet their domestic water supply needs. These wells are vulnerable to, among other things, degraded groundwater quality that may be caused by GSA authorized activities such as groundwater pumping or recharge activities.

3.5.3.1 Groundwater Quality Beneficial Uses and Users §354.26(b)(3)

Beneficial uses and users within the Tule Subbasin identified for groundwater quality include:

Municipal and Domestic Water Supply: Groundwater used for drinking, cooking, sanitation, and hygiene in homes, businesses, and institutions. The beneficial users of municipal and domestic supply include cities and towns connected to municipal water systems and individual private domestic well owners.

Agricultural Irrigation: Groundwater is a vital source for a variety of crops grown in the Tule Subbasin. Beneficial users of agricultural irrigation include farms and landowners with private agricultural wells and entities such as irrigation districts that manage and distribute water for agricultural use.

Industrial Water Supply: Certain industries may rely on groundwater for specific processes. Beneficial Users of Industrial water supply include Industrial facilities that utilize groundwater in their operations.

California Water Code Section 106.3 states "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes."

In terms of groundwater quality, drinking water supply wells are the highest priority due to essential needs, social equity and the risks to human health associated with degradation of groundwater quality. Well types from the OSCWR database that are categorized as "drinking water" are:

- Domestic
- Public
- Water Supply
- Water Supply Domestic
- Water Supply Public

Figures 1a and 1b of Attachment 5 show the locations and density of drinking water wells within the Tule Subbasin according to data accessed from DWR's Well Completion report database for the upper and lower aquifer, respectively. This data assists in prioritizing development of the groundwater quality monitoring network features to ensure sustainable management criteria is representative of the most vulnerable categories of beneficial users.

3.5.3.2 Definition of Significant and Unreasonable Degraded Groundwater Quality Conditions §354.26(b)(2)

The Tule Subbasin GSAs have revised the definition of significant and unreasonable conditions, as it relates to groundwater quality, as follows:

"Degraded groundwater quality that does not meet state and federal regulatory standards resulting in impacts to Beneficial Uses and Users that are not mitigated"

The level at which groundwater quality is considered an impact to a beneficial user is the point when the quality exceeds the established regulatory threshold for the defined beneficial use. Impacts to beneficial uses and users become significant and unreasonable if mitigation is not provided. As such, the Tule Subbasin GSAs have adopted a subbasin-wide mitigation plan to address unavoidable impacts, making them less than significant and unreasonable, including degraded groundwater quality.

Per SGMA regulations[3] GSAs are not responsible for addressing significant and unreasonable conditions that were present and have not been corrected prior to January 1, 2015. Additionally, many factors can contribute to degraded groundwater quality conditions that are not attributed to activities. Agency is charged with managing, specifically groundwater extractions. Therefore, GSAs are focusing on management actions that are intended to prevent further degrading of groundwater quality conditions where exceedances exist b t are not proposing to mitigate for pre-2015 legacy groundwater quality that exceed regulatory thresholds. GSAs are not mitigating impacts that are not attributed to groundwater extraction activities.

3.5.3.3 Quantification of Undesirable Results for Degraded Groundwater Quality §354.26(b)(2)

By regulation, the undesirable result for degradation of groundwater quality is a quantitative combination of groundwater quality minimum threshold exceedances. The Tule Subbasin GSAs have defined undesirable results for degraded groundwater quality as:

"*An undesirable result occurs if any single groundwater quality RMS well experiences a minimum threshold exceedance resulting from a GSA's groundwater management for 2 consecutive years, and cannot be mitigated by a GSA, is undesirable."*

Two years of consecutive exceedances is chosen to ensure that the exceedance represents an ongoing condition, while being short enough to address groundwater quality exceedances before significant degradation below state and federal groundwater quality standards. Any groundwater quality RMS well minimum thresholds exceeded will trigger an assessment of whether the exceedance results from the GSAs' authorized groundwater management activities for the purpose of determining the mitigation responsibility of the GSA. This assessment is discussed in **Attachment 5** . The ability of the Tule Subbasin GSAs to mitigate groundwater quality impacts is informed by conservatively estimating the potential mitigation costs, discussed in Section 6 of **Attachment 5**.

3.5.3.4 Groundwater Quality Constituents of Concern

Constituent of concern selection is based on the efficacy to determine degradation in groundwater quality by chronic lowering of groundwater levels and by existing regional exceedances of constituents of concern determined by existing data sources. Each constituent has been identified as a constituent of concern where exceedances of the SWRCB's Division of Drinking Water standards for Maximum Contaminant Level (MCL) may present significant risks to beneficial users and uses of groundwater from existing data sources or a monitoring parameter to determine changes in groundwater quality over time. SMCs will be established based on constituents of concern listed below. Additional constituents may be monitored as supplemental data for indicating potential impacts to groundwater quality.

Constituents of Concern in the Tule Subbasin include:
Arsenic
Uranium
Hexavalent Chromium
Total Dissolved Solids (TDS)
Dibromo-3-chloropropane (DBCP)
Nitrate as N
1,2,3-trichloropropane

Arsenic (As): Arsenic is naturally occurring in the environment and is found in rocks and minerals. Arsenic can dissolve into groundwater when rocks weather and erode. Contamination of Arsenic in groundwater can also be sourced from Industrial activities and previously in agricultural use, however Arsenic compounds have been phased out in California. Over pumping can mobilize naturally occurring arsenic from aquifer materials. The MCL of arsenic is 10 parts per billion (ppb). Exceedances of Arsenic have been reported in municipal water systems and in private wells within the Tule Subbasin (see **Figure 2a** of **Attachment 5**).

Uranium (U): Uranium is a naturally occurring radioactive element found in rocks and soils. Geologic sources of uranium are the primary source of uranium in groundwater. Over pumping of groundwater can mobilize naturally occurring uranium from aquifer materials. Sources of contamination in groundwater include natural sources from geologic formations, industrial activities and agricultural practices. Some phosphate-based fertilizers contain trace amounts of uranium which could over time create a source of groundwater contamination. The MCL of Uranium is 30 ppb or 20 picocuries per liter (pCi/L). Excessive uranium in groundwater has been reported in municipal water systems and private wells within the Tule Subbasin (see **Figure 2b** of **Attachment 5**).

Hexavalent Chromium (Cr(VI)): Hexavalent chromium is a form of elemental chromium, a naturally occurring element found in rocks and soils. Sources of contamination can include natural sources from the weathering and erosion of rocks as well as industrial activities that can include chrome plating, wood treatment and chemical manufacturing. Improperly disposed of chromium materials in landfills can leach into groundwater over time. Additionally, some wastewater treatment processes can generate hexavalent chromium as a byproduct which can contaminate groundwater. Groundwater pumping can mobilize naturally occurring hexavalent chromium from aquifer materials. The MCL of hexavalent chromium is 10 ppb. Exceedances of hexavalent chromium in groundwater have been reported primarily in Municipal water systems within the Tule subbasin (see **Figure 2c** of **Attachment 5**).

Total Dissolved Solids: Total dissolved solids (TDS) is a measurement of the total amount of Inorganic and organic substances in water. Typical sources of TDS are mineral dissolution from rocks and soils. A large contributor to high TDS values are the cations. Additional sources can include urban run-off and agricultural activities. Over pumping can concentrate existing dissolved solids in remaining groundwater, thus contributing to higher TDS values. The Secondary MCL for TDS is 1,000 ppm. High TDS can be an indicator of impacted groundwater, however exceedances of TDS within the Tule subbasin are generally low (see **Figure 2d** of **Attachment 5)** .

Tetrachloroethane (PCE): PCE is a synthetic chlorinated solvent used as a degreaser in industrial activities. Storage tank leaks and improper disposal of PCE waste are primary sources of contamination. Over pumping can increase mobility of PCE already present in the subsurface, which can expand zones of influence within the aquifer. The MCL of PCE is 5 ppb. Exceedances of PCE have been reported in municipal water systems within the Tule Subbasin (see **Figure 2e** of **Attachment 5**).

1,2,3- Trichloropropane (1,2,3-TCP): 1,2,3-TCP is a synthetic chlorinated hydrocarbon historically used as a soil fumigant in agricultural practices. 1,2,3-TCP has also been used as a solvent and extracting agent in industrial activities. Though 1,2,3-TCP was banned in soil fumigants and was added to SWRCB's list of carcinogens 1992 (Prop 65), it is still currently used as a chemical intermediate in the production, synthesis and cross-linking agent of other chemicals. In addition to agricultural and industrial activities, sources of 1,2,3-TCP contamination can include improper disposal of 1,2,3-TCP materials in landfills. Similar to PCE, over pumping can increase mobility of 1,2,3-TCE already present in the subsurface, which can expand zones of influence within the aquifer. The MCL of 1,2,3-TCP is 5 parts per trillion. Exceedances have been reported in municipal and domestic wells within the Tule Subbasin (see **Figure 2f** of **Attachment 5**).

Dibromo-3-chloropropane (DBCP): DBCP is a halogenated hydrocarbon historically used as a soil fumigant to control nematodes. DBCP was banned in the United States in 1979 but remains a legacy contamination issue in aquifer systems. Over pumping can increase mobility and spread contamination plumes of existing DBCP contamination which can increase areas of impacted groundwater. The MCL for DBCP is 0.2 ppb. Exceedances of DBCP have been reported in municipal and domestic supply wells within the Tule Subbasin (see **Figure 2g** of **Attachment 5**).

Chloride (Cl): Chloride is a negatively charged ion found dissolved in groundwater composed of chlorine. Chloride can occur naturally in groundwater when chloride minerals such as Halite and Sylvite are dissolved in water. Chloride exceedances can also be attributed to municipal and industrial wastewater discharges. Agricultural practices that involve saline water and certain fertilizers can also elevate chloride in groundwater. Over-pumping can increase chloride concentrations in remaining groundwater. Mobilization may also occur under certain geologic features. The Secondary MCL of Chloride is 500 ppm. Exceedances of Chloride are present in small concentrations within the Tule Subbasin (see **Figure 2h** of **Attachment 5**).

Perchlorate: While Perchlorate is a negatively charged ion, it is not used as a measurement of groundwater quality and is not used in determining water balance in the same way Sulfate, Chloride, Nitrate and Bicarbonate is used. Perchlorate is a manufactured constituent used in industrial processes and explosives. Primary sources of contamination include improper disposal of perchlorate in landfills and accidental spills during transportation of perchlorate materials. Over pumping groundwater can potentially draw contaminated shallow water into the aquifer. The MCL of perchlorate is 6 ppb. Exceedances of perchlorate MCL between 2005-2023 in the Tule Subbasin are shown on **Figure 2i** of **Attachment 5**.

Nitrate as N: Nitrate is a form of nitrogen in groundwater. While septic systems and animal waste can contribute, agricultural fertilizers are the primary source of nitrate contamination in groundwater. Over pumping of groundwater can draw contaminated shallow water into the aquifer or contaminants from soil can be pulled into the aquifer. The MCL of nitrates in groundwater is 10 ppm. Exceedances of nitrate are a subbasin-wide issue (see **Figure 2j** of **Attachment 5**). The Tule Basin Water Quality Coalition (TBWQC) operates as the third-party group under the Irrigated Lands Regulatory Program to address agricultural impacts to water quality within the Subbasin. The Tule Basin Management Zone also addresses nitrate exceedances within the Tule Subbasin.

Other constituents of potential concern are per-and polyfluoroalkyl Substances (PFAS). These compounds are manmade and historically used in cookware, clothing, carpets, and fire-fighting foams. They are often detected in wastewater discharges. In April 2024, the USEPA published National Primary Drinking Water Regulation (NPDWR) for six PFAS and established enforceable MCL's between 4 - 10 parts per trillion (ng/L) depending on the chemical. Under the NPDWR, public water systems have three years (by 2027) to complete initial monitoring and five years (by 2029) to implement solutions that reduce exceedances of MCL's of PFAS chemicals. Additionally, the SWRCB has issued General Order 2024-0002- DDW which requires monitoring for PFAS pursuant to Health and Safety Code Section 116378. As data becomes available, the GSA's will determine the impacts and degradation of groundwater by PFAS in the Tule Subbasin.

3.5.3.5 Degraded Groundwater Quality Minimum Thresholds and Measurable Objectives §354.28(c)(4)

Minimum Thresholds (MTs) and Measurable Objectives (MOs)Thresholds water quality are used to determine when Management Actions are required under the Groundwater Quality Management Action as described in Section 5. Management Actions include an investigation into the connection between groundwater extraction activities and the MO occurrence and refer to the Mitigation Program Management Action.

This plan establishes MTs and MOs at each groundwater quality RMS well with consideration to the drinking water Maximum Contamination Level (MCL) or agricultural Water Quality Objective

(WQO). For COCs that had both an MCL and agricultural WQO, the more restrictive standard was adopted as the minimum threshold (e.g., for TDS, the agricultural WQO of 750 mg/L was used to establish minimum thresholds).

For groundwater quality RMS wells that had 2005-2014 baseline data for COCs, the plan sets the minimum threshold at the greater of:

1. Drinking water MCL or agricultural WQO, or
2. Maximum 2005-2014 concentration

Measurable objectives were set at the greater of:

1. 75% of the minimum threshold, or
2. maximum 2005-2014 concentration.

For wells with insufficient 2005-2014 COC data, 2005-2023 is used to determine the maximum baseline concentration at the GWQ-RMS wells. For wells with insufficient 2005-2023 data, the MT is set at the greater of:

1. The average 2005-2014 baseline concentration in the applicable Public Supply Assessment Grid (PSAG); if insufficient 2005-2014 PSAG data, the average 2005-2013 baseline concentration in the applicable PSAG was used.
2. The drinking water standard MCL. Degraded groundwater quality measurable objectives, interim milestones, and minimum threshold at each GWQ RMS upper and lower aquifer wells are provided in Table 9 and Table 10, respectively.

Table 3-4 summarizes the groundwater quality MTs and MOs for the COCs in the Tule Subbasin.

Table 3-4: Groundwater Quality Minimum Thresholds and Measurable Objectives

Constituent	Units	Minimum Thresholds	Measurable Objectives
		Drinking Water Limits (MCL/SMCL)	75 %Drinking Water Limits (MCL/SMCL)
Arsenic	µg/L	10	7.5
Nitrate as N	mg/L	10	7.5
Hexavalent Chromium	µg/L	10	7.5
Dibromochloropropane (DBCP)	ppb	0.2	0.15
1,2,3-Trichloropropane (TCP)	µg/L	0.005	3.75
Tetrachloroethene (PCE)	µg/L	5	3.75
Chloride	mg/L	500	375
Total Dissolved Solids[1]	mg/L	750	562.5
Perchlorate	µg/L	6	4.5
Uranium	pCi/L	30	22.5

1: Total Dissolved Solids regulatory threshold based on Agricultural Water Quality Objective

3.5.3.6 Groundwater Quality Monitoring Network

The current groundwater quality monitoring network consists of wells perforated in either the upper or lower aquifers. The current network is adaptive and will change based on access, availability to sample and the value of the data with respect to groundwater quality degradation. This network will expand to include regions: where beneficial use is impacted by the lowering of groundwater levels; and where exceedances of groundwater quality constituents are determined based on available data. Current deficiencies within the network have been identified and are discussed in Section 4.4 of **Attachment 5**.

3.5.3.6.1 Upper Aquifer Groundwater Quality Monitoring Network

The current RMS network for the upper aquifer is provided in Figure 3-7. This figure shows RMS locations over the density of domestic and public supply wells perforated within the upper aquifer within each section. Domestic and Public supply have been identified as most vulnerable beneficial users within the lower aquifer. Details regarding the criteria for selection of groundwater quality RMS sites are provided in **Attachment 5**.

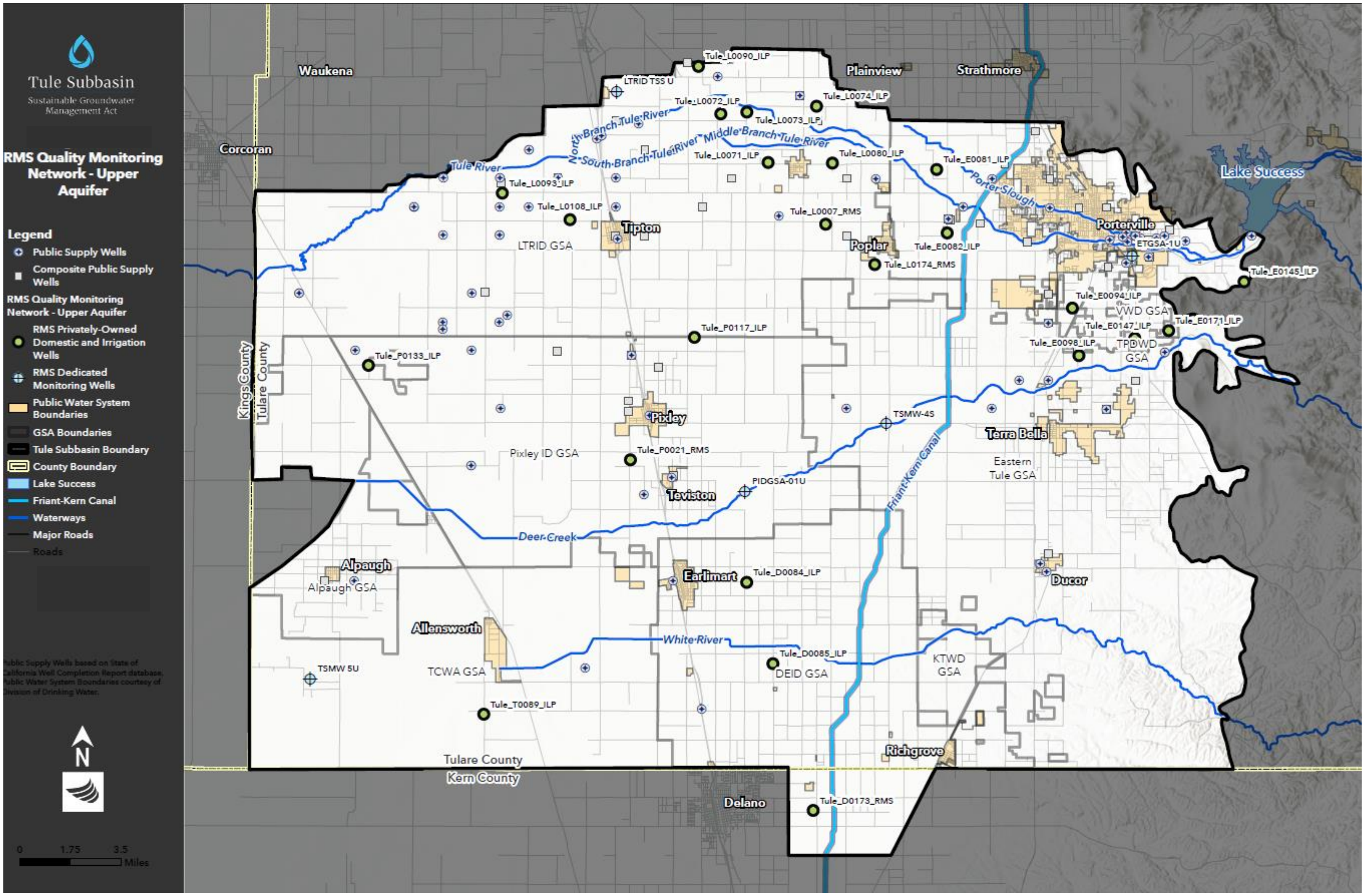


Figure 3-7. Upper aquifer groundwater quality monitoring network.

A summary of the Agency's upper aquifer RMS wells is shown in the following Table 3-5.

Table 3-5: Groundwater Quality Upper Aquifer RMS Wells

Groundwater Quality - Upper Aquifer Representative Monitoring Site Wells					
Master_Well_ID	Lat	Long	Top Perf	Bottom Perf	Well Depth
ETGSA-1U	36.0485573	-118.9930101	28	48	55

A summary of the sustainable management criteria specific to each upper aquifer RMS well is shown in Table 3-6.

Table 3-6: Groundwater Quality SMC for Upper Aquifer RMS Wells

Upper Aquifer RMS Well SMC					
GSA	PSAG	Well ID	Constituent of Concern	IMs & MO	MT
VWD	**SVJ_Tule16**	**ETGSA-1U**	Nitrate as Nitrogen (mg/L)	7.5	10
			Dibromochloropropane (ug/L)	0.15	0.2
			Arsenic (ug/L)	7.5	10
			Hexavalent Chromium (ug/L)	7.5	10
			1,2,3-Trichloropropane (ug/L)	0.00375	0.005
			Uranium (pCi/L)	15	20

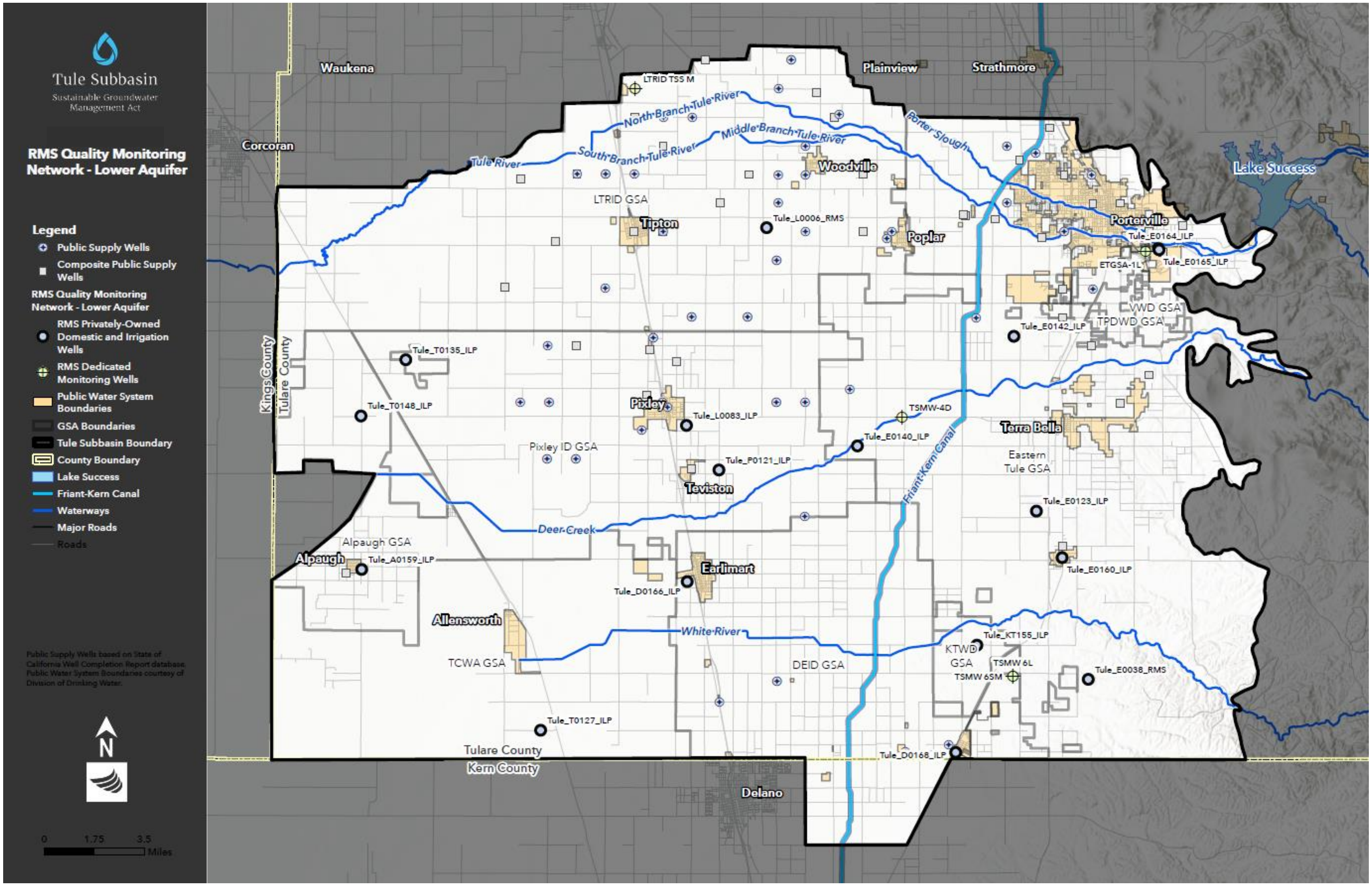
3.5.3.6.2 Lower Aquifer Groundwater Quality Monitoring Network

The current RMS network for the lower aquifer is provided in Figure 3-8. This figure shows RMS locations over the density of domestic and agricultural wells within each section. Domestic and Agricultural beneficial users have been identified as most vulnerable within the lower aquifer.

A summary of the Agency's lower aquifer RMS wells is shown in the following Table 3-7.

Table 3-7: Groundwater Quality Lower Aquifer RMS Wells

Groundwater Quality - Lower Aquifer Representative Monitoring Site Wells					
Master_Well_ID	Lat	Long	Top Perf	Bottom Perf	Well Depth
ETGSA-1U	36.0485573	-118.9930101	120	140	140


Tule Subbasin
Sustainable Groundwater Management Act
RMS Quality Monitoring Network - Lower Aquifer
Legend
Public Supply Wells
Composite Public Supply Wells
RMS Quality Monitoring Network - Lower Aquifer
RMS Privately-Owned Domestic and Irrigation Wells
RMS Dedicated Monitoring Wells
Public Water System Boundaries
GSA Boundaries
Tule Subbasin Boundary
County Boundary
Lake Success
Friant-Kern Canal
Waterways
Major Roads
Roads
Public Supply Wells based on State of California Well Completion Report database. Public Water System Boundaries courtesy of Division of Drinking Water.
N
0 1.75 3.5 Miles
Waukena
Corcoran
Plainview
Strathmore
Woodville
Tipton
Poplar
Porterville
Lake Success
Pixley
Teviston
Terra Bella
Earlimart
Alpaugh
Allensworth
Delano
Kings County
Tulare County
Kern County
LTRID GSA
Pixley ID GSA
Alpaugh GSA
TCWA GSA
DEID GSA
Eastern Tule GSA
KTWD GSA
VWD GSA
TPDWD GSA
Tule River
North Branch Tule River
Middle Branch Tule River
South Branch Tule River
Porter Slough
Deer Creek
White River
Friant-Kern Canal
LTRID TSS M
Tule_L0006_RMS
Tule_E0164_ILP
Tule_E0165_ILP
ETGSA-1L
Tule_E0142_ILP
Tule_T0135_ILP
Tule_T0148_ILP
Tule_L0083_ILP
TSMW-4D
Tule_E0140_ILP
Tule_P0121_ILP
Tule_E0123_ILP
Tule_A0159_ILP
Tule_D0166_ILP
Tule_E0160_ILP
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TSMW 6L
TSMW 65M
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Tule_T0127_ILP
Tule_D0168_ILP

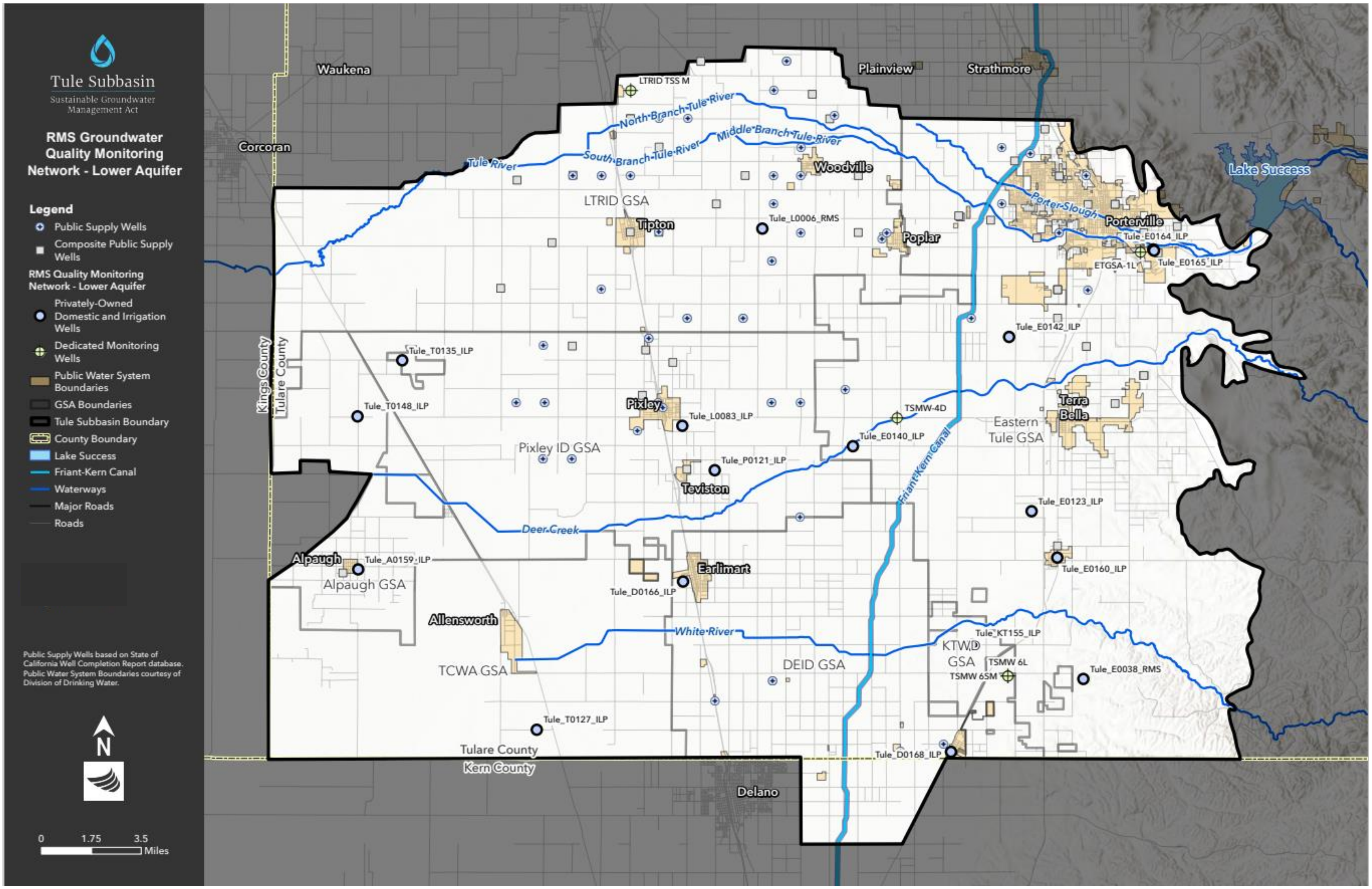

Figure 3-8. Lower aquifer groundwater quality monitoring network.

A summary of the sustainable management criteria specific to each upper aquifer RMS well is shown in Table 3-8.

Table 3-8: Groundwater Quality SMC for Lower Aquifer RMS Wells

Lower Aquifer RMS Well SMC					
GSA	PSAG	Well ID	Constituent of Concern	IMs & MO	MT
VDW	SVJ_Tule13	ETGSA-1U	DBCP (µg/L)	0.15	0.2
			Arsenic (µg/L)	7.5	10
			1,2,3 - TCP (µg/L)	0.00375	0.005
			PCE (µg/L)	0.00375	0.005
			Hexavalent Chromium (µg/L)	7.5	10
			Nitrate as N (mg/L)	7.5	10
			Uranium (pCi/L)	15	20

3.5.4 Land Subsidence

3.5.4.1 Land Uses and Infrastructure Vulnerable to Land Subsidence

§ 354.28(c)(5)(A)

There are multiple types of land uses that can be impacted by subsidence. In the Tule Subbasin, these land uses/infrastructure are summarized in Table 3-9 and include:

- Canals
- Water Delivery Pipelines
- Flood Control
- Wells
- Other Infrastructure (e.g. roads, buildings, other types of pipelines, etc.)

As noted in Section 2 of this Plan, the lands within the jurisdiction of the Agency are not anticipated to experience subsidence.

Friant-Kern Canal

The Friant-Kern Canal is a regional water delivery canal that extends from Millerton Reservoir northeast of Fresno to the Kern River in Bakersfield. The canal was completed by the United States Bureau of Reclamation (USBR) in 1951 with an original design capacity of 5,300 cubic feet per second (cfs). The canal delivers water for 26 contractors along its length.

Differential land subsidence rates along the portion of the Friant-Kern Canal that extends through portions of the Tule Subbasin has impacted the ability of the FWA to deliver surface water downstream of the impacted areas. Where the FKC crosses the northern and southern Eastern Tule GSA (ETGSA).

The FWA is currently repairing the FKC to restore the original flow capacity. The long-term effectiveness of the repairs at maintaining flow capacity in the canal relies on limiting additional land subsidence in the future within the design of the repairs. Recognizing the regional importance and value of the FKC, the ETGSA developed a Land Subsidence Monitoring Plan[3] and Management Plan[4] for the areas on either side of the canal. These plans are separate from, and in addition to, the monitoring plan established for the Tule Subbasin. The goal of the Land Subsidence Monitoring and Management Plans is to implement groundwater management measures necessary to minimize future non-recoverable land subsidence along the FKC in the SGMA transition period from 2020 – 2040 and to stop nonrecoverable land subsidence along the FKC after 2040. The area encompassed by the plan is shown on Figure 5 of **Attachment 6**, along with Management Zones that have been identified where management actions may be implemented.

The ETGSA Land Subsidence Monitoring Plan includes:

- An enhanced benchmark and groundwater level monitoring network,
- Establishment of a Land Subsidence Monitoring and Management Committee, and
- Annual Reporting

The Land Subsidence Management Plan establishes management action criteria for implementing enhanced management actions should land subsidence in any given Management Area reach certain thresholds. Four land subsidence thresholds, or "Tiers" have been established:

- Tier 1 – 0 to 1.49 ft of land subsidence
- Tier 2 – 1.5 to 1.99 ft of land subsidence
- Tier 3 – 2.0 to 2.49 ft of land subsidence
- Tier 4 – 2.5 to 2.99 ft of land subsidence.

Progressively aggressive management actions have been identified for each tier. Land subsidence in any given Management Area that exceeds the criteria, as measured semi-annually using InSAR data, triggers the management actions in the next higher tier.

These Tiers have been integrated into the MOs and MTs established for the Tule Subbasin.

[3] TH&Co, 2021. Eastern Tule Groundwater Sustainability Agency Land Subsidence Monitoring Plan. Dated September 2021.
[4] ETGSA, 2022. Eastern Tule Groundwater Sustainability Agency Land Subsidence Management Plan. Dated February 2022.

3.5.4.2 Land Subsidence Undesirable Results § 354.26(a)

3.5.4.2.1 Definition of Significant and Unreasonable Land Subsidence

The 2022 Tule Subbasin Coordination Agreement addressed undesirable results related to land subsidence as the following: *"Land subsidence that occurs during the transition period from 2020 to 2040 will be considered significant and unreasonable if damage and/or loss of functionality of a structure or a facility occurs to the extent that the structure or facility cannot reasonably operate without either repair or replacement, as determined by the GSA where the structure and facility are located or where beneficial use is impacted due to the damage and/or loss of functionality of the structure or facility."*

At a qualitative level, this definition is still applicable in the Tule Subbasin. Quantitative criteria for defining significant and unreasonable conditions vary depending on the type of land use and infrastructure under consideration.

3.5.4.2.2 Potential Causes of Undesirable Results § 354.26(b)(1)

Land subsidence in the Tule Subbasin is caused by prolonged pumping induced groundwater level declines, particularly during periods of below normal precipitation and limited surface water supplies. The rates and extent of subsidence in some areas of the subbasin are higher than others due to groundwater pumping patterns and unique area-specific hydrogeological conditions. Subsidence impacts may occur in the Subbasin even if groundwater levels stabilize, as residual subsidence from past overdraft can continue for many years after groundwater level decline slows or stops.[5]

3.5.4.2.3 Criteria for Defining Land Subsidence Undesirable Results § 354.26(b)(2)

The SGMA defines an undesirable result for land subsidence as "Significant and unreasonable land subsidence that substantially interferes with surface land uses."[6] DWR Best Management Practices for establishing SMC add that "All undesirable results will be based on minimum threshold exceedances. Undesirable results will be defined by minimum threshold exceedances at a single monitoring site, multiple monitoring sites, a portion of a basin, a management area, or an entire basin."[7]

In the Tule Subbasin, the primary criteria and metric to determine if land subsidence undesirable results occur will be the cumulative subsidence at each RMS. Reflecting the GSAs' commitment

[5] Lees, M., Knight, R., and Smith, R., 2022. Development and Application of a 1D Compaction Model to Understand 65 Years of Subsidence in the San Joaquin Valley. Water Resources Research, 58, e2021WR031390.

[6] California Water Code Part 2.74 Sustainable Groundwater Management, Chapter 2 Definitions, Section 10721(w)(5)

[7] CDWR, 2017. Best Management Practices for the Sustainable Management of Groundwater – Sustainable Management Criteria.

to minimizing subsidence and avoiding significant and unreasonable impacts to land uses throughout the subbasin, the quantitative definition of undesirable result is:

Ongoing land subsidence after 2020 that exceeds the cumulative subsidence minimum threshold at any given RMS Site that cannot be attributable to elastic conditions or measurement error is an undesirable result.

If the subsidence rate exceeds the interim milestone rate at any location or combination of locations in any given year, the GSA will expedite management actions before subsidence undesirable results occur.

3.5.4.2.4 Effects on Beneficial Users and Land Uses § 354.26(b)(3)

Land uses vulnerable to undesirable results from land subsidence include canals, pipelines, flood control, wells, or potentially other infrastructure (see Section 3.5.4.1 of this GSP). Historical land subsidence in the eastern part of the subbasin has caused reduced flow capacity in the Friant-Kern Canal (FKC), which has impacted downstream water rights holders.

The Tule Subbasin GSAs have established a Mitigation Program to address subsidence impacts to domestic and small community water system wells (see **Attachment 8**). The Mitigation Program allows for those believed to be impacted by land subsidence to submit a claim. Technical assistance to address claims and mitigation funding for claims shown to be caused by GSA activities will commence in the second quarter of 2025. The GSAs will perform outreach with local utility and infrastructure agencies to raise their awareness of the Mitigation Plan, how to apply, and benefits to them. The GSAs will also set up channels to routinely inquire as to any infrastructure damage from land subsidence which may occur during GSP implementation.

3.5.4.3 Land Subsidence Minimum Thresholds § 354.28(b)(1), (3), (4)

The minimum thresholds for land subsidence in the Tule Subbasin have been established to avoid significant and unreasonable impacts to land uses across the subbasin. As subsidence is not likely to occur in the Agency, therefore infrastructure such as local canals, water delivery pipelines, flood control and wells are not anticipated to be affected.

3.5.4.3.1 Relationship of Cumulative Land Subsidence Minimum Thresholds to Lower Aquifer Groundwater Levels § 354.28(b)(2)

The occurrence of land subsidence in the Tule Subbasin is directly correlated with pumping induced lowering of groundwater levels in areas where the subsurface aquifer system includes relatively thick silt and clay layers, as described in **Attachment 6** .

Under a stable condition, also known as a pre-consolidation condition, the forces maintaining the thickness of the compressible clay layers in the subsurface (the grain-to-grain contact and pore pressure) can counterbalance the weight of the sediments above the layer (the geostatic load). If the groundwater level is lowered below the pre-consolidation head, the pore pressure between the grains in the clay is reduced and the clay compresses under the weight of the sediments above it.

In the Tule Subbasin, the Lower Aquifer is confined beneath low permeability (i.e. silt and clay) layers (see **Attachment 2**). The large seasonal fluctuations and long-term decline in Lower Aquifer groundwater levels from pumping in this aquifer is a primary cause of land subsidence. Groundwater pumping from this aquifer creates large seasonal changes in groundwater levels, in many cases more than 100 feet. Land subsidence rates have been observed to increase during the low seasonal pumping levels.

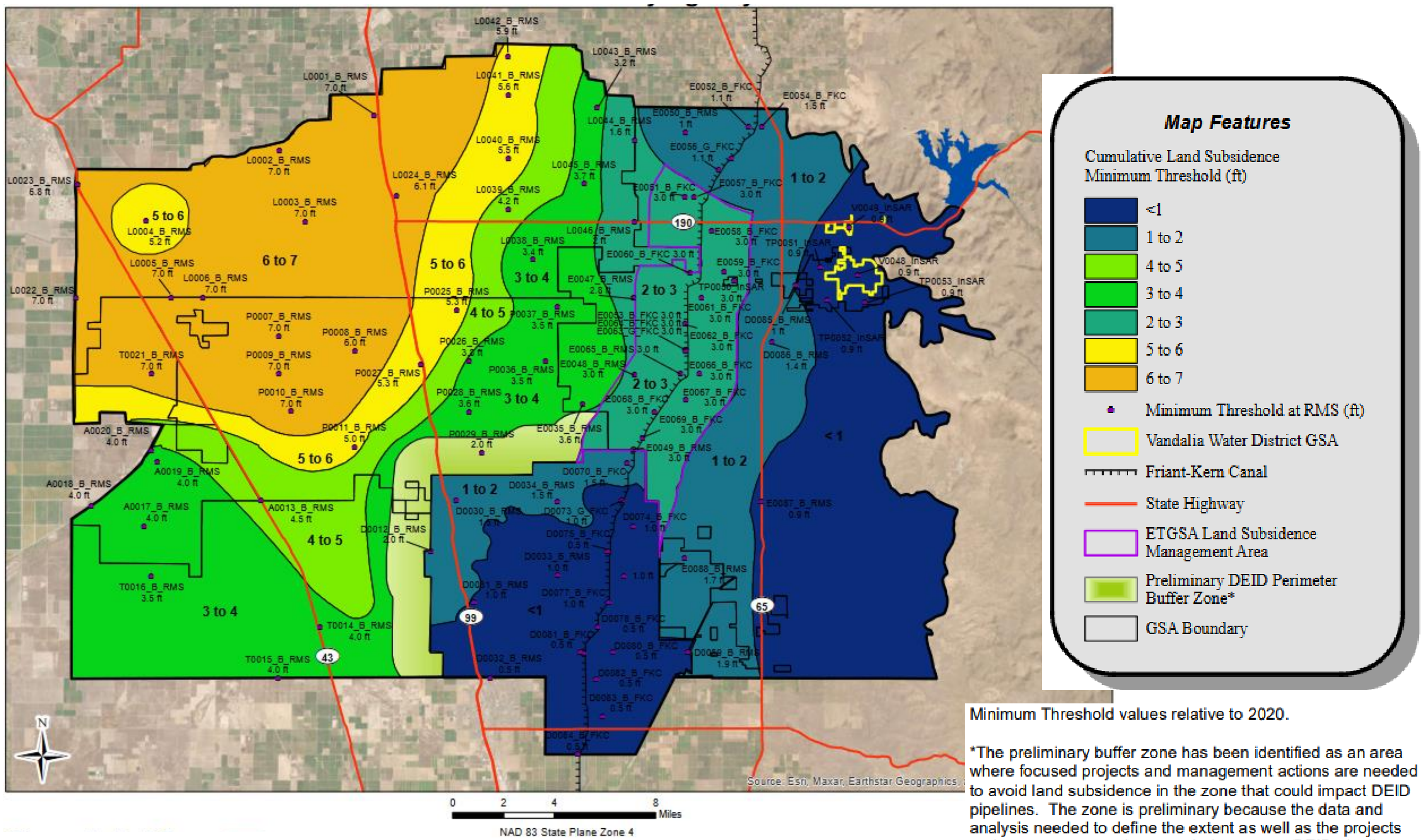

Figure 3-9. Cumulative land subsidence minimum thresholds.

Minimum Threshold values relative to 2020.

*The preliminary buffer zone has been identified as an area where focused projects and management actions are needed to avoid land subsidence in the zone that could impact DEID pipelines. The zone is preliminary because the data and analysis needed to define the extent as well as the projects and management actions needed to protect DEID pipelines are not available at this time (this is a data gap). In the meantime, the GSAs are coordinating to implement more frequent land subsidence monitoring as well as implementing a land subsidence management plan to avoid impacts to DEID's pipelines until the analysis can be completed.

Table 3-10: Cumulative Land Subsidence Minimum Thresholds by RMS Location

Land Subsidence RMS ID	Minimum Threshold (ft)
V0048_InSAR	0.9
V0049_InSAR	0.9

Given the correlation between Lower Aquifer groundwater levels and land subsidence, it is essential to establish Lower Aquifer groundwater level MTs and MOs to enable meeting the land subsidence goals. This is the reason that Lower Aquifer groundwater level MTs and MOs are addressed in this section of the GSP.

The methodology to establish Lower Aquifer MTs and MOs are based on data collected from InSAR and Lower Aquifer groundwater levels that have, for the most part, been collected since 2021. The methodology included the following steps:

1. TH&Co identified Lower Aquifer RMS wells with a suitable historical groundwater level record with which to correlate with land subsidence rates from InSAR (see Figure 3-10).
2. Historical groundwater levels were plotted on the same charts with InSAR land subsidence data to enable analysis of land subsidence rates and groundwater level changes over time (see Figure 3-10).
3. Lower Aquifer groundwater level MTs were selected to correlate to land subsidence rates that would prevent cumulative land subsidence at that location from reaching the cumulative land subsidence MT.

A notable exception to the methodology was implemented within the Agency, where no land subsidence occurred from 2015 to 2023, and less than 0.1 ft occurred between 2023 and 2024. In this area the MT for well 22S/28E-07M01 was based on the low groundwater level measured in 2015 (see Figure-3-10).

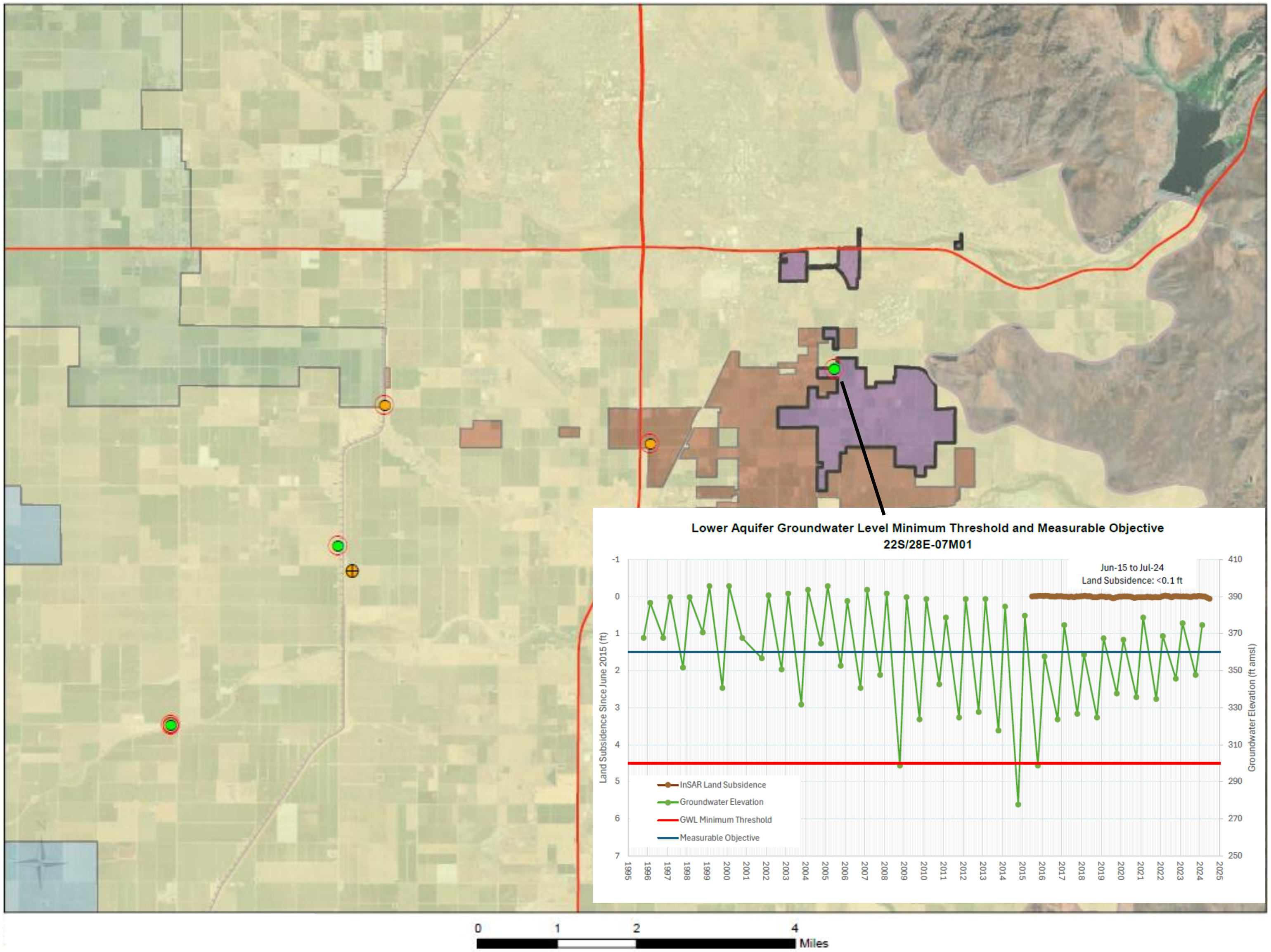

Figure 3-10. Lower aquifer representative monitoring site hydrographs.

Lower Aquifer groundwater level MOs were selected as the midpoint between the groundwater level MT and the April 2023 high groundwater level. Given the significant seasonal swings in groundwater levels, the MO level is meant to be an average annual groundwater level that should provide for operational flexibility while maintaining seasonal low levels above the MT.

3.5.4.3.2 Relationship of Cumulative Land Subsidence Minimum Thresholds to Other Sustainability Indicators §354.28(b)(2)

Potential relationships, if any, between the cumulative land subsidence MT and the MTs for other sustainability indicators include the following:

Reduction in groundwater storage. The groundwater storage MTs are based on the chronic lowering of groundwater level MTs. Because the subsidence MTs do not impact the chronic lowering of groundwater level MTs, they will similarly not impact the allowable reduction in groundwater storage MT.

Degraded water quality. A relationship between the land subsidence MT and water quality MTs has not been established. It is not anticipated that land subsidence will result in significant and unreasonable degradation of water quality. However, the Tule Subbasin GSAs are coordinating with other local agencies, non-profit organizations, and landowners to monitor for any potential degradation of water quality due to subsidence.

Depletion of interconnected surface water. Subsidence may change the slope of interconnected streams, but this likely has a marginal impact on depletion of interconnected surface water.

3.5.4.3.3 Effects on Adjacent Basins § 354.28(b)(3)

The Agency is a party to the Tule Subbasin Coordination Agreement, to coordinate minimum thresholds and measurable objectives within the Subbasin. There is ongoing work among the GSAs to coordinate the land subsidence MTs, particularly along the FKC and around the perimeter of DEID. Through this ongoing coordination, and with the collection of additional data, MTs in these areas may change.

The land subsidence MTs have been coordinated with adjacent basins to the extent possible. Subsidence MTs along the northern Agency boundary are the same as those proposed for the Kaweah Subbasin. Subsidence MTs along the western boundary are less than those proposed for the Tulare Lake Subbasin. As such, maintenance of land subsidence within the goals of the Agency should be protective of neighboring subbasins. As data is collected during the Plan implementation period, the Tule Subbasin GSAs, including the Agency will adapt and amend projects and management actions to achieve the sustainability goal.

3.5.4.3.4 Existing Standards § 354.28(b)(5)

There are no federal, state, or local regulations related to subsidence.

3.5.4.4 Land Subsidence Rates - Measurable Objective and Interim Milestones §354.30

Land subsidence rates in the Tule Subbasin will be used to define the subsidence measurable objective and interim milestones. Subsidence rates, as measured at each RMS, will provide the basis for compliance with subbasin subsidence goals.

The measurable objective (MO) for land subsidence in the Tule Subbasin is no inelastic (nonrecoverable) land subsidence after 2040. This is consistent with the GSAs' goal of minimizing and avoiding land subsidence in the Tule Subbasin.

Annual land subsidence rate interim milestones (IM) have been established to enable tracking of progress toward achieving the subsidence goals and to trigger projects and/or management actions if exceeded. Subsidence rate IMs were established at each RMS (see Figure 3-11). The subsidence rate IM was established for the period from 2024 to 2040 (16 years) and decreases over time. At each RMS, the rate IM for the first six years (2024 to 2030) is the average annual allowable land subsidence between 2024 and 2040 multiplied by 1.5 (see Figure 3-11). This allows for a higher rate in the first six years after revised GSP implementation to allow for implementation of projects and management actions to achieve the more aggressive cumulative land subsidence goals. The IM for the period between 2030 and 2035 is equal to the average annual subsidence multiplied by 0.75 to reflect the need to reduce subsidence to meet the goals. The MO for the period between 2035 and 2040 is zero inelastic land subsidence. Reducing the subsidence rate to zero prior to 2040 is intended to provide flexibility to account for potential residual subsidence although it is noted that Lower Aquifer groundwater level MTs have been established at elevations above the historical low elevations to enable meeting subsidence goals and minimizing residual land subsidence after 2040. A summary of land subsidence rate interim milestones for each Agency RMS is provided in Table 3-11.

Progress towards meeting land subsidence minimum thresholds, measurable objectives, and interim milestones will be tracked via the subsidence monitoring network shown on Figure 3-12. Within the Agency, this monitoring network consists of 2 InSAR measurement locations. Each of these InSAR data monitoring points constitutes a representative monitoring site for the purpose of monitoring progress with respect to land subsidence goals. Land subsidence rates will be documented on an annual basis.

Table 3-11: Land Subsidence Interim Milestones and Minimum Thresholds by RMS Location

Well Name	5 Year Interim Milestone (2024-2029)	6 Year Interim Milestone (2029-2035)	Land Subsidence Minimum Threshold (Relative to 01/2020)
22S/28E-07M01	0.09 ft/yr	0.04 ft/yr	0.9 ft

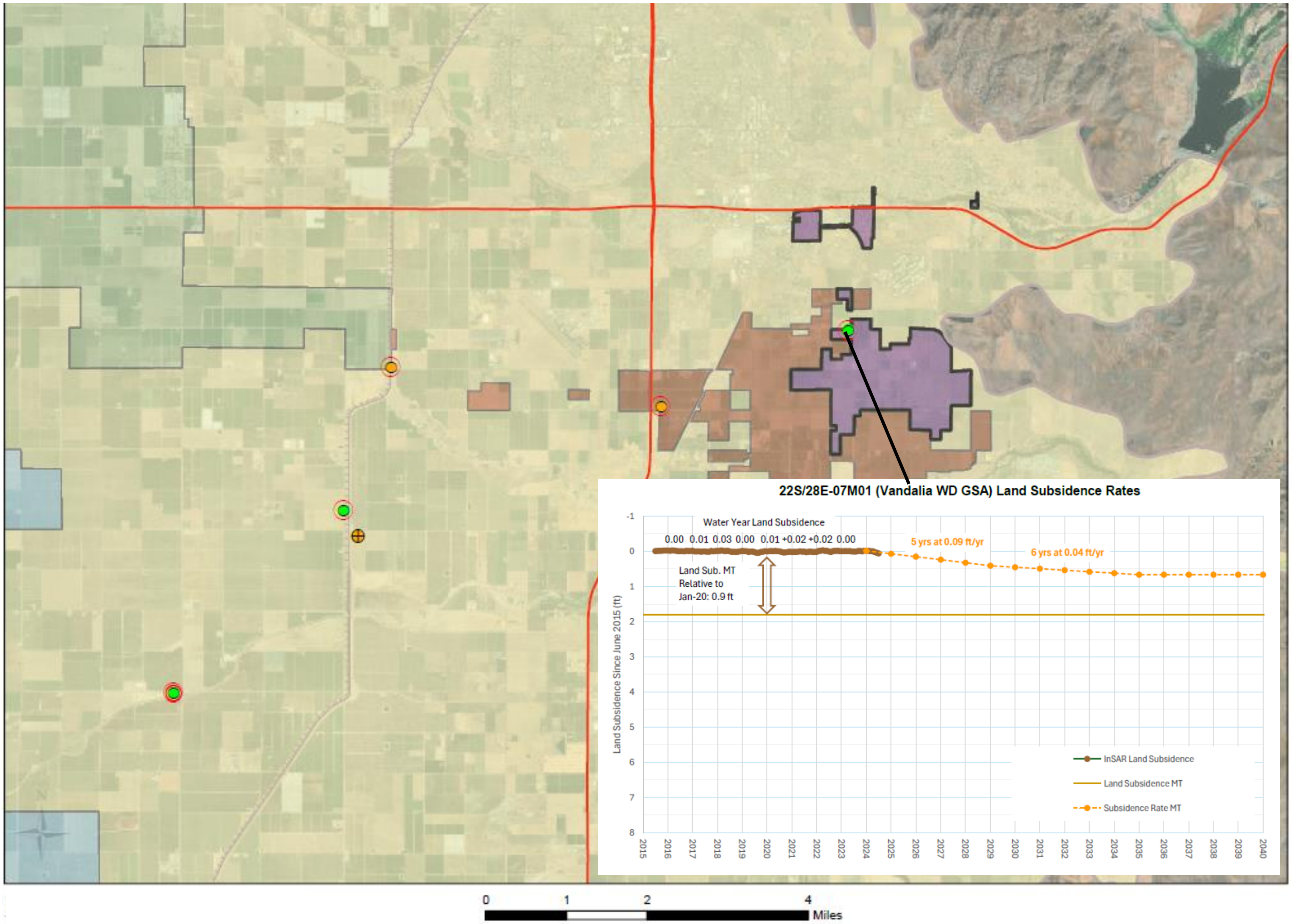

Figure 3-11. Land subsidence rate interim milestones.

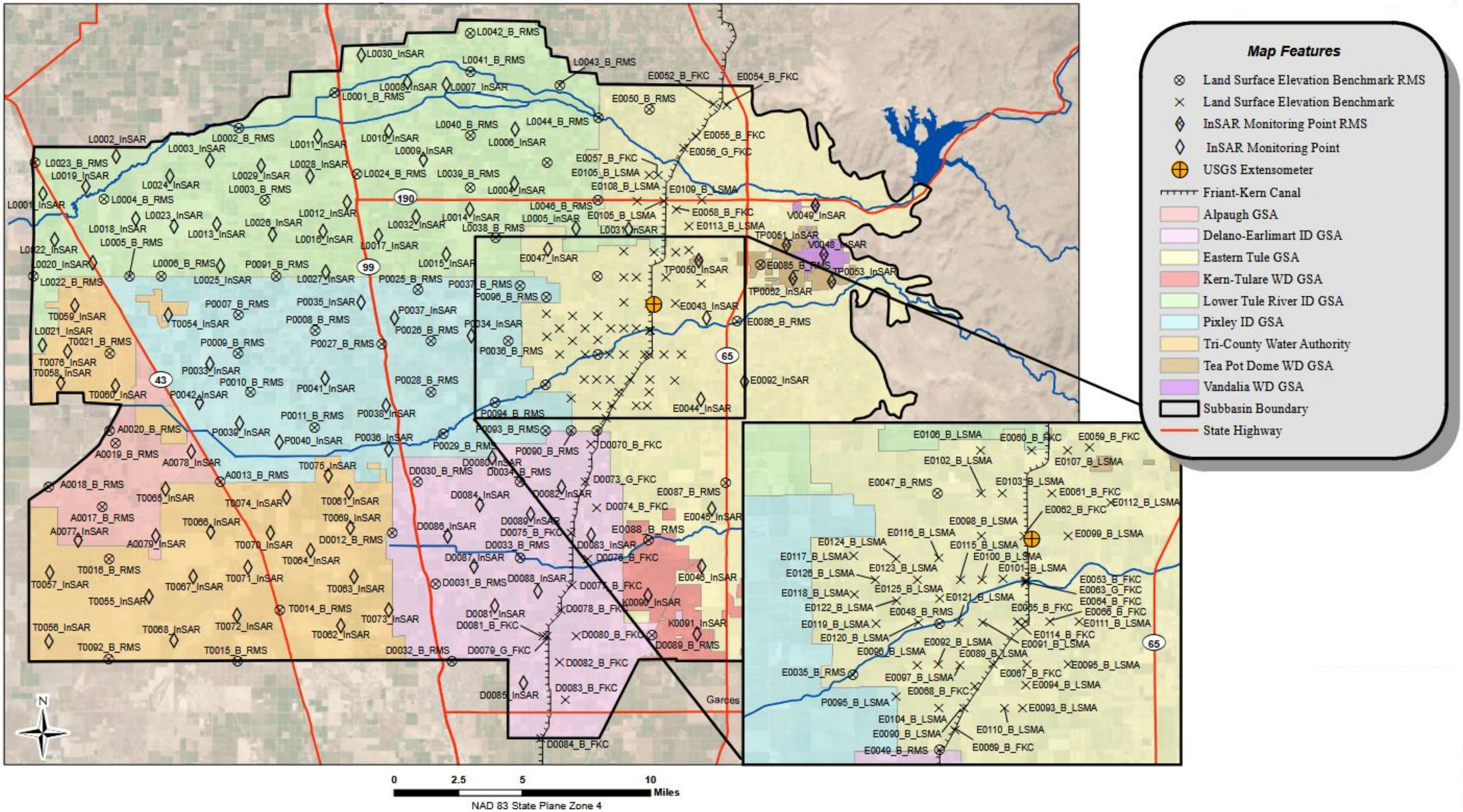

Figure 3-12. Land subsidence monitoring network.

3.5.5 Interconnected Surface Water §354.28(C)(6)(A), (6)(B)

3.5.5.1 Beneficial Uses and Users of Interconnected Surface Water § 354.26(b)

Beneficial uses and users of groundwater in the Tule Subbasin include domestic supply, municipal supply, agricultural supply, industrial supply, and environmental. Agricultural supply (related to surface water supply) and environmental (e.g. groundwater dependent ecosystems) are the most applicable beneficial uses and users related to Interconnect Surface Water.

3.5.5.1.2 Potential Causes of Undesirable Results § 354.26(b)(1)

Undesirable results from depletion of interconnected surface water can be caused by several factors, including groundwater pumping, extended periods of below normal precipitation and runoff, changes in groundwater and/or surface water management, or some combination of these factors. Within the Tule Subbasin, there are currently significant data gaps related to understanding the potential locations of interconnected surface waters and their nexus to depletions caused by groundwater pumping. More information is intended to be developed and shared through an Interconnected Surface Water Data Gap Workplan, which is outlined in the Tule Subbasin Monitoring Plan (see **Attachment 1**).

3.5.5.2 Undesirable Results for Interconnected Surface Water §354.26(a)

3.5.5.2.1 Definition of Significant and Unreasonable Conditions for Interconnected Surface Water §354.26(b)(2)

Impacts to ISW are considered significant and unreasonable when:
Groundwater dependent ecosystem (GDE) health has declined such that the ecosystem's recovery is non-recoverable. These fluctuations in GDE health are deemed significantly and unreasonably impacted due to groundwater pumping when a GDE cannot recover in seasonal high conditions.
Surface water access for surface water rights holders or riparian rights holders of adjacent or downstream users has been reduced due to groundwater pumping extracting underflows.

3.5.5.2.2 Quantification of Undesirable Results for Interconnected Surface Water §354.26(b)(2)

Quantification of undesirable results will require an understanding of the nature and locations of ISW within the Tule Subbasin and the cause and effect of groundwater pumping on depletions of ISW. Estimating depletions will require additional data and analyses that are not available at this time. Further, the methodology to estimate depletions will rely on guidance from the DWR which is not yet published. In the meantime, the Tule Subbasin GSAs have identified an interim monitoring network to monitor groundwater levels near areas where ISW is possible and have developed a work plan to supplement the monitoring network to address data gaps with respect to ISW and GDEs.

3.5.5.3 Interconnected Surface Water Minimum Thresholds and Measurable Objectives

Development of Sustainable Management Criteria (SMC) including MTs and MOs will be identified if ISW conditions are identified within the Agency. In the event that they are identified, SMC will be informed by the determination of undesirable results from the previous step.