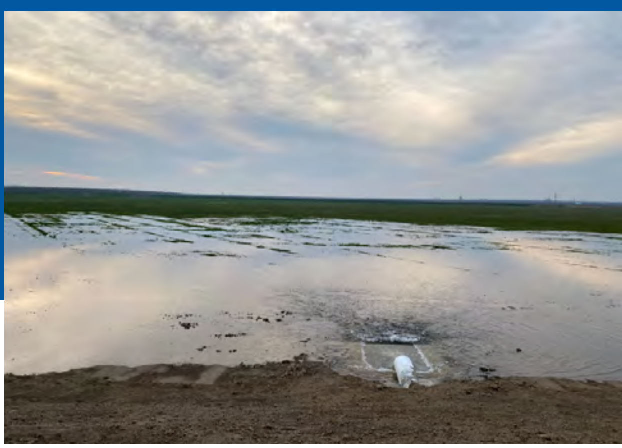

Madera Subbasin Groundwater Sustainability Plan

Periodic Evaluation

January 2025

DAVIDS ENGINEERING, INC

Luhdorff & Scalmanini Consulting Engineers

PROVOST&PRITCHARD CONSULTING GROUP

QK

PREPARED FOR

City of Madera GSA
County of Madera GSA - Madera Subbasin
Gravelly Ford Water District GSA
Madera Irrigation District GSA
Madera Water District GSA
New Stone Water District GSA
Root Creek Water District GSA

PREPARED BY

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AFY	acre-feet per year
AEM	Airborne Electromagnetic surveys
As	Arsenic
C2VSim	California Central Valley Groundwater-Surface Water Simulation Model
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
CM GSA	City of Madera GSA
DMP	demand management program
DMS	data management system
DWMP	Domestic Well Mitigation Program
DWR	California Department of Water Resources
EO	Executive Order
ET	Evapotranspiration
ETAW	evapotranspiration of applied groundwater
FWA	Friant Water Authority
GDE	Groundwater-dependent ecosystem
GFWD GSA	Gravelly Ford Water District GSA
GIS	geospatial information system
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWS	Groundwater System
HCM	Hydrogeologic Conceptual Model
IM	interim milestone
InSAR	Interferometric Synthetic Aperture Radar
IRWM	Integrated Regional Water Management
ISW	Interconnected Surface Water
MC GSA	County of Madera GSA – Madera Subbasin
MCL	Maximum contaminant level
MCSim	Madera-Chowchilla Groundwater-Surface Water Simulation Model
mg/L	Milligrams per liter
MID GSA	Madera Irrigation District GSA
MLRP	Multibenefit Land Repurposing Program
MO	measurable objective
MOU	memorandum of understanding
MT	minimum threshold
MWD GSA	Madera Water District GSA
MWELO	Model Water Efficient Landscape Ordinance
NM	no measurement
N	Nitrogen
NO3N	Nitrate
NRCS	Natural Resources Conservation Service
NSWD GSA	New Stone Water District GSA
PBO	Plate Boundary Observatory
PMAs	projects and management actions
POC	Point of Contact
PRISM	Parameter-elevation Regressions on Independent Slopes Model
RCWD GSA	Root Creek Water District GSA
RMS	representative monitoring site
SB	Senate Bill
SCADA	supervisory control and data acquisition
SGMA	Sustainable Groundwater Management Act
SJRRP	San Joaquin River Restoration Program
SMC	sustainable management criteria
SWS	Surface Water System
TDS	Total Dissolved Solids
ug/L	Micrograms per liter

USBR	United States Bureau of Reclamation
VLRP	Voluntary Land Repurposing Program
WY	water year

Executive Summary

Background

The Madera Subbasin (Subbasin[1]) is a critically overdrafted subbasin subject to the requirements of the Sustainable Groundwater Management Act of 2014 (SGMA). The Subbasin is cooperatively managed by seven Groundwater Sustainability Agencies (GSAs) under four Groundwater Sustainability Plans (GSPs) and one Coordination Agreement (**Table ES-1 and Figure ES-1**). Four GSAs have jointly developed one GSP that is referred to as the Joint GSP, including: City of Madera GSA (CM GSA), County of Madera GSA – Madera Subbasin (MC GSA), Madera Irrigation District GSA (MID GSA), and Madera Water District GSA (MWD GSA). These four GSAs are collectively referred to as the Joint GSP GSAs. The remaining three GSAs – Gravelly Ford Water District GSA (GFWD GSA), New Stone Water District GSA (NSWD GSA), and Root Creek Water District GSA (RCWD GSA) – have each developed their own GSPs. The four GSPs and Coordination Agreement are collectively referred to as the Plan for the Subbasin. The Plan for the Subbasin has been developed and is now being implemented with the objective of sustainably managing groundwater conditions in the Subbasin within 20 years of Plan implementation without adversely affecting the ability of an adjacent basin to likewise achieve and maintain sustainable groundwater conditions. Plans for all critically overdrafted subbasins were required to be adopted and submitted to the California Department of Water Resources (DWR) by January 31, 2020, with Plan implementation continuing thereafter through 2040.

Table ES-1. Organization of GSAs, GSPs, and Coordination Agreement in the Subbasin.

GSA	GSA Abbreviation	GSP	Coordination Agreement	GSA Area (Acres[1])
City of Madera GSA	CM GSA	Joint GSP	Madera Subbasin Coordination Agreement	10,100
County of Madera GSA – Madera Subbasin	MC GSA			177,800
Madera Irrigation District GSA	MID GSA			133,850
Madera Water District GSA	MWD GSA			3,700
Gravelly Ford Water District GSA	GFWD GSA	GFWD GSP		8,400
New Stone Water District GSA	NSWD GSA	NSWD GSP		4,200
Root Creek Water District GSA	RCWD GSA	RCWD GSP		9,550
			Total	347,600

[1] The GSA boundaries have been updated since the 2020 Initial Plan was developed and the boundaries indicated in this table may not include the most recent version of the boundaries. Updates will occur during the second Periodic Evaluation and/or Annual Reports as those updates are finalized and as geospatial information indicating those updates is available. This statement applies to all applicable boundary areas indicated in the 2025 Periodic Evaluation, the 2025 Plan Amendment, and appendices.

[1] Groundwater basin number 5-022.06, part of the San Joaquin Valley Groundwater Basin, as defined by DWR Bulletin 118 (DWR, 2003) and updated in 2016

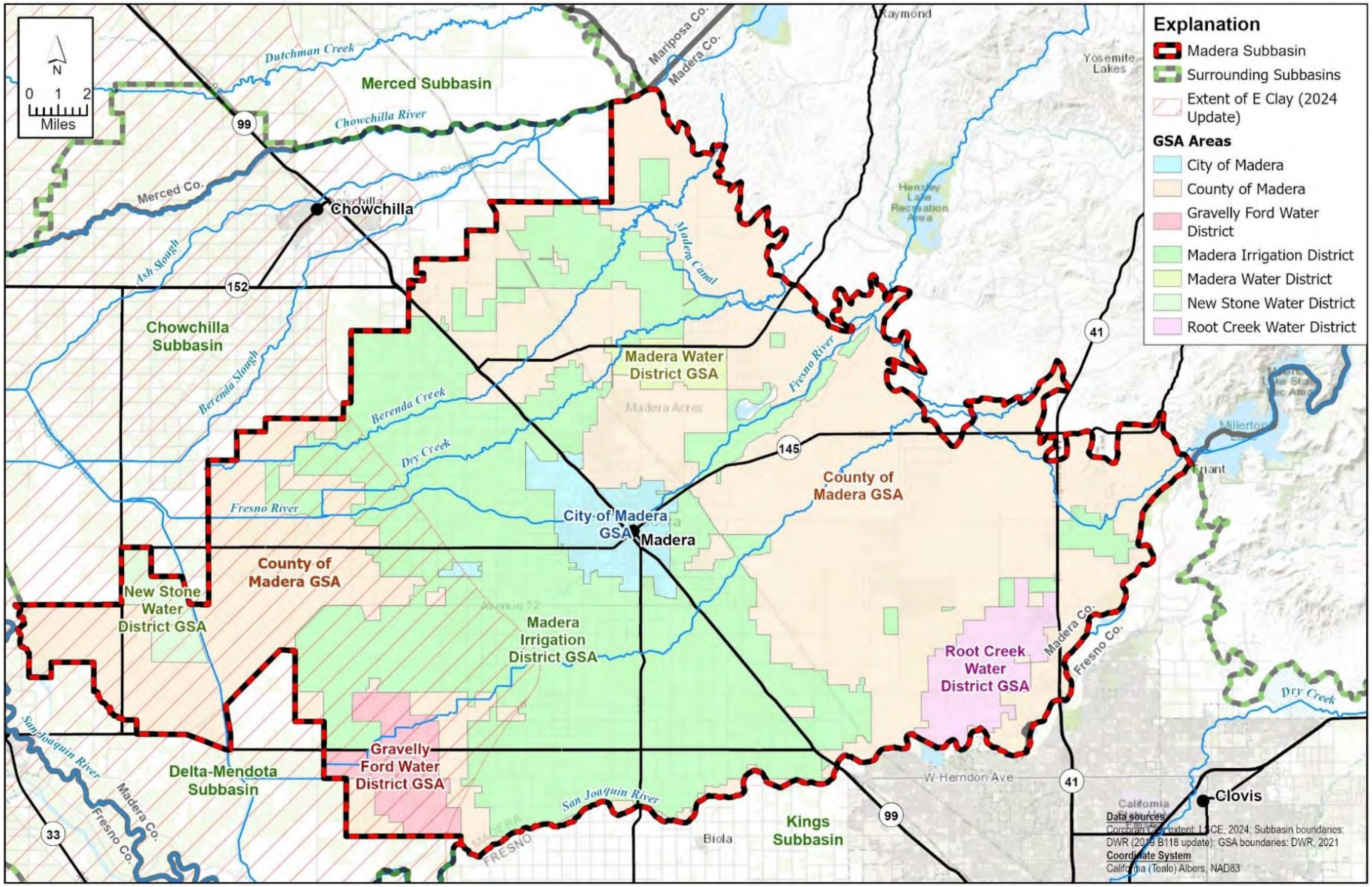


Figure ES-1. Subbasin Boundaries and GSAs.[1]

[1] The GSA boundaries have been updated since the 2020 Initial Plan was developed and the boundaries indicated in this figure may not include the most recent version of the boundaries. Updates to figures will occur during the second Periodic Evaluation and/or Annual Reports as those updates are finalized and as geospatial information indicating those updates is available. This statement applies to all figures contained in the 2025 Periodic Evaluation, the 2025 Plan Amendment, and appendices.

Overview of the 2025 Periodic Evaluation

The California Code of Regulations Title 23 (23 CCR) §356.4 requires GSAs in subbasins with a DWR-approved Plan to evaluate their Plan at least every five years and whenever the Plan is amended, and to provide a Periodic Evaluation to DWR at that time. The Periodic Evaluation is a written assessment describing whether implementation of the Plan, including implementation of projects and management actions (PMAs), are progressing to meet the sustainability goal for the subbasin. Specific requirements of Periodic Evaluations are described in 23 CCR §356.4.

This document is the 2025 Periodic Evaluation for the Plan, providing an assessment of conditions in the Subbasin and describing Plan implementation activities during the first Periodic Evaluation cycle from January 31, 2020 through January 31, 2025. During this period, the GSAs began implementing the initial Plan in January 2020 (the 2020 Initial Plan), and later revised the Plan in March 2023 (the 2023 Revised Plan). The 2023 Revised Plan was approved by the California Department of Water Resources (DWR) in December 2023. The 2023 Revised Plan was subsequently amended in 2024-2025, culminating in the adoption and submittal of the Amended Plan in January 2025 (the 2025 Plan Amendment). **The 2025 Plan Amendment accompanying the 2025 Periodic Evaluation has been amended to address recommended corrective actions identified by DWR in their December 2023 approval of the 2023 Revised Plan.** The Subbasin GSAs have reconciled or substantively progressed efforts to address all of DWR's recommended corrective actions in the 2025 Plan Amendment. Revisions to address DWR's recommended corrective actions are summarized in **Section 9** and in **Appendix 1.A.2** of this 2025 Periodic Evaluation. The GSAs' coordination and efforts to address all these topics are also described throughout this 2025 Periodic Evaluation, as applicable, and cross-referenced with the 2025 Plan Amendment.

The purpose of this 2025 Periodic Evaluation is to provide (1) an evaluation and written assessment of the 2025 Plan Amendment, including a discussion of the Plan amendments and the reasons for those amendments; and (2) an evaluation of whether the 2025 Plan Amendment is on track to meet the sustainability goal for the Subbasin, and whether it continues to meet the requirements of SGMA. **Consistent with guidance from DWR, this 2025 Periodic Evaluation is focused on an evaluation of the Subbasin and Plan implementation with respect to the 2025 Plan Amendment, following any amendments made in prior versions of the Plan.**

Despite multiple GSPs in the Subbasin, the GSAs have worked continuously over the last several years to seek consensus, striving to bring consistency across the four GSPs where possible and eliminating contradictory policies, procedures, and methodologies. The Subbasin GSAs have committed to continued coordination in an effort to eliminate areas of disagreement. The GSAs continued various outreach efforts identified in their GSPs during this Periodic Evaluation cycle, including public Board and governing body meetings during which they discussed topics pertinent to GSP implementation and groundwater management in the Subbasin. During development of the 2025 Plan Amendment and the 2025 Periodic Evaluation, the GSAs conducted further public outreach through these meetings and other PMA-focused public meetings with stakeholders.

Summary of Groundwater Conditions Relative to the Sustainable Management Criteria

Section 2 of this 2025 Periodic Evaluation evaluates and describes groundwater conditions in the Subbasin relative to the SMC established in the 2025 Plan Amendment. The Subbasin GSAs generally remain on track to achieving the Subbasin sustainability goal, as evidenced by current groundwater conditions in the Subbasin relative to the 2025 IMs described in the 2025 Plan Amendment:

- **Groundwater Levels:** Review of the Fall 2024 groundwater elevation measurements that are available for 30 RMS wells indicates that a majority (24 RMS wells) of groundwater elevations are above the 2025 IMs. RMS wells that are not currently above the 2025 IMs are evenly distributed throughout the Subbasin and are primarily lower aquifer wells. As recharge projects throughout the Subbasin continue to be implemented and operated, the benefits of these projects will take a longer time to appear in deeper wells. As is expected in a critically overdrafted basin, some impacts to beneficial uses and users have occurred within the first five years of the GSP implementation period specifically with regard to reported dry wells. However, the Subbasin GSAs have made progress towards the establishment of a Domestic Well Mitigation Program in the Subbasin to help address these impacts.
- **Groundwater Storage:** Groundwater levels are used as a proxy for the groundwater storage sustainability indicator.
- **Water Quality:** Review of the 2024 measurements that are available for water quality parameters indicate that concentrations at RMS sites remain generally below the 2025 IMs (arsenic: 75% of RMS are below; nitrate as nitrogen (N): 91% of RMS wells are below; total dissolved solids (TDS): 50% of RMS wells are below). IMs for groundwater quality were established based on available data with the intent to not lead to degradation of existing groundwater quality conditions that would make groundwater unsuitable for the most restrictive beneficial use of municipal and domestic supply. However, the IMs are based on the average concentration over a three-year monitoring period and there is insufficient data at this time to determine the three-year average, so the comparison to the 2025 IM should be considered a snapshot look at concentrations in the Subbasin.
- **Land Subsidence:** All RMS stations had a cumulative total less than the 2020 to 2025 IM.
- **Interconnected Surface Water:** Due to monitoring challenges at the selected RMS wells, there is not enough data currently available to evaluate the ISW SMC at this time. However, the Subbasin GSAs have continued various ISW-related efforts, including refinement of an ISW Workplan and ongoing ISW-related coordination with other agencies in the region – including USBR, FWA, and certain GSAs in the Kings Subbasin. The GSAs are also currently in discussions to take over monitoring of the ISW RMS wells from the SJRRP.
- **Seawater Intrusion**: Not applicable in the Subbasin.

Status of Projects and Management Actions

Projects and management actions (PMAs) that are being planned, developed, or implemented by the Subbasin GSAs are recognized in **Section 3** and described further in the GSP 2025 Periodic Evaluation Elements for each respective GSP (**Appendices 1.B.1** through **1.B.4**). The GSAs have made significant progress in implementing PMAs, as evidenced by the PMA status updates and the benefits reported thus far. Most PMAs proposed in the 2020 Initial Plan are still applicable, and the GSAs have made considerable strides to develop, refine, and implement planned PMAs, and to identify new PMAs during this Periodic Evaluation cycle. As described in the 2025 Plan Amendment, PMAs are focused on supporting groundwater conditions with respect to all applicable sustainability indicators primarily by increasing recharge, reducing groundwater pumping, and/or reducing demand. PMAs are also being prioritized to focus benefits, to the extent feasible, in areas with drinking water wells and areas prone to subsidence. These efforts directly support the GSAs' commitment to avoid undesirable results and achieve and maintain sustainable conditions with respect to groundwater levels, groundwater storage, groundwater quality, land subsidence, and ISW. Consequently, the suite of identified PMAs are also anticipated to benefit groundwater conditions for all beneficial uses and users in the Subbasin.

As of water year (WY) 2023 – the most recently completed Annual Report during this Periodic Evaluation cycle – updates were reported for more than 30 PMAs developed by the Subbasin GSAs. **In total, approximately 96,100 acre-feet per year (AFY) of reported benefits occurred, on average, in years when PMA implementation was feasible through WY 2023**[2] (**Table ES-2**), not including early benefits achieved through enforcement of MC GSA's groundwater allocation. This represents approximately 43% of the total estimated average benefits at 2040 for the Subbasin GSAs' PMAs. However, it is noted that WY 2019-2023 included very wet conditions and substantial recharge in 2023. The Subbasin GSAs are planning PMAs and other GSP implementation efforts with the expectation that landmark wet years, such as 2023, will not occur again prior to 2040 (see **Sections 3 and 4.3.2**).

The Subbasin GSAs remain committed to adaptive management of groundwater resources through their suite of identified PMAs. As PMAs are implemented and monitored, the timelines of other PMAs and the volume of demand management necessary to achieve sustainability will be reviewed. If adjustments are needed to meet the sustainability goal for the Subbasin, PMA implementation efforts will be evaluated and adjusted. Already, changes to PMA implementation have been informed by changing conditions and new understanding of the Subbasin. For instance, MC GSA has refined its demand reduction targets as part of its demand management program based on new understanding of overdraft in the MC GSA since the 2020 Initial Plan was developed, increasing targets from 90,000 AFY to 113,000 AFY. MID GSA and RCWD GSA have also substantially refined their PMAs, working to hasten recharge projects and facilitate surface water use to support groundwater sustainability, consistent with the Subbasin GSAs' adaptive management commitment. Each Annual Report represents an important milestone and recurrent opportunity for the GSAs to collectively review groundwater conditions in the Subbasin and report on the status of PMA implementation efforts.

[2] Averages were calculated based on reported PMA benefits in *only those years when implementation was feasible* during this Periodic Evaluation cycle. Benefits are reported through WY 2023, as that was the most recently completed Annual Report during this Periodic Evaluation cycle.

Table ES-2. Summary of Benefits to the Subbasin from PMA Implementation, Estimated and Reported as of the Water Year 2023 Annual Report.

GSA	Estimated Average Benefit of all PMAs at 2040 (AFY, rounded)[1]	Average Reported Benefit of all PMAs in Years Implementation Occurred[2,3] (WY 2019-2023) (AFY, rounded)	Average Reported Benefit as a Percent of Estimated Average Benefit at 2040[3] (%)	Agricultural Demand Reduction[4]
MWD	2,810	2,140	76	-
MID	49,170	38,540	78	💧
MC	145,090	42,130	29	💧💧💧💧💧
CM	4,000	4,120	103	-
GFWD	14,200	4,000	28	-
NSWD	1,600	110	7	-
RCWD	4,200	5,060	120	💧💧💧
Total	221,070	96,100	43	

[1] Estimates developed for full PMA implementation. Estimated average benefits are summarized from the 2025 Periodic Evaluation GSP Attachments (Appendix 1.B). Some PMAs have been modified since the 2020 Initial Plan was developed, so these totals may not equal the totals reported in the 2020 Initial Plan.
[2] Averages were calculated based on reported PMA benefits in *only those years when implementation was feasible* during this Periodic Evaluation cycle. Reported benefits are consistent with the water budgets in the Annual Reports completed during this Periodic Evaluation cycle, and do not otherwise change the Subbasin water budget as reported in the Annual Reports.
[3] Benefits are reported for PMAs through the most recently completed Annual Report during this Periodic Evaluation cycle (WY 2023).
[4] Symbols are representative of the relative magnitude of agricultural demand reduction anticipated from PMA implementation, and are not intended to indicate a specific volume of agricultural demand reduction.

Other Elements of the Periodic Evaluation

The remainder of this 2025 Periodic Evaluation addresses other elements required per 23 CCR §356.4, including:

- Evaluation of the basin setting based on new information or changes in water use (**Section 4**). Highlights include:
    - Updates to the Subbasin HCM afforded through new data, reports, and analyses in this Periodic evaluation cycle (**Section 4.1**).
    - Updates to Subbasin groundwater conditions based on improvements to understanding of regional conditions and new data, reports, and analyses in this Periodic evaluation cycle (**Section 4.2**).
    - Updates to the Subbasin water budget during this Periodic Evaluation cycle, incorporating new Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) updates and refinements (**Sections 4.3 and 4.4**).

- Evaluation of the Subbasin monitoring networks, including updates and improvements made to the monitoring networks and efforts to address data gaps during this Periodic Evaluation cycle (**Section 5**).

- Summary of the GSAs' authorities (e.g., regulations or ordinances) and enforcement or legal actions that the GSAs have established or exercised during the first Periodic Evaluation cycle in furtherance of the sustainability goal for the Subbasin (**Section 6**). Updates are also provided for other policies, regulations, and orders at the local, state, and/or federal level that have impacted SGMA implementation in the Subbasin.

- Summary of the GSAs' outreach, engagement, and coordination with other agencies on a variety of topics, including coordination amongst the Subbasin GSAs and coordination with other agencies outside the Subbasin (**Section 7**). Highlights include, but are not limited to:
    - Engagement of facilitation support services to assist the GSAs in working through and eliminating any areas of disagreement, including topics related to the Coordination Agreement and the domestic well mitigation program.
    - Coordinated development of the domestic well mitigation program.
    - ISW-related coordination with USBR, FWA, and GSAs in the Kings Subbasin.
    - Subsidence-related coordination with critical infrastructure owners and operators.

- Other information, including consideration of adjacent basins and challenges for SGMA implementation (**Section 8**).

- Summary of completed revisions to Plan elements in the 2025 Plan Amendment (**Section 9**). Specific revisions to the Plan elements that were completed as part of the 2025 Plan Amendment are also identified in **Appendix 1.A.2**.

Organization of the Periodic Evaluation

The 2025 Periodic Evaluation has been developed in alignment with the requirements of 23 CCR §356.4, describing efforts made to implement the Plan during this Periodic Evaluation cycle, as well as new insights into Subbasin conditions. The 2025 Periodic Evaluation also considers comments received from DWR in its review of the Subbasin Annual Reports, which requested greater coordination among the Subbasin GSAs and preparation of one cohesive Annual Report for the Subbasin.

In reflection of ongoing coordination across the Subbasin, the Subbasin GSAs have developed a coordinated 2025 Periodic Evaluation with the following organizational structure:

- **One cohesive Subbasin-wide document (this 2025 Periodic Evaluation)** that reviews and evaluates elements of the Periodic Evaluation pertinent to the entire Subbasin and all four GSPs.
- **Four GSP-specific attachments (the 2025 Periodic Evaluation GSP Attachments)** that each review and evaluate content and amendments specific to each GSP. The 2025 Periodic Evaluation GSP Attachments are included in **Appendix 1.B**, and are referenced where appropriate:
    - **Appendix 1.B.1**: Joint GSP 2025 Periodic Evaluation Elements
    - **Appendix 1.B.2**: GFWD GSA GSP 2025 Periodic Evaluation Elements
    - **Appendix 1.B.3**: NSWD GSA GSP 2025 Periodic Evaluation Elements
    - **Appendix 1.B.4**: RCWD GSA GSP 2025 Periodic Evaluation Elements

The 2025 Periodic Evaluation and the 2025 Periodic Evaluation GSP Attachments each follow the same general structure, with cross-referencing between documents as appropriate to capture all content pertinent to the Subbasin as a whole and to each individual GSP. Content across the 2025 Periodic Evaluation includes the following, in alignment with 23 CCR §356.4:

- New Information Collected (§356.4(f))
- Groundwater Conditions Relative to Sustainable Management Criteria (§356.4(a))
- Status of Projects and Management Actions (§356.4(b))
- Basin Setting Evaluation Based on New Information or Changes in Water Use (§356.4(c)-(d))
- Monitoring Networks Evaluation (§356.4(e))
- GSA Authorities and Enforcement Actions (§356.4(g)-(h))
- Outreach, Engagement, and Coordination with other Agencies (§356.4(j))
- Other Information (§356.4(k))
- Summary of Proposed or Completed Revisions to Plan Elements (§356.4(i))

1 New Information Collected or Acquired (§356.4(f))

This section describes new information that was collected or acquired during this Periodic Evaluation cycle that has informed updates to the 2025 Plan Amendment and/or this 2025 Periodic Evaluation. **Table 1-1** summarizes the new information sources with respect to monitoring data, reports, groundwater model updates, coordination with other agencies, data provided by DWR, and data from other non-DWR sources. Further details regarding each information source are provided in the subsections below.

Specific section references are given for the Joint GSP 2025 Plan Amendment, although these information sources may also be applicable to other portions of the 2025 Plan Amendment.

Table 1-1. Summary of New Information Collected or Acquired During the First Periodic Evaluation Cycle (January 2020 – January 2025).

Significant New Information Collected	Description	Aspects of Plan Affected[1]	Changes to Aspects of Plan Warranted?[1]
Drilling and monitoring data from installation of nested monitoring wells at 9 sites between 2019-2022	Lithologic and geophysical logs; Groundwater level and groundwater quality data.	2.2 Basin Setting (e.g., refinement of Corcoran Clay extent); 3.0 SMC (e.g., refinement of RMS networks)	Yes; Sections 2.2 and 3.0; also incorporated into Groundwater Model Updates (Appendix 6.D)
Reports from DWR	Considerations for Identifying and Addressing Drinking Water Well Impacts (DWR, 2023); ISW white papers released for public review in 2024 (DWR, 2024a; DWR, 2024b; DWR, 2024c)	4.0 PMA (e.g., plans for Domestic Well Mitigation Program); 3.0 SMC (e.g., description of next steps to refine ISW SMC and ISW Workplan)	Yes; incorporated into ongoing development of Domestic Well Mitigation Program; will be incorporated into refined ISW SMC in the future
Reports from non-DWR Sources	Domestic Well Inventory Report (2022); Monitoring Well Installation Reports (2020-2022); ISW/Subsidence Workplans (2024)	4.0 PMA (e.g., plans for Domestic Well Mitigation Program); 2.2 Basin Setting (e.g., refinement of Corcoran Clay extent; descriptions of data gaps); 3.0 SMC (e.g., refinement of RMS networks; steps to fill data gaps)	Yes; Sections 2.2, 3.0, and 4.0; Updated RMS Networks; Updated SMC; Groundwater Model Updates
Groundwater Model Updates	Update model with actual hydrology through WY 2023, incorporated DWR's Integrated Water Flow Model (IWFM) subsidence package, HCM refinements, and model recalibration	3.0 SMC (e.g., refinements to interim milestones (IM) and some measurable objectives (MO) and minimum thresholds (MT)	Groundwater Model Updates used to Refine SMC
Coordination with Other Agencies	Technical coordination with other Subbasin GSPs and GSAs; ISW Discussions w/ Kings Subbasin, USBR, FWA, and SJRRP	3.0 SMC (e.g., refinements to IM and some MO/MT); Refinements to ISW Workplan	Refinements and Updates to how SMC addressed in coordinated manner in all four Subbasin GSPs; Future ISW SMC updates will reflect

Significant New Information Collected	Description	Aspects of Plan Affected[1]	Changes to Aspects of Plan Warranted?[1]
			ISW coordination meetings/discussions
Data Provided by DWR	Interferometric Synthetic Aperture Radar (InSAR); Airborne Electromagnetic surveys (AEM)	2.2 Basin Setting (e.g., refinement of depth to bedrock, refined understanding of ongoing subsidence);	Groundwater Model Updates (Appendix 6.D); 1D Subsidence Model (Appendix 6.E)
Data from non-DWR Sources	OpenET	2.2 Basin Setting (water budget updates described in this 2025 Periodic Evaluation)	Water budget updates were made and are documented in this 2025 Periodic Evaluation

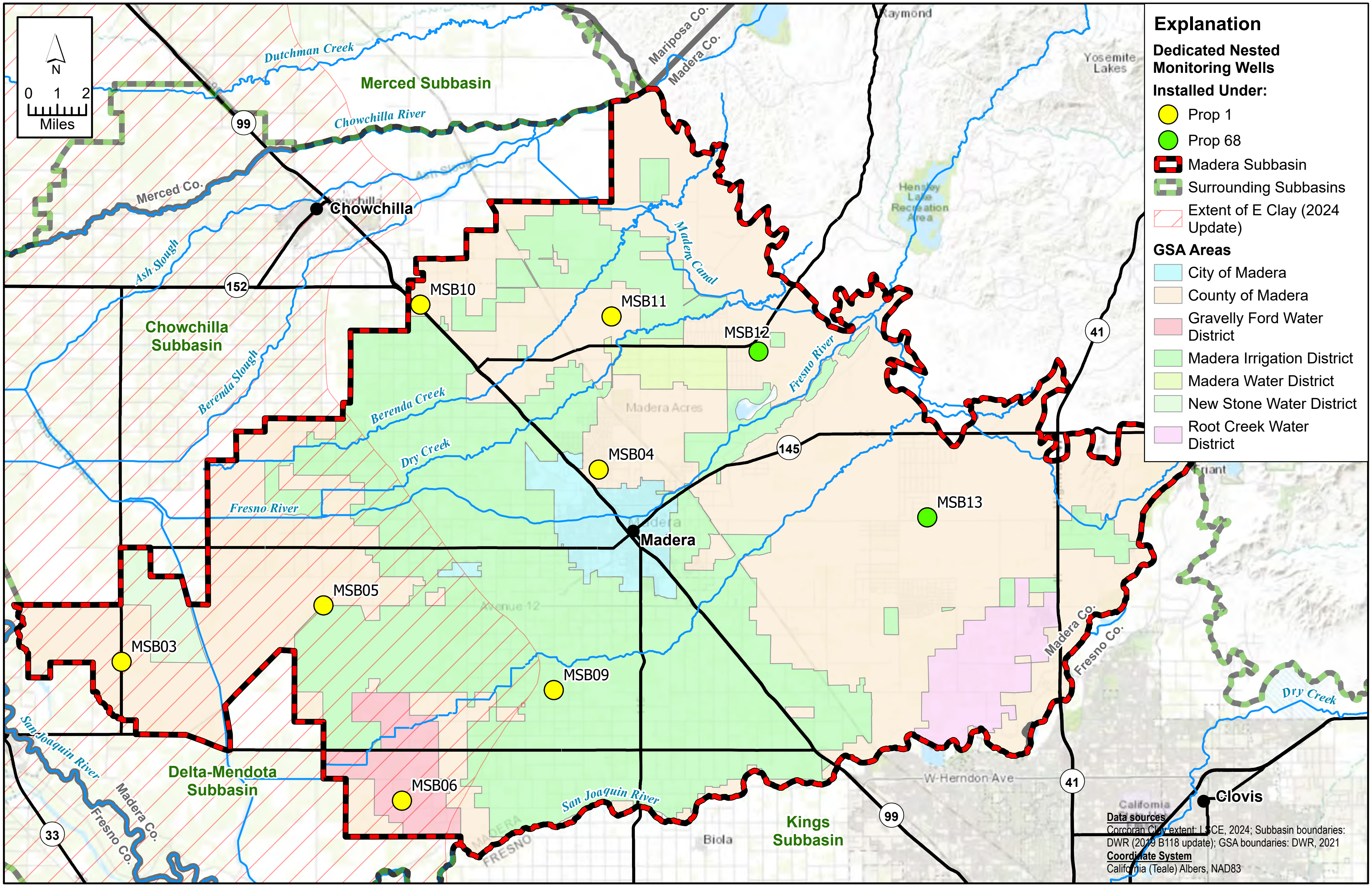
[1] Section and appendix references are given for the Joint GSP 2025 Plan Amendment.

1.1 Monitoring Data

New dedicated nested monitoring wells were installed at seven locations in 2019 and 2020 under a DWR Proposition 1 grant obtained by Madera County. Two additional monitoring well locations were added in 2022 as part of a DWR Proposition 68 grant obtained by the MC GSA (**Figure 1-1**). Eight of the nine locations have multiple (3) completions in different depth zones, and one of the locations is a single completion well. Lithologic and borehole geophysical logs were obtained at each drilling location, and groundwater level and quality data have been, and continue to be, collected from each monitoring well at the various locations. Due to their large file size, the monitoring well installation reports are available upon request to Madera County.

The new dedicated monitoring wells were immediately added to the overall Subbasin monitoring network as they have become available since 2019. Groundwater level data from the new dedicated monitoring wells are being used in development of groundwater elevation contour and storage change maps in Annual Reports, and related data have been posted to the SGMA Portal Monitoring Network Module since 2022. In addition, water quality sampling has been conducted for each monitoring well at the time of installation and on an annual basis thereafter. As part of the 2025 Plan Amendment, many of the new dedicated monitoring wells have been incorporated into the RMS networks for groundwater levels (Joint GSP 2025 Plan Amendment Figure 3-1) and groundwater quality (Joint GSP 2025 Plan Amendment Figure 3-4). It has become apparent during the past five years of data collection efforts that refinements to the groundwater level and quality RMS network were needed, as described in more detail in Appendices 3.K and 3.L of the Joint GSP 2025 Plan Amendment. These RMS network refinements include use of new dedicated nested monitoring wells as replacements for some of the original RMS wells that have become inaccessible or no longer exist and as additional RMS to fill data gaps.

The detailed logging of drill cuttings by the onsite geologist and collection of a suite of borehole geophysical logs has provided an improved understanding of the occurrence of fine-grained and coarse-grained units and overall stratigraphy, including an updated mapping of the extent of the Corcoran Clay. In addition, the borehole lithologic and geophysical logs have provided an improved understanding of the proportion of fine- and coarse-grained sediments in the Upper and Lower Aquifers, along with critical input to new 1D subsidence modeling conducted as part of the 2025 Plan Amendment.



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\GIS\MAD_Five_Year_Update\MAD_Five_Year_Update.aprx; Figure 1-X Nested Monitoring Wells

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Luhdorff & Scalmanini Consulting Engineers

FIGURE 1-1

Dedicated Nested Monitoring Wells

Madera Subbasin
Groundwater Sustainability Plan - Periodic Evaluation

1.2 Reports

In 2023, DWR released a report regarding drinking water well impacts titled “Considerations for Identifying and Addressing Drinking Water Well Impacts” (DWR, 2023). This report has been reviewed and is being considered in development of the Domestic Well Mitigation Program for the Subbasin. Information about the Domestic Well Mitigation program is provided in Sections 3.3.1.1 and Section 4.9.5 of the Joint GSP 2025 Plan Amendment, and in Section 3.1.6 of the Joint GSP 2025 Periodic Evaluation Attachment (**Appendix 1.B.1**).

In 2024, DWR released three white papers pertaining to ISW for public comment that will provide the basis for eventual DWR guidance for setting ISW SMC. These include:

- Depletions of Interconnected Surface Water: An Introduction (DWR, 2024a)
- Techniques for Estimating Interconnected Surface Water Depletion Caused by Groundwater Use (DWR, 2024b)
- Examples for Estimating Interconnected Surface Water Depletion Caused by Groundwater Use (DWR, 2024c)

While the Subbasin GSAs work towards implementation of the ISW Workplan (see Joint GSP 2025 Plan Amendment Appendix 3.I), the final DWR ISW guidance is needed to complete the overall evaluation of ISW and provide any refinements to the current ISW SMC.

Key non-DWR reports included the various monitoring well installation reports (see **Section 1.1**) and the domestic well inventory (LSCE, 2022). The monitoring well installation reports provided new lithologic and borehole geophysical data along with initial results for groundwater levels and quality. The domestic well inventory provided a detailed analysis of the number, locations, and depths of domestic wells from the DWR database and County well permit data, along with evaluation of the number and locations of domestic wells expected to go dry in the future based on groundwater modeling and domestic well records. These domestic well inventory results provided essential input for development of the MOU for the Subbasin Domestic Well Mitigation Program.

1.3 Groundwater Model Updates

Extensive work has been completed during 2024 related to updating and refining the Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim). The updated MCSim includes:

- Refinements to the HCM that were informed by new monitoring well data and AEM data provided by DWR (DWR April 2023, DWR February 2024),
- Incorporation of the IWFM subsidence module that became available after the initial development of MCSim for the 2020 Initial Plan submittal (the IWFM subsidence module was not available prior to the 2020 Initial Plan submittal and thus was not incorporated into the initial MCSim),
- Updated hydrology for the period from WY 2018 through WY 2023,
- Updated simulation of PMAs according to the Subbasin GSAs’ updated plans and timelines for PMA implementation, and
- Recalibration to observed groundwater levels and subsidence measurements.

The updated MCSim provided a basis for updating SMC that have some reliance on MCSim outputs (IM; some MO/MT where observed readings are not available for the specific dates needed). In addition, the modeling effort provided a means for re-evaluating the water budget for each Subbasin GSA as of 2023, and was used to prepare updated projections of future water budgets. Documentation of the updated MCSim is provided in Appendix 6.D of the 2025 Plan Amendment and in **Appendix 3** of this 2025 Periodic Evaluation.

1.4 Coordination with Other Agencies

Extensive coordination has occurred between the technical teams for each Subbasin GSA (or group of Subbasin GSAs in the case of the Joint GSP), serving at the direction of each GSA. Technical coordination meetings were held during preparation of the 2023 Revised GSPs, and have continued to occur on a regular basis since their submittal, in direct response to DWR's recommended corrective action that the GSAs increase coordination within the Subbasin. As part of the 2025 Plan Amendment, the technical teams met on a bi-weekly or weekly basis to discuss and collaborate on methodologies and preferred technical approaches for addressing DWR's recommended corrective actions. This collaborative approach has led to development of SMC for the various sustainability indicators in the four Subbasin GSPs that are coordinated and based on similar data and methodologies. Additional information on intra-basin coordination efforts is provided in **Section 7.3.1** of this 2025 Periodic Evaluation.

Extensive coordination has also been conducted, and will continue to be conducted, related to the Subbasin ISW Workplan and refinement of ISW SMC between the Subbasin GSAs and several other parties including: certain GSAs in the Kings Subbasin (McMullin Area GSA and North Kings GSA), USBR, FWA, and SJRRP. Since late 2023, regular meetings have been held to discuss various ISW-related concerns and topics. These ISW coordination meetings are expected to continue in the future as the ISW Workplan is implemented and ISW SMC are refined. Additional information about these ISW coordination meetings and related outcomes is provided in **Section 7.3.2** of this 2025 Periodic Evaluation.

1.5 Data Provided by DWR

DWR datasets and interpretations for InSAR (DWR California Open Data Portal) and AEM data (DWR, April 2023 and February 2024) have been made available since 2020. These datasets have been reviewed and incorporated into Subbasin SGMA-related efforts. InSAR data is reviewed and reported in each Annual Report and comparisons are periodically made to SJRRP benchmark surveys. AEM data has been and continues to be reviewed for potential use in HCM refinements, including with regard to depth to bedrock, extent of Corcoran Clay, shallow zone stratigraphy along streams, and evaluation of potential recharge sites. Through the end of 2024, the primary application of AEM data in Subbasin has been for refinement of depth to bedrock; however, ongoing efforts will consider further use of AEM data.

1.6 Data from Non-DWR Sources

OpenET data has been made available during this Periodic Evaluation cycle, and has been used in the water budget and model updates reported in **Section 4** of this 2025 Periodic Evaluation. OpenET is a multi-agency web-based geospatial information system (GIS) utility that quantifies ET over time with a spatial resolution of 30 m x 30 m (approximately 0.22 acres). While OpenET is a new utility, the underlying methodologies to quantify ET apply a variety of well-established modeling approaches that are widely used in government and research applications. The OpenET modeling approaches are also similar to the approaches used to quantify ET in MCSim during 2020 Initial Joint GSP development (see Section 2.2.3.3

and Appendix 6.D of the Joint GSP 2025 Plan Amendment for information about the ET inputs to MCSim developed for the 2020 Initial Joint GSP). Additional information about the OpenET team, data sources, and methodologies are available at: https://openetdata.org/.

2 Groundwater Conditions Relative to the Sustainable Management Criteria (§356.4(a))

The purpose of this section is to evaluate groundwater conditions for each applicable sustainability indicator relative to the SMC established and described in the 2025 Plan Amendment. Applicable updates for each sustainability indicator are provided in the subsections below, including:

- DWR's recommended corrective actions with respect to each sustainability indicator (from DWR's December 2023 letter approving the 2023 Revised Plan, see **Appendix 1.A.1**).
- How the 2025 Plan Amendment and the SMC therein were revised to address those recommended corrective actions. Specific section references are given for the Joint GSP 2025 Plan Amendment, although these revisions may also be applicable to other portions of the 2025 Plan Amendment.
- Current conditions relative to the SMC in the 2025 Plan Amendment.
- Progress toward achieving sustainability in the Subbasin.
- Impacts to beneficial uses and users.

These updates provide a basis for evaluating the Subbasin GSAs' progress towards achieving groundwater sustainability in the Subbasin.

In summary, the Subbasin GSAs have amended the applicable SMC in the 2025 Plan Amendment, as necessary, to address or substantively progress all of DWR's recommended corrective actions. The Subbasin GSAs generally remain on track to achieving the Subbasin sustainability goal, as evidenced by current groundwater conditions in the Subbasin relative to the 2025 interim milestones (IMs) described in the 2025 Plan Amendment and described throughout the remainder of this section.

2.1 Groundwater Levels

The following section discusses groundwater conditions in the Subbasin related to groundwater levels. Specific references are given for the Joint GSP 2025 Plan Amendment, although this discussion is applicable to the Subbasin and the 2025 Plan Amendment as a whole.

2.1.1 Recommended Corrective Actions

In DWR's 2023 Revised Plan approval letter, a recommended corrective action related to the chronic lowering of groundwater levels sustainability indicator was identified. The recommended corrective action stated:

> *Recommended Corrective Action 3: The GSAs should revise the GSPs to include a discussion of the relationship between the [SMC] for chronic lowering of groundwater levels and the other sustainability indicators, including an explanation of how the [SMC], including [IMs], were established to avoid undesirable results for each of the other sustainability indicators.*

In response to this recommended corrective action, the Joint GSP 2025 Plan Amendment has been revised to include a more detailed discussion of the impacts of the groundwater level SMC, including IMs, on other sustainability indicators. These updates were included in Sections 3.2.1.3.1, 3.2.1.3.2, and 3.3.1.4 of the Joint GSP 2025 Plan Amendment, and are described below.

2.1.2 Amendments to SMC

Groundwater level SMC have been refined as part of the 2025 Plan Amendment. The methodology for setting the measurable objectives (MOs) and minimum thresholds (MTs) has not changed from the 2023 Revised Plan: MOs are set at the Fall 2010 groundwater elevation and MTs are set at the Fall 2015 groundwater elevation for each RMS. However, in cases where observed Fall 2010 or 2015 groundwater elevation data were not available, simulated groundwater elevation values were used to determine the MO and MT, with consideration for offsets between historically observed and simulated groundwater elevations at each RMS. As part of the MCSim updates for the 2025 Plan Amendment, groundwater level MOs and MTs that were set based on simulated values have been refined.

The methodology for setting groundwater level IMs was changed to rely on the updated MCSim results. Groundwater level IMs have been set at the Fall 2024, 2029, and 2034 simulated groundwater elevations for 2025, 2030, and 2035, respectively. Offsets between historically observed and modeled data were accounted for, as needed, based on Fall observed and modeled groundwater elevations.

Table 2-1 summarizes the changes to SMC for groundwater levels as part of the 2025 Plan Amendment.

Table 2-1. Summary of Amendments to SMC for Groundwater Levels.

RMS_ID	MO Elevation (feet msl)		IM Elevation (feet msl)						MT Elevation (feet msl)		Description of Change to SMC
	Old	New	Old 2025	Old 2030	Old 2035	New 2025	New 2030	New 2035	Old	New	
COM RMS-1	66	68	-9	-21	14	12	2	1	37	50	MO and MT refined with new modeling. IMs updated with new methodology.
COM RMS-2	36	50	-33	-50	2	1	-4	-4	36	43	MO and MT refined with new modeling. IMs updated with new methodology.
COM RMS-4	-	47	-	-	-	11	3	0	-	24	Well added to the RMS network as part of 2025 Plan Amendment.
MCE RMS-2	117	117	49	35	77	80	80	84	105	115	MT refined with new modeling. IMs updated with new methodology. No change to MO.
MCE RMS-3	64	67	-43	-55	-18	-12	-17	-5	7	38	MO and MT refined with new modeling. IMs updated with new methodology.
MCE RMS-5	63	81	12	6	38	35	32	45	38	69	MO and MT refined with new modeling. IMs updated with new methodology.
MCE RMS-6	57	40	-27	-39	-4	-20	-23	-11	20	19	MO and MT refined with new modeling. IMs updated with new methodology.
MCE RMS-9	254	259	244	242	248	259	258	258	252	258	MO and MT refined with new modeling. IMs updated with new methodology.
MCW RMS-3	79	74	0	-26	23	4	-1	1	55	65	MO and MT refined with new modeling. IMs updated with new methodology.
MCW RMS-5	180	184	171	169	174	185	184	183	178	182	MO and MT refined with new modeling. IMs updated with new methodology.
MSB03B	-	69	-	-	-	54	43	50	-	52	Well added to the RMS network as part of 2025 Plan Amendment.
MSB03C	-	16	-	-	-	-1	-7	-5	-	5	Well added to the RMS network as part of 2025 Plan Amendment.

RMS_ID	MO Elevation (feet msl)		IM Elevation (feet msl)						MT Elevation (feet msl)		Description of Change to SMC
	Old	New	Old 2025	Old 2030	Old 2035	New 2025	New 2030	New 2035	Old	New	
MSB04B	-	58	-	-	-	-30	-36	-36	-	29	Well added to the RMS network as part of 2025 Plan Amendment.
MSB05A	-	77	-	-	-	43	37	42	-	63	Well added to the RMS network as part of 2025 Plan Amendment.
MSB05B	-	43	-	-	-	6	1	7	-	26	Well added to the RMS network as part of 2025 Plan Amendment.
MSB06A	-	68	-	-	-	46	38	38	-	51	Well added to the RMS network as part of 2025 Plan Amendment.
MSB06C	-	63	-	-	-	36	31	30	-	48	Well added to the RMS network as part of 2025 Plan Amendment.
MSB09C	-	103	-	-	-	59	54	53	-	79	Well added to the RMS network as part of 2025 Plan Amendment.
MSB10C	-	-4	-	-	-	-112	-125	-123	-	-62	Well added to the RMS network as part of 2025 Plan Amendment.
MSB11C	-	-30	-	-	-	-137	-156	-150	-	-79	Well added to the RMS network as part of 2025 Plan Amendment.
MSB12	-	64	-	-	-	18	18	32	-	37	Well added to the RMS network as part of 2025 Plan Amendment.
MID RMS-2	40	-14	-129	-145	-103	-92	-111	-119	-65	-65	MO refined with new modeling. IMs updated with new methodology. No change to MT.
MID RMS-3	25	15	-116	-137	-74	-92	-102	-104	-32	-32	MO refined with new modeling. IMs updated with new methodology. No change to MT.
MID RMS-4	13	-34	-127	-143	-104	-92	-104	-100	-64	-64	MO refined with new modeling. IMs updated with new methodology. No change to MT.
MID RMS-5	20	19	-83	-97	-55	-57	-68	-72	-27	-26	MO and MT refined with new modeling. IMs updated with new methodology.

RMS_ID	MO Elevation (feet msl)		IM Elevation (feet msl)						MT Elevation (feet msl)		Description of Change to SMC
	Old	New	Old 2025	Old 2030	Old 2035	New 2025	New 2030	New 2035	Old	New	
MID RMS-6	52	19	-65	-75	-46	-59	-71	-76	-27	-27	MO refined with new modeling. IMs updated with new methodology. No change to MT.
MID RMS-7	89	80	-10	-25	20	29	23	18	50	49	MO and MT refined with new modeling. IMs updated with new methodology.
MID RMS-10	85	64	20	13	30	28	23	21	42	42	MO refined with new modeling. IMs updated with new methodology. No change to MT.
MID RMS-11	114	112	55	47	72	68	65	64	89	89	MO refined with new modeling. IMs updated with new methodology. No change to MT.
MID RMS-12	128	128	60	50	79	68	63	62	98	98	IMs updated with new methodology. No change to MO and MT.
MID RMS-13	114	112	69	63	81	77	75	76	93	93	MO refined with new modeling. IMs updated with new methodology. No change to MT.
MID RMS-15	144	151	112	107	121	123	121	120	130	130	MO refined with new modeling. IMs updated with new methodology. No change to MT.
MID RMS-16	30	28	-98	-120	-54	-53	-70	-67	-10	-8	MO and MT refined with new modeling. IMs updated with new methodology.
MID RMS-17	200	200	190	188	194	201	200	199	198	198	IMs updated with new methodology. No change to MO and MT.
MWD RMS-1	40	24	-122	-145	-76	-53	-89	-94	-30	-14	MO and MT refined with new modeling. IMs updated with new methodology.
MWD RMS-2	5	7	-116	-136	-76	-58	-87	-88	-37	-37	MO refined with new modeling. IMs updated with new methodology. No change to MT.
MWD RMS-3	-8	-6	-148	-170	-104	-79	-105	-105	-60	-56	MO and MT refined with new modeling. IMs updated with new methodology.

2.1.3 Current Conditions Relative to SMC

As described in the previous section, IMs for chronic lowering of groundwater levels were established using the updated MCSim results and set at the Fall 2024, 2029, and 2034 simulated groundwater elevations for 2025, 2030, and 2035, respectively. Offsets between historically observed and modeled data were accounted for, as needed, based on Fall observed and modeled groundwater elevations.

MOs for groundwater levels were set at Fall 2010 groundwater elevations based on observed data when available. If observed data were not available, the Fall 2010 groundwater elevation was based on modeled results, with modification, if necessary, to account for the offset between historically observed and modeled groundwater elevations.

The GSP regulations define undesirable results as occurring when significant and unreasonable effects are caused by groundwater conditions occurring throughout the Plan area for a given sustainability indicator. Significant and unreasonable effects occur when MTs are exceeded for one or more sustainability indicators. The GSP regulations provide that the "minimum thresholds for chronic lowering of groundwater levels shall be the groundwater level indicating a depletion of supply at a given location that may lead to undesirable results" (23 CCR §354.28.c.1). As described in Section 3.3.1 of the Joint GSP 2025 Plan Amendment, chronic lowering of groundwater levels in the Plan area is determined to cause significant and unreasonable declines if they are sufficient in magnitude to lower the rate of production of pre-existing groundwater wells below that necessary to meet the minimum required to support overlying beneficial uses and users where alternative means of obtaining sufficient groundwater resources are not technically or financially feasible.

Table 2-2 and **Figures 2-1 and 2-2** present the Fall 2024 groundwater elevations at the groundwater level RMS wells and their status in relation to the 2025 IMs and MTs defined in the 2025 Plan Amendment. Review of the Fall 2024 groundwater elevation measurements that are available for 33 RMS wells indicates that groundwater elevations are generally below the MTs, with the exceptions of MCE RMS-2, MSB03B, MSB03C, MSB06A, and MID RMS-3. A majority (24 RMS wells) of groundwater elevations are above the 2025 IMs. RMS wells that are not currently above the 2025 IMs are evenly distributed throughout the Subbasin and are primarily lower aquifer wells.

Hydrographs for each groundwater level RMS well are presented in **Appendix 2.A**.

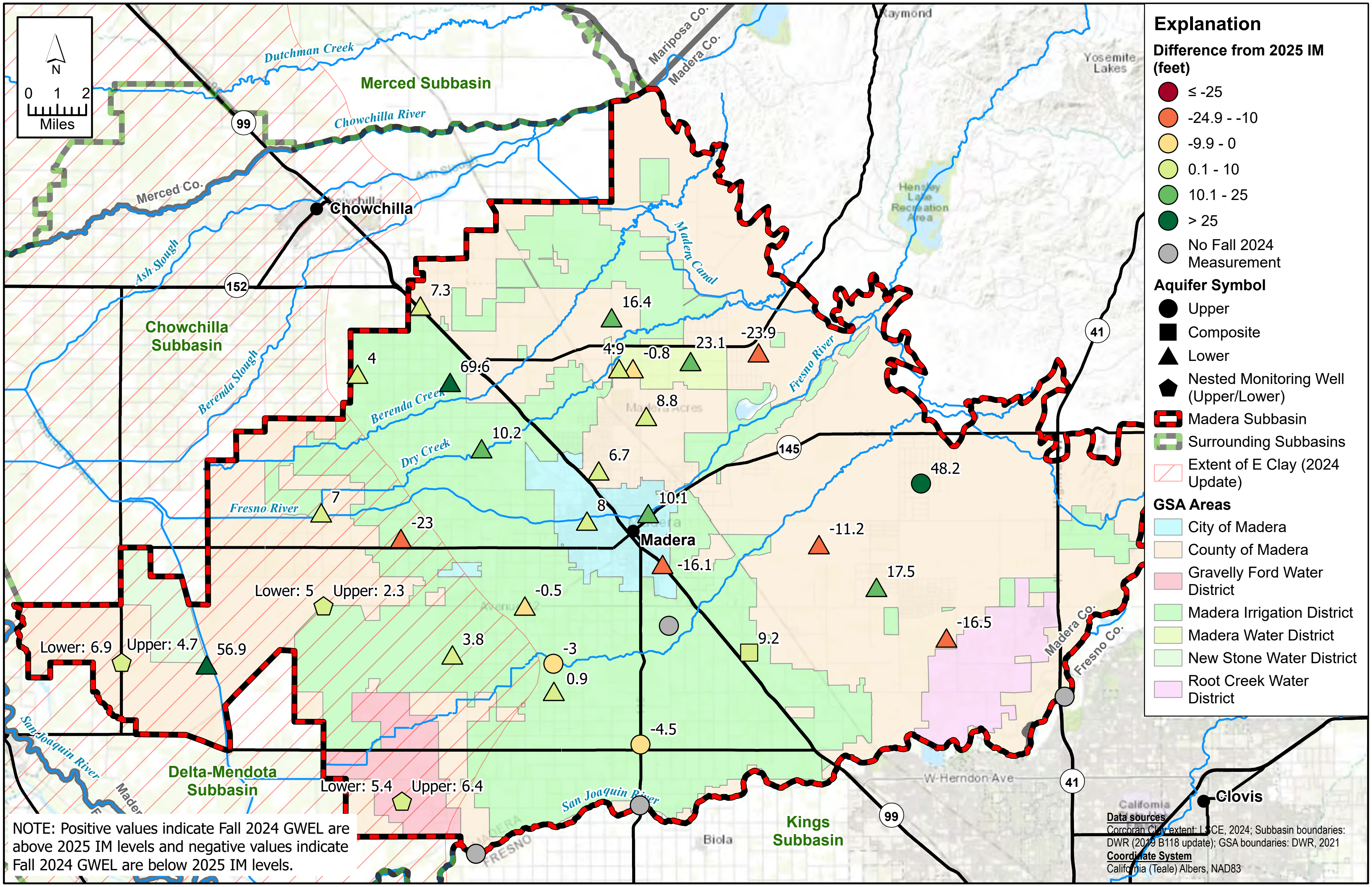
Table 2-2. Summary of RMS Well Groundwater Levels Relative to Interim Milestones, Minimum Thresholds, and Measurable Objectives.

RMS Well ID	Estimated Surface Elevation (feet msl)[1]	Aquifer Designation	MO GWEL (feet msl)	MT GWEL (feet msl)	2025 IM GWEL (feet msl)	Date of Fall Measurement	Fall 2024 GWEL (feet msl)	2025 IM Status (feet)	MT Status (feet)
COM RMS-1	278	Lower	68	50	12	10/22/2024	22.1	+10.1	-27.9
COM RMS-2	262	Lower	50	43	1	10/28/2024	9.0	+8	-34
COM RMS-4	268	Lower	47	24	11	10/22/2024	-5.1	-16.1	-29.1
MCE RMS-2	378	Upper	117	115	80	10/17/2024	128.2	+48.2	+13.2
MCE RMS-3	325	Lower	67	38	-12	10/17/2024	-23.2	-11.2	-61.2
MCE RMS-5	340	Lower	81	69	35	10/17/2024	18.5	-16.5	-50.5
MCE RMS-6	328	Lower	40	19	-20	11/1/2024	-2.5	+17.5	-21.5
MCE RMS-9	271	Shallow	259	258	259				
MCW RMS-3	162	Lower	74	65	4	10/16/2024	60.9	+56.9	-4.1
MCW RMS-5	202	Shallow	184	182	185				
MSB03B	148	Upper	69	52	54	10/16/2024	58.7	+4.7	+6.7
MSB03C	148	Lower	16	5	-1	10/16/2024	5.9	+6.9	+0.9
MSB04B	271	Lower	58	29	-30	10/17/2024	-23.3	+6.7	-52.3
MSB05A	177	Upper	77	63	43	10/17/2024	45.3	+2.3	-17.7
MSB05B	177	Lower	43	26	6	10/17/2024	11.0	+5.0	-15.0
MSB06A	192	Upper	68	51	46	10/16/2024	52.4	+6.4	+1.4
MSB06C	192	Lower	63	48	36	10/16/2024	41.4	+5.4	-6.6
MSB09C	233	Lower	103	79	59	10/17/2024	59.9	+0.9	-19.1
MSB10C	251	Lower	-4	-62	-112	10/15/2024	-104.7	+7.3	-42.7
MSB11C	306	Lower	-30	-79	-137	10/16/2024	-120.6	+16.4	-41.6
MSB12	350	Lower	64	37	18	10/16/2024	-5.9	-23.9	-42.9
MID RMS-2	218	Lower	-14	-65	-92	10/1/2024	-88.0	+4.0	-23.0
MID RMS-3	241	Lower	15	-32	-92	10/1/2024	-22.4	+69.6	+9.6
MID RMS-4	190	Lower	-34	-64	-92	10/1/2024	-85.0	+7.0	-21.0
MID RMS-5	204	Lower	19	-26	-57	10/14/2024	-80.0	-23.0	-54.0

RMS Well ID	Estimated Surface Elevation (feet msl)[1]	Aquifer Designation	MO GWEL (feet msl)	MT GWEL (feet msl)	2025 IM GWEL (feet msl)	Date of Fall Measurement	Fall 2024 GWEL (feet msl)	2025 IM Status (feet)	MT Status (feet)
MID RMS-6	237	Lower	19	-27	-59	10/1/2024	-48.9	+10.2	-21.9
MID RMS-7	237	Lower	80	49	29	10/8/2024	28.5	-0.5	-20.5
MID RMS-10	213	Lower	64	42	28	10/3/2024	31.8	+3.8	-10.2
MID RMS-11	232	Upper	112	89	68	10/14/2024	65.0	-3.0	-24.0
MID RMS-12	262	Upper	128	98	68	10/4/2024	NM[2]	-	-
MID RMS-13	271	Composite	112	93	77	10/4/2024	86.2	+9.2	-6.8
MID RMS-15	247	Upper	151	130	123	10/22/2024	118.5	-4.5	-11.5
MID RMS-16	308	Lower	28	-8	-53	10/2/2024	-44.2	+8.8	-36.2
MID RMS-17	224	Shallow	200	198	201				
MWD RMS-1	330	Lower	24	-14	-53	11/11/2024	-29.9	+23.1	-15.9
MWD RMS-2	310	Lower	7	-37	-58	11/20/2024	-58.83	-0.8	-21.8
MWD RMS-3	295	Lower	-6	-56	-79	11/11/2024	-74.06	+4.9	-18.1

[1] Estimated surface elevation and groundwater elevations (GWEL) are expressed in feet above mean sea level (msl).

[2] NM = no measurement. Measurement attempted but was unsuccessful.



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\GIS\MAD_Five_Year_Update\MAD_Five_Year_Update.aprx; Figure 2-1 RMS_WL_SustCri_IM2025

DAVIDS ENGINEERING, INC

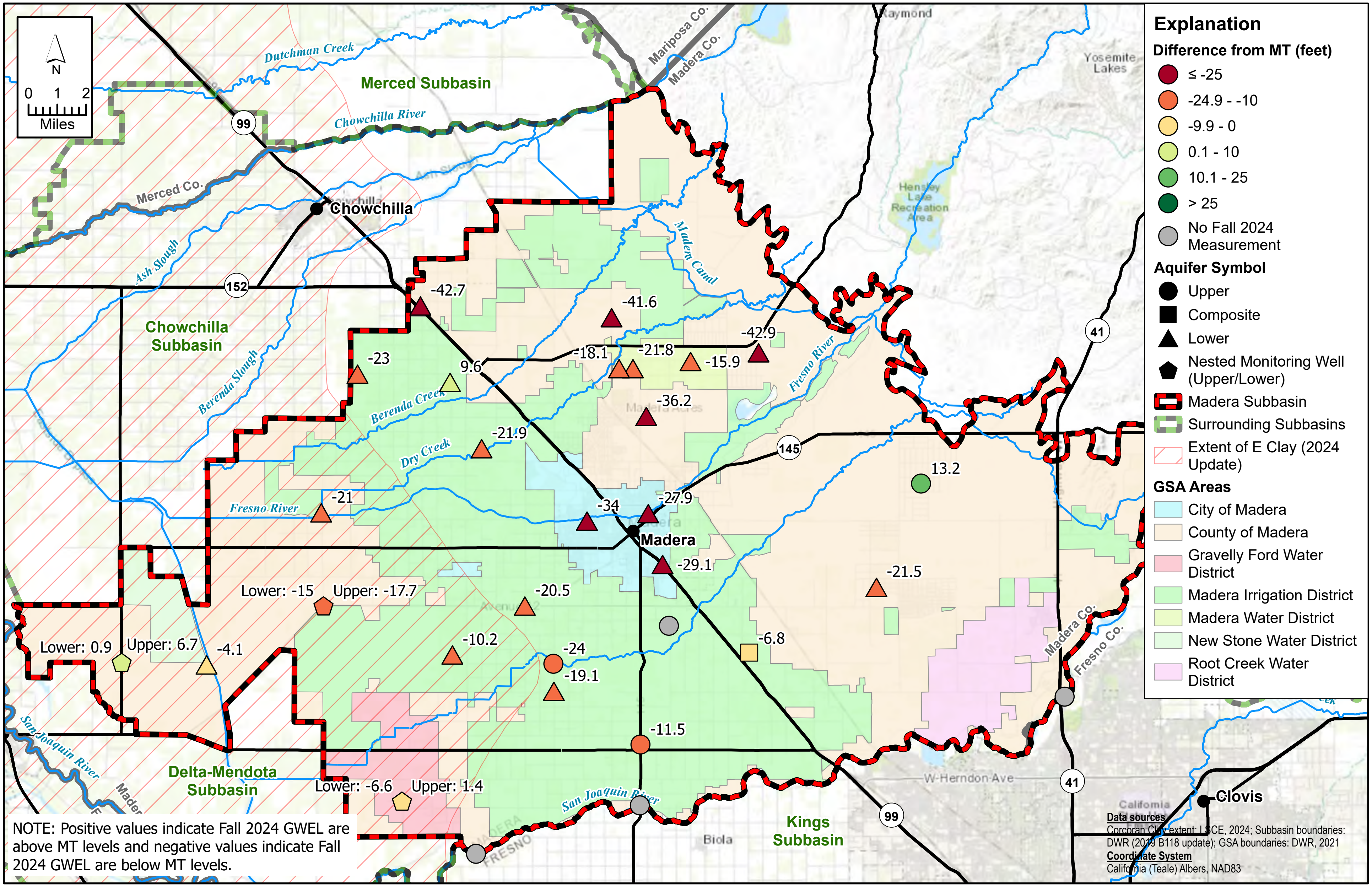
Luhdorff & Scalmanini Consulting Engineers

FIGURE 2-1

Fall 2024 Water Level Measurements at Groundwater Level RMS Wells compared to 2025 Interim Milestones

Madera Subbasin

Groundwater Sustainability Plan - Periodic Evaluation



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\GIS\MAD_Five_Year_Update\MAD_Five_Year_Update.aprx; Figure 2-2 RMS_WL_SustCri_MT

DAVIDS ENGINEERING, INC

Luhdorff & Scalmanini Consulting Engineers

FIGURE 2-2

Fall 2024 Water Level Measurements at Groundwater Level RMS Wells compared to Minimum Threshold

Madera Subbasin

Groundwater Sustainability Plan - Periodic Evaluation

2.1.4 Progress Toward Achieving Sustainability

In general, the Subbasin GSAs remain on track to achieving sustainability based on the 2025 IMs. As mentioned in **Section 2.1.3**, the RMS wells that are not above the 2025 IMs are primarily lower aquifer wells. As recharge projects throughout the Subbasin continue to be implemented and operated, the benefits of these projects will take a longer time to appear in deeper wells. It is notable that 2020 through 2022, the first three full years of the GSP implementation period, were very dry years in the Subbasin, while 2023 was a very wet year and 2024 was an above normal year. As a result, many of the recharge projects being implemented within the Subbasin have only achieved substantial benefits in one or two years thus far (see **Section 3**).

2.1.5 Impacts to Beneficial Uses and Users

As is expected in a critically overdrafted basin, some impacts to beneficial uses and users, including drinking water users, have occurred within the first five years of the GSP implementation period. According to DWR's California Groundwater Live tool[3], a total of 466 dry wells have been reported in the Subbasin since implementation of the 2020 Initial Plan. It should be noted that this dataset is user-reported and the cause and timing of wells going dry is unknown. An initial review of the reported dry wells finds that several of the reports appear to be due to problems other than regional groundwater levels declining below the bottom of a given domestic well.

Progress has been made towards the establishment of a Domestic Well Mitigation Program in the Subbasin, including the awarding of a grant to the MC GSA to facilitate the development and implementation of this program. Further detail about the Domestic Well Mitigation Program is presented in Section 3.3.1.1 of the Joint GSP 2025 Plan Amendment.

2.2 Groundwater Storage

There is a direct relationship between groundwater levels and groundwater storage; thus, groundwater levels are used as a proxy for the groundwater storage sustainability indicator in the 2025 Plan Amendment. See **Section 2.1** for discussion of the groundwater level SMC.

2.3 Water Quality

The following section discusses groundwater conditions in the Subbasin related to groundwater quality. Specific references are given for the Joint GSP 2025 Plan Amendment, although this discussion is applicable to the Subbasin and the 2025 Plan Amendment as a whole.

2.3.1 Recommended Corrective Actions

In DWR's 2023 Revised Plan approval letter, a recommended corrective action related to the groundwater quality sustainability indicator was identified. The recommended corrective action stated:

> *Recommended Corrective Action 6: The GSAs must provide more detailed explanation and justification regarding the selection of the sustainable management criteria for degradation of water quality. Department staff recommend the GSAs consider and address the following:*

[3] Available at: https://sgma.water.ca.gov/CalGWLive/

a. The GSAs should revise the definition of undesirable results so that exceedances of minimum thresholds caused by groundwater extraction are considered in the assessment of undesirable results in the Subbasin.

b. The GSAs should provide a clear definition of what the Plan considers an undesirable result for degraded water quality by describing conditions that it would consider to be significant or unreasonable. For example, the Plan should—in addition to qualitative descriptions—quantify the specific potential effects to beneficial users and uses from undesirable results using best available data and science. This definition should be supported by information described in the basin setting, and other data or models as appropriate, as required by the GSP Regulations.

c. The GSAs should identify which minimum threshold values—either the [maximum contaminant level (MCL)] or existing concentration plus 20 percent—will be used at which representative monitoring sites. Also, the GSAs should justify how establishing minimum thresholds at the higher of either MCLs or existing concentrations plus 20 percent does not constitute significant and unreasonable effects as defined by the GSP (i.e., when beneficial uses for groundwater are adversely impacted by constituent concentrations).

In response to this recommended corrective action, the Joint GSP 2025 Plan Amendment has been updated to revise the definition of undesirable results (Section 3.4.4 of the Joint GSP 2025 Plan Amendment), clearly define adverse impacts to beneficial users (Section 3.3.4 of the Joint GSP 2025 Plan Amendment), and provide justification for the MT methodology (Section 3.3.4.1 of the Joint GSP 2025 Plan Amendment).

2.3.2 Amendments to SMC

The 2025 Plan Amendment establishes groundwater quality SMC related to arsenic (As), nitrate as nitrogen (N) (NO3N), and total dissolved solids (TDS). Groundwater quality SMC have been refined as part of the 2025 Plan Amendment. The MO concentrations for RMS wells with existing or historical water quality results are the average of the recent concentrations for each of the key constituents rounded up to the nearest full integer of concentration for As (in units of micrograms per liter (ug/L)) and nitrate (in units of milligrams per liter (mg/L) as N) and rounded up to the nearest interval of 50 mg/L for TDS. IMs for water quality are the same as the MOs. The MT concentrations are the respective MCL values, except for cases where existing or historical concentrations for these constituents already exceed the MCL. When existing or historical concentrations for the key constituents already exceed the MCL, the MT is set at the recent concentration plus 20 percent.

A number of RMS wells did not have a sufficient historical record at the time of the 2020 Initial Joint GSP development to develop a baseline concentration to set SMC. As part of this Periodic Evaluation, the water quality data for each constituent at each RMS well was analyzed and the SMC identified in the 2020 Initial Joint GSP were evaluated. **Table 2-3** summarizes the changes to SMC for groundwater quality as part of the 2025 Plan Amendment.

A summary of groundwater quality measurements for RMS wells are presented in **Appendix 2.B.**

Table 2-3. Summary of Amendments to SMC for Groundwater Quality.

RMS ID	Arsenic (ug/L)					Nitrate as N (mg/L)					Total Dissolved Solids (mg/L)				
	Old MO Conc.	Old MT Conc.	Baseline Conc.[1]	New MO Conc.	New MT Conc.	Old MO Conc.	Old MT Conc.	Baseline Conc.[1]	New MO Conc.	New MT Conc.	Old MO Conc.	Old MT Conc.	Baseline Conc.[1]	New MO Conc.	New MT Conc.
MCE RMS-3	8	10	155	155	186	8	10	1	1	10	400	500	643	650	772
MID RMS-4	8	10	n/a†	8†	10†	8	10	n/a†	8†	10†	400	500	n/a†	400†	500†
MID RMS-5B	8	10	n/a†	8†	10†	8	10	n/a†	8†	10†	400	500	n/a†	400†	500†
MID RMS-6	8	10	n/a†	8†	10†	8	10	n/a†	8†	10†	400	500	n/a†	400†	500†
MID RMS-7	8	10	n/a†	8†	10†	8	10	n/a†	8†	10†	400	500	n/a†	400†	500†
MID RMS-13	8	10	n/a†	8†	10†	8	10	n/a†	8†	10†	400	500	n/a†	400†	500†
MWD RMS-1	8	10	3	3	10	8	10	2	3	10	400	500	205	250	500
MSB03A	8	10	3	4	10	8	10	8	8	10	400	500	828	850	994
MSB03B	8	10	5	5	10	8	10	0	1	10	400	500	345	350	500
MSB03C	8	10	5	6	10	8	10	ND	1	10	400	500	963	1,000	1,155
MSB04A	8	10	3	3	10	8	10	6	6	10	400	500	218	250	500
MSB04B	8	10	47	47	56	8	10	ND	1	10	400	500	380	400	500
MSB04C	8	10	53	54	65	8	10	ND	1	10	400	500	355	400	500
MSB05A	8	10	4	5	10	8	10	12	13	15	400	500	568	600	682
MSB05B	8	10	34	34	41	8	10	0	1	10	400	500	240	250	500
MSB05C	8	10	8	8	10	8	10	1	1	10	400	500	247	250	500
MSB06A	8	10	2	3	10	8	10	9	10	12	400	500	424	450	510
MSB06B	8	10	34	35	42	8	10	2	2	10	400	500	404	450	500
MSB06C	8	10	12	13	15	8	10	1	1	10	400	500	422	450	507

RMS ID	Arsenic (ug/L)					Nitrate as N (mg/L)					Total Dissolved Solids (mg/L)				
	Old MO Conc.	Old MT Conc.	Baseline Conc.[1]	New MO Conc.	New MT Conc.	Old MO Conc.	Old MT Conc.	Baseline Conc.[1]	New MO Conc.	New MT Conc.	Old MO Conc.	Old MT Conc.	Baseline Conc.[1]	New MO Conc.	New MT Conc.
MSB09A	8	10	2	2	10	8	10	7	8	10	400	500	500	550	600
MSB09B	8	10	3	3	10	8	10	2	2	10	400	500	203	250	500
MSB09C	8	10	113	113	135	8	10	ND	1	10	400	500	278	300	500
MSB10B	8	10	2	3	10	8	10	2	2	10	400	500	206	250	500
MSB10C	8	10	3	3	10	8	10	2	2	10	400	500	273	300	500
MSB11C	8	10	6	6	10	8	10	n/a†	8†	10†	400	500	490	500	588
MSB13A	8	10	n/a†	8†	10†	8	10	n/a†	8†	10†	400	500	n/a†	400†	500†
MSB13B	8	10	n/a†	8†	10†	8	10	n/a†	8†	10†	400	500	n/a†	400†	500†
MSB13C	8	10	n/a†	8†	10†	8	10	n/a†	8†	10†	400	500	n/a†	400†	500†
2000507-001	5	10	4	4	10	3	10	6	6	10	400	500	n/a†	400†	500†
2000553-001	3	10	2	3	10	4	10	8	9	10	250	500	261	300	500
2000682-002	3	10	3	3	10	3	10	7	7	10	400	500	n/a†	400†	500†
2000727-001	2	10	2	2	10	2	10	5	6	10	250	500	207	250	500
2000938-001	1	10	2	2	10	2	10	3	4	10	150	500	145	150	500
2010002-014	1	10	11	12	14	2	10	5	5	10	200	500	181	200	500
2010002-032	1	10	4	4	10	3	10	6	7	10	250	500	212	250	500
2010008-005	4	10	3	4	10	5	10	12	13	15	300	500	318	350	500
2010009-002	5	10	6	6	10	2	10	6	7	10	150	500	138	150	500
2010010-007	2	10	2	3	10	2	10	9	9	11	400	500	204	250	500

RMS ID	Arsenic (ug/L)					Nitrate as N (mg/L)					Total Dissolved Solids (mg/L)				
	Old MO Conc.	Old MT Conc.	Baseline Conc.[1]	New MO Conc.	New MT Conc.	Old MO Conc.	Old MT Conc.	Baseline Conc.[1]	New MO Conc.	New MT Conc.	Old MO Conc.	Old MT Conc.	Baseline Conc.[1]	New MO Conc.	New MT Conc.
2010801-001	15	18	15	15	18	1	10	2	3	10	400	500	242	250	500
2801077-001	8	10	n/a†	8†	10†	1	10	26	27	32	400	500	n/a†	400†	500†
ESJ12	n/a‡	n/a‡	n/a‡	n/a‡	n/a‡	5	10	7	7	11	450	500	493	500	592
ESJ17	n/a‡	n/a‡	n/a‡	n/a‡	n/a‡	8	10	n/a†	8†	10†	400	500	n/a†	400†	500†

[1] Baseline concentration calculated as average of all measurements pre-2024 (minimum of three years required to determine).

† Insufficient data available to calculate baseline value. SMC values will be confirmed and/or adjusted as needed after a baseline has been calculated.

‡ Monitoring for the Irrigated Lands Regulatory Program does not include testing for arsenic.

2.3.3 Current Conditions Relative to SMC

As described in the previous section, IMs for degraded groundwater quality were established at five-year intervals over the GSP implementation period from 2020 to 2040, at years 2025, 2030, and 2035, and are the same as the MOs. IMs and MOs for groundwater quality were established with the intent to not lead to degradation of existing groundwater quality conditions that would make groundwater unsuitable for the most restrictive beneficial use of municipal and domestic supply. The groundwater quality IMs and MOs are defined for individual groundwater quality RMS wells for the key water quality constituents arsenic, nitrate, and TDS based on consideration of existing or historical groundwater quality conditions and the drinking water MCLs for each of the key constituents. These key constituents were selected because they currently exist at elevated concentrations in the Subbasin or reflect a range of potential groundwater quality impacts related to implementation of GSP PMAs. Groundwater quality IMs and MOs are set to maintain existing or historical groundwater quality conditions over the GSP implementation period for wells in which the existing or historical conditions already exceed the MCL. The GSAs are also planning PMAs that, broadly speaking, are intended to benefit all applicable sustainability indicators in the Subbasin by providing groundwater recharge, supporting in-lieu recharge, improving understanding of Subbasin conditions, and/or otherwise reducing demand and contributing to groundwater sustainability (see **Section 3**).

As described in Section 3.4.4 of the Joint GSP 2025 Plan Amendment, degraded water quality is significant and unreasonable if the magnitude of degradation precludes the use of groundwater for existing beneficial use(s). Therefore, an undesirable result for degraded groundwater quality occurs when groundwater quality exceeds an established MCL and MT for arsenic, nitrate, or TDS for a significant duration of time and at a significant number of RMS wells and is the direct result of PMAs undertaken as part of the GSP implementation. An exceedance of a MT at a given representative monitoring site is defined based on the average concentration for a given key constituent over a three-year monitoring period. An undesirable result for degraded groundwater quality is greater than 10 percent of representative groundwater quality monitoring wells exceeding a MT for a given constituent (based on a 3-year running average) related to GSP actions and/or overall groundwater extraction in the subbasin.

The following sections discuss the current groundwater conditions related to the groundwater quality SMC for each constituent.

2.3.3.1 Arsenic

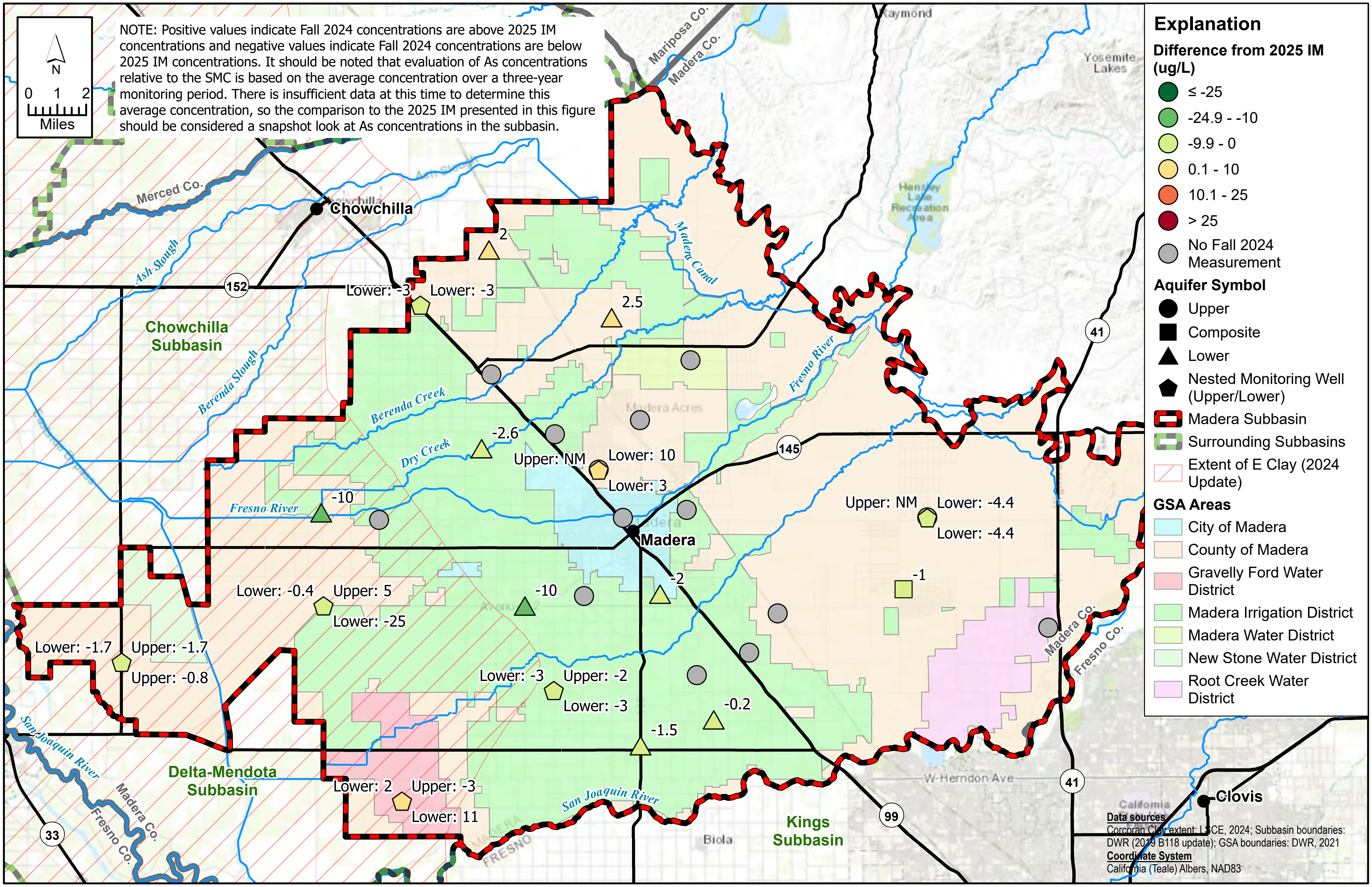
Table 2-4 and **Figure 2-3** present the 2024 As measurements at the groundwater quality RMS wells and their status in relation to the 2025 IMs, MOs, and MTs defined for As in the 2025 Plan Amendment. Review of the 2024 As measurements that are available for 28 RMS wells indicates that As concentrations are generally below the 2025 IMs (75% of RMS are below). It should be noted that evaluation of As concentrations relative to the SMC is based on the average concentration over a three-year monitoring period. There is insufficient data at this time to determine this average concentration, so the comparison to the 2025 IM presented in **Table 2-4** and **Figure 2-3** should be considered a snapshot look at As concentrations in the Subbasin.

Table 2-4. Summary of RMS Well Groundwater Quality Relative to Interim Milestones, Minimum Thresholds, and Measurable Objectives for Arsenic.

RMS Well ID	Aquifer Designation	Baseline Conc. (ug/L)[1]	MO Conc. (ug/L)	MT Conc. (ug/L)	2025 IM Conc. (ug/L)	Date of 2024 Measurement	2024 Conc. (ug/L)	2025 IM Status (ug/L)
MCE RMS-3	Lower	155	155	186	155	7/30/2024	ND[3]	-155
MID RMS-4	Lower	n/a†	8†	10†	8†	8/22/2024	ND[3]	-8
MID RMS-5B	Lower	n/a†	8†	10†	8†	-	NM[2]	-
MID RMS-6	Lower	n/a†	8†	10†	8†	8/22/2024	5.4	-2.6
MID RMS-7	Lower	n/a†	8†	10†	8†	7/25/2024	ND[3]	-8
MID RMS-13	Composite	n/a†	8†	10†	8†	-	NM[2]	-
MWD RMS-1	Lower	3	3	10	3	-	NM[2]	-
MSB03A	Upper	3	4	10	4	7/23/2024	2.3	-1.7
MSB03B	Upper	5	5	10	5	7/23/2024	4.2	-0.8
MSB03C	Lower	5	6	10	6	7/23/2024	4.3	-1.7
MSB04A	Upper	3	3	10	3	-	NM[2]	-
MSB04B	Lower	47	47	56	47	7/24/2024	57	10
MSB04C	Lower	53	54	65	54	7/24/2024	57	3
MSB05A	Upper	4	5	10	5	7/23/2024	10	5
MSB05B	Lower	34	34	41	34	7/23/2024	9	-25
MSB05C	Lower	8	8	10	8	7/23/2024	7.6	-0.4
MSB06A	Upper	2	3	10	3	7/23/2024	ND[3]	-3
MSB06B	Lower	34	35	42	35	7/23/2024	46	11
MSB06C	Lower	12	13	15	13	7/23/2024	15	2
MSB09A	Upper	2	2	10	2	7/25/2024	ND[3]	-2
MSB09B	Lower	3	3	10	3	7/25/2024	ND[3]	-3
MSB09C	Lower	113	113	135	113	7/25/2024	110	-3
MSB10B	Lower	2	3	10	3	7/26/2024	ND[3]	-3
MSB10C	Lower	3	3	10	3	7/26/2024	ND[3]	-3
MSB11C	Lower	6	6	10	6	7/31/2024	8.5	2.5
MSB13A	Upper	n/a†	8†	10†	8†	-	NM[2]	-
MSB13B	Lower	n/a†	8†	10†	8†	7/24/2024	3.6	-4.4
MSB13C	Lower	n/a†	8†	10†	8†	7/24/2024	3.6	-4.4
2000507-001	Lower	4	4	10	4	-	NM[2]	-
2000553-001	Lower	2	3	10	3	2/14/2024	1.5	-1.5
2000682-002	Lower	3	3	10	3	-	NM[2]	-
2000727-001	Lower	2	2	10	2	2/21/2024	1.8	-0.2
2000938-001	Lower	2	2	10	2	-	NM[2]	-

RMS Well ID	Aquifer Designation	Baseline Conc. (ug/L)[1]	MO Conc. (ug/L)	MT Conc. (ug/L)	2025 IM Conc. (ug/L)	Date of 2024 Measurement	2024 Conc. (ug/L)	2025 IM Status (ug/L)
2010002-014	Lower	11	12	14	12	-	NM[2]	-
2010002-032	Lower	4	4	10	4	3/25/2024	2	-2
2010008-005	Composite	3	4	10	4	3/25/2024	3	-1
2010009-002	Composite	6	6	10	6	-	NM[2]	-
2010010-007	Lower	2	3	10	3	-	NM[2]	-
2010801-001	Lower	15	15	18	15	7/2/2024	17	2
2801077-001	Composite	n/a†	8†	10†	8†	-	NM[2]	-
ESJ12	Upper	n/a‡	n/a‡	n/a‡	n/a‡	-	n/a‡	-
ESJ17	Unknown	n/a‡	n/a‡	n/a‡	n/a‡	-	n/a‡	-

[1] Baseline concentration calculated as average of all measurement pre-2024 (minimum of three years required to determine)
[2] NM = no measurement.
[3] ND = non-detect.
† Insufficient data available to calculate baseline value. SMC values will be confirmed and/or adjusted as needed after a baseline has been calculated.
‡ Monitoring for the Irrigated Lands Regulatory Program does not include testing for arsenic.



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\GIS\MAD_Five_Year_Update\MAD_Five_Year_Update.aprx; Figure 2-3 RMS_WQ_AS_SustCri_IM2025

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FIGURE 2-3

2024 Arsenic Measurements at Groundwater Quality RMS Wells compared to 2025 Interim Milestones

Madera Subbasin

Groundwater Sustainability Plan - Periodic Evaluation

2.3.3.2 Nitrate as N

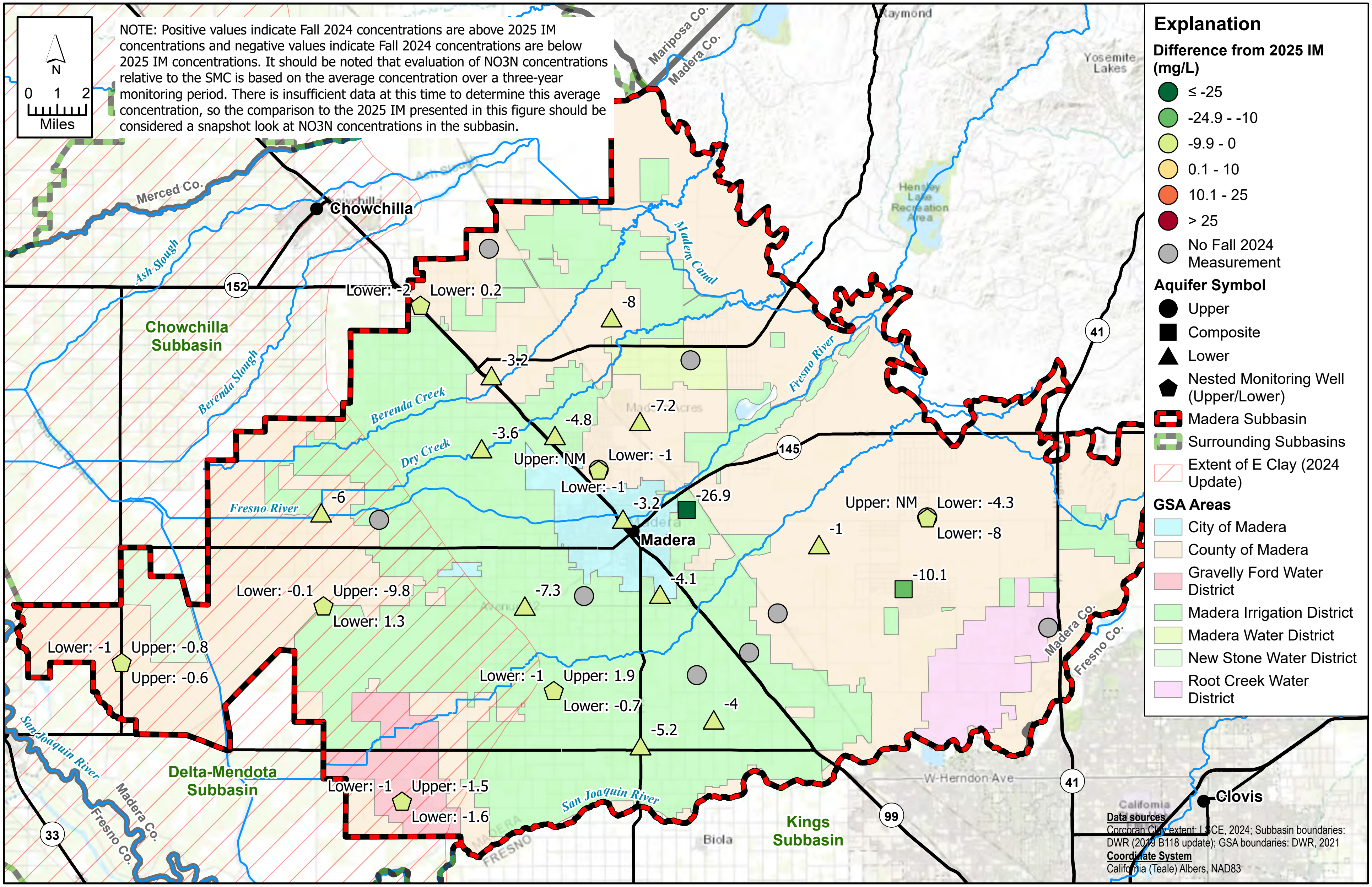
Table 2-5 and **Figure 2-4** present the Fall 2024 NO3N measurements at the groundwater quality RMS wells and their status in relation to the 2025 IMs, MOs, and MTs defined for NO3N in the 2025 Plan Amendment. Review of the Fall 2024 NO3N measurements that are available for 32 RMS wells indicates that NO3N concentrations are primarily below 2025 IMs (91% of RMS wells). It should be noted that evaluation of NO3N concentrations relative to the SMC is based on the average concentration over a three-year monitoring period. There is insufficient data at this time to determine this average concentration, so the comparison to the 2025 IM presented in **Table 2-5** and **Figure 2-4** should be considered a snapshot look at NO3N concentrations in the Subbasin.

Table 2-5. Summary of RMS Well Groundwater Quality Relative to Interim Milestones, Minimum Thresholds, and Measurable Objectives for Nitrate as N.

RMS Well ID	Aquifer Designation	Baseline Conc. (ug/L)[1]	MO Conc. (ug/L)	MT Conc. (ug/L)	2025 IM Conc. (ug/L)	Date of 2024 Measurement	2024 Conc. (ug/L)	2025 IM Status (ug/L)
MCE RMS-3	Lower	1	1	10	1	7/30/2024	ND[3]	-1
MID RMS-4	Lower	n/a†	8†	10†	8†	8/22/2024	2	-6
MID RMS-5B	Lower	n/a†	8†	10†	8†	-	NM[2]	-
MID RMS-6	Lower	n/a†	8†	10†	8†	8/22/2024	4.4	-3.6
MID RMS-7	Lower	n/a†	8†	10†	8†	7/25/2024	0.7	-7.3
MID RMS-13	Composite	n/a†	8†	10†	8†	-	NM[2]	-
MWD RMS-1	Lower	2	3	10	3	-	NM[2]	-
MSB03A	Upper	8	8	10	8	7/23/2024	7.2	-0.8
MSB03B	Upper	0	1	10	1	7/23/2024	0.45	-0.6
MSB03C	Lower	ND[3]	1	10	1	7/23/2024	ND[3]	-1
MSB04A	Upper	6	6	10	6	-	NM[2]	-
MSB04B	Lower	ND[3]	1	10	1	7/24/2024	ND[3]	-1
MSB04C	Lower	ND[3]	1	10	1	7/24/2024	ND[3]	-1
MSB05A	Upper	12	13	15	13	7/23/2024	3.2	-9.8
MSB05B	Lower	0	1	10	1	7/23/2024	2.3	1.3
MSB05C	Lower	1	1	10	1	7/23/2024	0.92	-0.1
MSB06A	Upper	9	10	12	10	7/23/2024	8.5	-1.5
MSB06B	Lower	2	2	10	2	7/23/2024	0.38	-1.6
MSB06C	Lower	1	1	10	1	7/23/2024	ND[3]	-1
MSB09A	Upper	7	8	10	8	7/25/2024	9.9	1.9
MSB09B	Lower	2	2	10	2	7/25/2024	1.3	-0.7
MSB09C	Lower	ND[3]	1	10	1	7/25/2024	ND[3]	-1
MSB10B	Lower	2	2	10	2	7/26/2024	2.2	0.2
MSB10C	Lower	2	2	10	2	7/26/2024	ND[3]	-2

RMS Well ID	Aquifer Designation	Baseline Conc. (ug/L)[1]	MO Conc. (ug/L)	MT Conc. (ug/L)	2025 IM Conc. (ug/L)	Date of 2024 Measurement	2024 Conc. (ug/L)	2025 IM Status (ug/L)
MSB11C	Lower	n/a†	8†	10†	8†	7/31/2024	ND[3]	-8
MSB13A	Upper	n/a†	8†	10†	8†	-	NM[2]	-
MSB13B	Lower	n/a†	8†	10†	8†	7/24/2024	3.7	-4.3
MSB13C	Lower	n/a†	8†	10†	8†	7/24/2024	ND[3]	-8
2000507-001	Lower	6	6	10	6	6/28/2024	2.8	-3.2
2000553-001	Lower	8	9	10	9	7/9/2024	3.8	-5.2
2000682-002	Lower	7	7	10	7	1/16/2024	2.2	-4.8
2000727-001	Lower	5	6	10	6	2/21/2024	2	-4
2000938-001	Lower	3	4	10	4	-	NM[2]	-
2010002-014	Lower	5	5	10	5	6/3/2024	1.8	-3.2
2010002-032	Lower	6	7	10	7	3/25/2024	2.9	-4.1
2010008-005	Composite	12	13	15	13	3/25/2024	2.9	-10.1
2010009-002	Composite	6	7	10	7	-	NM[2]	-
2010010-007	Lower	9	9	11	9	1/2/2024	1.8	-7.2
2010801-001	Lower	2	3	10	3	-	NM[2]	-
2801077-001	Composite	26	27	32	27	4/24/2024	0.1	-26.9
ESJ12	Upper	7	7	11	7	-	NM[2]	-
ESJ17	Unknown	n/a†	8†	10†	8†	-	NM[2]	-

[1] Baseline concentration calculated as average of all measurement pre-2024 (minimum of three years required to determine)
[2] NM = no measurement.
[3] ND = non-detect.
† Insufficient data available to calculate baseline value. SMC values will be confirmed and/or adjusted as needed after a baseline has been calculated.



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\GIS\MAD_Five_Year_Update\MAD_Five_Year_Update.aprx; Figure 2-5 RMS_WQ_NO3N_SustCri_IM2025

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FIGURE 2-4

2024 Nitrate (as N) Measurements at Groundwater Quality RMS Wells compared to 2025 Interim Milestones

Madera Subbasin

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2.3.3.3 Total Dissolved Solids

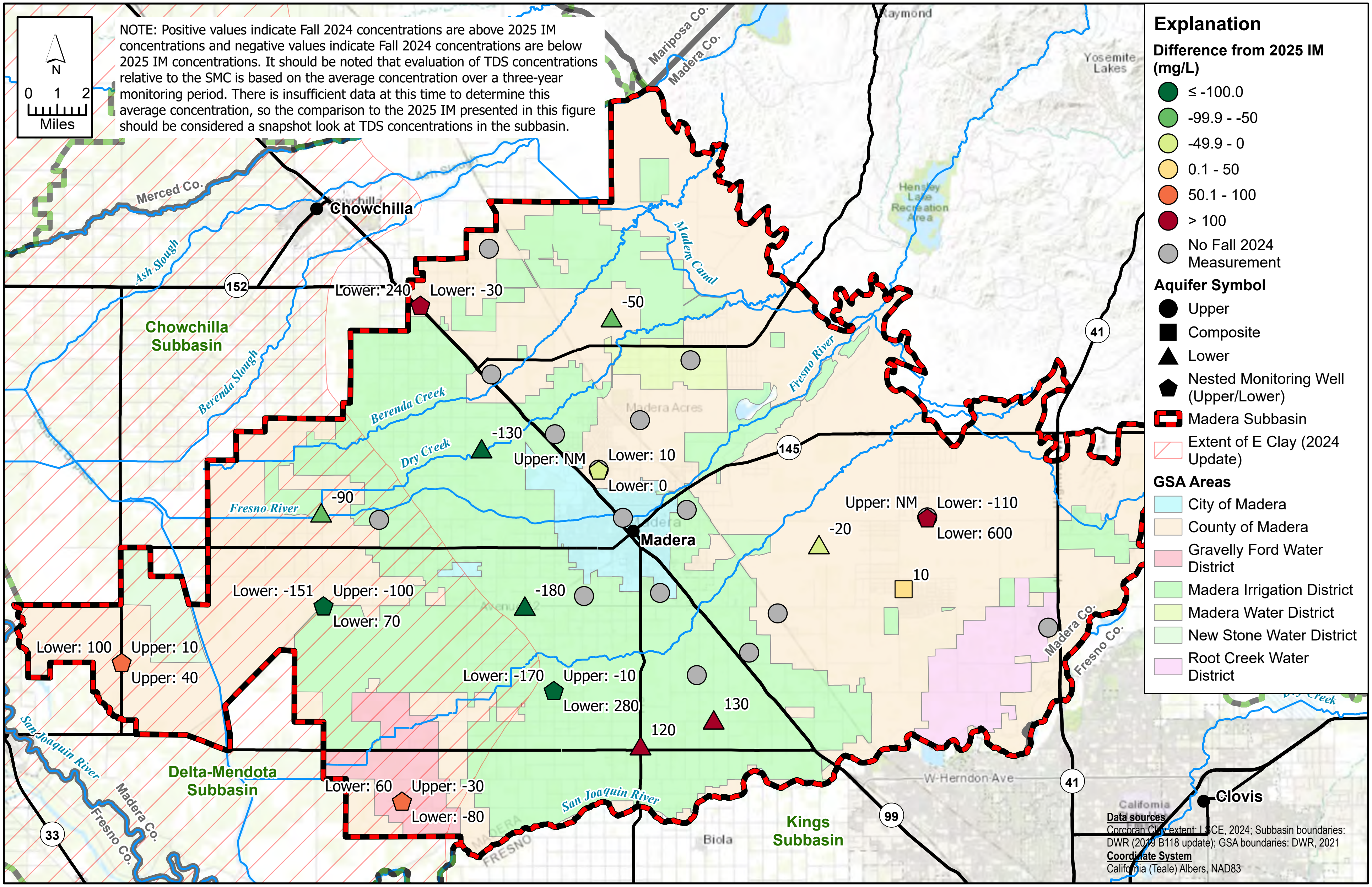
Table 2-6 and **Figure 2-5** present the 2024 TDS measurements at the groundwater quality RMS wells and their status in relation to the 2025 IMs, MOs, and MTs defined for TDS in the 2025 Plan Amendment. Review of the 2024 TDS measurements that are available for 26 RMS wells indicates that TDS concentrations are below 2025 IMs in half of the RMS wells (50% of RMS wells). It should be noted that evaluation of TDS concentrations relative to the SMC is based on the average concentration over a three-year monitoring period. There is insufficient data at this time to determine this average concentration, so the comparison to the 2025 IM presented in **Table 2-6** and **Figure 2-5** should be considered a snapshot look at TDS concentrations in the Subbasin.

Table 2-6. Summary of RMS Well Groundwater Quality Relative to Interim Milestones, Minimum Thresholds, and Measurable Objectives for Total Dissolved Solids.

RMS Well ID	Aquifer Designation	Baseline Conc. (mg/L)[1]	MO Conc. (mg/L)	MT Conc. (mg/L)	2025 IM Conc. (mg/L)	Date of 2024 Measurement	2024 Conc. (mg/L)	2025 IM Status (mg/L)
MCE RMS-3	Lower	643	650	772	650	7/30/2024	630	-20
MID RMS-4	Lower	n/a†	400†	500†	400†	8/22/2024	310	-90
MID RMS-5B	Lower	n/a†	400†	500†	400†	-	NM[2]	-
MID RMS-6	Lower	n/a†	400†	500†	400†	8/22/2024	270	-130
MID RMS-7	Lower	n/a†	400†	500†	400†	7/25/2024	220	-180
MID RMS-13	Composite	n/a†	400†	500†	400†	-	NM[2]	-
MWD RMS-1	Lower	205	250	500	250	-	NM[2]	-
MSB03A	Upper	828	850	994	850	7/23/2024	860	+10
MSB03B	Upper	345	350	500	350	7/23/2024	390	+40
MSB03C	Lower	963	1,000	1,155	1,000	7/23/2024	1,100	+100
MSB04A	Upper	218	250	500	250	-	NM[2]	-
MSB04B	Lower	380	400	500	400	7/24/2024	410	+10
MSB04C	Lower	355	400	500	400	7/24/2024	400	0
MSB05A	Upper	568	600	682	600	7/23/2024	500	-100
MSB05B	Lower	240	250	500	250	7/23/2024	320	+70
MSB05C	Lower	247	250	500	250	7/23/2024	99	-151
MSB06A	Upper	424	450	510	450	7/23/2024	420	-30
MSB06B	Lower	404	450	500	450	7/23/2024	370	-80
MSB06C	Lower	422	450	507	450	7/23/2024	510	+60
MSB09A	Upper	500	550	600	550	7/25/2024	540	-10
MSB09B	Lower	203	250	500	250	7/25/2024	530	+280
MSB09C	Lower	278	300	500	300	7/25/2024	130	-170
MSB10B	Lower	206	250	500	250	7/26/2024	220	-30
MSB10C	Lower	273	300	500	300	7/26/2024	540	+240

RMS Well ID	Aquifer Designation	Baseline Conc. (mg/L)[1]	MO Conc. (mg/L)	MT Conc. (mg/L)	2025 IM Conc. (mg/L)	Date of 2024 Measurement	2024 Conc. (mg/L)	2025 IM Status (mg/L)
MSB11C	Lower	490	500	588	500	7/31/2024	450	-50
MSB13A	Upper	n/a†	400†	500†	400†	-	NM[2]	-
MSB13B	Lower	n/a†	400†	500†	400†	7/24/2024	290	-110
MSB13C	Lower	n/a†	400†	500†	400†	7/24/2024	1,000	+600
2000507-001	Lower	n/a†	400†	500†	400†	-	NM[2]	-
2000553-001	Lower	261	300	500	300	2/14/2024	420	+120
2000682-002	Lower	n/a†	400†	500†	400†	-	NM[2]	-
2000727-001	Lower	207	250	500	250	2/21/2024	380	+130
2000938-001	Lower	145	150	500	150	-	NM[2]	-
2010002-014	Lower	181	200	500	200	-	NM[2]	-
2010002-032	Lower	212	250	500	250	-	NM[2]	-
2010008-005	Composite	318	350	500	350	3/25/2024	360	+10
2010009-002	Composite	138	150	500	150	-	NM[2]	-
2010010-007	Lower	204	250	500	250	-	NM[2]	-
2010801-001	Lower	242	250	500	250	-	NM[2]	-
2801077-001	Composite	n/a†	400†	500†	400†	-	NM[2]	-
ESJ12	Upper	493	500	592	500	-	NM[2]	-
ESJ17	Unknown	n/a†	400†	500†	400†	-	NM[2]	-

[1] Baseline concentration calculated as average of all measurement pre-2024 (minimum of three years required to determine)
[2] NM = no measurement.
† Insufficient data available to calculate baseline value. SMC values will be confirmed and/or adjusted as needed after a baseline has been calculated.



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\GIS\MAD_Five_Year_Update\MAD_Five_Year_Update.aprx; Figure 2-7 RMS_WQ_TDS_SustCri_IM2025

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FIGURE 2-5
2024 Total Dissolved Solids Measurements at Groundwater Quality RMS Wells compared to 2025 Interim Milestones

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2.3.4 Progress Toward Achieving Sustainability

There is currently insufficient data to draw any conclusions related to progress towards sustainability for the groundwater quality indicator. It should be noted that evaluation of groundwater quality concentrations relative to SMC is based on the average concentration for a given key constituent over a three-year monitoring period. The comparisons provided in **Section 2.3.3** provide a snapshot look at groundwater conditions related to groundwater quality based on available data. It is important to evaluate groundwater quality over a long-term (three years or more) period in order to identify trends and to draw conclusions related to progress toward sustainability. An accurate evaluation of progress toward sustainability will be possible in the future after longer monitoring histories are developed for each RMS well.

2.3.5 Impacts to Beneficial Uses and Users

As discussed in the previous section, there is currently insufficient data to draw any conclusions related to progress towards sustainability or impacts to beneficial uses and users for the groundwater quality indicator.

2.4 Land Subsidence

The following section discusses groundwater conditions in the Subbasin related to land subsidence. Specific references are given for the Joint GSP 2025 Plan Amendment, although this discussion is applicable to the Subbasin and the 2025 Plan Amendment as a whole.

2.4.1 Recommended Corrective Actions

In DWR's 2023 Revised Plan approval letter, a recommended corrective action related to the land subsidence sustainability indicator was identified. The recommended corrective action stated:

> *Recommended Corrective Action 4: Department staff recommend the following as it relates to land subsidence:*
>
> > *a. The GSAs should refine the description of undesirable results to clearly describe the significant and unreasonable conditions the GSAs are managing the Subbasin to avoid, as it relates to land subsidence. More specifically, the GSAs should reevaluate the quantitative metrics that define an undesirable result for subsidence. The reevaluation should consider localized subsidence conditions and the irreversibility of continued inelastic subsidence, especially in the area deemed of "greater subsidence concern." This is to say that the current quantitative metrics (i.e., 75 percent of the representative monitoring sites in the Subbasin exceed threshold levels for two consecutive years across the entire Subbasin) would not minimize or avoid inelastic subsidence in the most susceptible areas of the Subbasin – predominantly in the north-northwestern portion of the Subbasin which are describe as the areas of greater subsidence concern.*
> >
> > *b. The GSAs should identify the cumulative amount of subsidence that, if exceeded, would substantially interfere with groundwater and land surface beneficial uses and users in the Subbasin. The Plan should explain how the rate and extent of any future subsidence permitted in the Subbasin may interfere with surface land uses. The Plan should also include additional details describing measures that consider and disclose the current and*

potentially lasting impacts of subsidence on land uses and groundwater beneficial uses and users.

Additionally, the GSAs should provide specific details and schedule for projects or management actions that will be implemented to minimize or eliminate subsidence. The projects or management actions must be supported by best available information and science and consider the level of uncertainty associated with the Subbasin.

c. The GSAs should revise the GSPs to include a discussion of the relationship between the management criteria for land subsidence and the other sustainability indicators, including an explanation of how criteria, including interim milestones, were established to avoid undesirable results for each of the other sustainability indicators.

d. The GSAs should reevaluate or eliminate the application of the level of uncertainty as it relates to subsidence measurements according to standard professional practices. Establishment of sustainable management criteria should not allow for subsidence in perpetuity based on the error of measurement. The GSAs should also consider incorporation of remotely sensed subsidence data (i.e., InSAR data) made available by the Department on an ongoing basis to monitor for subsidence in conjunction with the representative monitoring sites. For reference, the statewide vertical displacement measurements provided via the InSAR data present an error of 0.1 foot.

In response to this recommended corrective action, the Joint GSP 2025 Plan Amendment has been revised in a number of locations to address each item:

- Corrective Action 4.a: Section 3.4.3
- Corrective Action 4.b: Sections 3.2.3.2, 3.3.3.7; Chapter 4
- Corrective Action 4.c: Section 3.2.1.3.2
- Corrective Action 4.d: Sections 3.2.3.1, 3.3.3.1, 3.5.1.3

2.4.2 Amendments to SMC

The MOs and MTs for land subsidence have not been changed from the 2023 Revised Plan (both are set as a rate of 0.0 feet/year). However, the methodology for establishing IMs has changed in the 2025 Plan Amendment. IMs have been informed by a detailed infrastructure sensitivity assessment and recent interviews with critical infrastructure owners and operators. Based on the updated infrastructure sensitivity assessment, it has been determined that the maximum allowable additional cumulative subsidence within the Subbasin should be set at two feet between December 2023 and January 2040 in order to be protective of critical infrastructure. IMs were established for additional cumulative subsidence between December 2019 and December 2024, and at five-year intervals for 2025 to 2030, 2030 to 2035, and 2035 to 2040 to ensure a ramp down to the zero subsidence MO by 2040. An IM for the average annual rate of subsidence has also been set for each five-year interval in order to evaluate annual progress toward meeting the cumulative subsidence IMs. A summary of the amended land subsidence IMs is presented in **Table 2-7**.

Table 2-7. Summary of Land Subsidence Interim Milestones.

5-Year Interval Ending at Year	Maximum Average Annual Rate of Subsidence (feet/year)	Maximum 5-Year Cumulative Subsidence (feet)
2025	-	-1.5
2030	-0.2	-1.0
2035	-0.1	-0.5
2040	-0.05	-0.25

A detailed discussion of the IM methodology is presented in Section 3.2.3.2 of the Joint GSP 2025 Plan Amendment.

2.4.3 Current Conditions Relative to SMC

In the 2025 Plan Amendment, IMs for land subsidence were established at five-year intervals over the GSP implementation period from 2020 to 2040, at years 2025, 2030, and 2035. IMs for land subsidence were established based on information gathered through a detailed infrastructure sensitivity assessment and recent interviews with critical infrastructure owners and operators. IMs were established for a maximum cumulative subsidence for each five-year interval from 2020 to 2025, 2025 to 2030, 2030 to 2035, and 2035 to 2040 to ensure a ramp down to the zero subsidence MO by 2040. An IM for the average annual rate of subsidence has also been set for each five-year interval in order to evaluate annual progress toward meeting the cumulative subsidence IMs. The MO for land subsidence was established at a rate of 0 feet/year of subsidence with the goal of long-term avoidance of land subsidence.

Table 2-8 and **Figure 2-6** present the status of land subsidence RMS stations in relation to the 2025 IMs, MOs, and MTs defined in the GSP.

2.4.4 Progress Toward Achieving Sustainability

As shown in **Table 2-8**, all RMS stations had a cumulative total less than the 2020 to 2025 IM. This indicates that the Subbasin is on track toward sustainability.

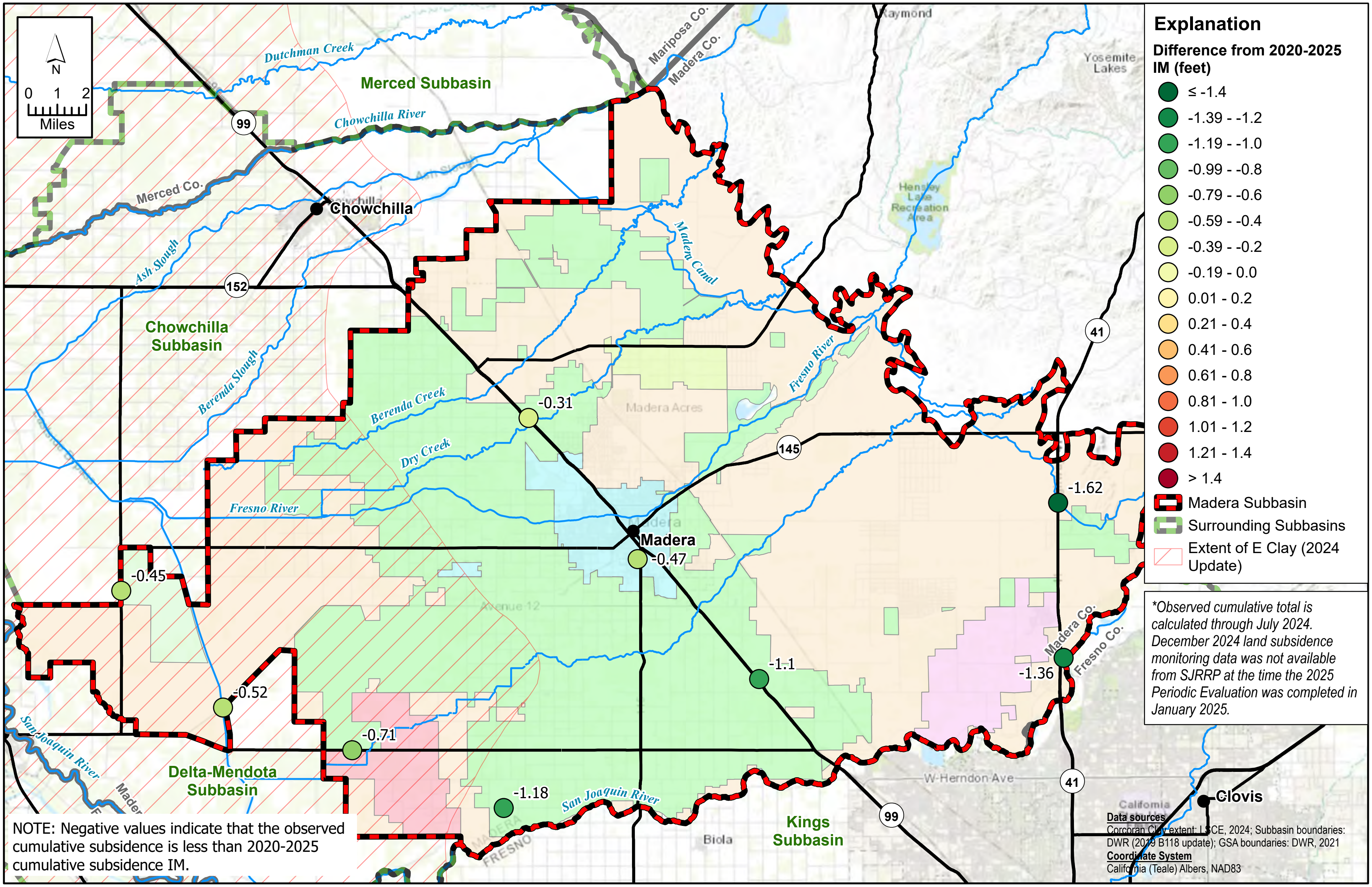
2.4.5 Impacts to Beneficial Uses and Users

No reported impacts to beneficial uses and users have been identified during this evaluation period.

Table 2-8. Summary of RMS Station Land Subsidence Rates Relative to Interim Milestones, Minimum Thresholds, and Measurable Objectives.

RMS ID	Dataset	MO (feet/year)	2020 to 2025 IM - Annual Rate of Subsidence (feet/year)	2020 to 2025 IM - Cumulative Subsidence (feet)	Observed Annual Rate (feet/year)[1]	Observed Cumulative Total (feet)[1]
SJRRP_29	SJRRP	0.0	-	-1.5	-	-1.19
SJRRP_127	SJRRP	0.0	-	-1.5	-	-0.79
SJRRP_1007R	SJRRP	0.0	-	-1.5	-	-1.05
SJRRP_141	SJRRP	0.0	-	-1.5	-	-0.40
SJRRP_142	SJRRP	0.0	-	-1.5	-	0.12
SJRRP_160R	SJRRP	0.0	-	-1.5	-	-0.32
SJRRP_165	SJRRP	0.0	-	-1.5	-	-0.14
SJRRP_201R	SJRRP	0.0	-	-1.5	-	-0.98
P307	PBO	0.0	-	-1.5	-	-1.03

[1] Observed cumulative total is calculated through July 2024. December 2024 land subsidence monitoring data was not available from SJRRP at the time the 2025 Periodic Evaluation was completed in January 2025. Updates will be provided with available data in future Annual Reports and Periodic Evaluations, as applicable.



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\GIS\MAD_Five_Year_Update\MAD_Five_Year_Update.aprx; Figure 2-6 RMS_SUBS_SustCri_IM2025

DAVIDS ENGINEERING, INC

Luhdorff & Scalmanini Consulting Engineers

FIGURE 2-6

Land Subsidence Measurements compared to 2025 Interim Milestones

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2.5 Interconnected Surface Water

The following section discusses groundwater conditions in the Subbasin related to ISW. Specific references are given for the Joint GSP 2025 Plan Amendment, although this discussion is applicable to the Subbasin and the 2025 Plan Amendment as a whole.

2.5.1 Recommended Corrective Actions

No recommended corrective action related to ISW was identified in DWR's 2023 Revised Plan approval letter. However, the Subbasin GSAs have taken proactive steps to improve the understanding and management of ISW in the Subbasin. As part of the 2023 Revised Plan, a workplan was developed to refine and improve the hydrogeologic understanding related to ISW in the Subbasin. The workplan is included in Appendix 3.I of the Joint GSP 2025 Plan Amendment. In addition to the GSAs' ISW Workplan described above, since late 2023 and as a result of individual comments received following submission of the 2020 Initial Plan, representatives from the Subbasin and Kings Subbasin have been meeting monthly with representatives from the USBR and FWA to better understand their issues and concerns related to ISW along the San Joaquin River These ISW coordination efforts are described in **Section 7.3.2** of this Periodic Evaluation. The Subbasin GSAs also plan to review DWR's ISW guidance documents (released in 2024) and may consider revisions to the current ISW SMC as GSP implementation continues. These activities are described in more detail in Section 4.9.5 of the Joint GSP 2025 Plan Amendment.

2.5.2 Amendments to SMC

In the 2023 Revised Plan, interim SMC for the depletion of ISW were established due to limited data available to quantify the relationship between groundwater and the San Joaquin River. No amendments have been made to the ISW SMC in the 2025 Plan Amendment. It is anticipated that ISW SMC may be refined following review of DWR's forthcoming guidance for managing ISW depletion (anticipated Winter 2024/2025, see **Section 8.2** for additional discussion).

2.5.3 Current Conditions Relative to SMC

For the purposes of establishing interim SMC for ISW along the San Joaquin River, three groundwater level RMS wells screened in the Upper Aquifer in close proximity to the San Joaquin River were evaluated by comparing modeled groundwater elevations to adjacent stream thalweg elevations in order to calculate the percent of time over the historical time period from 1989 to 2015 that ISW exists at that given location. The IMs and MOs for ISW along the San Joaquin River are the same, and are to maintain the percent of time the San Joaquin River is connected to shallow groundwater levels equal to or greater than existing and historical conditions at RMS wells screened in the Upper Aquifer in close proximity to the San Joaquin River. In order to create SMC that can be evaluated using this metric on an annual basis, a rolling average for the past five years will be used as the current conditions for percent of time connected. The five-year current rolling average will be compared to the historical base period percent of time connected to determine if MOs are being achieved.

Due to monitoring challenges at the selected RMS wells, there is not enough data currently available to evaluate the ISW SMC at this time. The Joint GSP GSAs are currently in discussions to take over monitoring of the ISW RMS wells from the SJRRP.

2.5.4 Progress Toward Achieving Sustainability

As described in **Section 2.5.1** and **Section 7.3.2**, the Subbasin GSAs have taken proactive steps to improve the understanding of ISW in the Subbasin and to engage other stakeholders in the region to coordinate an approach to the understanding and management of ISW.

2.5.5 Impacts to Beneficial Uses and Users

No reported impacts to beneficial uses and users have been identified during this evaluation period.

2.6 Seawater Intrusion

The seawater intrusion sustainability criteria are not applicable to Plan Area, because it is located more than 70 miles inland and is hydraulically disconnected from the ocean.

3 Status of Projects and Management Actions (23 CCR §356.4(b))

The purpose of this section is to describe the Subbasin GSAs' advancements in implementing projects and management actions (PMAs), and the benefits those PMAs have achieved for the Subbasin through the most recently completed Annual Report during this Periodic Evaluation cycle (WY 2023), including how those benefits are contributing to the Subbasin achieving its sustainability goal and operating within its sustainable yield. This Periodic Evaluation covers the first Periodic Evaluation cycle, during which Annual Reports have been completed for WY 2019 through WY 2023. Thus, PMA implementation efforts described in this section are focused on this period.

In summary, as of WY 2023 – the most recently completed Annual Report during this Periodic Evaluation cycle – updates were reported for more than 30 PMAs developed by the Subbasin GSAs. **In total, approximately 96,100 acre-feet per year (AFY) of reported benefits occurred, on average, in years when PMA implementation was feasible through WY 2023**[4] (**Table ES-2**), not including early benefits achieved through enforcement of MC GSA's groundwater allocation. This represents approximately 43% of the total estimated average benefits at 2040 for the Subbasin GSAs' PMAs. However, it is noted that WY 2019-2023 included very wet conditions and substantial recharge in 2023. The Subbasin GSAs are planning PMAs and other GSP implementation efforts with the expectation that landmark wet years, such as 2023, will not occur again prior to 2040 (see **Section 4.3.2**).

Updates on PMAs are provided for each of the four GSPs in the four 2025 Periodic Evaluation GSP Attachments. Please refer to the following appendices for more information:

- **Appendix 1.B.1**: Joint GSP 2025 Periodic Evaluation Elements
- **Appendix 1.B.2**: GFWD GSA GSP 2025 Periodic Evaluation Elements
- **Appendix 1.B.3**: NSWD GSA GSP 2025 Periodic Evaluation Elements
- **Appendix 1.B.4**: RCWD GSA GSP 2025 Periodic Evaluation Elements

The Subbasin GSAs remain committed to adaptive management of groundwater resources through their suite of identified PMAs. As PMAs are implemented and monitored, the timelines of other PMAs and the volume of demand management necessary to achieve sustainability will be reviewed. If adjustments are needed to meet the sustainability goal for the Subbasin, PMA implementation efforts will be evaluated and adjusted. Already, changes to PMA implementation have been informed by changing conditions and new understanding of the Subbasin. For instance, MC GSA has refined its demand reduction targets as part of its demand management program based on new understanding of overdraft in the MC GSA since the 2020 Initial Plan was developed, increasing targets from 90,000 AFY to 113,000 AFY. MID GSA and RCWD GSA have also substantially refined their PMAs, working to hasten recharge projects and facilitate surface water use to support groundwater sustainability, consistent with the Subbasin GSAs' adaptive management commitment. Each Annual Report represents an important milestone and recurrent opportunity for the GSAs to collectively review groundwater conditions in the Subbasin and report on the status of PMA implementation efforts.

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[4] Averages were calculated based on reported PMA benefits in *only those years when implementation was feasible* during this Periodic Evaluation cycle. Benefits are reported through WY 2023, as that was the most recently completed Annual Report during this Periodic Evaluation cycle.

4 Basin Setting Evaluation Based on New Information or Changes in Water Use (23 CCR §356.4(c)-(d))

The purpose of this section is to evaluate the basin setting component of the 2025 Plan Amendment in the context of new information and changes in water use in the Subbasin evaluated over the first Periodic Evaluation cycle. Information in this section serves to document and explain the major causes and effects of any significant changes in the understanding of the basin setting (e.g., changes attributed to water supply and use or changes in model assumptions and results linked to new data and information).

Specific section references are given for the Joint GSP 2025 Plan Amendment, although this discussion is applicable to the Subbasin and the 2025 Plan Amendment as a whole.

The contents of this section are organized as follows:

- **Section 4.1** summarizes updates to the HCM, including efforts to fill data gaps related to the HCM.
- **Section 4.2** summarizes updates pertaining to groundwater conditions in the Subbasin that have been afforded by new data and tools.
- **Section 4.3** summarizes updates to the Subbasin water budget with consideration of new data and updates through WY 2023.
- **Section 4.4** summarizes updates and refinements to the Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) to update the Subbasin water budget (**Section 4.3**), and also to simulate land subsidence.

4.1 Hydrogeologic Conceptual Model

Several updates to the Subbasin HCM were made and are described in Section 2.2 (Basin Setting) of the 2025 Plan Amendment to both incorporate new data and reports that have become available over the last five years and to address DWR's recommended corrective actions in the 2023 Revised Plan approval letter. In particular, significant updates and revisions were made to Section 2.2.1.3 in the Joint GSP 2025 Plan Amendment (Major Aquifers/Aquitards - Groundwater System Conceptualization). Some minor revisions were made in other sections of the 2025 Plan Amendment.

Lithologic and borehole geophysical data collected during installation of dedicated monitoring wells at nine different locations has significantly improved overall understanding of the occurrence and distribution of fine- and coarse-grained layers. It has also allowed for further confirmation of the presence/absence and thickness of Corcoran Clay throughout the Subbasin, and resulted in refinement in one area of the previously mapped Corcoran Clay extent near the boundary with Chowchilla Subbasin (see Figure 2-15 in the Joint GSP 2025 Plan Amendment). The Corcoran Clay was found to be more extensive than previously mapped in the north central portion of Subbasin adjacent to Chowchilla Subbasin.

AEM data provided by DWR were primarily found to be useful (in conjunction with review of well logs and surface geology maps) in refining the understanding of depth to bedrock in the southeast portion of Subbasin (see Joint GSP 2025 Plan Amendment Figures 2-19 and 2-20). In general, bedrock was found to be considerably shallower in this portion of the Subbasin than was previously mapped and incorporated into the DWR California Central Valley Groundwater-Surface Water Simulation Model (C2VSim) that was adopted and modified into MCSim. In addition to updating the HCM description in the Joint GSP 2025 Plan Amendment, the updates to the Corcoran Clay extent and depth to bedrock were incorporated into the

MCSim update described in Appendix 6.D of the Joint GSP 2025 Plan Amendment and in **Appendix 3** of this 2025 Periodic Evaluation.

While the magnitude and extent of data gaps have been significantly reduced as described above, some data gaps remain, particularly with regard to subsidence and ISW. Workplans had previously been developed for both subsidence and ISW as part of the 2023 Revised Plan, and are planned for implementation (see Joint GSP 2025 Plan Amendment Appendices 3.H and 3.I). The GSAs are currently working on ISW Workplan coordination with adjacent Kings Subbasin GSAs and a broader working group that includes USBR, FWA, and SJRRP (see **Section 7.3.2**). The Subsidence Workplan has recently evolved to refine the scope of work based on input received from DWR regarding the subsidence SMC in the 2023 Revised Plan. Implementation of these two workplans will be major steps towards the filling of remaining data gaps in Subbasin. In addition, the MC GSA is currently working with DWR on installation of another dedicated nested monitoring well site in the southeastern portion of the Subbasin near an area with numerous domestic wells.

4.2 Groundwater Conditions

Several updates to the Subbasin groundwater conditions were made and are described in Section 2.2 (Basin Setting) of the 2025 Plan Amendment to both incorporate new data and reports that have become available over the last five years and to address DWR's recommended corrective actions in the 2023 Revised Plan approval letter. Significant updates and revisions were made to the following groundwater conditions sections in the Joint GSP 2025 Plan Amendment: Relationships Between Groundwater levels and Subsidence (2.2.2.4.2), Residual Subsidence Resulting from Historical Conditions (2.2.2.4.3), Groundwater – Surface Water Interaction (2.2.2.5), and Uncertainty and Data Gaps in Hydrogeologic Conceptualization and Groundwater Conditions (2.2.2.7). Some minor revisions were made in other sections.

The understanding of regional groundwater conditions has been greatly improved with the collection of more groundwater level and quality data from recently installed dedicated monitoring wells, which include data collection from both shallow and deep zones at each location. InSAR data has been used in Annual Reports to help confirm and refine our understanding (based on SJRRP benchmark surveys) of the magnitude and distribution of subsidence in Subbasin. InSAR also provide a better temporal resolution regarding the occurrence of subsidence for comparison to SJRRP semi-annual benchmark survey results. DWR's Dry Well Reporting System has been reviewed for comparison to the domestic well inventory estimates of expected dry wells to ensure that dry well estimates are in line with what is actually being reported.

The GSAs have been in the process of collecting background water quality data since 2020 to allow for establishment of the baselines needed for setting SMC. It has become apparent during the past five years of data collection efforts that refinements to the groundwater quality RMS network were needed, as described in more detail in Appendix 3.L of the Joint GSP 2025 Plan Amendment. The status of groundwater quality RMS network data collection efforts and establishment of SMC are described in more detail in **Section 2** of this Periodic Evaluation. There were no changes to key constituents or their related regulatory water quality standards during the past five years.

As described in **Sections 1.2 and 8.2**, DWR released one ISW white paper in February 2024 and two ISW white papers in September 2024 to provide some general methodologies and examples for assessment and characterization of ISW. DWR guidance for setting ISW SMC and for managing ISW depletion is pending and expected in Winter 2024/2025. When the DWR ISW guidance is provided it will be incorporated into the ISW Workplan. In addition, the Subbasin GSAs have engaged in ISW coordination meetings with adjacent Kings Subbasin GSAs and members of key agencies (USBR, FWA, and SJRRP) that are particularly interested in the ISW SMC being developed for the Subbasin. A MOU was developed as an initial step and these coordination meetings are expected to continue as the ISW Workplan is implemented and refined ISW SMC are developed for Subbasin. Additional information on progress to date with ISW coordination meetings is provided in **Section 7.3.2** of this Periodic Evaluation.

4.3 Water Use Changes and Associated Water Budget

This section describes updates to the Subbasin water budget that were made during this Periodic Evaluation cycle, with consideration of new data through WY 2023. These water budgets are reported from MCSim, which was extensively updated and refined during this Periodic Evaluation cycle (see **Sections 1.3 and 4.4** of this 2025 Periodic Evaluation for additional information.)

Water use in the Subbasin is impacted by a variety of factors, including hydrology, surface water supplies, and land use changes. These topics are each described below, considering both new data available during the first Periodic Evaluation cycle and changes in assumptions of future conditions in the projected water budgets.

4.3.1 Water Budgets

Updates to the Subbasin water budgets during this Periodic Evaluation cycle are compared to historical, current, and projected water budgets in the 2020 Initial Plan and 2023 Revised Plan. Water budgets presented in this section are based on the updated MCSim modeling conducted as part of the 2025 Plan Amendment (see **Sections 1.3 and 4.4** of this 2025 Periodic Evaluation for additional information). Detailed descriptions of water budget development process and components in the 2020 Initial Plan and 2023 Revised Plan are presented in Section 2.2.3 of the Joint GSP 2025 Plan Amendment.

Water budgets presented in the 2020 Initial Plan and 2023 Revised Plan were prepared for the Surface Water System (SWS) and Groundwater System (GWS). The SWS represents the land surface down to the bottom of the plant root zone, within the lateral boundaries of the Plan area. The GWS extends from the bottom of the root zone to the definable bottom of the Subbasin, within the lateral boundaries of the Subbasin. These systems are referred to as accounting centers. Flows between accounting centers and storage within each accounting center are water budget components.

The water budget components summarized in this section include Net Seepage, Deep Percolation, and Groundwater Extraction, as summarized from updated MCSim results. These components sum to the Net Recharge from the SWS to the GWS. Net Seepage includes all seepage from surface water to the GWS, including natural stream seepage, conveyance losses, and recharge projects. Deep Percolation includes applied water and precipitation that infiltrates through the root zone to the GWS. Groundwater extraction includes all groundwater pumping, including for both urban and agricultural uses.

Water budget results are rounded to two significant digits consistent with the typical uncertainty associated with the methods and sources used in the analysis. Water budget component results presented in the tables below may not sum to the totals presented because of rounding.

The water budgets reported in this section include the:

- **Historical Water Budget**: Representing historical land use, surface water supplies, hydrology, and groundwater conditions in the Subbasin. Results are summarized for the WY 1989 through WY 2014 period, for consistency and comparison with the water budgets in the 2020 Initial Plan.
- **Current Water Budget**: Representing current (or "now") land use and PMA implementation as of WY 2023, and long-term average surface water supplies and hydrology simulated through WY 2090 (based on data from WY 1973 through WY 2023, with adjustment as appropriate for anticipated changes in future conditions).
- **Projected Water Budget**: Representing projected (or "future") changes in land use and PMA implementation through WY 2090, and long-term average surface water supplies and hydrology simulated through WY 2090 (based on data from WY 1973 through WY 2023, with adjustment as appropriate for anticipated changes in future conditions).

Additional details about the historical, current, and projected water budget periods and MCSim inputs used to develop these water budget results are described further in **Section 4.4** and in **Appendix 3** of this Periodic Evaluation, and in Appendix 6.D of the Joint GSP 2025 Plan Amendment.

4.3.1.1 Historical Water Budget

The historical water budget is calculated over the period from WY 1989 through WY 2014. This period was selected in order to evaluate water budgets over a representative hydrologic period. The water budget results presented here reflect the updated modeling conducted as part of the 2025 Plan Amendment. Results presented in **Table 4-1** for the historical water budget are presented as the average annual volume over the 2020 Initial Plan historical water budget period from WY 1989-2014.

Table 4-1. Historical Water Budget for the Subbasin.

		Historical Water Budget (AF/year)			
		Net Seepage	Deep Percolation	Groundwater Extraction	Net Recharge from SWS
Annual Average (1989-2014)		130,000	230,000	-480,000	-110,000
Average by Water Year Type (1989-2014)	W	210,000	370,000	-400,000	170,000
	AN	140,000	210,000	-450,000	-100,000
	BN	99,000	170,000	-510,000	-240,000
	D	100,000	170,000	-530,000	-260,000
	C	87,000	170,000	-520,000	-270,000

Note: Water Year Type is based on the San Joaquin Valley Water Year Index and is classified into five types:

W Wet
AN Above Normal
BN Below Normal
D Dry
C Critical

4.3.1.2 Current Water Budget

The current water budget is meant to evaluate current or "now" conditions (in this case, WY 2023) over a long-term average hydrology period. For this scenario, WY 2023 land use was held constant and any PMAs implemented as over WY 2023 were simulated together with the projected future hydrology (described in Appendix 6.D of the Joint GSP 2025 Plan Amendment and in **Appendix 3** of this 2025 Periodic Evaluation). Results presented in **Table 4-2** for the current water budget are presented as the average annual volume over the GSP sustainability period from WY 2040-2090.

Table 4-2. Current Water Budget for the Subbasin.

		Current (WY 2023) Water Budget (AF/year)			
		Net Seepage	Deep Percolation	Groundwater Extraction	Net Recharge from SWS
Annual Average (2040-2090)		190,000	230,000	-540,000	-120,000
Average by Water Year Type (2040-2090)	W	300,000	350,000	-460,000	180,000
	AN	200,000	220,000	-530,000	-120,000
	BN	140,000	160,000	-590,000	-290,000
	D	130,000	160,000	-580,000	-290,000
	C	100,000	150,000	-600,000	-350,000

Note: Water Year Type is based on the San Joaquin Valley Water Year Index and is classified into five types:

W Wet
AN Above Normal
BN Below Normal
D Dry
C Critical

4.3.1.3 Projected Water Budgets

The projected water budget is meant to evaluate projected with projects conditions over a long-term average hydrology period. For this scenario, all planned PMAs and applicable land use changes were simulated together with the projected future hydrology (described in Appendix 6.D of the Joint GSP 2025 Plan Amendment and in **Appendix 3** of this 2025 Periodic Evaluation). Results presented in **Table 4-3** for the projected water budget are presented as the average annual volume over the GSP sustainability period from WY 2040-2090.

Table 4-3. Projected Water Budget for the Subbasin (Projected with Projects).

		Projected Water Budget (AF/year)			
		Net Seepage	Deep Percolation	Groundwater Extraction	Net Recharge from SWS
Annual Average (2040-2090)		230,000	200,000	-390,000	35,000
Average by Water Year Type (2040-2090)	W	380,000	340,000	-330,000	400,000
	AN	230,000	180,000	-380,000	35,000
	BN	160,000	110,000	-420,000	-150,000
	D	130,000	120,000	-420,000	-170,000
	C	110,000	110,000	-440,000	-230,000

Note: Water Year Type is based on the San Joaquin Valley Water Year Index and is classified into five types:
W Wet
AN Above Normal
BN Below Normal
D Dry
C Critical

4.3.2 Hydrology and Surface Water Supply

Based on new data incorporated into MCSim and considered in the water budgets above, the Subbasin GSAs are planning for generally drier hydrologic and water supply conditions, on average, during the remainder of the GSP implementation period (before 2040), as compared with the updated historical water budget period (1989-2023) and the GSP sustainability period (2040-2090). Recent years added to the historical water budget period since the 2020 Initial Plan (initially 1989-2014), in particular, include both very dry conditions (2020-2022), but also very wet conditions (2017 and 2023). During the remainder of the GSP implementation period, the Subbasin GSAs are planning for hydrologic patterns similar to the 1999-2013 period, which is a generally average period, but will account for dry conditions observed in the early 2000s and 2012-2013. The Subbasin GSAs are planning PMAs and other GSP implementation efforts with the expectation that landmark wet years, such as 2023, will not occur again prior to 2040 (see **Section 3**).

The impacts of these assumptions are reflected in:

- Average inflows to key waterways (e.g., the San Joaquin River, Madera Canal, and the Fresno River, see **Table 4-4** and **Figure 4-1**). In particular, more inflows occurred in the San Joaquin River during the 2025 Amended Plan historical water budget period (1989-2023), on average, than was either observed during the 2020 Initial Plan historical water budget period (1989-2014) or is anticipated to occur during the remainder of the GSP implementation period (before 2040). This is attributed mainly to large inflows in 2017 and 2023 that were not included in the 2020 Initial Plan historical water budget, and that are not anticipated before 2040. Rather, the projected water budgets are accounting for potential streamflow impacts associated with the SJRRP and estimated future water supplies reported by the FWA (Friant Water Authority, 2018). Changes in projected Madera Canal and Fresno River inflows are less pronounced, although lower projected inflows in winter months may impact recharge opportunities within the Subbasin (**Figure 4-1**).
- Average precipitation across the Subbasin compared between the historical and projected water budget periods (see **Figure 4-2** and **Figure 4-3**). While average precipitation during the GSP sustainability period (2040-2090) is expected to be similar to the historical water budget period (1989-2023), average precipitation during the remaining GSP implementation period (2024-2039) is anticipated to be lower. These differences occur primarily during late winter and early spring (January-March).

These assumptions are reasonably conservative for groundwater sustainability planning purposes, although the Subbasin GSAs will continue to evaluate hydrologic and water supply conditions to ensure that GSP implementation efforts remain on track to achieve the Subbasin sustainability goal despite changing future conditions. The Subbasin GSAs also recognize that inflows to these major waterways are subject to hydrology, management decisions, and other factors, and could vary further in the future from what is anticipated in the projected water budgets, although projected surface water supplies do consider potential foreseeable impacts (e.g., impacts related to the SJRRP).

Any future increases in surface water supplies will benefit groundwater sustainability in the Subbasin, as the Subbasin GSAs are developing a wide array of direct and in-lieu recharge projects that will allow them to divert and recharge or irrigate using surface water whenever it is available (e.g., see Section 3 and Figure 3-1 in the Joint GSP 2025 Periodic Evaluation Attachment, **Appendix 1.B.1**). While future decreases in surface water supplies would limit direct and in-lieu recharge opportunities, the Subbasin GSAs will continue their adaptive management approach to achieve the sustainability goal for the Subbasin. See **Section 3** for examples of the Subbasin GSAs' adaptive management efforts thus far.

Table 4-4. Historical and Projected Average Annual Surface Water Inflows – San Joaquin River, Madera Canal, and Fresno River (Thousand Acre-Feet per Water Year).

Period			San Joaquin River Inflows (Millerton Lake Releases)	Madera Canal Inflows	Fresno River Inflows (Hensley Lake Releases)
Historical Periods	1989-2014 Average (2020 Initial Plan Historical Period)		458.0	238.8	71.2
	1989-2023 Average (2025 Plan Amendment Historical Period)		543.1	232.5	76.0
	Average by Water Year Type (1989-2023)	W	1,273.6	373.7	163.7
		AN	264.1	300.4	72.1
		BN	172.0	232.9	27.5
		D	190.0	182.5	34.5
		C	212.6	111.0	29.3
Projected Periods	2024-2039 Average (Remaining Implementation Period)		376.2	243.8	63.9
	2040-2090 Average (Sustainability Period)		511.5	242.8	74.4
	Average by Water Year Type (2040-2090)	W	1,081.0	360.7	145.5
		AN	271.9	309.4	72.3
		BN	172.2	266.6	27.5
		D	171.0	186.8	31.9
		C	194.5	108.7	25.2

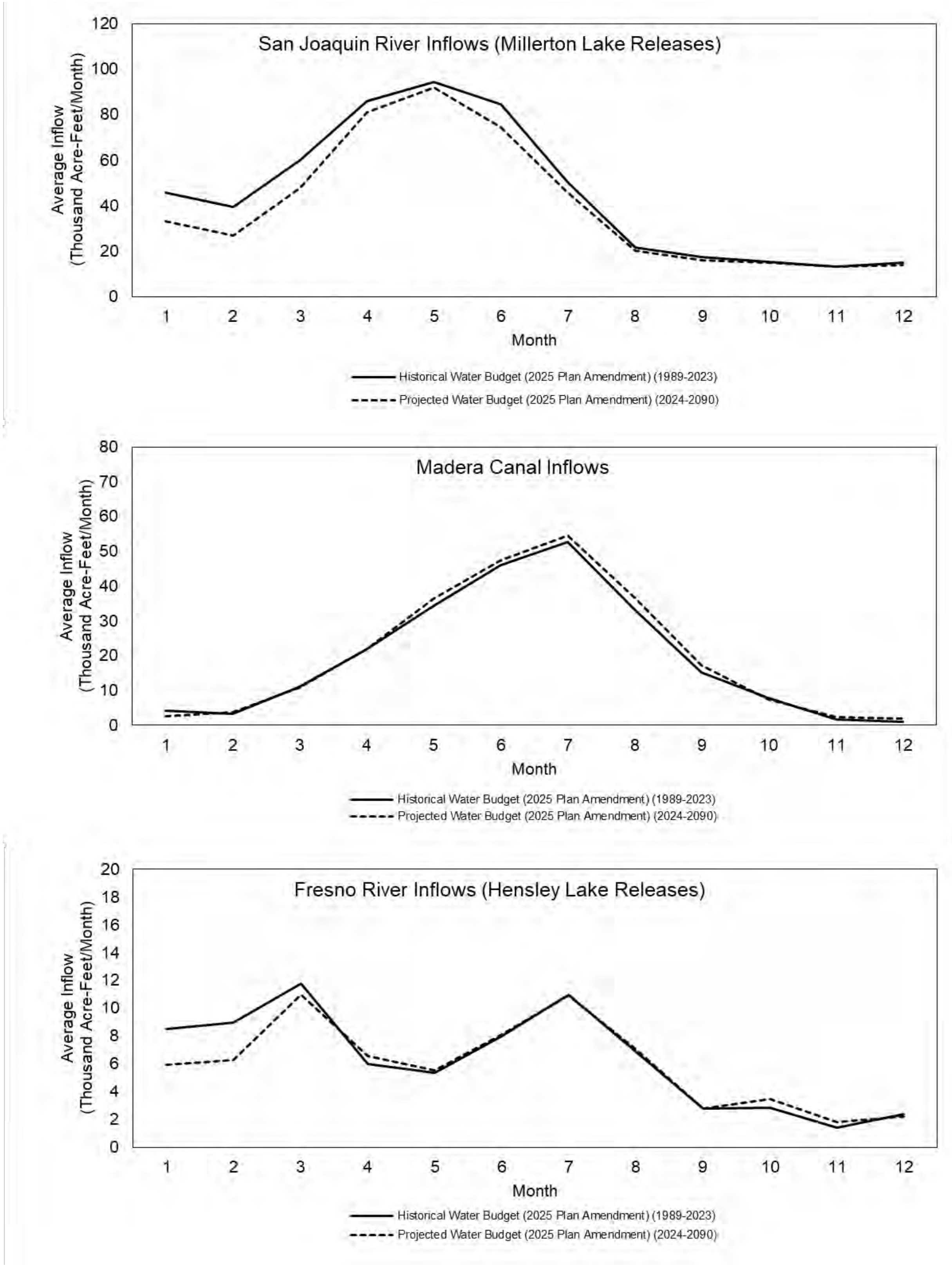

Figure 4-1. Historical and Projected Average Monthly Surface Water Inflows – San Joaquin River, Madera Canal, and Fresno River.

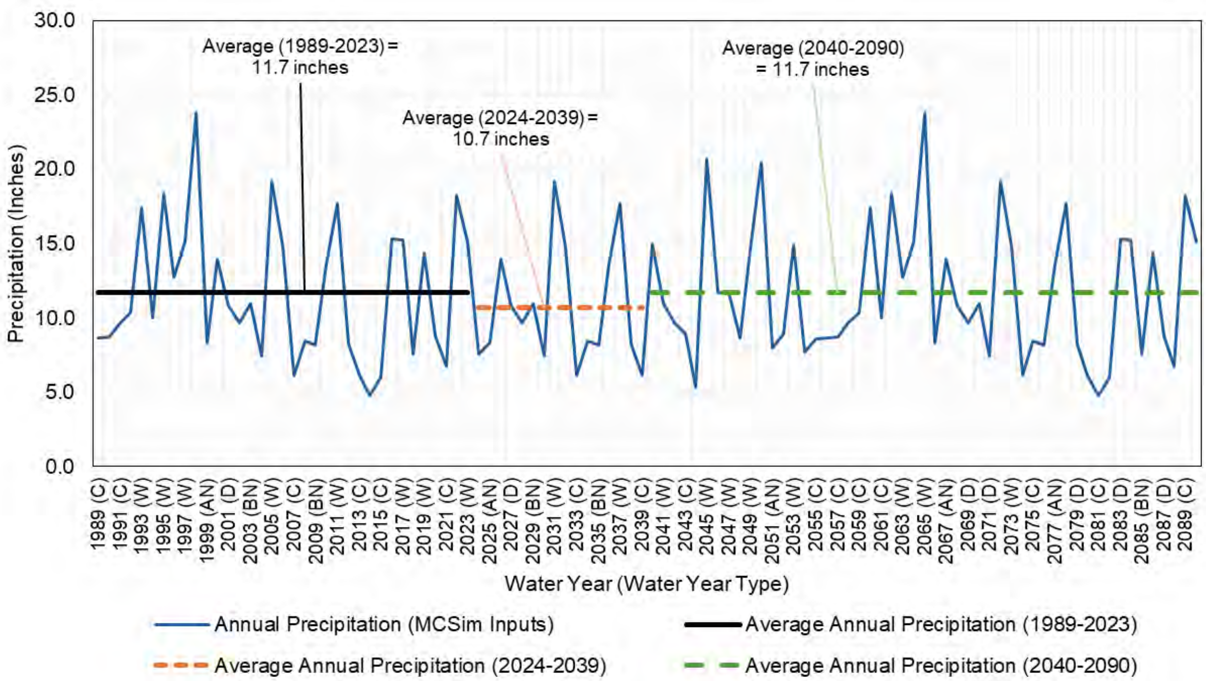

Figure 4-2. Historical and Projected Annual Precipitation (1989-2090), and Average Annual Precipitation Over Sequential Periods.

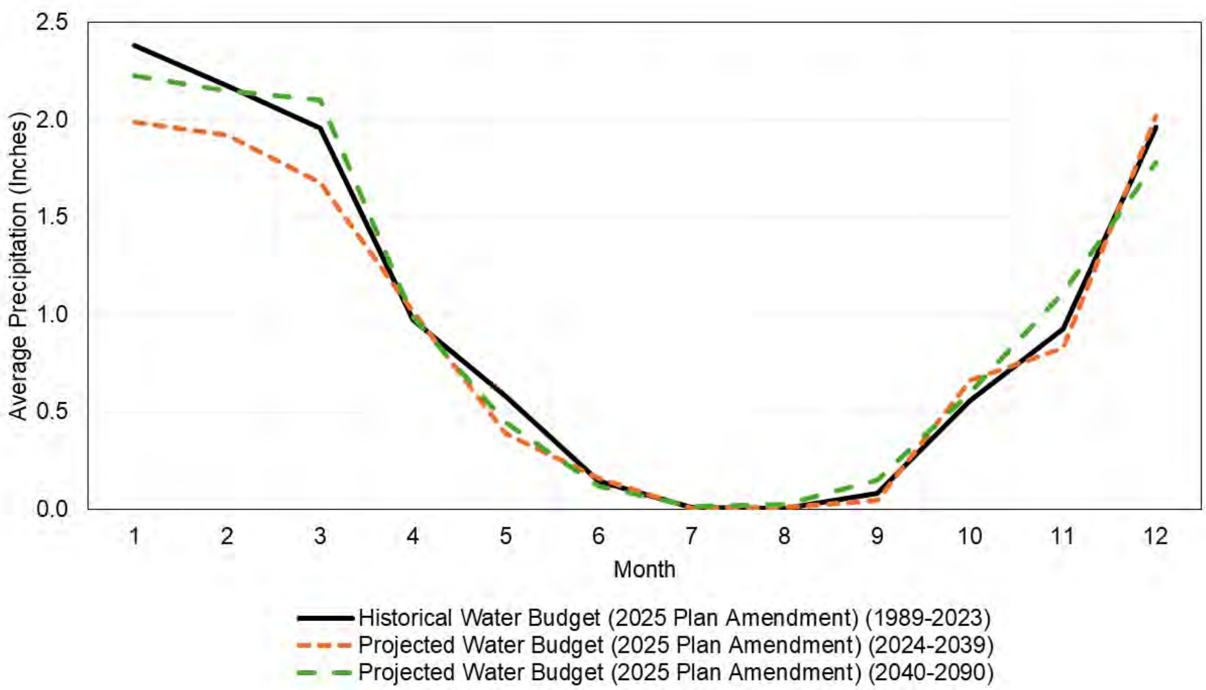

Figure 4-3. Average Monthly Historical and Projected Precipitation.

4.3.3 Land Use Changes

Historical and projected changes in land use and cropping patterns in the Subbasin are shown in **Figure 4-4**, as summarized from the MCSim model inputs (see **Section 4.4**). Since the 1990s, cropping pattern trends in the Subbasin have led to an expansion of orchard crops and an associated decrease in grapes, alfalfa, mixed pasture, grain, hay, and annual crops. These trends have contributed to historical and current water use challenges in the Subbasin, in that orchard crops typically have higher irrigation requirements than other crops, and orchard crops require large, multi-year investments and are not readily fallowed during dry years and in drought conditions. Associated trends in irrigation methods over time have also led to greater use of drip and micro irrigation systems in recent years, which typically provide less groundwater recharge than flood irrigation.

During the projected water budget period, the Subbasin GSAs are anticipating land use or cropping pattern changes due to:

- The MC GSA demand management program (Program), which is expected to result in demand reduction to reach the sustainable yield for the MC GSA (approximately 90,000 AFY) by 2040, consistent with the MC GSA's current planning efforts. Anticipated demand reduction is based on current plans for the Program, although future updates may be warranted to the extent that Program implementation or other assumptions change before 2040. See Section 3.1.3 and Section 6.1.2 of the Joint GSP 2025 Periodic Evaluation Attachment (**Appendix 1.B.1**) for additional information about the Program.
- Conversion of certain irrigated agricultural parcels to dedicated recharge basins in the MID GSA. See Section 3 of the Joint GSP 2025 Periodic Evaluation Attachment (**Appendix 1.B.1**) for additional information about the MID GSA's planned PMAs.
- Urban growth in the City of Madera and communities (simulated in MCSim through 2070), accompanied by commensurate decreases in agricultural and native vegetation land uses.

The simulation of these land use and cropping pattern changes in MCSim is described in **Section 4.4** and in **Appendix 3** of this 2025 Periodic Evaluation, and in Appendix 6.D of the Joint GSP 2025 Plan Amendment. It is noted that these projected changes are based on the current best available information, although actual future changes in cropping patterns will also be influenced by other factors, including commodity prices.

Altogether, these land use and cropping pattern changes are expected to collectively support the Subbasin sustainability goal by reducing the water use of irrigated agricultural land. However, the Subbasin GSAs will continue their adaptive management approach to achieve the sustainability goal for the Subbasin, to the extent that actual land use changes may diverge from these projections (see **Section 3** for more information).

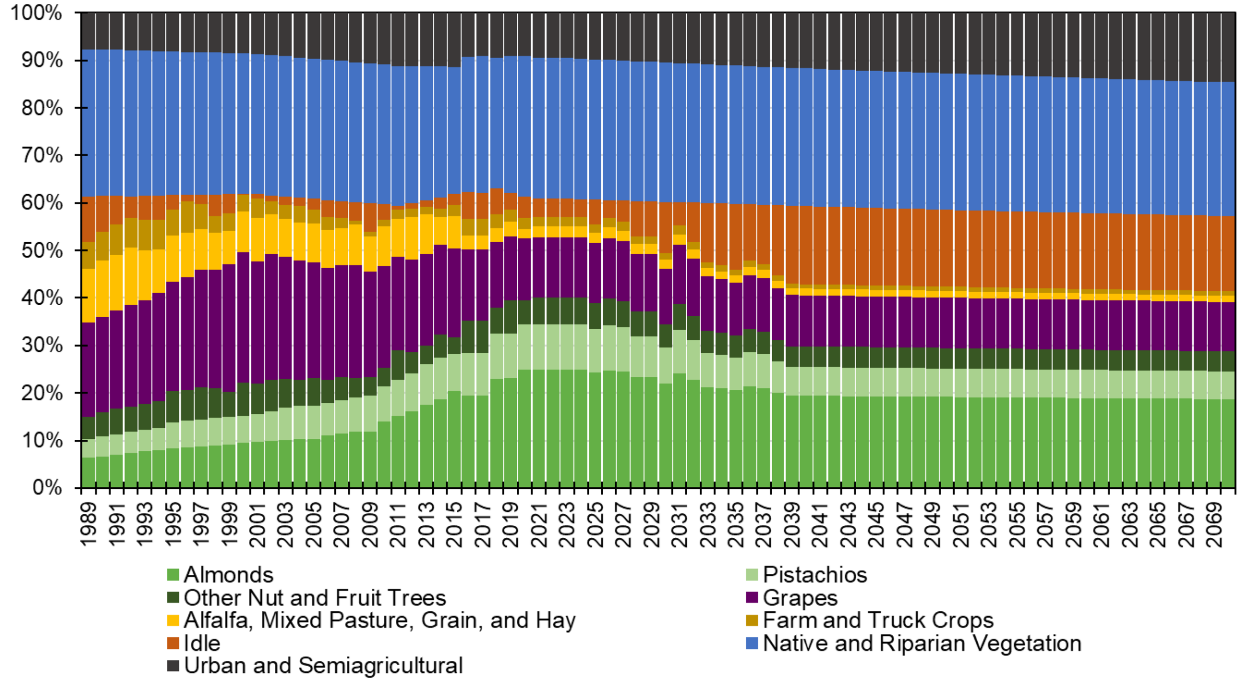

Figure 4-4. Historical and Projected Land Use in the Subbasin, as a Percent of the Total Subbasin Area.

4.4 Model Updates

As described in **Section 1.3** of this 2025 Periodic Evaluation, extensive work has been completed during 2024 related to updating and refining MCSim. The updated MCSim provided a basis for updating SMC that have some reliance on the MCSim outputs (IM; some MO/MT where observed readings are not available for the specific dates needed). In addition, the modeling effort provided a means for re-evaluating the water budget for each Subbasin GSA as of 2023, and was used to prepare updated water budgets (see **Section 4.3**).

Documentation of the updated MCSim and its refinements is provided in Appendix 6.D of the 2025 Plan Amendment and in **Appendix 3** of this 2025 Periodic Evaluation.

4.4.1 Updates to the Groundwater System

Updates to the groundwater system within MCSim include:

- Refinements to the HCM that were informed by new monitoring well data and AEM data provided by DWR (DWR April 2023, DWR February 2024).
- Incorporation of the IWFM subsidence module that became available after initial development of MCSim for the 2020 Initial Plan submittal.
- Recalibration to observed groundwater levels and subsidence measurements.

Information on these updates is provided in Appendix 6.D of the Joint GSP 2025 Plan Amendment and in **Appendix 3** of this 2025 Periodic Evaluation.

4.4.2 Updates to the Surface Water System Simulation

Updates to the surface water system simulation in MCSim during this Periodic Evaluation cycle included:

- "Historical" simulation input updates (adding WY 2016 through WY 2023 to the historical simulation used in 2020 Initial Joint GSP development, in addition to the calibration described above)
- "Current" (or "Now") simulation updates (revising the current simulation used in 2020 Initial Joint GSP development to simulate surface water system conditions – including land use and PMA implementation – to be representative of current conditions as of WY 2023).
- "Projected (No Action)" simulation input updates (updating the projected simulation inputs with updated historical data through WY 2023, and revising inputs according to the updated projected hydrologic sequence through WY 2090)
- "Projected with Projects" simulation input updates (incorporating the same "Projected (No Action)" simulation input updates, with additional updates for the simulation of GSP-related PMAs in the Subbasin)

The projected simulations were also evaluated with consideration of climate change adjustment factors, consistent with methods used in the 2020 Initial Joint GSP development and described in the Joint GSP 2025 Plan Amendment. See Tables 2-27, 2-28, and Appendix 6.D of the Joint GSP 2025 Plan Amendment for information about the projected simulations and climate change adjustments. Information is also provided in **Appendix 3** of this 2025 Periodic Evaluation.

Updates to key MCSim inputs pertinent to the surface water system include:

- ET inputs updated through WY 2023 using satellite-based remote sensing analyses available from OpenET (see **Section 1.6**), and projected through WY 2090 with appropriate mapping to the updated long-term average projected hydrologic sequence and appropriate climate change adjustments.
- Precipitation inputs updated through WY 2023 using information from the Parameter-elevation Regressions on Independent Slopes Model (PRISM)[5], and projected through WY 2090 with appropriate mapping to the updated long-term average projected hydrologic sequence and appropriate climate change adjustments.
- Historical and current land use inputs updated using the most recent and reliable spatial land use data in the region, including:
    - Statewide crop mapping, available from the California Department of Water Resources (DWR) (DWR, 2024d)
    - CropScape Cropland Data Layer coverage, available from the United States Department of Agriculture (USDA, 2024).
- Projected land use inputs, starting from the 2023 current baseline and updated to simulate:
    - Projected urban growth through 2070.
    - Projected PMA-related land use changes associated with the MC GSA demand management program to reach the sustainable yield for the MC GSA (approximately 90,000 AFY) by 2040 (see Section 3 of the Joint GSP 2025 Periodic Evaluation Attachment in **Appendix 1.B.1**).

[5] Additional information about the PRISM data and methodologies are available at: https://prism.oregonstate.edu.

    - Projected PMA-related land use changes associated with MID GSA's recharge basin conversions, to convert certain currently irrigated agricultural parcels to dedicated recharge basins (see Section 3 of the Joint GSP 2025 Periodic Evaluation Attachment in **Appendix 1.B.1**).
- Stream inflows and historical diversions updated through WY 2023 with available historical data, and projected through WY 2090 with appropriate mapping to the updated long-term average projected hydrologic sequence, appropriate climate change adjustments, and/or consideration of potential impacts associated with the San Joaquin River Restoration Program and estimated future water supplies reported by the FWA (Friant Water Authority, 2018).
- Projected PMA-related diversions, updated as appropriate and consistent with the GSAs' planned implementation strategies. A summary of all PMAs simulated in the "Projected with Projects" scenario is provided in the four 2025 Periodic Evaluation GSP Attachments.

Other inputs were updated following the same data sources, assumptions, and processes described in the Joint GSP (see Section 2.2.3 and Appendix 6.D of the Joint GSP 2025 Plan Amendment).

Additional information on these updates is provided in **Appendix 3** of this 2025 Periodic Evaluation.

5 Monitoring Networks Evaluation (23 CCR §356.4(e))

This section provides an assessment of the Subbasin monitoring network for each applicable sustainability indicator and summarizes any changes to these monitoring networks. Specific section references are given for the Joint GSP 2025 Plan Amendment, although this discussion is applicable to the Subbasin and the 2025 Plan Amendment as a whole.

5.1 Groundwater Levels

This section provides an overview and assessment of the Subbasin groundwater level monitoring network. Specific section references are given for the Joint GSP 2025 Plan Amendment, although this discussion is applicable to the Subbasin and the 2025 Plan Amendment as a whole.

5.1.1 Overview of Monitoring Network

As part of the 2025 Plan Amendment, a comprehensive review of the groundwater level RMS network was conducted and the network was updated as necessary. In summary, the review and revision of the groundwater level RMS network resulted in removal of 11 wells from the original network due to well abandonment, inaccessibility, or inability to get reliable measurements, and addition of 12 wells to the updated network that are expected to remain accessible over the long term. Notable in this update of the monitoring network is the inclusion of dedicated monitoring wells that have been drilled to date as part of the Joint GSP implementation (see **Section 1.2**). In addition, the updated groundwater level monitoring network includes a higher proportion of RMS with known well construction. A detailed discussion of wells removed and added to the network as part of this evaluation is presented in Appendix 3.K of the Joint GSP 2025 Plan Amendment.

Table 5-1 and **Figure 5-1** present the groundwater level RMS network for the Subbasin. This network includes a total of 37 wells comprised of 10 upper aquifer wells, 26 lower aquifer wells, and one composite well. Wells are monitored, at a minimum, twice a year, in the Spring and Fall. The extended supplemental groundwater level monitoring network is summarized in Appendix 3.J of the Joint GSP 2025 Plan Amendment.

Table 5-1. Summary of Groundwater Level RMS Monitoring Network.

RMS ID	Latitude	Longitude	First Year of Data	Last Year of Data	Years Measured	Number of Measurements
Upper Aquifer						
MCE RMS-2	36.9852	-119.8799	1979	2024	45	44
MCE RMS-9	36.8780	-119.7900	2009	2019[1]	10	175
MCW RMS-5	36.7991	-120.1592	2012	2018[1]	7	144
MSB03B	36.8951	-120.3818	2019	2024	5	18
MSB05A	36.9238	-120.2552	2019	2024	5	22
MSB06A	36.8257	-120.2057	2019	2024	5	18
MID RMS-11	36.8946	-120.1108	1962	2024	62	108
MID RMS-12	36.9138	-120.0383	2008	2024	16	33
MID RMS-15	36.8541	-120.0561	2015	2024	9	20
MID RMS-17	36.8235	-120.0565	2009	2023[2]	14	324
Lower Aquifer						
COM RMS-1	36.9708	-120.0513	1983	2023[2]	40	48
COM RMS-2	36.9670	-120.0898	1996	2023[2]	27	36
COM RMS-4	36.9452	-120.0423	2009	2023[2]	14	23
MCE RMS-3	36.9552	-119.9441	1964	2024	60	75
MCE RMS-5	36.9082	-119.8641	1978	2024	46	56
MCE RMS-6	36.9337	-119.9080	2014	2024	10	303
MCW RMS-3	36.8943	-120.3285	1950	2024	74	89
MSB03C	36.8951	-120.3818	2019	2024	5	18
MSB04B	36.9922	-120.0825	2019	2024	5	22
MSB05B	36.9238	-120.2552	2019	2024	5	21
MSB06C	36.8257	-120.2057	2019	2024	5	17
MSB09C	36.8814	-120.1105	2019	2024	5	17
MSB10C	37.0750	-120.1948	2019	2024	5	24
MSB11C	37.0692	-120.0745	2019	2024	5	14
MSB12	37.0516	-119.9820	2022	2024	2	8
MID RMS-2	37.0407	-120.2342	2015	2024	9	15
MID RMS-3	37.0366	-120.1760	1954	2024	70	116
MID RMS-4	36.9709	-120.2568	2015	2024	9	18
MID RMS-5	36.9581	-120.2067	1958	2024	66	122
MID RMS-6	37.0033	-120.1561	2015	2024	9	15
MID RMS-7	36.9243	-120.1288	1936	2024	88	144
MID RMS-10	36.8996	-120.1742	2015	2024	9	20
MID RMS-16	37.0196	-120.0526	2011	2024	13	17
MWD RMS-1	37.0472	-120.0248	1994	2024	30	32
MWD RMS-2	37.0436	-120.0610	2003	2024	21	30
MWD RMS-3	37.0436	-120.0697	2011	2024	13	30
Composite						
MID RMS-13	36.9003	-119.9879	2015	2024	9	16

[1] Have communicated with well owner. Plan is for Madera County to take over monitoring.
[2] Well is currently monitored, but 2024 data has not yet been reported.

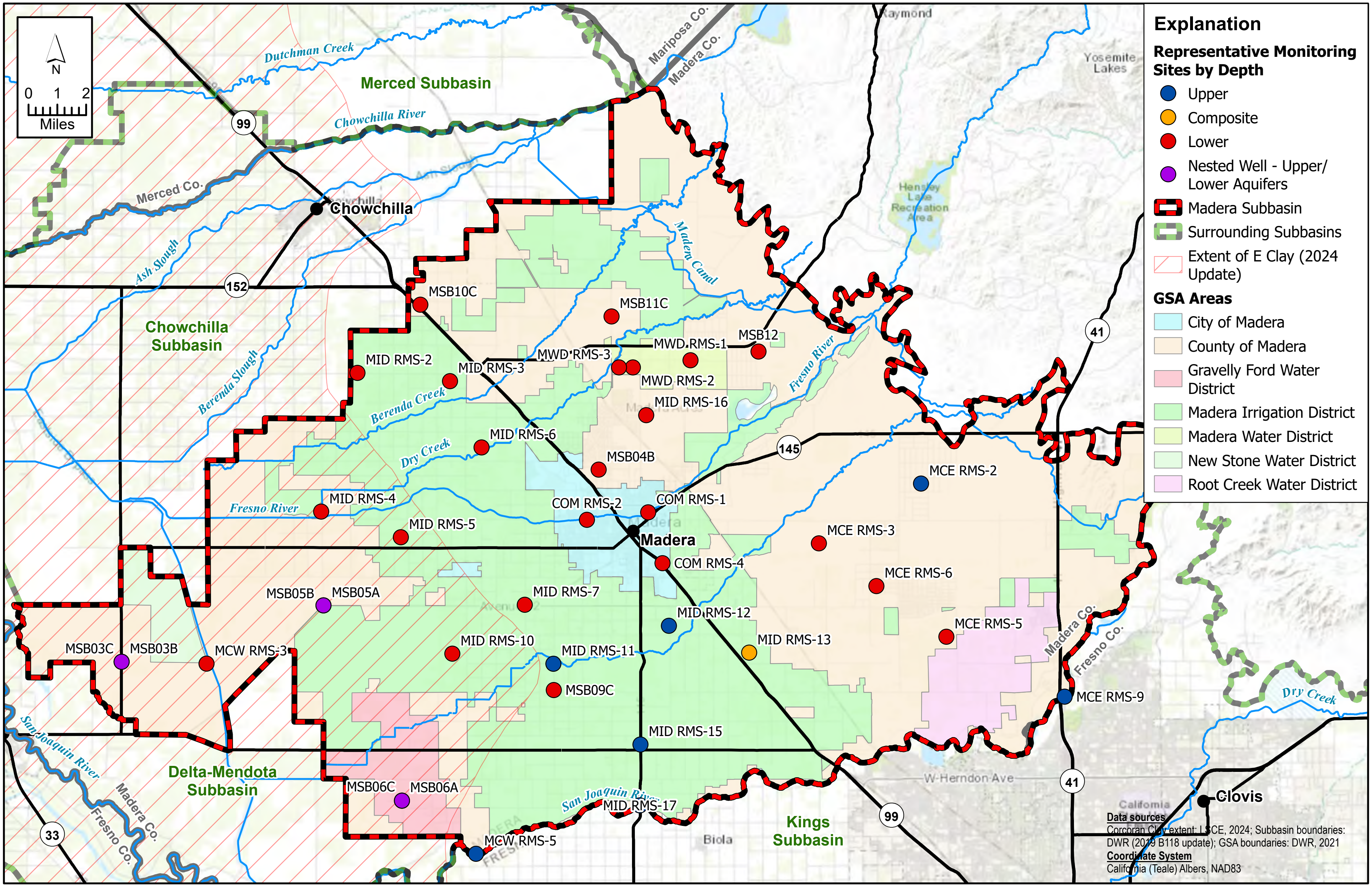

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FIGURE 5-1
Groundwater Level Sustainability Indicator Representative Monitoring Sites

Madera Subbasin
Groundwater Sustainability Plan - Periodic Evaluation

5.1.2 Data Gaps

The 2023 Revised Plan (submitted March 2023) identified spatial and temporal data gaps throughout the Subbasin. The subsequent installation of 9 dedicated nested monitoring wells (see **Figure 1-1**) and transducers within these wells have helped to address this data gap. Two small remaining data gap areas for the groundwater level RMS network are in the northeastern portion of the Subbasin along Berenda Creek to the east of Highway 99 and along Highway 145 to the east-northeast of the City of Madera between the Fresno River and Cottonwood Creek. The Joint GSP GSAs will continue to explore funding opportunities to install additional dedicated monitoring wells throughout the subbasin to continue to fill in spatial data gaps, and these areas will be considered further in the future as more dedicated monitoring wells are installed. One additional nested monitoring well is already planned for installation in the southeast portion of Subbasin through a joint effort between MC GSA and DWR.

5.2 Groundwater Storage

Because changes in groundwater storage are directly dependent on changes in groundwater levels, the 2025 Plan Amendment adopts groundwater levels as a proxy for assessing change in storage. The wells selected for monitoring changes in groundwater storage will be the same wells used for groundwater level monitoring (see **Section 5.1**).

5.3 Water Quality

This section provides an overview and assessment of the Subbasin groundwater quality monitoring network. Specific section references are given for the Joint GSP 2025 Plan Amendment, although this discussion is applicable to the Subbasin and the 2025 Plan Amendment as a whole.

5.3.1 Overview of Monitoring Network

As part of the 2025 Plan Amendment, a comprehensive review of the groundwater quality RMS network was conducted and the network was updated as necessary. In summary, the review and revision of the groundwater quality RMS network resulted in removal of 7 wells from the original network due to well abandonment, inaccessibility, or inability to get water samples, and addition of 4 wells to the updated network that are expected to remain accessible over the long term. Notable in this update of the monitoring network is the inclusion of dedicated monitoring wells that have been drilled to date as part of the Joint GSP implementation (see **Section 1.2**). In addition, the updated groundwater quality monitoring network includes a higher proportion of RMS with known well construction. A detailed discussion of wells removed and added to the network as part of this evaluation is presented in Appendix 3.L of the Joint GSP 2025 Plan Amendment.

Table 5-2 and **Figure 5-2** present the groundwater quality RMS network for the Subbasin. This network includes a total of 42 wells comprised of 8 upper aquifer wells, 29 lower aquifer wells, 4 composite wells, and one well with unknown construction. The extended supplemental groundwater quality monitoring network is summarized in Appendix 3.J of the Joint GSP 2025 Plan Amendment.

Table 5-2. Summary of Groundwater Quality RMS Monitoring Network.

RMS ID	Aquifer	Latitude	Longitude	Arsenic			Nitrate as N			Total Dissolved Solids		
				First Year of Data	Last Year of Data	Number of Measurements	First Year of Data	Last Year of Data	Number of Measurements	First Year of Data	Last Year of Data	Number of Measurements
MCE RMS-3	Lower	36.9552	-119.9441	2021	2024	5	2021	2024	4	2021	2024	4
MID RMS-4	Lower	36.9709	-120.2568	2024	2024	1	2024	2024	1	2024	2024	1
MID RMS-5B	Lower	36.9668	-120.2204	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MID RMS-6	Lower	37.0033	-120.1561	2022	2024	2	2022	2024	2	2022	2024	2
MID RMS-7	Lower	36.9243	-120.1288	2022	2024	2	2022	2024	2	2022	2024	2
MID RMS-13	Composite	36.9003	-119.9879	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWD RMS-1	Lower	37.0472	-120.0248	2019	2022	4	2019	2022	4	2019	2022	4
MSB03A	Upper	36.8951	-120.3818	2020	2024	9	2022	2024	6	2020	2024	10
MSB03B	Upper	36.8951	-120.3818	2020	2024	6	2021	2024	4	2020	2024	5
MSB03C	Lower	36.8951	-120.3818	2020	2024	6	2021	2024	4	2020	2024	5
MSB04A	Upper	36.9922	-120.0825	2020	2023	9	2021	2023	5	2020	2023	7
MSB04B	Lower	36.9922	-120.0825	2020	2024	6	2021	2024	4	2020	2024	5
MSB04C	Lower	36.9922	-120.0825	2020	2024	6	2021	2024	4	2020	2024	5
MSB05A	Upper	36.9238	-120.2552	2020	2024	6	2022	2024	3	2020	2024	7
MSB05B	Lower	36.9238	-120.2552	2020	2024	4	2022	2024	3	2020	2024	4
MSB05C	Lower	36.9238	-120.2552	2020	2024	4	2022	2024	3	2020	2024	4
MSB06A	Upper	36.8257	-120.2057	2020	2024	14	2021	2024	7	2020	2024	12
MSB06B	Lower	36.8257	-120.2057	2020	2024	8	2021	2024	5	2020	2024	6
MSB06C	Lower	36.8257	-120.2057	2020	2024	8	2021	2024	5	2020	2024	6
MSB09A	Upper	36.8814	-120.1105	2020	2024	9	2021	2024	5	2020	2024	9
MSB09B	Lower	36.8814	-120.1105	2020	2024	6	2021	2024	4	2020	2024	5
MSB09C	Lower	36.8814	-120.1105	2020	2024	6	2021	2024	4	2020	2024	5
MSB10B	Lower	37.0750	-120.1948	2020	2024	8	2021	2024	4	2020	2024	8
MSB10C	Lower	37.0750	-120.1948	2020	2024	6	2021	2024	4	2020	2024	5
MSB11C	Lower	37.0692	-120.0745	2020	2024	3	2022	2024	2	2020	2024	3
MSB13A	Upper	36.9682	-119.8760	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MSB13B	Lower	36.9682	-119.8760	2023	2024	2	2023	2024	2	2023	2024	2
MSB13C	Lower	36.9682	-119.8760	2023	2024	2	2023	2024	2	2023	2024	2

RMS ID	Aquifer	Latitude	Longitude	Arsenic			Nitrate as N			Total Dissolved Solids		
				First Year of Data	Last Year of Data	Number of Measurements	First Year of Data	Last Year of Data	Number of Measurements	First Year of Data	Last Year of Data	Number of Measurements
2000507-001	Lower	37.0400	-120.1500	2008	2023	4	2004	2024	10	n/a	n/a	n/a
2000553-001	Lower	36.8541	-120.0561	2008	2024	6	2005	2024	36	2005	2024	8
2000682-002	Lower	37.0100	-120.1100	2008	2023	4	2008	2024	18	2008	2008	1
2000727-001	Lower	36.8671	-120.0102	2008	2024	8	2006	2024	25	2008	2024	8
2000938-001	Lower	36.9200	-119.9700	2008	2022	6	2008	2023	21	n/a	n/a	n/a
2010002-014	Lower	36.9680	-120.0672	1986	2023	13	1986	2024	35	1986	2023	15
2010002-032	Lower	36.9303	-120.0439	2006	2024	12	2006	2024	23	2006	2021	11
2010008-005	Composite	36.9321	-119.8909	1997	2024	8	1997	2024	37	1997	2024	10
2010009-002	Composite	36.9127	-119.8001	1985	2013	7	1985	2017	20	1985	2013	7
2010010-007	Lower	37.0171	-120.0565	2005	2022	7	2005	2024	21	2005	2022	7
2010801-001	Lower	37.1032	-120.1517	1998	2024	150	1998	2023	31	1998	2021	11
2801077-001	Composite	36.9720	-120.0271	2002	2002	1	2002	2024	22	n/a	n/a	n/a
ESJ12	Upper	36.9287	-120.0916	2021	2021	2	n/a	n/a	n/a	2018	2022	5
ESJ17	Unknown	36.8890	-120.0208	2021	2021	2	n/a	n/a	n/a	2019	2019	2

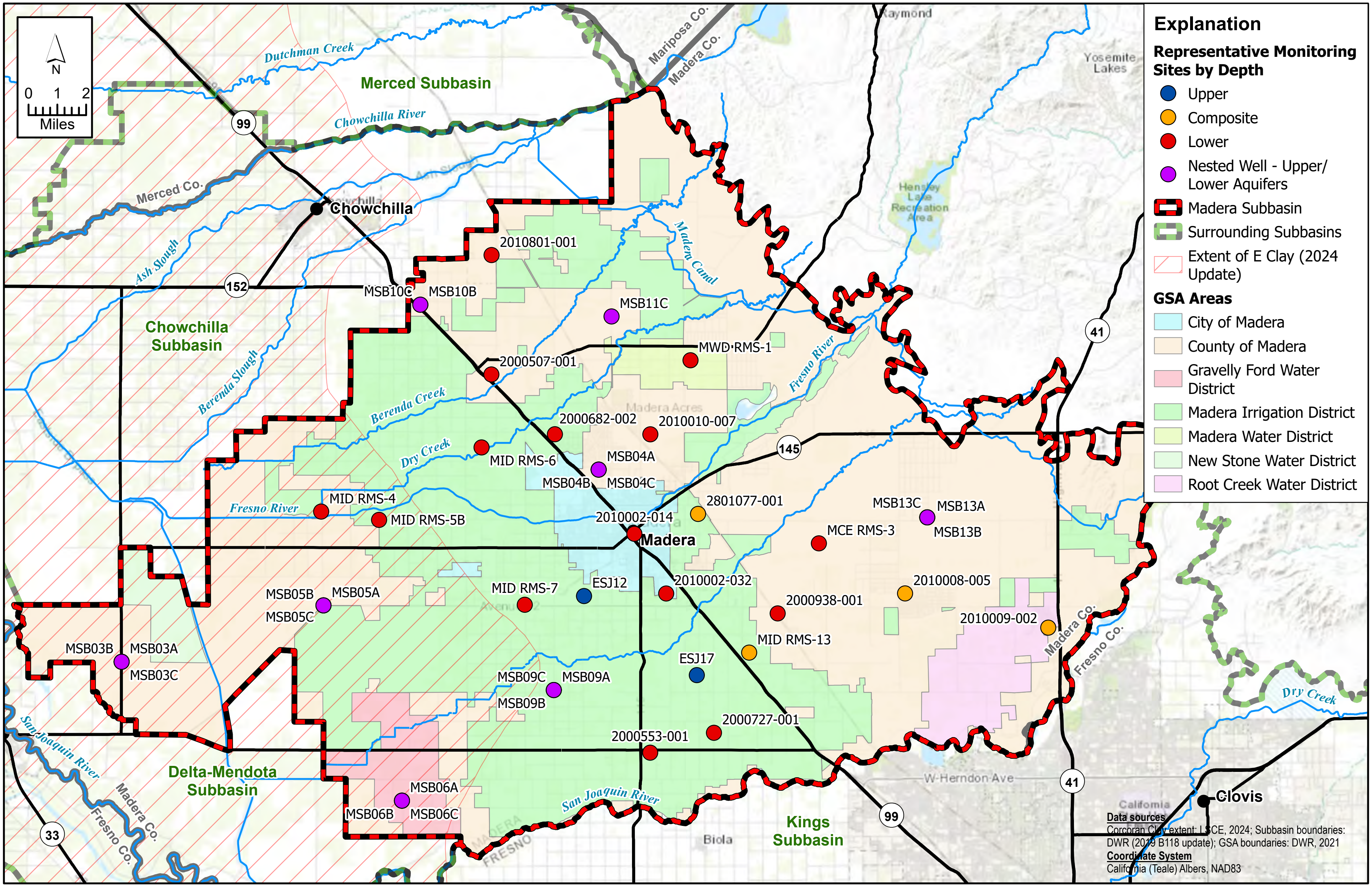

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FIGURE 5-2
Groundwater Quality Sustainable Indicator Representative Monitoring Sites

Madera Subbasin
Groundwater Sustainability Plan - Periodic Evaluation

5.3.2 Data Gaps

The 2025 Plan Amendment identifies data gaps for the water quality network related to data availability. While the RMS network evaluation sought to remove wells with the most restrictive monitoring challenges, some of the wells included in the water quality RMS network do not have a robust monitoring history. Consistent monitoring of these wells into the future will help to improve this data gap.

Two small remaining spatial data gap areas for the groundwater quality RMS network are in the northeastern portion of the Subbasin along Berenda Creek to the east of Highway 99 and along Highway 145 to the northeast of the City of Madera between the Fresno River and Cottonwood Creek. These areas will be considered further in the future as more dedicated monitoring wells are installed.

5.4 Land Subsidence

This section provides an overview and assessment of the Subbasin land subsidence monitoring network. Specific section references are given for the Joint GSP 2025 Plan Amendment, although this discussion is applicable to the Subbasin and the 2025 Plan Amendment as a whole.

5.4.1 Overview of Monitoring Network

The subsidence RMS network in the 2020 Initial Plan included six SJRRP benchmark survey points and one continuous GPS station. These RMS generally provided good coverage in the western portion of the Subbasin and in the middle portion of the Subbasin along Highway 99. There was also one station in the southeast portion of the Subbasin. The subsidence RMS network was expanded in the 2025 Plan Amendment with addition of two SJRRP benchmark locations; one in the southwest portion and one in the southeast portion of the Subbasin.

Table 5-3 and **Figure 5-3** present the subsidence RMS network for the Subbasin. This network includes a total of 9 subsidence monitoring stations comprised of 8 elevation benchmark survey points monitored by USBR as part of the SJRRP and one continuous GPS station monitored by UNAVCO as part of the Plate Boundary Observatory (PBO) Project. The extended supplemental subsidence monitoring network also includes DWR's InSAR subsidence data.

The control points selected for inclusion in the monitoring network are currently monitored for other purposes. As a result, control points may be added or removed from the monitoring network as they are added or removed from the various programs currently maintaining these networks. An expansion of the subsidence monitoring network is planned in the Subbasin and described in more detail in the Subsidence Workplan provided in Appendix 3.H of the Joint GSP 2025 Plan Amendment.

Table 5-3. Summary of Land Subsidence RMS Monitoring Network.

RMS ID	Monitoring Entity	Latitude	Longitude	First Year of Data	Last Year of Data	Count of Measurements	Monitoring Frequency
SJRRP_29	SJRRP	37.0182	-120.1266	2012	2024	24	Biannual
SJRRP_127	SJRRP	36.8510	-120.2369	2011	2024	25	Biannual
SJRRP_1007R	SJRRP	36.9308	-120.3822	2012	2024	24	Biannual
SJRRP_141	SJRRP	36.8870	-119.9816	2011	2024	25	Biannual
SJRRP_142	SJRRP	36.9754	-119.7938	2011	2024	25	Biannual
SJRRP_160R	SJRRP	36.8221	-120.1418	2011	2024	25	Biannual
SJRRP_165	SJRRP	36.8975	-119.7905	2017	2024	13	Biannual
SJRRP_201R	SJRRP	36.8723	-120.3180	2017	2024	14	Biannual
P307	PBO	36.9473	-120.0579	2005	2024	6,958	Daily

5.4.2 Data Gaps

The 2025 Plan Amendment identifies data gaps related to land subsidence including spatial data gaps and lack of coupled subsidence and water level monitoring to understand the mechanisms and conditions causing land subsidence in the Subbasin, including the relationship between land subsidence and declining groundwater levels. The primary spatial data gaps in the original subsidence RMS network included a portion of the western Subbasin between Highway 99 and the western Subbasin boundary and a portion of the eastern Subbasin between Highway 99 and the eastern Subbasin boundary. In order to address these data gaps, a Subsidence Workplan has been developed to help develop a more robust subsidence monitoring program and expand the understanding of subsidence in the Subbasin. The Subsidence Workplan is included in Appendix 3.H of the Joint GSP 2025 Plan Amendment.

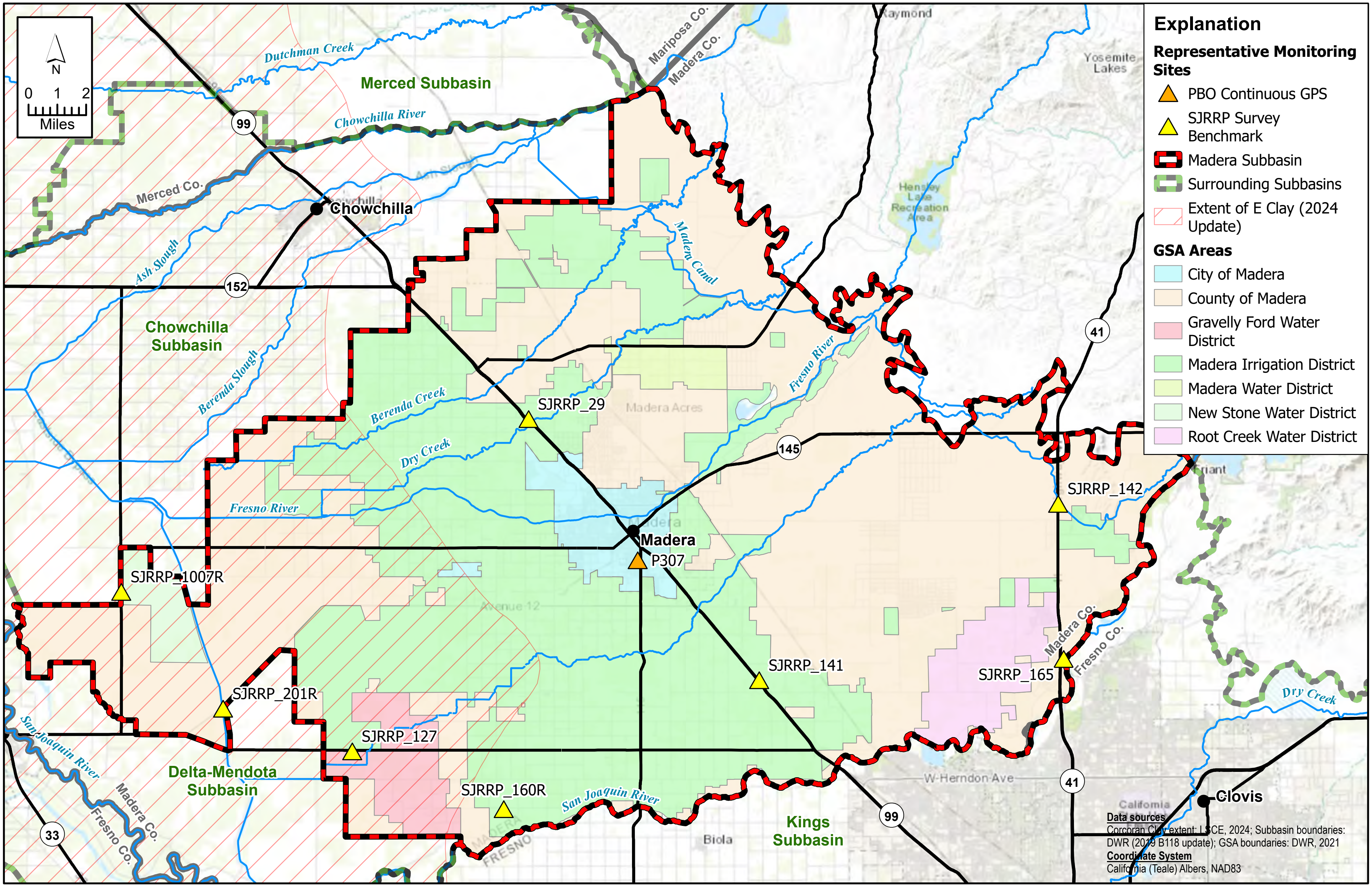

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FIGURE 5-3
Subsidence Sustainability Indicator Representative Monitoring Sites

Madera Subbasin
Groundwater Sustainability Plan - Periodic Evaluation

5.5 Interconnected Surface Water

This section provides an overview and assessment of the Subbasin ISW monitoring network. Specific section references are given for the Joint GSP 2025 Plan Amendment, although this discussion is applicable to the Subbasin and the 2025 Plan Amendment as a whole.

5.5.1 Overview of Monitoring Network

Table 5-4 and **Figure 5-4** present the ISW RMS network for the Subbasin. The sustainability indicator for ISW is evaluated by monitoring groundwater levels at a network of wells screened in the Upper Aquifer near the San Joaquin River. This network includes a total of three shallow wells. Significant challenges related to obtaining consistent data from these have emerged. The Joint GSP GSAs are currently in communication with the well owners (SJRRP) with plans to take over monitoring of these wells. Changes to the ISW monitoring network are not being made at this time pending implementation of the ISW workplan (see Appendix 3.I of the Joint GSP 2025 Plan Amendment) and DWR's future publication of ISW SMC guidance.

Table 5-4. Summary of Interconnected Surface Water RMS Monitoring Network.

RMS ID	Latitude	Longitude	First Year of Data	Last Year of Data	Years Measured	Number of Measurements
MCE RMS-9	36.8780	-119.7900	2009	2019[1]	10	175
MCW RMS-5	36.7991	-120.1592	2012	2018[1]	7	144
MID RMS-17	36.8235	-120.0565	2009	2023[2]	14	324

[1] Have communicated with well owner. Plan is for Madera County to take over monitoring.
[2] Well is currently monitored, but 2024 data has not yet been reported.

5.5.2 Data Gaps

Significant data gaps exist for adequately characterizing ISW along the San Joaquin River along the southern boundary of Subbasin. The relationships between occurrence of shallow groundwater levels, streamflow, and pumping need an improved understanding. Whether or not (and to what degree) shallow groundwater levels that occur along the San Joaquin River may be impacted by regional groundwater pumping is yet to be determined, and requires an improved understanding of shallow subsurface stratigraphy, groundwater elevations in various depth zones, and potential variations in streamflow along this reach of the San Joaquin River. In order to address these data gaps, an ISW workplan has been developed to help develop a more robust ISW monitoring program and expand the understanding of ISW in the Subbasin. The ISW workplan is included in Appendix 3.I of the Joint GSP 2025 Plan Amendment.

5.6 Seawater Intrusion

The seawater intrusion sustainability criteria are not applicable to Plan Area, because it is located more than 70 miles inland and is hydraulically disconnected from the ocean.

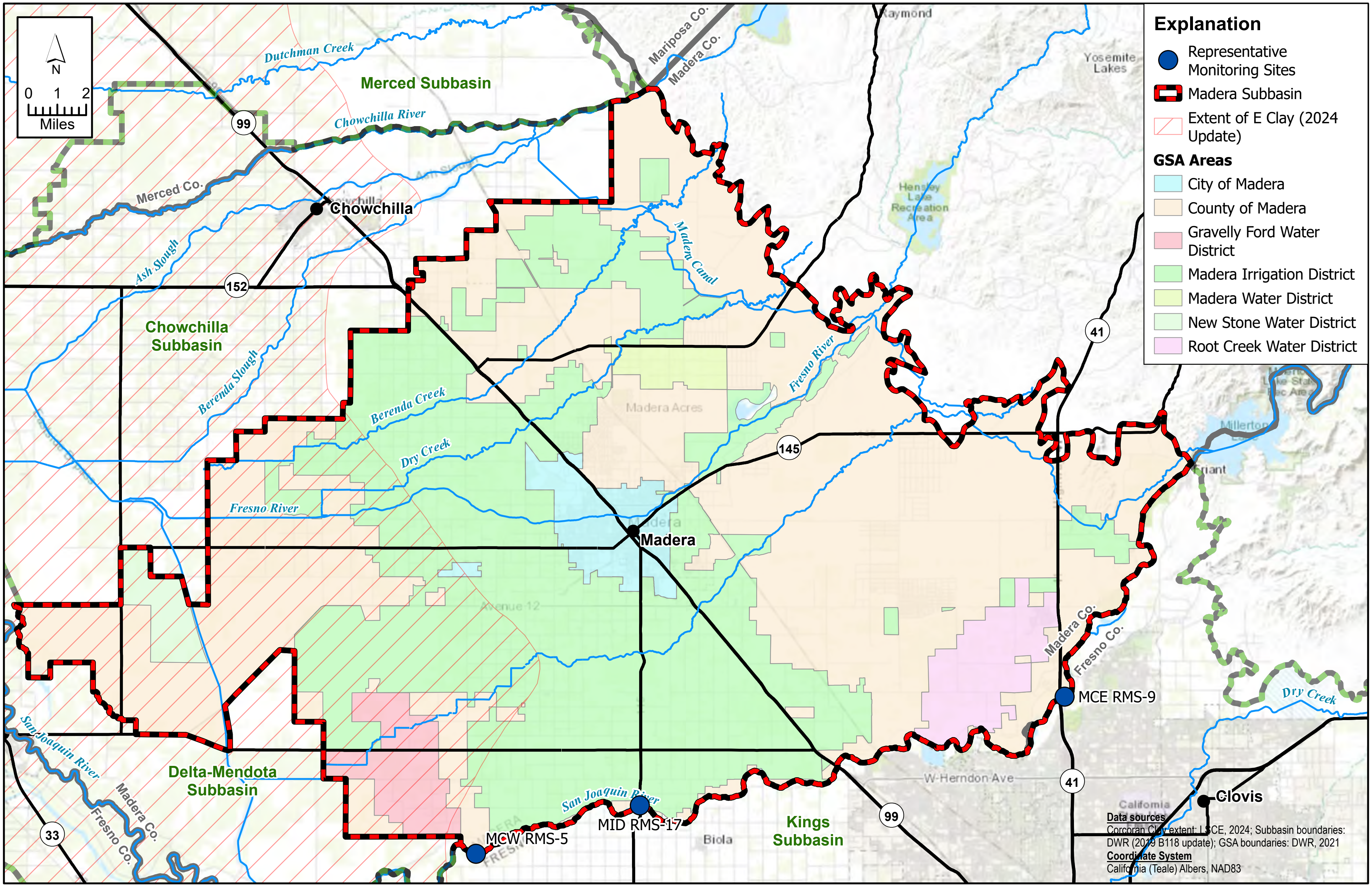

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FIGURE 5-4

Interconnected Surface Water Sustainability Indicator Representative Monitoring Sites

Madera Subbasin

Groundwater Sustainability Plan - Periodic Evaluation

6 GSA Authorities and Enforcement Actions (23 CCR §356.4(g)-(h))

The purpose of this section is to document any authorities (e.g., regulations or ordinances) and enforcement or legal actions that the Subbasin GSAs have established or exercised during the first Periodic Evaluation cycle in furtherance of the sustainability goal for the Subbasin. This section also describes other policies, regulations, and orders at the local, state, and/or federal level that have impacted SGMA implementation in the Subbasin.

The contents of this section are provided for each of the four GSPs in the four 2025 Periodic Evaluation GSP Attachments. Please refer to the following appendices for more information:

- **Appendix 1.B.1**: Joint GSP 2025 Periodic Evaluation Elements
- **Appendix 1.B.2**: GFWD GSA GSP 2025 Periodic Evaluation Elements
- **Appendix 1.B.3**: NSWD GSA GSP 2025 Periodic Evaluation Elements
- **Appendix 1.B.4**: RCWD GSA GSP 2025 Periodic Evaluation Elements

7 Outreach, Engagement, and Coordination with other Agencies (23 CCR §356.4(j))

The purpose of this section is to describe the outreach, engagement, and coordination efforts conducted by the Subbasin GSAs. The contents of this section are organized as follows:

- **Section 7.1** describes outreach and engagement efforts conducted by the GSAs to engage interested parties, the public, and beneficial users in the Subbasin during GSP implementation.
- **Section 7.2** describes responsibilities of the GSA governing bodies and their activities to coordinate and communicate with interested parties related to SGMA implementation.
- **Section 7.3** describes coordination efforts and activities between the Subbasin GSAs, with GSAs in adjacent Subbasins, and local, state, and/or federal agencies related to SGMA implementation in the Subbasin.

7.1 Outreach and Engagement

The GSAs continued various outreach efforts identified in their GSPs during this Periodic Evaluation cycle. Outreach and engagement efforts are specifically described in the GSPs in the following locations:

- **Joint GSP**:
  - Executive Summary (GSP Development, Coordination, and Outreach)
  - Section 2.1.5 (Notice and Communication)
  - Appendix 2.C, including the Madera Subbasin Stakeholders Communication and Engagement Plan (Appendix 2.C.a)
- **GFWD GSP**: Section 2.1.5 (Notice and Communication)
- **NSWD GSP**: Section 2.5 (Notice and Communication)
- **RCWD GSP**: Section 2.5 (Notice and Communication)

7.1.1 Public Outreach and Engagement

At least once a year, all GSAs in the Subbasin provide updates to the public on groundwater conditions, groundwater management, and PMA implementation activities in the Subbasin through their GSP Annual Reports (submitted to DWR no later than April 1 each year and made publicly available through DWR's SGMA Portal). Since January 2020, the GSAs have also continued or initiated robust communication efforts related to PMA implementation and related groundwater management activities, as applicable. Each GSA is responsible for outreach and engagement related to their respective PMAs.

During this Periodic Evaluation cycle, specifically, the GSAs conducted the following activities to engage interested parties, the public, and beneficial users in the Subbasin:

- All GSAs in the Subbasin continued to hold public Board and governing body meetings throughout this Periodic Evaluation cycle, during which they discussed topics pertinent to GSP implementation and groundwater management in the Subbasin.
- All GSAs in the Subbasin continued email outreach through their interested parties lists, as applicable.
- MID GSA continued outreach efforts through a number of efforts, including:

  - Robust outreach and communication with growers regarding PMAs, specifically related to MID's incentive program and on-farm recharge program (see Section 3 of the Joint GSP 2025 Periodic Evaluation Attachment in **Appendix 1.B.1**). MID GSA's public outreach has included emails, mailers, and informational workshops held throughout the first Periodic Evaluation cycle.
  - MID outreach video, highlighting MID's vital role in the community and Subbasin.
  - Other updates regarding GSP implementation on its public website (https://www.madera-id.org/public-information/mid-groundwater-sustainability-agency/), with links to GSA publications on groundwater management and GSP development (in English and Spanish), semiannual updates on groundwater levels at MID wells, and maps of the Subbasin and GSA.
- MC GSA likewise continued to engage with the public through various efforts, including:
  - Extensive communication and public outreach regarding MC GSA's demand management program and its impacts to stakeholders in the MC GSA area. As part of these efforts, outreach has been conducted for the groundwater allocation and verification programs, the VLRP, LandFlex, and the MLRP (described further in Sections 3 and 6 of the Joint GSP 2025 Periodic Evaluation Attachment in **Appendix 1.B.1**). MC GSA's public outreach has included emails, mailers, and informational workshops held throughout the first Periodic Evaluation cycle.
  - Communication regarding potential rates, including a survey of stakeholders' level of support for future fees and how they would be used to fund certain packages of PMAs.
  - Communication regarding groundwater resiliency and recharge efforts in Fairmead through the Fairmead Community Groundwater Resiliency project, a new PMA that the MC GSA began this Periodic Evaluation cycle. MC GSA's outreach has included emails and informational workshops.
  - Other updates regarding GSP implementation on its public website (https://www.maderacountywater.com/county-gsas/), with links to resources related to SGMA and GSP implementation in the Subbasin and MC GSA.

Stakeholder outreach and engagement is expected to continue in the second Periodic Evaluation cycle through similar processes, with PMA-focused outreach and engagement at the GSA level and Subbasin or GSP-wide outreach and engagement happening through ongoing GSA coordination, including through the Coordination Workgroup (see **Section 7.3.1**).

7.1.2 GSP Comments and Responses

Since submittal of the 2020 Initial Plan in January 2020, the GSAs have received and responded to several comments that include:

- **Letter from DWR received in September 2022**, which determined that the 2020 Initial Plan was incomplete and identified certain deficiencies that the GSAs needed to resolve. The GSAs reviewed DWR's comments and the identified deficiencies, consulted with DWR on potential resolutions to those deficiencies, and coordinated their response through the development and submittal of the revised GSPs and Coordination Agreement in March 2023.
- **Letter from DWR received in December 2023**, which determined the revised GSPs and Coordination Agreement to be approved, but also identified certain recommended corrective actions. The GSAs reviewed DWR's comments and recommended corrective actions, conferred

and coordinated on resolutions to those issues, and prepared the 2025 Plan Amendment to address DWR's comments. **Section 9** of this Periodic Evaluation summarizes where in 2025 Plan Amendment revisions were made to address DWR's comments and recommended corrective actions.

- **Comments received through the SGMA Portal**, including those from:
  - SWRCB staff (March 2022), which were provided to DWR regarding their review of the initial GSPs and Coordination Agreement. Comments in the March 2022 letter were similar to DWR's comments in their September 2022 letter, and were considered in developing the revised GSPs and Coordination Agreement submitted to DWR in March 2023.
  - USBR SJRRP (June 2023), which were provided in two separate letters and identified, in particular, concerns with the consideration of ISW and groundwater-dependent ecosystems (GDEs) in the revised GSPs. The GSAs are considering and responding to these comments through:
    - Development of an ISW workplan, which will fill data gaps and refine the understanding of ISW and GDEs in the Subbasin (see Appendix 3.I of the Joint GSP 2025 Plan Amendment).
    - ISW-related coordination between the Madera and Kings Subbasins, USBR, and FWA, discussed further in **Section 7.3.2** of this Periodic Evaluation (also see Appendix 3.I of the Joint GSP 2025 Plan Amendment).
  - Self-Help Enterprises (May 2023), which identified concerns that the revised GSPs did not adequately address DWR's corrective actions with regard to coordination, SMC for chronic lowering of groundwater levels, SMC for land subsidence, or SMC for ISW. These comments were similar to the recommended corrective actions identified by DWR in their December 2023 letter and comments from the SJRRP. These comments have been addressed through the 2025 Plan Amendment and the ongoing ISW coordination efforts described above.
  - Leadership Counsel for Justice and Accountability (June 2023), which identified concerns that the revised GSPs did not adequately address DWR's corrective actions related to chronic lowering of groundwater levels, concerns related to degradation of water quality, concerns that public input was not adequately considered in the GSP revisions process, and concerns that the 2023 Revised Joint GSP was not adopted by all GSAs. These comments were similar to the recommended corrective actions identified by DWR in their December 2023 letter, and were addressed through the 2025 Plan Amendment.
- Other comments received through the SGMA Portal between January 2020 and December 2020 as part of the public comment period. The Joint GSP GSAs responded to those comments in a letter posted on DWR's SGMA portal in July 2021.

During the 2025 Plan Amendment process, the GSAs distributed the draft GSP amendments for public review and comment in November-December 2024. A webinar workshop was held in December 2024 where the GSAs presented key changes made in the 2025 Plan Amendment process and received public comment. Public comments were considered in the final 2025 Plan Amendment and responses to those comments are provided as an appendix to the 2025 Plan Amendment.

7.2 Responsibilities of GSA Boards

The GSA Boards and governing bodies are implementing SGMA in the Subbasin by fulfilling their various responsibilities, including the following:

- All GSAs in the Subbasin continued to hold public governing body meetings throughout this Periodic Evaluation cycle, during which they discussed topics pertinent to GSP implementation and groundwater management in the Subbasin. Information about these meetings is typically shared with each GSA's respective interested parties list.
- As described in **Section 7.3.1**, the Subbasin GSAs have formed a Coordination Workgroup, consistent with Section 5.1 of the 2020 Coordination Agreement. The Coordination Workgroup serves as the formal coordinating body for all Subbasin GSAs, and provides a forum for coordinating the GSPs and satisfying the coordination obligation of SGMA. Additional discussion about the Coordination Workgroup is provided below and in Section 1.3.1 of the Joint GSP 2025 Plan Amendment.
- Individual GSAs in the Subbasin are considering forming potential "Groundwater Committees" for their respective GSAs that would hear issues related to SGMA (among other topics) before those issues are raised with the GSA governing body. The added forum of public Groundwater Committee meetings may help to enhance discussions and transparency surrounding important SGMA-related topics, and gain important stakeholder feedback, while streamlining discussions at the governing body level.

7.3 Coordination Among Agencies

7.3.1 Coordination Between GSAs in the Subbasin

Since the adoption of the 2020 Initial Plan, the Subbasin GSAs have formed a Coordination Workgroup to satisfy the coordination obligation of SGMA, consistent with Section 5.1 of the 2020 Coordination Agreement. The Coordination Workgroup serves as the formal coordinating body for all Subbasin GSAs and provides a forum for coordinating implementation of all GSPs in the Subbasin. Each GSA's governing body members consider the Coordination Workgroup's recommendations when making policy decisions for their individual GSAs. Specific authorities of the Coordination Workgroup are defined in Section 5.3 of the Coordination Agreement. Additional information about the Coordination Workgroup is provided in Section 1.3.1 of the Joint GSP 2025 Plan Amendment. Further detail is also provided in the Coordination Agreement.

Other specific coordination efforts between the GSA governing bodies include:

- The engagement of facilitation support services to assist the GSAs in working through and eliminating any areas of disagreement, including topics related to the Coordination Agreement and the domestic well mitigation program.
- Signing a new coordination agreement for the Subbasin.
- Coordinated development of the domestic well mitigation program (discussed in Section 4.9.5 of the Joint GSP 2025 Plan Amendment).

Coordination has also occurred between the technical teams for each GSA (or group of GSAs in the case of the Joint GSP), serving at the direction of each GSA. The technical teams have continued meeting on a regular basis since development of the 2023 Revised GSPs, in direct response to DWR's recommended corrective action that the GSAs increase coordination within the Subbasin. As part of the 2025 Plan Amendment, the technical teams met on a bi-weekly or weekly basis to discuss and collaborate on methodologies and preferred technical approaches for addressing DWR's recommended corrective actions. As reflected in the 2025 Plan Amendment, these technical team meetings have served as the basis for reaching consensus and ensuring consistent policies, procedures, and methodologies and ultimately, consistent groundwater management to achieve the Subbasin sustainability goal. Specific points of coordination resulting from these meetings include:

- Use of one consistent groundwater model (MCSim) by the GSAs in the Subbasin, serving as a uniform and consistent basis for other elements of the GSPs including water budgets, future subsidence estimates, and establishment of SMC.
- Consistent water budgets for all GSAs, through the use of MCSim.
- Consistent SMC for all sustainability indicators, with consistent monitoring.

The GSAs plan to continue similar coordination efforts during the second Periodic Evaluation cycle to ensure ongoing consistency in GSP implementation across the Subbasin.

7.3.2 Coordination with Other Agencies

In addition to the public outreach and coordination efforts among the Subbasin GSAs described above, the GSAs have also continued or initiated various coordination efforts with other agencies during this Periodic Evaluation cycle. Specific coordination activities include the following:

San Joaquin Valley Basin Point of Contact Discussions

Through the Subbasin Point of Contact (POC), the Subbasin is coordinating with other subbasins across the San Joaquin Valley (SJV) through regularly-scheduled SJV POC meetings. Meetings are held quarterly with all SJV POCs and DWR representatives, and also quarterly with all SJV POCs without DWR representatives (i.e., eight meetings annually). Meetings include various topics of conversation and coordination pertinent to SGMA implementation across the entire SJV.

ISW Coordination with USBR, FWA, and GSAs in the Kings Subbasin

The Subbasin GSAs have coordinated with various agencies regarding ISW SMC, monitoring, and related topics during this Periodic Evaluation cycle. These coordination efforts are described throughout the 2025 Plan Amendment (e.g., see Sections 2.2.2.5, 3.2.5, 3.3.5, and 3.4.5 in the Joint GSP 2025 Plan Amendment), and are also summarized below.

Since late 2023, representatives from the Subbasin and Kings Subbasin (McMullin Area GSA and North Kings GSA) have been meeting monthly with representatives from the USBR and FWA to better understand their issues and concerns related to ISW along the San Joaquin River. These discussions have led to more detailed analyses by USBR and FWA of total diversions, uses, and losses along portions of the San Joaquin River, and more detailed analyses by USBR related to the Holding Contracts and the groundwater pumping allowances and limitations that will need to be factored into any allowable groundwater pumping within proximity to the San Joaquin River.

Through this coordination, efforts have also been made to draw greater consistency between ISW workplans for the Subbasin GSAs and participating Kings Subbasin GSAs (McMullin Area GSA and North

Kings GSA). These efforts have resulted in updates to the Subbasin ISW workplan as part of the January 2025 Plan Amendment (see Appendix 3.I.a of the Joint GSP 2025 Plan Amendment).

To facilitate ongoing coordination, GSAs in the Madera and Kings Subbasins have developed a MOU with USBR and FWA that includes a cooperative scope of work for further investigation of possible ISW along portions of the San Joaquin River (see Appendix 3.I.b of the Joint GSP 2025 Plan Amendment).

Basin Setting and Water Budget Coordination with the Chowchilla Subbasin

The Subbasin GSAs are continuing to coordinate with GSAs in adjacent and hydrologically-connected subbasins, particularly with the Chowchilla Subbasin. The Chowchilla Subbasin is located north-northwest of the Subbasin, and is the only subbasin subject to SGMA that is not separated from the Subbasin by the San Joaquin River. Specific points of coordination with the Chowchilla Subbasin include:

- Fully coordinated data sharing and development of the basin setting for both subbasins by the same GSP consultant team.
- Use of the same, consistent groundwater model (MCSim) by the GSAs in both Subbasins. This provides a uniform and consistent basis for other elements of the GSPs including water budgets, future subsidence estimates, and establishment of SMC.
- Consistent development of the same data management system (DMS) for both subbasins.

SMC Coordination with Surrounding Subbasins

The Subbasin GSAs have developed consistent SMC for all applicable sustainability indicators, and have further coordinated or verified those SMC for consistency with the SMC in surrounding Subbasins. The consistency of the MOs is highlighted below, as these provide a good basis for understanding the potential long-term impacts of the Subbasin SMC on adjacent subbasins during the sustainability period (after 2040). Specifically:

- **Chronic Lowering of Groundwater Levels**: MOs set for the Subbasin are based on Fall 2010 groundwater elevations. This is consistent with proposed Chowchilla Subbasin MOs, and generally higher than MOs proposed in Delta Mendota Subbasin and higher than DWR-approved MOs in Kings Subbasin.
- **Reduction in Groundwater Storage**: Groundwater levels serve as a proxy.
- **Land Subsidence**: The MO for subsidence of 0.00 feet/year was established with the goal of long-term avoidance of land subsidence, with consideration for uncertainty. This MO and goal is consistent with approved or currently-proposed MOs in adjacent subbasins.
- **Degraded Water Quality**: MOs are defined for the key water quality constituents As, nitrate, and TDS based on current constituent concentrations that exist in the Subbasin, with consideration of historical groundwater quality conditions and the drinking water MCLs. Groundwater quality conditions will thus remain at current conditions after 2040, and are consistent with approved or currently-proposed MOs in adjacent subbasins.
- **Depletion of Surface Water (ISW)**: The interim MO for ISW along the San Joaquin River is to maintain the percent of time the San Joaquin River is connected to shallow groundwater levels equal to or greater than existing and historical conditions at RMS wells screened in the Upper Aquifer in close proximity to the San Joaquin River. This is the same as the proposed MO in the Chowchilla Subbasin. Ongoing ISW coordination with GSAs in the Kings Subbasin is also working to ensure consistency of the ISW SMC with adjacent portions of the Kings Subbasin. The interim

MO is subject to potential refinement pending finalization of DWR's guidance on ISW SMC and monitoring

Subsidence Coordination with Critical Infrastructure Owners and Operators

- During the 2025 Plan Amendment process, the Subbasin GSAs conducted a detailed Infrastructure Assessment to evaluate critical infrastructure in the Subbasin (e.g., highways, bridges, waterways, wells, etc.) and the historical and potential future impacts from subsidence (see Sections 3.2.3 and 3.4.3 of the Joint GSP 2025 Plan Amendment). Various points of coordination occurred as part of the Infrastructure Assessment, including interviews held in 2024 with critical infrastructure owners and operators to better understand subsidence concerns and how the potential for future subsidence may be accounted for in agency maintenance and/or future design of critical infrastructure within the Subbasin. This coordination with critical infrastructure owners and operators directly informed discussions and decisions related to the subsidence IMs.
- Following the Infrastructure Assessment and interviews, the Subbasin GSAs, with support from the agencies interviewed, are proposing to establish a Subbasin Critical Infrastructure Operator Group. Although discussions are ongoing, the Critical Infrastructure Operator Group is planning to meet annually to provide updates on any potential critical infrastructure impacts related to subsidence, to coordinate ongoing PMA implementation, and to discuss any potential critical infrastructure mitigation concerns.

Well Permitting Coordination

As described in Section 6.2 of the Joint GSP 2025 Periodic Evaluation Attachment (**Appendix 1.B.1**) and in Section 2.1.3.3 of the Joint GSP 2025 Plan Amendment, the Madera County Environmental Health Division is entrusted with all permitting and enforcement for the construction, reconstruction, and destruction of wells in Madera County, including the entire Subbasin. Well permitting processes in Madera County are consistent with all applicable State requirements.

Land Use Coordination

Land use decisions within the Subbasin GSAs are being coordinated with all applicable agencies, programs, and policies. Applicable topics pertaining to ongoing land use coordination efforts include:

- County and City land use policies, specifically land use policies in the Madera County General Plan (applicable to land within the entire Subbasin) and the City of Madera General Plan (applicable to land within the City of Madera). As described in Section 6.2 of the Joint GSP 2025 Periodic Evaluation Attachment (**Appendix 1.B.1**), adherence to applicable General Plan policies is expected to reduce and/or not to increase water demands in the Subbasin.
- Land use changes in the Subbasin coordinated through various projects and programs (e.g., VLRP and MLRP).

8 Other Information (23 CCR §356.4(k))

This section highlights other topics relevant to this Periodic Evaluation that help to describe the progress that has been made, or the challenges that have been met, in the GSAs' efforts to achieve the sustainability goal for the Subbasin.

8.1 Consideration of Adjacent Basins (23 CCR §356.4(j))

Interbasin coordination efforts are described in **Section 7.3.2** of this Periodic Evaluation, including:

- San Joaquin Valley Basin Point of Contact Discussions
- ISW Coordination with USBR, FWA, and GSAs in the Kings Subbasin
- Basin Setting and Water Budget Coordination with the Chowchilla Subbasin
- SMC Coordination with Surrounding Subbasins
- Subsidence Coordination with Critical Infrastructure Owners and Operators

8.2 Challenges for SGMA Implementation in the Subbasin

Despite the many successes and substantial progress that has been made toward achieving the Subbasin sustainability goal, the GSAs have encountered various technical and financial challenges to GSP implementation during this Periodic Evaluation cycle. Challenges include the following:

Funding Challenges
The Subbasin GSAs made significant strides during this first Periodic Evaluation cycle to identify and move forward with funding strategies for SGMA implementation in the Subbasin. Nevertheless, the GSAs have faced significant challenges in their efforts, in particular the MC GSA.

Since adoption of the 2020 Initial Joint GSP, MC GSA has completed multiple planning studies and a rate study to fund Joint GSP implementation. The MC GSA rate study and Proposition 218 process were completed in 2022 and led to approval of an acreage-based rate for irrigated lands within the MC GSA in the Subbasin (under Resolution 2022-086, see Section 6.1 of the Joint GSP 2025 Periodic Evaluation Attachment (**Appendix 1.B.1**) for more information). The rate was intended to fund implementation of specific GSP-defined projects, including recharge facilities, water purchases, and domestic well mitigation programs. However, following a lawsuit and preliminary injunction issued by the Madera County Superior Court in December 2022, Madera County was ordered to refrain from imposing and/or collecting any fees, rates, and/or GSP-related PMA fees enacted under Resolution 2022-086 against landowners in the Subbasin. As of fall 2024, the preliminary injunction remains in place, although Madera County has filed a motion to dismiss the lawsuit. Regardless of the outcome, the MC GSA is continuing GSP implementation and is seeking ways to reduce implementation costs (e.g., grants, refinements to costs) with stakeholder input and discussion. Continued implementation of the allocation program is not delayed. The MC GSA has also circulated a survey among stakeholders to solicit their feedback and level of support for future fees and how they would be used to fund certain packages of PMAs.

The MC GSA will continue to provide updates regarding funding in future Annual Reports. Aside from the Proposition 218 challenges, the MC GSA continues to collect a Proposition 26 exempt administrative fee of approximately $20-30 per acre for irrigated acres within the GSA that is used for SGMA-related administration and planning efforts. While the administrative fee is useful for supporting SGMA implementation, these funds cannot be used for implementation of GSP PMAs, including construction of recharge facilities, purchasing surface water for in-lieu recharge, voluntary land repurposing, or for domestic well mitigation efforts.

The MC GSA has approved and begun enforcing a penalty for groundwater extraction above the allocation (described in Section 6.1.2 of the Joint GSP 2025 Periodic Evaluation Attachment in **Appendix 1.B.1**). Funds generated from these penalties are available to support GSP implementation moving forward, as directed by the GSA Board, which has indicated an inclination to fund domestic well mitigation first as a top priority. Aside from these penalties, the MC GSA is predominantly using SGMA-related grant awards (including Proposition 68 and LandFlex grant awards) to fund PMAs in the Subbasin until such a time as the Proposition 218 lawsuit is dismissed.

At a broader level, lack of new SGMA-related funding opportunities remains a challenge for the GSAs, especially for smaller agencies and those agencies whose populace and beneficial uses and users are predominantly Disadvantaged Communities (DACs). Existing state-level funding opportunities have significantly benefitted these communities during this Periodic Evaluation cycle, for instance through the Fairmead Community Groundwater Resiliency project in the MC GSA that has been made possible through grant funding as part of the California Resilience Challenge. Continuance of SGMA-related grant funding opportunities would be greatly beneficial to DACs in the Subbasin.

Technical Guidance Challenges

One technical challenge the GSAs experienced during this Periodic Evaluation cycle was the delayed release of ISW guidance documents from DWR. The Subbasin GSAs made significant efforts to coordinate with various agencies (including USBR, FWA, and GSAs in the Kings Subbasin) regarding ISW SMC, monitoring, and related topics during this Periodic Evaluation cycle (see **Section 7.3.2** of this Periodic Evaluation for more details). These coordination efforts were intended to be informed by and consistent with DWR's guidance on ISW SMC and monitoring. However, DWR's white papers describing techniques and examples for estimating ISW depletion caused by groundwater use were not made available until September 2024, which did not provide sufficient time to incorporate those considerations into the 2025 Plan Amendment (Public Review began in October 2024). DWR's guidance for managing ISW depletion was also not anticipated to be released until sometime during the Winter 2024/2025, coinciding with the submittal of this Periodic Evaluation. The GSAs may consider revisions to the current ISW SMC based on information gleaned from these documents in future Periodic Evaluations and/or Plan Amendments, though there was not sufficient time to do so as part of the 2025 Plan Amendment and Periodic Evaluation.

GSA Boundaries and Governance Challenges

Some concerns among the Subbasin GSAs during this Periodic Evaluation cycle relate to potential fragmentation of existing GSA areas and formation of additional GSAs in the Subbasin during the GSP implementation period.

Certain GSA boundaries have already been revised since the 2020 Initial Plan was developed, including those of MID GSA, MC GSA, GFWD GSA, and RCWD GSA. The boundaries indicated in figures and tables within the 2025 Plan Amendment and this Periodic Evaluation may not include the most recent version of the boundaries. Updates are expected occur during the second Periodic Evaluation and/or Annual Reports as those updates are finalized and as geospatial information indicating those updates is available.

In terms of GSA governance, rifts and splintering of existing GSAs between 2020-2040 would bring a myriad of challenges to successful GSP implementation in the Subbasin, including loss of clarity for the affected GSAs' responsibilities and associated challenges for continued coordination across the Subbasin to achieve the Subbasin sustainability goal.

Regulatory Challenges

Regulatory challenges identified during this Periodic Evaluation cycle pertain primarily to the permitting and regulatory landscape for recharge project infrastructure in association with PMAs. Multiple GSAs in the Subbasin, including the MWD GSA and the MC GSA, have experienced long processes and/or delays in permitting and regulatory processes for implementing their planned PMAs. These processes and delays have delayed the timeline for PMA roll-out from what was originally intended in the 2020 Initial Plan, despite efforts by the GSAs to move forward with their PMAs according to their planned schedules.

Additionally, while SB122 was seen as a boon for streamlining recharge efforts beginning this Periodic Evaluation cycle, the GSAs have identified certain potential challenges for PMA implementation associated with regulatory interpretations of SB122, specifically related to considerations for new permanent infrastructure construction and its eligibility for use in flood diversions under SB122 (Water Code Section 1242.1). In particular, interpretations by some permitting agencies when applying SB122 have taken a strict stance on new infrastructure, suggesting that new diversion facilities are broadly not to be constructed if they will be used for diversions under SB122, despite the GSAs' pre-existing plans to construct that infrastructure for other planned recharge.

Legal Challenges

Legal challenges and concerns experienced during this Periodic Evaluation cycle include topics covered above:

- Funding challenges in the MC GSA, associated with the injunction related to MC GSA's Proposition 218 process.
- Challenges to the MC GSA allocation system, associated with a lawsuit from the Never Irrigated landowners.
- Potential governance challenges, associated with concerns for fragmentation of existing GSA areas during the GSP implementation period (2020-2040).

9 Summary of Proposed or Completed Revisions to Plan Elements (23 CCR §356.4(i))

As described previously and throughout this Periodic Evaluation, **the 2025 Plan Amendment accompanying the 2025 Periodic Evaluation has been amended to address recommended corrective actions identified by DWR in their December 2023 letter approving the 2023 Revised Plan.**

Through the 2025 Plan Amendment, each of the four GSPs and the Coordination Agreement have been amended to reconcile or substantively progress DWR's recommended corrective actions. Despite multiple GSPs in the Subbasin, the GSAs have worked continuously over the last several years to seek consensus, striving to bring consistency across the four GSPs where possible and eliminating contradictory policies, procedures, and methodologies. The Subbasin GSAs have committed to continued coordination in an effort to eliminate areas of disagreement

9.1 DWR's Recommended Corrective Actions

DWR's recommended corrective actions are documented in their December 2023 letter to the Subbasin GSAs (see **Appendix 1.A.1**), and are summarized as follows:

- **Corrective Action 1 – Plan Adoption**: Add language to the Joint GSP explaining that all Joint GSP GSAs have adopted the Joint GSP and are committed to implementing the 2023 Revised Plan consistent with SGMA.
- **Corrective Action 2 – Coordination**: Continue to coordinate to eliminate areas of disagreement.
- **Corrective Action 3 – Chronic Lowering of Groundwater Levels**: Amend the 2023 Revised Plan to discuss the relationship between the sustainable management criteria (SMC) for chronic lowering of groundwater levels and the other sustainability indicators, including how the SMC avoid undesirable results for each of the other sustainability indicators.
- **Corrective Action 4 – Land Subsidence:** Amend the 2023 Revised Plan to address several land subsidence-related topics. Recommended corrective actions include:
    - Refine the description of land subsidence undesirable results to clearly describe the significant and unreasonable conditions the GSAs are managing the Subbasin to avoid, and reevaluate the quantitative metrics that define an undesirable result.
    - Identify the cumulative amount of land subsidence that, if exceeded, would substantially interfere with groundwater and land surface beneficial uses and users in the Subbasin.
    - Amend the 2023 Revised Plan to discuss the relationship between the SMC for land subsidence and the other sustainability indicators, including how the SMC avoid undesirable results for each of the other sustainability indicators.
    - Reevaluate or eliminate the application of the level of uncertainty as it relates to subsidence measurements.
    - Describe PMAs that will be implemented to minimize or eliminate subsidence.
- **Corrective Action 5 – Hydrogeologic Conceptual Model (HCM):** Amend the 2023 Revised Plan to discuss the uncertainty concerning the HCM and provide a description of HCM data gaps.
- **Corrective Action 6 – Degraded Water Quality**: Amend the 2023 Revised Plan to address several water quality-related topics. Recommended corrective actions include:
    - Refine the definition of undesirable results for degraded water quality to consider exceedances of minimum thresholds (MTs) caused by groundwater extraction.

- o Clearly define what the 2023 Revised Plan considers an undesirable result for degraded water quality by describing conditions that it would consider to be significant or unreasonable.
- o Clearly identify the MT values at each representative monitoring site (RMS), and justify why levels below the MTs do not constitute significant and unreasonable effects.

9.2 Specific Revisions to the Plan Elements

The 2025 Plan Amendment – including all four amended GSPs and the Coordination Agreement – was adopted before the January 2025 submittal. Specific revisions to the Plan elements that were completed as part of the 2025 Plan Amendment are identified in **Appendix 1.A.2**, and are summarized as follows:

- **Revisions Related to Corrective Action 1 – Plan Adoption:** Text was added describing the adoption of the Joint GSP (March 2023 Revisions) by all four Joint GSP GSAs and their commitment to implementing the Plan consistent with SGMA. The 2025 Plan Amendment was further adopted by all Subbasin GSAs (e.g., see Appendix 1.H of the Joint GSP 2025 Plan Amendment).
- **Revisions Related to Corrective Action 2 – Coordination:** Text was added documenting the robust coordination efforts and commitments the Subbasin GSAs have taken to eliminate any areas of disagreement ensuring that groundwater sustainability is achieved within the Subbasin. This includes the engagement of facilitation support services to assist the GSAs in working through and eliminating any areas of disagreement, including topics related to the Coordination Agreement and the domestic well mitigation program; developing consensus regarding data, methods, and use of data across the Subbasin; and signing a new Coordination Agreement.
- **Revisions Related to Corrective Action 3 – Chronic Lowering of Groundwater Levels:** Revisions were made to describe the relationship between the SMC for chronic lowering of groundwater levels and the other sustainability indicators. This includes an explanation of how the SMC, including IMs, were established to avoid undesirable results for each of the other sustainability indicators and an explanation of how groundwater levels and subsidence are separate sustainability indicators, and that the most restrictive SMC governs.
- **Revisions Related to Corrective Action 4 – Land Subsidence:** Revisions were made to document efforts to reevaluate and refine the land subsidence analysis for the Subbasin. This includes clearly describing the significant and unreasonable conditions the GSAs are managing the Subbasin to avoid; reviewing and refining the quantitative metrics that define an undesirable result for subsidence (including identifying and defining the cumulative amount of subsidence that, if exceeded, would substantially impact groundwater and land surface beneficial uses and users); conducting interviews with critical infrastructure owners and operators; and describing PMAs that will be implemented to minimize or eliminate subsidence.
- **Revisions Related to Corrective Action 5 – HCM:** Additional discussion was added to discuss uncertainties related to the HCM and a description of HCM data gaps and how these have been or are being addressed.
- **Revisions Related to Corrective Action 6 – Degraded Water Quality**: Text was added describing revisions related to the SMC for water quality, including revisions to undesirable results, justification for undesirable result definitions, an explanation of how interim milestones were established, and a discussion of uncertainties.

In addition to addressing DWR's recommended corrective actions, the Subbasin GSAs have proactively addressed two additional topics in the 2025 Plan Amendment:

- **Revisions Related to Additional Topic 1 – ISW**: Though not specifically requested by DWR, the GSAs have taken the initiative to engage in ISW coordination with applicable GSAs in the Kings Subbasin, the USBR, the FWA, and the SJRRP. Through this coordination, efforts have also been made to draw greater consistency between ISW workplans for the Subbasin GSAs and participating Kings Subbasin GSAs.
- **Revisions Related to Additional Topic 2 – Updates Regarding PMAs**: Additionally, though not specifically requested by DWR, the GSAs have provided updates on PMA planning and implementation since the 2023 Revised Plan was completed and submitted in March 2023.

As discussed in **Section 7.1**, the GSAs conducted public outreach during the 2025 Plan Amendment process through email outreach and through public Board and governing body meetings. The GSAs distributed the draft GSP amendments for public review and comment in November-December 2024. A webinar workshop was held in December 2024 where the GSAs presented key changes made in the 2025 Plan Amendment process and received public comment. Public comments were considered in the final 2025 Plan Amendment and responses to those comments are provided as an appendix to the 2025 Plan Amendment.

10 References

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Appendix 1.A. DWR Recommended Corrective Actions and Corresponding Revisions to Plan Elements (§356.4(i))

Appendix 1.A.1. DWR 2023 Revised Plan Approval Letter: Approved Determination of the Revised Groundwater Sustainability Plans Submitted for the San Joaquin Valley – Madera Subbasin

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CALIFORNIA DEPARTMENT OF WATER RESOURCES

SUSTAINABLE GROUNDWATER MANAGEMENT OFFICE

715 P Street, 8th Floor | Sacramento, CA 95814 | P.O. Box 942836 | Sacramento, CA 94236-0001

December 21, 2023

John Davids
Madera Point of Contact
1772 Picasso Avenue, Suite A
Davis, CA 95618
john@davidsengineering.com

RE: Approved Determination of the Revised Groundwater Sustainability Plans Submitted for the San Joaquin Valley – Madera Subbasin

Dear John Davids,

The Department of Water Resources (Department) has evaluated the four groundwater sustainability plans (GSPs) submitted for the San Joaquin Valley – Madera Subbasin (Subbasin), as well as the materials considered to be part of the required coordination agreement. Collectively, the four GSPs and the coordination agreement are referred to as the Plan for the Subbasin. The Department has evaluated the resubmitted Plan for the Madera Subbasin in response to the Department's incomplete determination on September 22, 2022, and has determined the Plan is approved. The approval is based on recommendations from the Staff Report, included as an exhibit to the attached Statement of Findings, which describes that the Plan has taken sufficient action to correct deficiencies identified by the Department and satisfies the objectives of the Sustainable Groundwater Management Act (SGMA) and substantially complies with the GSP Regulations. The Staff Report also proposes recommended corrective actions that the Department believes will enhance the GSP and facilitate future evaluation by the Department. The Department strongly encourages the recommended corrective actions be given due consideration and suggests incorporating all resulting changes to the GSP in future updates.

Recognizing SGMA sets a long-term horizon for groundwater sustainability agencies (GSAs) to achieve their basin sustainability goals, monitoring progress is fundamental for successful implementation. GSAs are required to evaluate their GSPs at least every five years and whenever the Plan is amended, and to provide a written assessment to the Department. Accordingly, the Department will evaluate approved GSPs and issue an assessment at least every five years. The Department will initiate the first periodic review of the Plan no later than January 31, 2025.

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Please contact Sustainable Groundwater Management staff by emailing sgmps@water.ca.gov if you have any questions related to the Department's assessment or implementation of your GSP.

Thank You,

Paul Gosselin

Paul Gosselin
Deputy Director
Sustainable Groundwater Management

Attachment:

1. Statement of Findings Regarding the Determination of Approval of the San Joaquin Valley – Madera Subbasin Groundwater Sustainability Plans (December 21, 2023)

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

STATEMENT OF FINDINGS REGARDING THE APPROVAL OF THE SAN JOAQUIN VALLEY – MADERA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

The Department of Water Resources (Department) is required to evaluate whether a submitted groundwater sustainability plan (GSP or Plan) conforms to specific requirements of the Sustainable Groundwater Management Act (SGMA or Act), is likely to achieve the sustainability goal for the basin covered by the Plan, and whether the Plan adversely affects the ability of an adjacent basin to implement its GSP or impedes achievement of sustainability goals in an adjacent basin. (Water Code § 10733.) The Department is directed to issue an assessment of the Plan within two years of its submission. (Water Code § 10733.4.) If a Plan is determined to be Incomplete, the Department identifies deficiencies that preclude approval of the Plan and identifies corrective actions required to make the Plan compliant with SGMA and the GSP Regulations. The groundwater sustainability agency (GSA) has up to 180 days from the date the Department issues its assessment to make the necessary corrections and submit a revised Plan. (23 CCR § 355.2(e)(2)). This Statement of Findings explains the Department's decision regarding the revised Plan submitted by the City of Madera GSA, Madera County GSA, Madera Irrigation District GSA, Madera Water District GSA, Gravelly Ford Water District GSA, New Stone Water District GSA, and Root Creek Water District GSA (GSAs or Agencies) for the San Joaquin Valley – Madera Subbasin (No. 5-022.06) (Subbasin) on March 21, 2023 (2023 Plan).

Department management has discussed the 2023 Plan with staff and has reviewed the Department Staff Report, entitled Sustainable Groundwater Management Program Groundwater Sustainability Plan Assessment Staff Report, attached as Exhibit A, recommending approval of the 2023 Plan. Department management is satisfied that staff have conducted a thorough evaluation and assessment of the 2023 Plan and concurs with staff's recommendation and all the recommended corrective actions. The Department therefore **APPROVES** the 2023 Plan and makes the following findings:

A. The initial Plan for the basin submitted by the GSAs for the Department's evaluation on January 31, 2020 (2020 GSP or 2020 Plan) was determined by Department staff to satisfy the preliminary requirements for Plan review as outlined in § 355.4(a) of the GSP Regulations (23 CCR § 350 et seq.), and Department Staff therefore evaluated the initial Plan.

B. On September 22, 2022, the Department issued a Staff Report and Findings determining the initial 2020 GSP submitted by the Agencies for the basin to be incomplete because the 2020 Plan did not satisfy the requirements of

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SGMA, nor did it substantially comply with the GSP Regulations. At that time, the Department provided corrective actions in the Staff Report that were intended to address the deficiencies that precluded approval. Consistent with the GSP Regulations, the Department provided the Agencies with up to 180 days to address the deficiencies detailed in the Staff Report. On March 21, 2023, within the 180 days provided to remedy the deficiencies identified in the Staff Report related to the Department's initial incomplete determination, the Agencies resubmitted a revised Plan to the Department for evaluation.

When evaluating a revised Plan that was initially determined to be incomplete, the Department reviews the materials (e.g., revised or amended Plan) that were submitted within the 180-day deadline and does not review or rely on materials that were submitted to the Department by the GSAs after the resubmission deadline. Part of the Department's review focuses on how the Agencies have addressed the previously identified deficiencies that precluded approval of the initially submitted Plan. The Department shall find a Plan previously determined to be incomplete to be inadequate if, after consultation with the State Water Resources Control Board, the Agencies have not taken sufficient actions to correct the deficiencies previously identified by the Department. (23 CCR § 355.2(e)(3)(C).) If the Department determines the Agencies have sufficiently addressed those deficiencies, the Department may evaluate other components of the Plan, particularly to assess whether and, if so, how revisions to address deficiencies may have affected other components of a Plan or its likelihood of achieving sustainable groundwater management.

C. The Department's initial Staff Report identified the deficiencies that precluded approval of the initially submitted 2020 Plan. After staff's thorough evaluation of the revised 2023 Plan, the Department makes the following findings regarding the sufficiency of the actions taken by the Agencies to address those deficiencies:

    1. Deficiency 1: The corrective action advised the Agencies to modify several aspects of their respective GSPs to substantially comply with the GSP Regulations in a coordinated manner. The Department found that the initial GSPs did not sufficiently coordinate on data and methodologies, including coordination of the sustainability goal, water budget and sustainable yield, and undesirable results as required by SGMA and the GSP Regulations. The Department also determined that the 2020 Plan's definition of an undesirable result for the chronic lowering of groundwater levels was not consistent with the requirements of SGMA.

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The 2023 Staff Report indicates that the Agencies have taken sufficient actions to correct this deficiency, and it should no longer materially affect the ability of the Agencies to achieve sustainability and the ability of the Department to evaluate the likelihood of the 2023 Plan to achieve sustainability.

2. Deficiency 2: The corrective action advised the Agencies to address several aspects of the 2020 Plan's disclosure, discussion, and analyses of groundwater level sustainable management criteria and potential impacts to groundwater users and uses. The initial 2020 Plan did not establish undesirable results and minimum thresholds for chronic lowering of groundwater levels in a manner substantially compliant with the GSP Regulations. Additionally, the Department found that the Plan did not present sufficient analysis of the effects of minimum thresholds on beneficial uses and users of groundwater in the Subbasin.

   The 2023 Staff Report indicates that the Agencies have taken sufficient actions to correct this deficiency, and it should no longer materially affect the ability of the Agencies to achieve sustainability and the ability of the Department to evaluate the likelihood of the 2023 Plan to achieve sustainability.

3. Deficiency 3: The corrective action advised the Agencies to address several aspects of the 2020 Plan's disclosure, discussion, and analyses of land subsidence sustainable management criteria and potential impacts to groundwater users and uses. The initial Plan did not establish sustainable management criteria for subsidence. The Department determined that the GSAs did not sufficiently demonstrate that undesirable results related to land subsidence are not present and are not likely to occur in the Subbasin.

   The 2023 Staff Report indicates that the Agencies have taken sufficient actions to correct this deficiency, and it should no longer materially affect the ability of the Agencies to achieve sustainability and the ability of the Department to evaluate the likelihood of the 2023 Plan to achieve sustainability.

4. Deficiency 4: The corrective action advised the Agencies to address several aspects of the 2020 Plan's disclosure, discussion, and analyses of interconnected surface water sustainable management criteria and potential impacts to groundwater users and uses. The initial 2020 Plan did not establish sustainable management criteria for interconnected surface water. The Department determined that the GSAs do not sufficiently demonstrate that interconnected surface

water or undesirable results related to depletions of interconnected surface water are not present and are not likely to occur in the Subbasin.

The 2023 Staff Report indicates that the Agencies have taken sufficient actions to correct this deficiency, and it should no longer materially affect the ability of the Agencies to achieve sustainability and the ability of the Department to evaluate the likelihood of the 2023 Plan to achieve sustainability.

D. The 2023 Plan satisfies the required conditions as outlined in § 355.4(a) of the GSP Regulations (23 CCR § 350 et seq.):

1. The 2020 Plan was submitted within the statutory deadline of January 31, 2022 (Water Code § 10720.7(a); 23 CCR § 355.4(a)(1)), and the 2023 Plan was submitted within 180 days of the Department's Incomplete determination (23 CCR § 355.2(e)(2)).

2. The 2023 Plan is complete, meaning it generally appeared to include the information required by the Act and the GSP Regulations sufficient to warrant a thorough evaluation and issuance of an assessment by the Department. (23 CCR § 355.4(a)(2).)

3. The 2023 Plan, either on its own or in coordination with other Plans, covers the entire Subbasin. (23 CCR § 355.4(a)(3).)

E. The general standards the Department applied in its evaluation and assessment of the Plan are: (1) "conformance" with the specified statutory requirements, (2) "substantial compliance" with the GSP Regulations, (3) whether the Plan is likely to achieve the sustainability goal for the Subbasin within 20 years of the implementation of the Plan, and (4) whether the Plan adversely affects the ability of an adjacent basin to implement its GSP or impedes achievement of sustainability goals in an adjacent basin. (Water Code § 10733.) Application of these standards requires exercise of the Department's expertise, judgment, and discretion when making its determination of whether a Plan should be deemed "approved," "incomplete," or "inadequate."

The statutes and GSP Regulations require Plans to include and address a multitude and wide range of informational and technical components. The Department has observed a diverse array of approaches to addressing these technical and informational components being used by GSAs in different basins throughout the state. The Department does not apply a set formula or criterion that would require a particular outcome based on how a Plan addresses any one of SGMA's numerous informational and technical components. The Department finds that affording flexibility and discretion to

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local GSAs is consistent with the standards identified above; the state policy that sustainable groundwater management is best achieved locally through the development, implementation, and updating of local plans and programs (Water Code § 113); and the Legislature's express intent under SGMA that groundwater basins be managed through the actions of local governmental agencies to the greatest extent feasible, while minimizing state intervention to only when necessary to ensure that local agencies manage groundwater in a sustainable manner. (Water Code § 10720.1(h)). The Department's final determination of a Plan is made based on the entirety of the Plan's contents on a case-by-case basis, considering and weighing factors relevant to the particular Plan and Subbasin under review.

F. In making these findings and Plan determination, the Department also recognized that: (1) it maintains continuing oversight and jurisdiction to ensure the Plan is adequately implemented; (2) the Legislature intended SGMA to be implemented over many years; (3) SGMA provides Plans with 20 years of implementation to achieve the sustainability goal in a Subbasin (with the possibility that the Department may grant GSAs an additional five years upon request if the GSA has made satisfactory progress toward sustainability); and, (4) local agencies acting as GSAs are authorized, but not required, to address undesirable results that occurred prior to enactment of SGMA. (Water Code §§ 10721(r); 10727.2(b); 10733(a); 10733.8.)

G. The 2023 Plan conforms with Water Code §§ 10727.2 and 10727.4, substantially complies with 23 CCR § 355.4, and appears likely to achieve the sustainability goal for the Subbasin. It does not appear at this time that the 2023 Plan will adversely affect the ability of adjacent basins to implement their GSPs or impede achievement of sustainability goals.

1. The sustainable management criteria and the 2023 Plan's goal to implement a package of projects and management actions that will, by 2040, balance long-term groundwater system inflows and outflows based on a 50-year period representative of average historical hydrologic conditions are sufficiently justified and explained. The 2023 Plan relies on credible information and science to quantify the groundwater conditions that the Plan seeks to avoid and provides an objective way to determine whether the Subbasin is being managed sustainably in accordance with SGMA. (23 CCR § 355.4(b)(1).)

2. The 2023 Plan demonstrates an understanding of where data gaps exist and has identified areas for improvement of its Plan, including addressing data gaps related to land subsidence and interconnected surface water, refining water budgets, incorporating new information

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into the numerical model, and expanding monitoring networks. (23 CCR § 355.4(b)(2).)

3. The projects and management actions proposed are designed to meet interim milestones and bring groundwater levels back up to minimum thresholds, mitigate overdraft, and operate the Subbasin sustainably. The projects and management actions are reasonable and commensurate with the level of understanding of the Subbasin setting. The projects and management actions described in the Plan provide a feasible approach to achieving the Subbasin's sustainability goal and should provide the GSAs with greater versatility to adapt and respond to changing conditions and future challenges during GSP implementation. (23 CCR § 355.4(b)(3).)

4. The 2023 Plan provides a detailed explanation of how the varied interests of groundwater uses and users in the Subbasin were considered in developing the sustainable management criteria and how those interests, including domestic wells, would be impacted by the chosen minimum thresholds. (23 CCR § 355.4(b)(4).)

5. The 2023 Plan's projects and management actions appear feasible at this time and appear likely to prevent undesirable results and ensure that the Subbasin is operated within its sustainable yield within 20 years. The Department will continue to monitor Plan implementation and reserves the right to change its determination if projects and management actions are not implemented or appear unlikely to prevent undesirable results or achieve sustainability within SGMA timeframes. (23 CCR § 355.4(b)(5).)

6. The 2023 Plan includes a reasonable assessment of overdraft conditions and includes reasonable means to mitigate overdraft. (23 CCR § 355.4(b)(6).)

7. At this time, it does not appear that the 2023 Plan will adversely affect the ability of an adjacent basin to implement its GSP or impede achievement of sustainability goals in an adjacent basin. The Plan states that the Subbasin's GSAs have met with GSAs in adjacent basins to share data and information to ensure that the implementation of the GSPs will not interfere with neighboring basins. The Plan also qualitatively describes how minimum thresholds and measurable objectives may affect an adjacent basin, concluding that the Madera Subbasin Plan will not hinder the ability of an adjacent basin to be sustainable; however, the evaluation is provided without specifics. (23 CCR § 355.4(b)(7).)

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8. A satisfactory coordination agreement has been adopted by all relevant parties. (23 CCR § 355.4(b)(8).)

9. The City of Madera GSA, Madera County GSA, Madera Irrigation District GSA, Madera Water District GSA, Gravelly Ford Water District GSA, New Stone Water District GSA, and Root Creek Water District GSA have historically had a role in water planning and management in the Subbasin. The seven GSAs' history of groundwater management provide a reasonable level of confidence that the GSAs have the legal authority and financial resources necessary to implement the 2023 Plan. (23 CCR § 355.4(b)(9).)

10. Through review of the 2023 Plan and consideration of public comments, the Department determines that the GSAs adequately responded to comments that raised credible technical or policy issues with the Plan, sufficient to warrant approval of the Plan at this time. The Department also notes that the recommended corrective actions included in the Staff Report are important to addressing certain technical or policy issues that were raised and, if not addressed before future, subsequent plan evaluations, may preclude approval of the Plan in those future evaluations. (23 CCR § 355.4(b)(10).)

H. In addition to the grounds listed above, DWR also finds that:

1. The 2023 Plan provides an analysis that documents the expected location and quantity of domestic wells that will experience undesirable results during the GSP implementation period based on future modeled groundwater conditions. Additionally, the Plan describes a domestic well mitigation program that the GSAs will implement to provide assistance to domestic and municipal wells adversely impacted by declining groundwater levels that have occurred since 2015. The Plan describes that the cost of mitigating domestic wells due to lowering groundwater levels is shown to be economically preferable to the costs associated with immediately stabilizing groundwater levels and the resulting impact to the local economy. The Plan's compliance with the requirements of SGMA and substantial compliance with the GSP Regulations supports the state policy regarding the human right to water (Water Code § 106.3). The Department developed its GSP Regulations consistent with and intending to further the policy through implementation of SGMA and the Regulations, primarily by achieving sustainable groundwater management in a basin. By ensuring substantial compliance with the GSP Regulations, the Department has considered the state policy

regarding the human right to water in its evaluation of the Plan. (23 CCR § 350.4(g).)

2. The 2023 Plan acknowledges and identifies interconnected surface waters within the Subbasin. The GSAs propose interim sustainable management criteria to manage this sustainability indicator and measures to improve understanding and management of interconnected surface water. The GSAs acknowledge, and the Department agrees, many data gaps related to interconnected surface water exist. The GSAs should continue filling data gaps, collecting additional monitoring data, and coordinating with resources agencies and interested parties to understand beneficial uses and users that may be impacted by depletions of interconnected surface water caused by groundwater pumping. Future updates to the Plan should aim to improve the initial sustainable management criteria as more information and improved methodology becomes available.

3. The California Environmental Quality Act (Public Resources Code § 21000 *et seq*.) does not apply to the Department's evaluation and assessment of the Plan.

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Accordingly, the revised 2023 Plan submitted by the Agencies for the San Joaquin Valley – Madera Subbasin is hereby **APPROVED.** The recommended corrective actions identified in the Staff Report will assist the Department's future review of the Plan's implementation for consistency with SGMA and the Department therefore recommends the Agencies address them by the time of the Department's periodic review, which is set to begin on January 31, 2025, as required by Water Code § 10733.8. Failure to address the Department's Recommended Corrective Actions before future, subsequent plan evaluations, may lead to a Plan being determined incomplete or inadequate.

Signed:

Karla Nemeth

Karla Nemeth, Director
Date: December 21, 2023

Exhibit A: Groundwater Sustainability Plan Assessment Staff Report – San Joaquin Valley – Madera Subbasin (December 21, 2023)

State of California
Department of Water Resources
Sustainable Groundwater Management Program
Groundwater Sustainability Plan Assessment
Staff Report

Groundwater Basin Name:	San Joaquin Valley - Madera Subbasin (No. 5-022.06)
Number of GSPs:	4 (see list below)
Number of GSAs:	7 (see list below)
Submittal Type:	Revised Plan in response to Incomplete Determination
Submittal Date:	March 21, 2023
Recommendation:	Approve
Date:	December 21, 2023

On March 21, 2023, multiple groundwater sustainability agencies (GSAs) resubmitted multiple groundwater sustainability plans (GSPs) for the entire Madera Subbasin (Subbasin), which are coordinated pursuant to a required coordination agreement, to the Department of Water Resources (Department) in response to the Department's incomplete determination on September 22, 2022[1] for evaluation and assessment as required by the Sustainable Groundwater Management Act (SGMA) [2] and GSP Regulations.[3] In total, four GSPs have been revised and implemented by seven GSAs. Collectively, all GSPs and the Coordination Agreement are, for evaluation and assessment purposes, treated and referred to as the Plan for the Subbasin. Individually, the GSPs include the following:

- *Gravelly Ford Water District Groundwater Sustainability Plan (Gravelly Ford GSP)* – prepared by the Gravelly Ford Water District GSA.
- *Joint Groundwater Sustainability Plan (Joint GSP)* – prepared jointly by the City of Madera GSA, Madera County GSA, Madera Irrigation District GSA, and Madera Water District GSA.
- *New Stone Water District Groundwater Sustainability Agency Groundwater Sustainability Plan (New Stone GSP)* – prepared by the New Stone Water District GSA.

[1] Water Code § 10733.4(b); 23 CCR § 355.4(a)(4). https://sgma.water.ca.gov/portal/service/gspdocument/download/9363; Water Code § 10733.4(b); 23 CCR § 355.4(a)(4).
[2] Water Code § 10720 *et seq*.
[3] 23 CCR § 350 *et seq*.

- *Root Creek Water District Groundwater Sustainability Agency Groundwater Sustainability Plan (Root Creek GSP)* – prepared by the Root Creek Water District GSA.

After evaluation and assessment, Department staff conclude the GSAs have taken sufficient actions to correct deficiencies identified by the Department; however, Department staff have provided recommended corrective actions which will be required to be addressed by the Plan's next periodic evaluation.

Overall, Department staff believe the Plan contains the required components of a GSP, demonstrates a thorough understanding of the Subbasin based on what appears to be the best available science and information, sets well explained, supported, and reasonable sustainable management criteria to prevent undesirable results as defined in the Plan, and proposes a set of projects and management actions that, if successfully implemented, are likely achieve the sustainability goal defined for the Subbasin.[4] Department staff will continue to monitor and evaluate the Subbasin's progress toward achieving the sustainability goal through Annual Reports and future Periodic Evaluations of the GSP and its implementation.

Based on the reevaluation of the Plan, Department staff recommend the Plan be approved.

This assessment includes six sections:

- **Section 1 – Summary:** Provides an overview of the Department Staff's assessment and recommendations.
- **Section 2 – Evaluation Criteria:** Describes the legislative requirements and the Department's evaluation criteria.
- **Section 3 – Required Conditions:** Describes the submission requirements of a response to an incomplete determination to be evaluated by the Department.
- **Section 4 – Deficiency Evaluation:** Provides an assessment of whether and how the contents included in the GSP submittal addressed the deficiencies identified by the Department in the initial incomplete determination.
- **Section 5 – Plan Evaluation:** Provides a detailed assessment of the contents included in the GSP organized by each Subarticle outlined in the GSP Regulations.
- **Section 6 – Staff Recommendation:** Includes the staff recommendation for the Plan and any recommended corrective actions.

[4] 23 CCR § 354.24.

1 SUMMARY

Department staff recommend approval of the Plan for the Madera Subbasin and have recommended corrective actions designed to address shortcomings of the Plan described in this Staff Report. In the evaluation of the Plan, Department staff concluded that sufficient action was taken to correct the deficiencies; however, Department staff have provided recommended corrective actions which will be required to be address by the Plan's next periodic evaluation.

The GSA has identified areas for improvement of its Plan (e.g., addressing data gaps related to land subsidence and interconnected surface water, refining water budgets, incorporating new information into the numerical model, and expanding monitoring networks). Department staff concur that those items are important and recommend the GSA address them as soon as possible. As mentioned, Department staff have also identified additional recommended corrective actions that the GSA should consider for the next periodic evaluation of the Plan or sooner (see Section 6). Addressing these recommended corrective actions will be important to demonstrate, on an ongoing basis, that implementation of the Plan is likely to achieve the sustainability goal. The recommended corrective actions generally focus on the following:

1. Providing a detailed explanation specifically discussing and identifying Madera Irrigation District GSA's legal, contractual, or other authorities or arrangements to implement its obligations under the Joint GSP in the next periodic evaluation.
2. Continuing efforts to further coordinate the GSPs and groundwater management.
3. Sufficiently describing the effect of chronic lowering of groundwater level interim milestones on other sustainability indicators.
4. Reevaluating the quantitative metrics that constitute undesirable results due to land subsidence and sufficiently describing the effect and extent of land subsidence interim milestones that allow continued subsidence during the GSP implementation period.
5. Describing data gaps in the hydrogeologic conceptual model.
6. Sufficiently detailing the degraded water quality undesirable results and explaining the rationale to allow potential further degradation.

2 EVALUATION CRITERIA

The Department evaluates whether a Plan conforms to the statutory requirements of SGMA[5] and is likely to achieve the basin's sustainability goal,[6] whether evaluating a basin's first Plan,[7] a Plan previously determined incomplete,[8] an amended Plan,[9] or a GSA's periodic update to an approved Plan.[10] To achieve the sustainability goal, each version of the Plan must demonstrate that implementation will lead to sustainable groundwater management, which means the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.[11] The Department is also required to evaluate, on an ongoing basis, whether the Plan will adversely affect the ability of an adjacent basin to implement its groundwater sustainability program or achieve its sustainability goal.[12]

The Plan evaluated in this Staff Report is a revision of the 2020 Plan, which was evaluated by the Department and found to be incomplete. An incomplete Plan is one which Department staff identify as containing one or more deficiencies that preclude its initial approval. Deficiencies may result from supporting information that is insufficiently detailed or analyses that are insufficiently thorough or unreasonable, or where Department staff determine it is unlikely the GSAs in the basin could achieve the sustainability goal under the proposed Plan. After a GSA has been afforded up to 180 days to address the deficiencies and based on the GSA's efforts, the Department can either approve[13] the Plan or determine the Plan inadequate.[14]

The Department's evaluation and assessment of a revised or amended Plan, subsequent to the initial Plan being found to be incomplete, as presented in this Staff Report, continues to follow Article 6 of the GSP Regulations[15] to determine whether the Plan, with revisions or additions prepared by the GSA, complies with SGMA and substantially complies with the GSP Regulations.[16] As stated in the GSP Regulations, "substantial compliance means that the supporting information is sufficiently detailed and the analyses sufficiently thorough and reasonable, in the judgment of the Department, to evaluate the Plan, and the Department determines that any discrepancy would not materially affect the

[5] Water Code §§ 10727.2, 10727.4, 10727.6.
[6] Water Code § 10733; 23 CCR § 354.24.
[7] Water Code § 10720.7.
[8] 23 CCR § 355.2(e)(2).
[9] 23 CCR § 355.10.
[10] 23 CCR § 355.6.
[11] Water Code § 10721(v).
[12] Water Code § 10733(c).
[13] 23 CCR §§ 355.2(e)(1).
[14] 23 CCR §§ 355.2(e)(3).
[15] 23 CCR § 355 *et seq*.
[16] 23 CCR § 350 *et seq*.

ability of the Agency to achieve the sustainability goal for the basin, or the ability of the Department to evaluate the likelihood of the Plan to attain that goal."[17]

The recommendation to approve a Plan previously determined to be incomplete is based on a determination that the GSAs have taken sufficient actions (e.g., amended or revised the Plan) to correct the deficiencies previously identified by the Department that precluded earlier approval.

3 REQUIRED CONDITIONS

For a Plan that the Department determines to be incomplete, the Department identifies corrective actions to address those deficiencies that preclude approval of the Plan as initially submitted. The GSAs in a basin, whether developing a single GSP covering the basin or multiple GSPs, must attempt to address those corrective actions within the time provided, not to exceed 180 days, for the Plan to be evaluated by the Department.

3.1 INCOMPLETE RESUBMITTAL

GSP Regulations specify that the Department shall evaluate a resubmitted GSP in which the GSAs have taken corrective actions within 180 days from the date the Department issued an incomplete determination to address deficiencies.[18]

The Department issued the incomplete determination on September 22, 2022. The GSAs resubmitted their individual GSPs and the Coordination Agreement on March 21, 2023 in compliance with the 180 day deadline. However, the Madera Irrigation District GSA (MID GSA) did not adopt a resolution approving and/or adopting the Revised Joint GSP, which was prepared jointly by MID GSA, the City of Madera GSA, Madera County GSA, and Madera Water District GSA. However, MID GSA did approve the related Coordination Agreement.

MID GSA's failure to adopt the Revised Joint GSP concerned Department staff. Accordingly, on April 6, 2023, the Sustainable Groundwater Management Office sent a letter seeking clarification from MID GSA regarding its failure to adopt the Revised Joint GSP. The MID GSA responded by letter dated April 21, 2023, confirming that "the MID GSA has not and does not intend to adopt the Revised Joint GSP," stating that "MID GSA has determined the Revised Joint GSP is inadequate," and explaining that "the MID GSA cannot adopt the Revised Joint GSP without substantial revision." At the same time, the letter indicated that "[t]he lack of action on the Revised Joint GSP was not due to any intention on the part of MID GSA to avoid its implementation of the Revised Joint GSP," and vowed that "MID GSA will continue to fully implement its own obligations under the Revised Joint GSP."

[17] 23 CCR § 355.4(b).
[18] 23 CCR § 355.4(a)(4).

MID GSA's refusal to adopt the Revised Joint GSP, but its apparent intent to implement its obligations under the Revised Joint GSP, creates a level of inconsistency and uncertainty regarding Plan implementation that continues to concern staff. SGMA provides that a GSA may exercise any of the powers granted by SGMA if the GSA adopts and submits a Plan to the Department. Because of MID GSA's failure to adopt the Revised Joint GSP, it is unclear whether MID GSA has the necessary powers and authorities to implement its obligations under the Revised Joint GSP. In its previous letter, MID GSA claimed it would implement the Plan, but did not provide specific references to existing, non-SGMA authorities granting it the powers to implement the Revised Joint GSP or otherwise explaining how it retained SGMA authorities to do so, or identifying other agreements or entities that had the power and would implement those aspects of the Revised Joint GSP. Without an understanding of these issues, Department staff remain concerned that overall SGMA implementation in the Subbasin may be infeasible or delayed as a result of MID GSA's failure to adopt the Revised Joint GSP. However, Department staff do not believe this issue precludes an approval recommendation at this time, because various components of the overall Subbasin Plan have been and continue to be implemented and staff is not aware of any existing impediment or delay in implementation caused by these circumstances.

Nevertheless, MID GSA is the only GSA of which Department staff are aware that has refused to adopt a GSP that it intends to implement. This novel circumstance continues to be a concern to Department staff. To alleviate those concerns, Department staff provide a recommended corrective action requiring identification and listing of the specific projects and management actions that MID GSA will or may be responsible for implementing under the Revised Joint GSP and a parallel listing and detailed identification and discussion of the legal, contractual, or other authorities or arrangements that MID GSA is relying or will rely upon in adequately implementing the Plan including those projects or management actions to clearly demonstrate the feasibility of all projects and management actions (see Recommended Corrective Action 1) Department staff will closely monitor Plan implementation and may change its recommendation if MID GSA does not provide a satisfactory response addressing these issues in the next periodic evaluation or if it appears that MID GSA's failure to adopt the Revised Joint GSP is preventing or delaying Plan implementation or otherwise impacting the likelihood of the Subbasin to achieve sustainability consistent with SGMA timelines.

4 DEFICIENCY EVALUATION

As stated in Section 355.4 of the GSP Regulations, a basin "shall be sustainably managed within 20 years of the applicable statutory deadline consistent with the objectives of the Act." The Department's assessment is based on a number of related factors including whether the elements of a GSP were developed in the manner required by the GSP Regulations, whether the GSP was developed using appropriate data and methodologies and whether its conclusions are scientifically reasonable, and whether the GSP, through the implementation of clearly defined and technically feasible projects and management actions, is likely to achieve a tenable sustainability goal for the basin.

In its initial incomplete determination, the Department identified deficiencies in the Plan which precluded the Plan's approval in September 2022.[19] In September 2022 the GSAs were given 180 days to take corrective actions to remedy the identified deficiencies. Consistent with the GSP Regulations, Department staff have evaluated the revised 2022 Plan to determine if the GSAs have taken sufficient actions to correct the deficiencies.

4.1 DEFICIENCY 1. THE GSPS HAVE NOT SUFFICIENTLY COORDINATED ON DATA AND METHODOLOGIES INCLUDING COORDINATION OF SUSTAINABILITY GOAL, WATER BUDGET AND SUSTAINABLE YIELD, AND UNDESIRABLE RESULTS AS REQUIRED BY SGMA AND THE GSP REGULATIONS.

4.1.1 Corrective Action 1

As described in the Department's GSP Assessment Staff Report released on September 22, 2022, Department staff determined that the Subbasin's definition of an undesirable result for the chronic lowering of groundwater levels was not consistent with the requirements of SGMA. The Department provided the following corrective actions for the Subbasin to consider and address:

> *The Plan does not provide sufficient explanation to confirm that the GSPs have been developed using the same data and methodologies and that elements of the GSPs have been based upon consistent interpretations of the Subbasin's setting. The GSAs in the Subbasin should modify each of their respective GSPs, as well as any applicable coordination materials, to substantially comply with the GSP Regulations and define sustainable yield and undesirable results, and develop water budgets in a manner that addresses groundwater conditions occurring throughout the Subbasin, not for only the portion of the Subbasin represented by the respective GSPs.*

[19] *Incomplete Determination of the 2020 Groundwater Sustainability Plan for the San Joaquin Valley – Madera Subbasin*, Department of Water Resources, September 22, 2022. https://sgma.water.ca.gov/portal/service/gspdocument/download/9363

4.1.2 Evaluation

To address the identified deficiencies, the GSAs have supplemented portions of each Plan to use consistent data and methodologies. Specifically, the descriptions supporting the sustainability goal, water budgets, and undesirable results have been further detailed or revised. Most of the supplemented material is provided in the Joint GSP and Coordination Agreement and referenced by the other GSPs.

The Department's Incomplete Determination notified the GSAs that the Plan did not present a coordinated sustainability goal in the Coordination Agreement applicable to the entire Subbasin. Instead, each GSP described related, but varied sustainability goals. In response, the GSAs amended the Coordination Agreement to include a sustainability goal that all parties agree to as presented below:

> *The sustainability goal for the Madera Subbasin is to implement a package of projects and management actions that will, by 2040, balance long-term groundwater system inflows and outflows based on a 50-year period representative of average historical hydrologic conditions.*[20]

The Gravelly Ford GSP,[21] New Stone GSP,[22] and Root Creek GSP[23] still contain the varied language describing the sustainability goal that was present in the initial Plan submission; however, the language does not conflict with the overarching sustainability goal definition found in the Coordination Agreement. A detailed assessment of the sustainability goal is provided in Section 5.3.1.

The Department's Incomplete Determination also notified the GSAs that the water budgets presented in each GSP were unclear, used different data, and were difficult to assess. Additionally, the water budget along with an estimate of sustainable yield was not included in the Coordination Agreement as required. In response, the GSAs have amended the GSPs and the Coordination Agreement to include agreed upon water budgets and estimates of sustainable yield. Specifically, the GSPs now all reference historical, current, and projected water budgets[24] developed in February 2018 for the entire Madera Subbasin and developed for the seven subregions representing each GSA. This water budget information was part of the initial Joint GSP submission in 2020 but was not clearly recognized in the other GSPs at the time. A detailed assessment of the water budget is provided in Section 5.2.3.

The GSPs acknowledge that there are still refinements needed to remove discrepancies and further improve the accuracy of the water budgets. The New Stone and Root Creek resubmitted GSPs note that the availability of more specific information and knowledge on the regional scale (i.e., geography, geology, water management practices, familiarity,

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[20] Madera Subbasin Coordination Agreement, p. 34.
[21] Gravelly Ford GSP (Redlined), Section 3.1, p. 53.
[22] New Stone GSP (Redlined), Section 4.1, pp. 129-130.
[23] Root Creek GSP (Redlined), Section 4.1, pp. 184-185.
[24] Joint GSP (Resubmitted), Appendix 2.F, pp. 1322-1620; Appendix 6.D, pp. 2012-3335.

and understanding)[25] have been discussed amongst the GSAs and updates to the model will occur during the 2025 evaluation cycle.[26] Department staff encourage these efforts and also recommend the GSAs continue productive coordination and refinement of each GSP to be a cohesive Plan for sustainable groundwater management in the Subbasin (see Recommended Corrective Action 2).

4.1.3 Conclusion

Overall, Department staff believe the GSAs have taken sufficient action to address the identified deficiencies. Staff conclude that the enhanced coordination and addition of a coordinated sustainability goal and water budget with agreed upon estimates of sustainable yield for the Subbasin allows the GSAs to manage the Subbasin as intended by SGMA. However, as highlighted in the recommended corrective actions, the GSP should continue efforts to increase cooperative coordination and alignment of each GSP by the next periodic evaluation. The Plan also provides an agreed upon definition of undesirable results occurring in the Subbasin, which is discussed in Section 4.2.2.1.

4.2 Deficiency 2. The Plan does not establish minimum thresholds for chronic lowering of groundwater levels in a manner substantially compliant with the GSP Regulations.

4.2.1 Corrective Action 2

As described in the Department's GSP Assessment Staff Report released on September 22, 2022, Department staff determined that the GSAs must provide more detailed explanation and justification regarding the selection of the sustainable management criteria for groundwater levels, particularly the undesirable results, the minimum thresholds, and the effects of those criteria on the interests of beneficial uses and users of groundwater. The Department provided the following corrective actions for the Subbasin to consider and address:

1. The GSAs should describe the specific undesirable results they aim to avoid through implementing the Plan. If, for example, significant and unreasonable impacts to domestic wells are a primary management concern for the Subbasin, then the GSAs should sufficiently explain why that effect was selected and what level of impact(s) to those wells the GSAs consider to be significant and unreasonable. In support of its explanation, the GSPs should also clearly discuss and disclose the anticipated impact of operating the Subbasin at conditions protective against those effects on users of domestic wells and all other beneficial uses and users of groundwater in the Subbasin. The discussion should be supported using best available information, such as using State or county information on well completion reports and dry well reports, to analyze the

[25] New Stone GSP (Redlined), Section 3.3, p. 106; Root Creek GSP (Redlined), Section 3.3.3, p. 180.
[26] New Stone GSP (Redlined), Section 3.3.1, p. 107.

locations and quantities of domestic wells and other types of well infrastructure that could be impacted by groundwater management when implementing the Plan.

2. The GSAs should either explain how the existing minimum threshold groundwater levels are consistent with avoiding undesirable results or they should establish minimum thresholds at the representative monitoring wells that account for the specific undesirable results the GSAs aim to avoid. The Plan should include a detailed description of the factors and information considered and the analytic route and rationale the GSAs employed to reach conclusions regarding significant and unreasonable effects constituting undesirable results for groundwater levels and other applicable sustainability indicators.

3. The GSAs need to provide a description of the relationship between established minimum thresholds for all applicable sustainability indicators including how conditions at minimum thresholds avoid undesirable results for each applicable indicator.

4.2.2 Evaluation

To address the identified deficiencies, the GSAs have supplemented portions of the Plan related to the sustainable management criteria for chronic lowering of groundwater levels. Specifically, descriptions supporting the undesirable result, minimum thresholds, measurable objectives, interim milestones, and a domestic well mitigation program have been further detailed or revised. Most of the supplemented material is provided in the Joint GSP and referenced by the other GSPs.

4.2.2.1 Describing Undesirable Results and Potential Effects (1)

The Department's Incomplete Determination notified the GSAs that the Plan incorrectly established undesirable results which were applicable only within each GSP area—without agreement between GSPs—and some of the information provided in each GSP was insufficiently detailed.

In response to the corrective action, the GSAs coordinated to develop agreed-upon undesirable results applicable to the entire Subbasin. The GSPs reference information in the Joint GSP as a basis for developing undesirable results, particularly coordinating on defining when an undesirable result will occur (i.e., the quantitative description of minimum threshold exceedances that cause significant and unreasonable effects). In describing undesirable results, each GSP provides a different level of detail. For example, the Joint GSP describes an undesirable result as "those conditions that: 1) Cause significant financial burden to local agricultural interests or other beneficial uses and users who rely on the Subbasin's groundwater resources, 2) Cause groundwater level conditions at private domestic wells that cannot be mitigated, and 3) Interfere with other sustainability indicators." [27] The Gravelly Ford GSP refers to this information but also, alongside the New Stone GSP and the Root Creek GSP, provides additional description

[27] Joint GSP (Redlined), Section 3.4.1, p. 323.

such as: “Chronic lowering of groundwater levels in the Plan area cause significant and unreasonable declines if they are sufficient in magnitude to lower the rate of production of pre-existing groundwater wells below that necessary to meet the minimum required to support overlying beneficial use where alternative means of obtaining sufficient groundwater resources are not technically or financially feasible.”[28] The varied descriptions presented in each GSP do not conflict and appear to be generally coordinated. All GSPs refer to a domestic well mitigation framework which provides more specific information describing effects on beneficial uses and users.[29]

The Plan states that an undesirable result would occur when “… more than 30 percent of RMS in the Subbasin (including RMS in all four GSP plan areas) [are] exceeding their [minimum thresholds] for the same two consecutive Fall readings.”[30] The Plan further describes that “…implementation of the GSP is designed to avoid undesirable results during the sustainability period (i.e., the “planning and implementation horizon,” per CWC §10721(v)), after 2040.”[31]

As mentioned, the Plan describes details for a domestic well mitigation program,[32] which the GSAs will implement to provide assistance to domestic and municipal wells adversely impacted by declining groundwater levels that have occurred since 2015.[33] The Plan includes supporting information for the mitigation program which document the expected location and quantity of domestic wells that will experience undesirable results during the GSP implementation period. Staff believe the details provided for this framework effectively describe the specific undesirable results the GSAs are trying to avoid. Based on an analysis of 4,822 wells, the GSP documents that up to 1,294 wells,[34] located primarily in the central and eastern portion of the Subbasin,[35] would be impacted due to future modeled groundwater conditions. The total cost to assist impacted wells is estimated to be approximately $39,000,000; however, the Plan describes that the cost of mitigating domestic wells due to lowering groundwater levels is shown to be economically preferable to the costs associated with immediately stabilizing groundwater levels and the resulting impact to the local economy.[36] The GSAs have provided a commitment to this program including a schedule, timeline, and have reported progress in recent Annual Reports. The GSAs expect that the program would be implemented during the GSP

[28] Gravelly Ford GSP (Redlined), Section 3.4.1, p. 60; New Stone GSP (Redlined), Section 4.2.1.1, p. 131; Root Creek GSP (Redlined), Section 4.2.1, p. 186.
[29] Joint GSP (Redlined), Section 3.3.1.1, pp. 294-295; Gravelly Ford GSP (Redlined), Section 3.4.1, p. 60; New Stone GSP (Redlined), Section 4.2.1.2, pp. 132-133; Root Creek GSP (Redlined), Section 4.2.1.1, pp. 187-188.
[30] Joint GSP (Redlined), Section 3.4.1, p. 323.
[31] Joint GSP (Redlined), Section 3.4.1, p. 323.
[32] Joint GSP (Resubmitted), Appendix 3.E, pp. 1904-1918, Appendix 2.G, pp. 1733-1813.
[33] Joint GSP (Redlined), Section 3.3.1.1, p. 294.
[34] Joint GSP (Resubmitted), Appendix 2.G, p. 1762.
[35] Joint GSP (Resubmitted), Appendix 2.G, pp. 1783-1787.
[36] Joint GSP (Resubmitted), Appendix 3.D, p. 1902.

implementation period, no later than 2025; as of March 2023, the GSP states, the GSAs are continuing to develop the program's eligibility criteria and terms.[37]

In addition to the domestic well mitigation program, the Plan includes a suite of over 25 projects and management actions (e.g., demand management, increased recharge, increased surface water supply) which will be utilized to meet interim milestones and bring groundwater levels back up to minimum thresholds, mitigate overdraft, and operate the Subbasin sustainably. At full implementation, by 2040, the projects and actions will provide 215,840 acre-feet per year of annual gross benefit. The estimated capital cost of the projects is over $260,000,000, with an estimated annual operating cost of over $70,000,000; Department staff note that the GSAs have included an estimated economic cost from reduced crop production resulting from demand management in the estimated annual operating cost, which is approximately $54,000,000 per year or over 75% of the total annual cost provided.[38] The implementation schedule and expected benefit of each project was also considered in the modeling scenario used to develop interim milestones.[39] A review of the Annual Reports submitted to the Department shows progress on many of the projects.[40] For example, the GSAs report a cumulative total benefit of over 63,000 acre--feet from projects and management actions to date, with a benefit of 7,300 acre-feet for the latest reported water year.[41] With reporting of active progress toward project implementation, Department staff have increased confidence in the likelihood of the Plan to achieve the sustainability goal of the Subbasin.

Based on the information provided, Department staff think the Plan provides a reasonable description of the potential effects of undesirable results due to lowering of groundwater levels to domestic wells, generally the shallowest wells, and encourage the GSAs to continue development of the domestic well mitigation program and provide progress updates in Annual Reports. The GSAs should continue to progress projects and provide updates of observed benefits to the Department in Annual Reports. Department staff conclude that defining agreed upon undesirable results for the Subbasin and describing the potential effects of planned undesirable results that are likely to occur has sufficiently addressed component 1 of the corrective action.

4.2.2.2 Establishing Minimum Thresholds, Measurable Objectives, and Interim Milestones (2)

The Department's Incomplete Determination notified the GSAs that each Plan's varied descriptions and methods to establish minimum thresholds for chronic lowering of groundwater levels were not provided with sufficient supporting information to allow Department staff to evaluate whether the criteria were reasonable or whether operating

[37] Joint GSP (Redlined), Section 3.3.1.1, p. 295.
[38] Joint GSP (Redlined), Table 4-3, p. 366; Section 4.4.4.5, p. 409.
[39] Joint GSP (Redlined), Section 3.2.1.2, p. 270; Joint GSP, Appendix 6.D, pp. 2323-2326.
[40] Madera Subbasin Annual Reports, https://sgma.water.ca.gov/portal/gspar/submitted.
[41] Joint GSP Water Year 2022 Annual Report, pp. 57-58.

the Subbasin to avoid those thresholds is consistent with avoiding undesirable results—in part due to undesirable results being insufficiently defined in the Plan.

In response to the corrective action, the GSAs revised the chronic lowering of groundwater levels minimum thresholds to be set at the fall 2015 groundwater level measurement recorded at each representative monitoring site.[42] The Plan explains that the groundwater level minimum thresholds based on fall 2015 groundwater levels are consistent with the avoidance of significant and unreasonable impacts to other sustainability indicators.[43] The Plan states that the minimum thresholds will keep groundwater elevations generally above levels that have been experienced in the past, and that impacts to shallow well users and other beneficial users of groundwater will generally not exceed what has historically been experienced in the Subbasin.[44] Furthermore, the Plan explains that minimum thresholds established at fall 2015 groundwater levels are consistent with the avoidance of significant and unreasonable impacts for subsidence, water quality, and depletions of interconnected surface water.[45] The measurable objectives were revised to the fall 2010 groundwater levels which represents Subbasin conditions prior to the 2012 to 2015 drought period.[46]

Department staff believe that establishing minimum thresholds at the fall 2015 groundwater level is a reasonable approach. However, the GSAs intend to allow continued groundwater level declines during the 20-year implementation period based on the GSP's proposed interim milestones. The process to establish interim milestones is described as a "review and evaluation of measured groundwater level data and future projected fluctuations in groundwater levels during the GSP implementation period utilizing the numerical groundwater flow model, which simulated implementation of projects and management actions."[47] As a result, interim milestones were set to levels below minimum thresholds in years 2025, 2030, and 2035, prior to recovering by 2040 due to the implementation of projects and management actions.[48] Interim milestones for 2030 are the lowest groundwater elevations expected to occur during the GSP implementation period. When examining the hydrographs provided, Department staff note the 2030 milestones are frequently below historical lows.[49]

To successfully implement such a management program, GSAs are required to fully and thoroughly describe undesirable results that may occur prior to achieving sustainability, implement necessary projects and management actions to eliminate those undesirable results, and show measurable progress in annual reporting. The GSP provides information detailing how the proposed management of lowering groundwater levels

[42] Joint GSP (Redlined), Section 3.3.1, p. 293.
[43] Joint GSP (Redlined), Section 3.3.1.4, pp. 301-303.
[44] Joint GSP (Redlined), Section 3.3.1, pp. 293-294.
[45] Joint GSP (Redlined), Section 3.3.1.4, pp. 302-303.
[46] Joint GSP (Redlined), Section 3.2.1.1, pp. 269-270.
[47] Joint GSP (Redlined), Section 3.2.1.2, p. 270.
[48] Joint GSP (Redlined), Section 3.2.1.3, p. 271.
[49] Joint GSP (Resubmitted), Appendix 2.E.b, pp. 1243-1380; Gravelly Ford GSP (Redlined), Appendix G, pp. 218-224.

below minimum thresholds for an extended period will affect the interests of beneficial uses and users of groundwater in the Subbasin. As discussed above, during the period when interim milestones exceed minimum thresholds, the GSAs plan to implement a domestic well mitigation program to assist impacted users that effectively manages the effects of the undesirable results that are expected to occur; also, the Plan includes a suite of over 25 projects and management actions which the GSAs have reported progress on implementing in recent Annual Reports.

Based on a review of the information found in the resubmitted Plan and Annual Reports, Department staff conclude that at this time the GSAs have sufficiently addressed component 2 of the corrective action.

4.2.2.3 Describing How Minimum Thresholds Avoid Undesirable Results For Other Sustainability Indicators (3)

The Department's Incomplete Determination notified the GSAs that the GSPs require a description of how conditions at minimum thresholds avoid undesirable results for each applicable indicator.

In response to the corrective action, the GSAs revised the GSPs to include a discussion of the relationship between established minimum thresholds and undesirable results for other sustainability indicators. However, the GSP Regulations require the Department to evaluate whether the minimum thresholds and interim milestones are reasonable[50] and established in a manner to avoid undesirable results for each of the other sustainability indicators.[51] Department staff believe the lower interim milestones have the potential to cause undesirable results related to land subsidence, water quality, and interconnected surface water in the Subbasin. For example, the highest annual rate of subsidence was recorded between December 2012 and July 2014, when groundwater levels were declining to historical lows.[52] The GSAs should consider and disclose their understanding of the correlation between the declining groundwater levels and the maximum historical rate of subsidence while also describing the relationships between groundwater levels and the other applicable sustainability indicators. Department staff are concerned that impacts on other indicators (such as subsidence and water quality) may not recover in the same manner that groundwater levels may. Therefore, the GSAs should analyze how the groundwater levels at interim milestones will avoid causing undesirable results for other sustainability indicators (see Recommended Corrective Action 3).

Based on a review of the information found in the resubmitted Plan, Department staff conclude that the GSAs have taken sufficient action to address component 3 of the corrective action.

[50] 23 CCR § 355.4(b)(1).
[51] 23 CCR § 354.28(b)(2).
[52] New Stone GSP (Redlined), Section 3.2.6.1, p. 99.

4.2.3 Conclusion

At this time, Department staff believe the GSAs have taken sufficient action to address the deficiency identified. Department staff believe that having all the GSPs coordinated and establishing minimum thresholds at 2015 groundwater levels – in conjunction with the implementation of a well mitigation program and the projects and managements actions outlined in the Plan – to be a reasonable means of mitigating overdraft to achieve sustainability by 2040. However, Department staff note the GSAs intend to continue overdraft before 2040 based on the revised interim milestones, which after examining the hydrographs provided, are frequently below historical lows.[53] While SGMA and the GSP Regulations do not preclude undesirable results from occurring during Plan implementation, undesirable results cannot remain or continue after 20 years of Plan implementation. Department staff encourage the GSAs to continue with planning and implementation of the domestic well mitigation program to assist those users and uses of groundwater and other sustainability indicators (e.g., land subsidence, water quality, or interconnected surface water) that may be affected by lowering groundwater levels. The recommended corrective actions should also be considered by the next Periodic Evaluation for further advancement of the sustainable groundwater management in the Subbasin.

4.3 Deficiency 3. The Plan does not develop sustainable management criteria for land subsidence based on best available information and science.

4.3.1 Corrective Action 3

As described in the Department's GSP Assessment Staff Report released on September 22, 2022, Department staff determined that the GSAs do not sufficiently demonstrate that undesirable results related to land subsidence are not present and are not likely to occur in the Subbasin. The Department provided the following corrective actions for the Subbasin to consider and address the following:

1. Clarify and address the currently conflicting information in the Plan regarding what is known, qualified by the level of associated uncertainty, about the existence and impact of land subsidence.

2. The GSP should develop sustainable management criteria based on information in the basin setting and establish a monitoring network to adequately monitor conditions.[54] The basin setting should sufficiently detail the physical setting and characteristics of the Subbasin including descriptions of principal aquifers. the definable bottom of the Subbasin and identify data gaps and uncertainty within the

[53] Joint GSP (Resubmitted), Appendix 2.E.b, pp. 1243-1380; Gravelly Ford GSP (Redlined), Appendix G, pp. 218-224, New Stone GSP (Redlined), Figures 4-2 through 4-7, pp. 145-150; Root Creek GSP (Redlined), Figures 4-2 through 4-7, pp. 196-201.
[54] 23 CCR § 354.26.

hydrogeologic conceptual model. If applicable, data gaps monitoring and steps to fill data gaps before the next periodic assessment should be described.

4.3.2 Evaluation

To address the identified deficiency, the GSAs have supplemented portions of each Plan to develop sustainable management criteria and monitoring for land subsidence. Most of the supplemented material is provided in the Joint GSP and referenced by the other GSPs.

4.3.2.1 Clarifying Conflicting Information in the Plan (1)

The Department's Incomplete Determination notified the GSAs that the GSPs provided conflicting information related to whether significant and unreasonable land subsidence has occurred or will occur in the Subbasin.

In response to the corrective action, the GSPs acknowledge that significant and unreasonable land subsidence has historically occurred during periods with groundwater pumping in excess of the sustainable yield in areas where critical infrastructure exists and in the western areas that overlay the Lower Aquifer, where the Corcoran Clay exists.[55] Additionally, loss of groundwater storage and associated reduction in pore pressures in clay layers in the Lower Aquifer (indicated by lowering groundwater levels) is understood by all parties to lead to conditions that cause or exacerbate land subsidence.[56] Between 1926 and 1972, subsidence resulted in up to 4.0 feet of elevation change within the western portion of the Subbasin.[57] The highest rate of subsidence, also in western portion of the Subbasin, was 0.60 feet per year from December 2012 through July 2014.[58] The Plan also provides various maps documenting the location and extent of subsidence in the Subbasin.[59]

The Plan provides information about infrastructure that is susceptible to subsidence. Specifically, the Joint GSP provides an infrastructure sensitivity assessment of critical infrastructure including roads, railroads, highways, waterways, surface water conveyance structures, agricultural wells, domestic wells, public supply wells, and wastewater infrastructure. The assessment discusses impacts or interference with surface land uses and includes details such as proximity, orientation, and relative vulnerability to adverse effects of land subsidence.[60] Generally, the assessment states that the critical infrastructure were not anticipated to be impacted by future subsidence rates. For example, the GSP identifies the Chowchilla Bypass and the Eastside Bypass as critical infrastructure overlaying the Corcoran Clay, near an area of past documented subsidence; based on annual average subsidence rates from 2011 to 2017, the design profile and freeboard of the bypass will not be impacted by residual subsidence through

[55] Joint GSP (Redlined), Section 3.4.3, p. 325.
[56] Joint GSP (Redlined), Section 3.3.3.7, p. 313.
[57] Gravelly Ford GSP (Redlined), Section 2.2.2, p. 41.
[58] New Stone GSP (Redlined), Section 3.2.6.1, p. 99.
[59] New Stone GSP (Redlined), Figures 3-23 and 3-24, pp. 101-102.
[60] Joint GSP (Resubmitted), Appendix 3.G, pp. 1921-1953.

2026.[61] Additionally, for impacted wells, such as domestic wells, well owners are to be assisted by the domestic well mitigation program.[62] The GSP also states the GSAs are analyzing the potential to couple implementation efforts with the Subsidence Control Measures Agreement that is currently in effect in parts of the Chowchilla Subbasin near the Subbasin boundary.[63]

Based on a review of the information found in the resubmitted Plan, Department staff conclude that the GSAs have addressed component 1 of the corrective action.

4.3.2.2 Developing Sustainable Management Criteria and Monitoring Network (2)

The Department's Incomplete Determination notified the GSAs that the GSPs do not sufficiently demonstrate that undesirable results related to land subsidence are not present and are not likely to occur in the Subbasin.

In response to the corrective action, the GSPs establish revised, coordinated sustainable management criteria for the Subbasin to not allow subsidence once sustainability is achieved in 2040. With that the GSPs amended the minimum thresholds to 0 feet per year (ft/yr).[64] The Plan also identifies a total uncertainty of subsidence to be -0.16 ft/yr, meaning any amount of subsidence less than -0.16 ft/yr would be considered within the uncertainty of measurement and considered 0 ft/yr.[65] The Plan states that this minimum threshold is consistent with the sustainable management criteria for groundwater levels which seeks to keep levels above 2015 conditions by 2040.[66] The GSAs also revised the measurable objective rate to 0 ft/yr.[67] The Plan allows for minimum threshold exceedances throughout the duration of the implementation phase with the proposed interim milestones, which were revised based on two areas: areas of subsidence monitoring and areas of greater subsidence concern.[68] For areas of monitoring, interim milestones are established at -0.20 ft/yr by 2025, -0.13 ft/yr by 2030, -0.07 ft/yr by 2035, and 0 ft/yr by 2040 which are monitored by three survey benchmarks and one continuous GPS station. For areas of concern, interim milestones are established at -0.60 ft/yr by 2025, -0.40 ft/yr by 2030, -0.20 ft/yr by 2035, and 0 ft/yr by 2040 and monitored at three survey benchmarks. The established interim milestones are based on observed data with the highest rates (i.e., milestones to 2025) being slightly higher than actual subsidence rates experienced in the Subbasin between 2011 and 2016.[69] The Plan defines an undesirable result as occurring when "… the average subsidence across 75 percent or

[61] Joint GSP (Resubmitted), Appendix 3.G, p. 1932.
[62] Joint GSP (Resubmitted), Appendix 3.G, p. 1935.
[63] Joint GSP (Resubmitted), Appendix 3.G, p. 1933; Joint GSP (Redlined) Section 3.3.3.7, p. 312.
[64] Joint GSP (Redlined), Section 3.3.3, pp. 310-314.
[65] Joint GSP (Redlined), Section 3.3.3.1, p. 311.
[66] Joint GSP (Redlined), Section 3.3.1.4, p. 301.
[67] Joint GSP (Redlined), Section 3.2.3.1, p. 279.
[68] Joint GSP (Redlined), Section 3.2.3.2, pp. 279-280.
[69] Joint GSP (Redlined), Section 3.2.3.2, p. 280.

more RMS in the Subbasin (including RMS in all four GSP plan areas) exceeds the minimum threshold for two consecutive years."[70]

Department staff have identified areas for improvement in the GSAs' defined undesirable results. Specifically, the quantification of conditions that likely would cause undesirable results as when more than 75 percent of the representative monitoring sites in the Subbasin exceed threshold levels for two consecutive years is unsatisfactory, because the Plan does not explain how this threshold would avoid effects the GSAs have determined to be significant and unreasonable. On the contrary, the values and timing of exceedances appear to be arbitrary. Subsidence is prominent and likely to occur in western portions of the Subbasin in correlation with the presence of the Corcoran Clay. Two of the seven representative monitoring sites are located in that area of the Subbasin; using the current definition, localized subsidence could occur indefinitely without meeting the quantitative criteria for an undesirable result. Furthermore, when considering land subsidence, compacted sediments may not rebound alongside rising groundwater levels due to irreversible changes in the subsurface. Additionally, the Plan establishes two subsidence areas, as mentioned above, which the GSAs do not consider when establishing the quantitative metrics for an undesirable result (i.e., Department staff would expect more stringent metrics in the areas of greater subsidence concern as compared to the subsidence monitoring areas). These criteria should be considered when defining when and where undesirable results occur (see Recommended Corrective Action 4a)

While Department staff are encouraged by the updated sustainable management criteria, the Plan still does not identify a total (i.e., cumulative) amount of subsidence which would be considered significant and unreasonable. The interim milestones established using annual rates would allow for up to 6.5 feet of total subsidence by 2040. This appears inconsistent with the legislative intent of SGMA to avoid or minimize subsidence, and no adequate justification for allowing this amount of additional subsidence is provided in the GSP.[71] Considering the Subbasin has recently experienced subsidence and contains infrastructure that the GSP identifies as susceptible to subsidence, the GSAs should identify and disclose the cumulative amount of subsidence that can occur without causing significant and unreasonable impacts to the beneficial uses and users of groundwater, surface land uses, and property interests, all of which must be clearly defined. In establishing the cumulative amount of potential subsidence that could occur during GSP implementation, the GSAs should consider the conditions necessary to minimize or halt subsidence during GSP implementation and maintain those conditions once sustainability has been achieved on or before 2040. Based on the amount of subsidence anticipated between now and 2025, Department staff believe this does not preclude approval at this time. However, given that the Plan projects minimum threshold exceedances during implementation, which may likely result in undesirable results related to water levels, and the Plan intends for subsidence to be 0 ft/yr only by and after 2040, Department staff

[70] Joint GSP (Redlined), Section 3.4.3, p. 325.
[71] Water Code § 10720.1 (e).

recommend identifying and including a quantitative value for cumulative subsidence for minimum thresholds and other sustainability criteria related to subsidence by the first Periodic Evaluation (see Recommended Corrective Action 4b).

SGMA and the GSP Regulations indicate that for a basin to be sustainably managed, the basin must experience no undesirable results within 20 years of plan implementation and then throughout the planning and implementation horizon. Unlike other indicators, the legislature specifically indicated its intent that SGMA implementation avoid or minimize subsidence.[72] Unlike groundwater levels that may fall and then rise in a basin, subsidence can often be inelastic and permanent. This means that undesirable results from subsidence during plan implementation will likely still exist and persist to 2040 and beyond. For instance, subsidence that occurs during early Plan implementation that causes lasting impacts to infrastructure, like flood control structures, that substantially interferes with the infrastructure's operations and utility in 2040 and beyond, constitutes an undesirable result under SGMA. Department staff believe that the Plan's continued allowance of minimum threshold exceedances during the first 20 years of plan implementation (i.e., allowing further subsidence as a result of water level declines below historic lows at the interim milestones) and potential permanent impacts to surface infrastructure and uses is not consistent with the intent of SGMA to achieve sustainability and to avoid or minimize subsidence. The Plan should consider and provide details describing the current and potentially lasting impacts of subsidence on land uses and groundwater beneficial uses and users as described above in Recommended Corrective Action 4b.

The GSP Regulations require the Department to evaluate whether the minimum thresholds and interim milestones are reasonable[73] and established in a manner to avoid undesirable results for each of the other sustainability indicators.[74] Department staff believe the interim milestones below the minimum threshold have the potential to cause undesirable results related to other sustainability indicators which the GSAs also have a responsibility to avoid. For example, the Plan does not provide a discussion of how the subsidence milestones, that allow for continued subsidence and associated irreversible compaction of aquifer materials, relate to the reduction of groundwater storage or the degradation of water quality sustainability indicators. The GSAs should consider and disclose their understanding of this and other relationships between sustainability indicators. The GSAs should analyze whether or how the land subsidence rates at interim milestones will avoid causing undesirable results for other sustainability indicators (see Recommend Corrective Action 4c).

In the establishment of the minimum thresholds for land subsidence, the Plan describes the application of a level of uncertainty to measurements, claiming that the survey measurements have a vertical accuracy of plus or minus 2.5 centimeters. The Plan

[72] Water Code § 10720.1(e).
[73] 23 CCR § 355.4(b)(1).
[74] 23 CCR § 354.28(b)(2).

proposes adding these uncertainty values so that when two measurements are taken the Agencies consider the total uncertainty in subsidence to be 5 centimeters, which equals approximately -0.16 ft/yr. By this rationale, the Plan assumes that subsidence values less than 0.16 ft/yr are within the uncertainty of measurement and considered to be compliant with the minimum threshold of 0 ft/yr.[75] However, although there may be some uncertainty in subsidence measurements, the uncertainty does not necessarily mean that small measurements of subsidence within that range of uncertainty (or accuracy) should be ignored or mean that no subsidence is occurring. Department staff believe this approach of always rounding any annual subsidence measurements within the range of error to zero every year is inconsistent with standard practices. When multiple measurements are taken at the same location, they are compared to the same baseline measurement and, in turn, have the same single level of uncertainty. While it's understandable to build in an allowance for some level of uncertainty, it appears the Plan allows for the continued subsidence if the measured rate is equal to or less than 0.16 ft/yr. Department staff recommend the Plan revise its application of the level of uncertainty as it relates to subsidence measurements according to standard professional practices (see Recommended Corrective Action 4d).

The Plan acknowledges there are data gaps in assessing subsidence in the Subbasin and provides a workplan[76] which aims to provide sufficient data and analysis to fill data gaps, including enhancing monitoring and understanding relationships between land subsidence and groundwater levels at different depths within the western part of the Subbasin, improving quantification of groundwater pumping within Upper Aquifer and Lower Aquifer, and assessing the adequacy of the sustainable management criteria. Considering the Department provides quarterly updates for monthly InSAR subsidence data covering much of the Subbasin, the GSP should address or explain why the GSAs have decided to not utilize this reliable data source to assess whether management is causing significant and unreasonable effects to surface land uses. Department staff encourage these efforts and also recommend the GSAs take steps to address the recommended corrective actions by the next Periodic Evaluation of the Plan.

Based on a review of the information found in the resubmitted Plan, Department staff conclude that the GSAs have addressed component 2 of the corrective action.

4.3.3 Conclusion

Overall, Department staff believe the GSAs have taken sufficient action to address the deficiency identified. Staff conclude that the zero tolerance for land subsidence minimum thresholds and measurable objectives at the end of the implementation period in 2040 is commensurate with the understanding of SGMA. However, Department staff are concerned with the amount of subsidence that may occur during the implementation period and the potential undesirable results that may cause as a result of permanent impacts to infrastructure and surface land uses. The recommended corrective actions

[75] Joint GSP (Redlined), Section 3.3.3.1, p. 311.
[76] Joint GSP (Resubmitted), Appendix 3.H, pp. 1954-1968.

should be considered by the next Periodic Evaluation to more align with the intent of SGMA to avoid or minimize subsidence.

4.4 Deficiency 4. The Plan does not develop sustainable management criteria for the depletions of interconnected surface water based on best available information and science.

4.4.1 Corrective Action 4

As described in the Department's GSP Assessment Staff Report released on September 22, 2022, Department staff determined that the GSAs do not sufficiently demonstrate that interconnected surface water or undesirable results related to depletions of interconnected surface water are not present and are not likely to occur in the Subbasin. The Department provided the following corrective actions for the Subbasin to consider and address the following:

1. Clarify and address the currently conflicting information in the Plan regarding what is known, qualified by the level of associated uncertainty, about the presence and degree of interconnected surface water and, if applicable, the depletion of that interconnected surface water by groundwater use, including quantities, timing, and locations.[77]

2. If the GSAs cannot provide a sufficient, evidence-based justification for the absence of interconnected surface water, then they should develop sustainable management criteria, as required in the GSP Regulations[78] based on best available information and science. Evaluate and disclose, sufficiently and thoroughly, the potential effects of the Plan's sustainable management criteria for depletion of interconnected surface water on beneficial uses of the interconnected surface water and on groundwater uses and users. Additionally, development of sustainable management criteria must be supported by information in the basin setting and the GSAs must develop a monitoring network capable of collecting sufficient data to support analysis of the quantified spatial and temporal exchanges between surface water and groundwater that can be associated with groundwater pumping.

4.4.2 Evaluation

To address the identified deficiency, the GSAs have supplemented portions of the Plan to describe the basin setting, develop sustainable management criteria and monitoring for depletions of interconnected surface water.

4.4.2.1 Clarifying Conflicting Information in the Plan (1)

The Department's Incomplete Determination notified the GSAs that the GSPs provided conflicting information related to identifying the presence of interconnected surface water in the Subbasin.

[77] 23 CCR §§ 354.28(c)(6)(A-B).
[78] 23 CCR §§ 354.26, 354.28, 354.30.

In response to the corrective action, the GSPs revised the descriptions of groundwater—surface water interactions in the Subbasin, acknowledging that data indicates that the San Joaquin River appears to be in connection with groundwater during some periods and there is at least some potential for regional groundwater pumping to impact groundwater dependent ecosystems (GDEs) with roots extending down 20 to 30 feet along the San Joaquin River.[79]

The method the GSP used to determine the connectivity was to compare the historical regional aquifer groundwater elevations to stream thalweg (deepest portion of stream channel) elevations and assess stream seepage. The comparison of the groundwater levels and stream thalweg suggest the San Joaquin River was likely connected with groundwater from 1958 through 1984, but groundwater was about 10 to 50 feet below the thalweg from 1989 through 2016.[80] While this approach is sufficient to confirm the presence of a hydraulic connection, Department staff note groundwater levels dropping below the thalweg of the San Joaquin River would not be sufficient to prove surface water and groundwater are disconnected. This is because water from the river is still recharging the aquifer and may do so at a rate that would cause mounding in the local water table surrounding the river. The mounding in the water table may enable the river and aquifer to maintain a saturated hydraulic connection when groundwater levels drop well below the bottom of the river. Additionally, stream seepage indicates that during above normal and wet years, such as 2017 and 2019, groundwater is discharged to streams.[81] The GSP states that there are data gaps, and provides a workplan[82] which aims to provide sufficient data and analysis to fill data gaps, including making a more informed determination of whether or not interconnected surface water is present along the San Joaquin River, improving understanding of the relationship between streamflow and regional groundwater pumping, and providing an improved basis for setting sustainable management criteria if it is determined that interconnected surface water conditions exist.[83] At this time, Department staff conclude sufficient action has been taken on this deficiency and believe the GSAs can work with the Department to further efforts on interconnected surface water.

Based on a review of the information found in the resubmitted Plan, Department staff conclude that the GSAs have addressed component 1 of the corrective action.

4.4.2.2 Sustainable Management Criteria and Monitoring Network (2)

The Department's Incomplete Determination notified the GSAs that the GSPs do not sufficiently demonstrate that undesirable results related to depletions of interconnected surface water are not present and are not likely to occur in the Subbasin. Therefore, if the GSAs cannot provide a sufficient, evidence-based justification for the absence of

[79] Joint GSP (Redlined), Section 2.2.2.5, p. 120.
[80] Joint GSP (Redlined), Section 2.2.2.4, p. 118.
[81] Joint GSP (Resubmitted), Figure 2-76, p. 310.
[82] Joint GSP (Resubmitted), Appendix 3.I, pp. 1969-1981
[83] Joint GSP (Resubmitted), Appendix 3.I, p. 1971.

interconnected surface water, then they should develop sustainable management criteria, as required in the GSP Regulations.

In response to the corrective action, the GSPs established interim sustainable management criteria for depletions of interconnected surface water along the San Joaquin River. Specifically, the GSAs define an undesirable result occurring when greater than 30 percent of representative monitoring wells exceed their minimum thresholds for two consecutive five-year rolling averages.[84] Minimum thresholds are defined as the percent of time surface water and groundwater was connected over the historical period of 1989 to 2015. Measurable objectives and interim milestones are the same as minimum thresholds. Monitoring will be conducted annually using three monitoring sites.

The GSAs used a metric called "percent of time connected" to develop the interim sustainable management criteria for depletion of interconnected surface water.[85] In reviewing the information provided in the GSP, Department staff conclude that while developing sustainable management criteria for interconnected surface water is a substantial step forward in addressing the deficiency, the development of sustainable management criteria in the Plan is not consistent with the GSP Regulations. Reporting the percent of time connected does not provide adequate information to describe or evaluate the quantity and timing of depletions of interconnected surface water due to groundwater use, as required by the GSP Regulations.[86] As mentioned in Section 4.4.2.1, the GSAs prepared a work plan outlining an approach to fill these data gaps.[87] The work plan states the GSAs intend to compile and review pertinent existing data and reports, construct and install new monitoring facilities, collect additional field data, and conduct additional technical analysis. The purpose is to make a more informed determination of whether interconnected surface water is present along the San Joaquin River, to improve understanding of the relationships between streamflow, shallow groundwater levels, and regional groundwater pumping.[88] While the work plan states that the GSAs will potentially refine or modify the interim sustainable management criteria, it also indicates that the GSAs will continue using the metric of "percent of time connected" for sustainable management criteria[89] – a metric Department staff conclude is not appropriate in estimating timing and volume of interconnected surface water depletion and evaluating potential impacts to beneficial uses and users. The GSAs proposed to complete most of the tasks in the work plan by 2024 with the intent of including the early results in the first Periodic Evaluation.[90] Department staff are encouraged by the GSA's intent to increase data collection and fieldwork. At this time, Department staff conclude sufficient action has

[84] Joint GSP (Redlined), Section 3.4.5, p. 327.
[85] Joint GSP (Redlined), Section 3.2.5.1, p. 291, Section 3.3.5.1, p. 319.
[86] 23 CCR §§ 354.28(c)(6)(A), 354.28(c)(6)(B).
[87] Joint GSP (Resubmitted), Appendix 3.I, pp. 1969-1981.
[88] Joint GSP (Resubmitted), Appendix 3.I, pp. 1970-1971.
[89] Joint GSP (Resubmitted), Appendix 3.I, p. 1979.
[90] Joint GSP (Resubmitted), Appendix 3.I, p. 1980.

been taken on this deficiency and believe the GSAs can work with the Department to further efforts on interconnected surface water.

Based on a review of the information found in the resubmitted Plan, Department staff conclude that the GSAs have addressed component 2 of the corrective action.

4.4.3 Conclusion

Overall, Department staff believe the GSAs have taken sufficient action to address the deficiency identified.

Department staff understand that quantifying depletions of interconnected surface water from groundwater extractions is a complex task that likely requires developing new, specialized tools, models, and methods to understand local hydrogeologic conditions, interactions, and responses. During the initial review of GSPs, Department staff have observed that most GSAs have struggled with this requirement of SGMA. However, staff believe that most GSAs will more fully comply with regulatory requirements after several years of Plan implementation that includes projects and management actions to address the data gaps and other issues necessary to understand, quantify, and manage depletions of interconnected surface waters. Department staff further advise that at this stage in SGMA implementation GSAs address deficiencies related to interconnected surface water depletion where GSAs are still working to fill data gaps related to interconnected surface water and where these data will be used to inform and establish sustainable management criteria based on timing, volume, and depletion as required by the GSP Regulations.

The Department will continue to support GSAs in this regard by providing, as appropriate, financial and technical assistance to GSAs, including the development of guidance describing appropriate methods and approaches to evaluate the rate, timing, and volume of depletions of interconnected surface water caused by groundwater extractions. Once the Department's guidance related to depletions of interconnected surface water is publicly available, GSAs, where applicable, should consider incorporating appropriate guidance approaches into their future periodic updates to the GSP. GSAs should consider availing themselves of the Department's financial or technical assistance, but in any event must continue to fill data gaps, collect additional monitoring data, and implement strategies to better understand and manage depletions of interconnected surface water caused by groundwater extractions and define segments of interconnectivity and timing within their jurisdictional area. Furthermore, GSAs should coordinate with local, state, and federal resources agencies as well as interested parties to better understand the full suite of beneficial uses and users that may be impacted by pumping induced surface water depletion.

5 PLAN EVALUATION

As stated in Section 355.4 of the GSP Regulations, a basin "shall be sustainably managed within 20 years of the applicable statutory deadline consistent with the objectives of the Act." The Department's assessment is based on a number of related factors including whether the elements of a GSP were developed in the manner required by the GSP Regulations, whether the GSP was developed using appropriate data and methodologies and whether its conclusions are scientifically reasonable, and whether the GSP, through the implementation of clearly defined and technically feasible projects and management actions, is likely to achieve a tenable sustainability goal for the basin.

The Department staff's evaluation of the likelihood of the Plan to attain the sustainability goal for the Basin is provided below. Department staff consider the information presented in the Plan to satisfy the general requirements of the GSP Regulations.

5.1 ADMINISTRATIVE INFORMATION

The GSP Regulations require each Plan to include administrative information identifying the submitting Agency, describing the plan area, and demonstrating the legal authority and ability of the submitting Agency to develop and implement a Plan for that area.[91]

The Madera Subbasin is bound by the San Joaquin River and Kings Subbasin in the south, Delta-Mendota Subbasin in the west, Chowchilla Subbasin in the north, and the foothills of Sierra Nevada in the east.[92] No adjudicated areas are shown on the maps provided in the GSP.[93] The Subbasin does not have any considerable federal lands or state-owned lands.[94]

The Subbasin is managed by seven groundwater sustainability agencies. Four of those seven groundwater sustainability agencies have developed the Madera Joint Groundwater Sustainability Plan, and the other three groundwater sustainability agencies developed individual groundwater sustainability plans.[95] The four GSPs that cover the entire Madera Subbasin are:

- Madera Joint Groundwater Sustainability Plan (Joint GSP)
- Gravelly Ford Water District Groundwater Sustainability Plan (Gravelly Ford GSP)
- New Stone Water District Groundwater Sustainability Plan (New Stone GSP)

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[91] 23 CCR § 354.2 *et seq*.
[92] Joint GSP, Section 2.1, p. 63.
[93] Joint GSP, Section 2.1.1, p. 63, Figure 2-1, p. 64.
[94] Joint GSP, Section 2.1.1, p. 63. Note: Federal land includes primarily rights of way along canals conveying USBR Central Valley Project water. State land includes primarily California Department of Parks and Recreation land along San Joaquin River near Friant, California.
[95] Joint GSP, Table 1-4, p. 56.

- Root Creek Water District Groundwater Sustainability Plan (Root Creek GSP)

The four groundwater sustainability agencies that developed the Joint GSP collectively are:

- Madera County Groundwater Sustainability Agency
- City of Madera Groundwater Sustainability Agency
- Madera Irrigation District Groundwater Sustainability Agency
- Madera Water District Groundwater Sustainability Agency

The Joint GSP plan area represents 94% of the Madera Subbasin.[96] The Joint GSP provides information that is encompassing-of, relevant-to, and reiterated-in the other three groundwater sustainability plans and is often cited by Department staff when referencing information relevant to the entire Subbasin. Collectively, unless otherwise specified, the four GSPs are referred to as the Plan for the Subbasin.

The Gravelly Ford GSP boundaries are contiguous with the Gravelly Ford Water District and contain approximately 8,500 acres comprised of grape vineyards, tree groves, and rural residences.[97] The New Stone GSP boundaries are coterminous with the New Stone Water District boundaries, encompassing approximately 4,200 acres in the northwestern area of the Madera Subbasin. The New Stone Water District consists primarily of agriculture and two landowners.[98] The Root Creek GSP boundaries are the same as the Root Creek Water District boundaries and is located in the southeastern portion of the Madera subbasin—bounded on the south by San Joaquin River—with the majority of the land being used as agriculture.[99]

A map showing the Subbasin and adjacent subbasins is shown in Figure 1 below.

[96] Joint GSP, Table 1-2, p. 42.
[97] Gravelly Ford GSP, Section 1.1.1, p. 6.
[98] New Stone GSP, Executive Summary, p. 12.
[99] Root Creek GSP, Executive Summary, p. 13, Figure 2-5, p. 43.

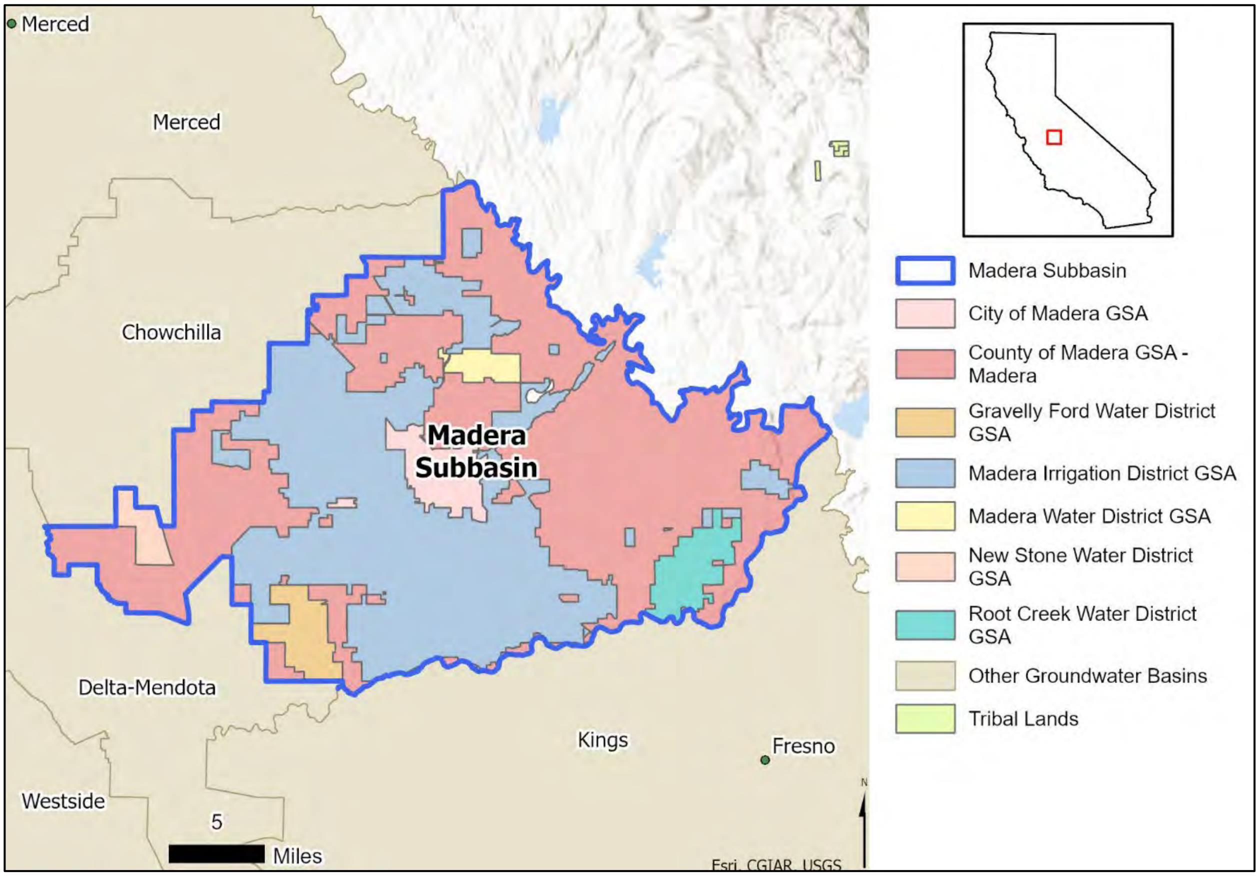

Figure 1. Madera Subbasin Location Map[100]

The land use areas in the Subbasin are broadly classified across three sectors: agricultural (including dairies), urban, and native vegetation.[101] The Plan includes a summary of land use stating irrigated agriculture is the most prominent land use in the Subbasin, covering approximately 213,000 acres.[102] For example, the New Stone GSP states that 100% of land use in the GSP is agricultural.[103] Native vegetation and water surfaces collectively were reported to cover the second highest acreage approximately 100,000 acres.[104] Urban area that includes cities, residential, and semi-agricultural cover approximately 36,000 acres.[105]

The water use source type was not independently presented for the entire Subbasin. For example, the Gravelly Ford GSP states an unquantified, small amount of groundwater pumping occurs for domestic use.[106] Instead, it is reported that the water source type is

100 Joint GSP, Figure 2-1, p. 64.
101 Joint GSP, Section 2.1.1, p. 65, Figure 2-2, p. 66.
102 Joint GSP, Table 2-1, p. 68.
103 New Stone GSP, Section 2.5.1, p. 38.
104 Joint GSP, Table 2-1, p. 68.
105 Joint GSP, Table 2-1, p. 68.
106 Gravelly Ford GSP, Section 2.1.5, p. 21.

both groundwater and local surface water supplies, but groundwater appears to be the primary water source in the Subbasin.[107]

The Plan includes maps that depict the density of wells (domestic, agricultural, and public supply) by township range and section in Figure 2-5, Figure 2-6, and Figure 2-7 of the Joint GSP prepared from the Department's Well Completion Report Map Application.[108] The highest concentrations of reported domestic wells are centered primarily around the City of Madera and Bonadelle Ranchos-Madera Ranchos in the eastern portion of the Subbasin.[109] Reported irrigation wells are generally less concentrated and more evenly distributed across the Subbasin, though slightly higher concentrations are found in some areas within rural Madera County, Madera Irrigation District, and Root Creek Water District.[110]

The Plan describes existing water resource management programs operating in the Subbasin. The Joint GSP states the local agencies that have formed each of the Subbasin's groundwater sustainability agencies have prepared and adopted several water planning documents in the past, including Madera Integrated Regional Water Management Plan and Madera Regional Groundwater Management Plan. The Subbasin's other local water management plans, federal, state, and regional groundwater and surface water programs were discussed.[111] The Joint GSP states the existing water resource monitoring and management programs constitute a well-developed and broadly distributed system that provides representative data throughout the Subbasin that have been, and will be, incorporated into the Plan as appropriate.[112]

The Plan provides a list of public meetings where the Plan was discussed, including GSA board meetings, Coordination Committee meetings, stakeholder advisory committee meetings, and public workshops.[113] The GSPs include stakeholder communication and engagement plans to assist Subbasin groundwater sustainability agencies in their efforts to develop general and strategic communications to engage stakeholders in groundwater management activities.[114]

The Plan identifies beneficial uses and users of groundwater in the Subbasin. The various stakeholders identified are the general public, private water users, urban and agricultural water users, industrial water users, environmental and ecosystem water uses, tribes, federal lands and integrated regional water management groups.[115] The Plan describes the beneficial uses of groundwater in the Subbasin, which includes irrigation and drinking

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[107] Joint GSP, Figure 2-2, p. 66.
[108] Joint GSP, Figures 2-5 through 2-7, pp. 171-173.
[109] Joint GSP, Section 2.1.1, p. 70.
[110] Joint GSP, Section 2.1.1, p. 70.
[111] Joint GSP, Section 2.1.2, pp. 70-77.
[112] Joint GSP, Section 2.1.2, pp. 70-77.
[113] Joint GSP, Section 2.1.5, pp. 83-90, Table A6.C-2, pp. 1768-1779.
[114] Joint GSP, Appendix 2.C.a, pp. 586-638; Gravely Ford GSP, Section 2.1.5, p. 22, New Stone GSP, Section 2.5.3 and 2.5.4, pp.39-40, Root Creek GSP, Section 2.5.3 to 2.5.4, pp. 73-75.
[115] Joint GSP, Table 2-5, pp. 85-86, Table A2.C.a-1, pp. 592-593.

water supply (i.e., municipal, urban, and rural).[116] According to the Joint GSP, each of the seven groundwater sustainable agencies in the Subbasin held regular public meetings, coordination committee meetings, and subbasin wide technical meetings.[117] For example, according to the Root Creek GSP,[118] engagement with the groundwater users occurred at the time of formation of GSAs, development of the draft GSP, finalization of the GSP and engagement will continue for the implementation of the GSP.[119]

Overall, Department staff believe the GSAs have thoroughly described Agency information, plan area, and notice and communication process, in substantial compliance with the GSP Regulations.

5.2 Basin Setting

GSP Regulations require information about the physical setting and characteristics of the basin and current conditions of the basin, including a hydrogeologic conceptual model; a description of historical and current groundwater conditions; and a water budget accounting for total annual volume of groundwater and surface water entering and leaving the basin, including historical, current, and projected water budget conditions.[120]

5.2.1 Hydrogeologic Conceptual Model

The GSP Regulations require a descriptive hydrogeologic conceptual model of the basin that includes a written description supported by cross sections and maps.[121] The hydrogeologic conceptual model is a non-numerical model of the physical setting, characteristics, and processes that govern groundwater occurrence within a basin, and represents a GSA's understanding of the geology and hydrology of the basin that support the geologic assumptions used in developing mathematical models, such as those that allow for quantification of the water budget.[122]

The Plan provides a description of the hydrogeologic conceptual model documented in a 2017 technical memoranda[123] and qualified maps.[124] The Gravelly Ford GSP provided additional descriptions to the hydrogeological conceptual model using a 2018 report titled *Hydrogeologic Conceptual Model and Groundwater Conditions for the Gravelly Ford Water District GSP*,[125] which describes the physical components in the Gravelly Ford

[116] Joint GSP, Section 1, p. 40.
[117] Joint GSP, Section 2.1.5.3, p. 86.
[118] Root Creek GSP, Appendix 2-C, pp. 245-246.
[119] Root Creek GSP, Section 2.5.1, pp. 72-73.
[120] 23 CCR § 354.12 *et seq*.
[121] 23 CCR § 354.12 *et seq*.
[122] DWR Best Management Practices for the Sustainable Management of Groundwater: Hydrogeologic Conceptual Model, December 2016: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-3-Hydrogeologic-Conceptual-Model_ay_19.pdf.
[123] Joint GSP, Section 2.2.1, pp. 90-96.
[124] Joint GSP, Figures 2-5 through Figure 2-46, pp. 171-211, Appendix 2.D, pp. 1078-1090.
[125] Gravelly Ford GSP, Appendix B, pp. 89-124.

GSP area, including, but not limited to, the principal aquifers,[126] surface water bodies,[127] and primary users of groundwater[128] in the Gravelly Ford GSP area.

The surface geology of the Subbasin is described predominantly as younger and older alluvium with subsurface deposits, from the surface to the bottom of the Subbasin, consisting of alluvium and unconsolidated continental deposits.[129] The Subbasin is depicted to be underlain by crystalline basement complex rocks of the Sierra Nevada.[130]

The lateral boundaries of the Subbasin are described as the hydrogeologic boundary created by the bedrock of the Sierra Nevada to the east; and the political boundaries of the Kings Subbasin to the south, Chowchilla Subbasin to the north, and Delta-Mendota Subbasin to the west.[131]

The Plan describes that the bottom of the Subbasin, throughout most of the Subbasin, is defined by the depth to the base of fresh water (groundwater with conductivity up to 3,000 micromhos per centimeter), except in the eastern portion where it is defined by the depth to basement rock.[132] However, the Plan states that there are wells screened below the defined base of fresh water while explaining these wells will likely have hydraulic connection with the overlying freshwater zone, so they are considered to be part of the Subbasin.[133] For example, cross-sections provided by the Joint GSP depict wells that extend below the bottom of the Subbasin.[134]

The Plan does not explicitly use the term principal aquifers to describe aquifers within the Subbasin, instead the Plan provides a description of aquifer systems present in the Subbasin. The Plan states that the Corcoran Clay underlies the western one-third of the Subbasin[135] and acts as a confining layer separating the upper unconfined aquifer from the lower confined aquifer.[136] The top of Corcoran Clay lies between 200 to 350 feet beneath the New Stone GSP area.[137] The Plan describes that the area outside of the Corcoran Clay, located in the central and eastern portions of the Subbasin, contains discontinuous clay layers interspersed with permeable coarse-grained units and is generally considered to be semi-confined. The semi-confined aquifer is further described as an upper semi-confined aquifer and a lower semi-confined aquifer (at an estimated depth ranging from 200 to 400 feet which generally correlates to the depth of the Corcoran Clay).[138] The Plan states the Subbasin contains areas of perched water. For example,

[126] Gravelly Ford GSP, Appendix B, p. 102.
[127] Gravelly Ford GSP, Appendix B, pp. 96-99.
[128] Gravelly Ford GSP, Appendix B, p. 107.
[129] Joint GSP, Section 2.2.1.1, p. 91.
[130] Joint GSP, Section 2.2.1.1, p. 91, Figure 2-19, p. 184.
[131] Joint GSP, Section 2.2.1.2, p. 91, Figure 2-17, p. 182.
[132] Joint GSP. Section 2.2.1.2. pp. 91-92, Figures 2-24 through 2-34, pp. 189-199.
[133] Joint GSP, Section 2.2.1.2, p. 92.
[134] Joint GSP, Figures 2-24 to 2-34, pp. 189-199.
[135] Joint GSP, Section 2.2.1.3, p. 93.
[136] New Stone GSP, Section 3.1.8, p. 60.
[137] New Stone GSP, Section 3.1.8, p. 60.
[138] Joint GSP, Section 2.2.1.3, pp. 93-94.

the Joint GSP states that the approximate location of the perched aquifers are six miles southeast of the City of Madera and ten miles northwest of the City of Madera; depths range from 3 to 27 feet southeast of the City of Madera, 100 feet within the City of Madera, and 105 to 130 feet northeast of Madera. Other sites with perched groundwater are believed to exist, but locations and depths are uncertain due to limited data.[139]

Department staff find that the Plan introduces uncertainty in the hydrogeologic conceptual model by identifying several aquifers in the Subbasin, but not directly defining any of these aquifers as principal aquifer(s). Additional details are provided below.

- The Plan identifies formations (i.e., Modesto, Riverbank, and Turlock Lake Formation - which contains the Corcoran Clay)[140] of the Subbasin but does not associate them with principal aquifer(s).
- The Plan describes the lateral and vertical boundaries of the Subbasin[141] but does not provide details that describe the lateral and vertical boundaries by principal aquifer. Also, the GSP does not provide sufficient details to support that east of the Corcoran Clay, the upper regional aquifer is semi-confined, instead of unconfined.
- The Plan does not provide a map depicting the source and point of delivery for imported waters.
- The Plan provides a description of water quality for total dissolved solids, nitrate, and arsenic along with maps of concentrations within the Subbasin.[142] None of the water quality data is identified by principal aquifer, although some of the data is identified by different aquifer descriptions such as upper, lower, shallow wells and deep wells.[143]

The Plan provides cross-sections that provide sufficient information to depict the major stratigraphic and structural features in the Subbasin. Physical characteristics of the Subbasin are depicted on various maps and figures. The cross-sections depict the base of freshwater, top of crystalline basement complex of the Sierra Nevada along the eastern portion of the Subbasin. Also shown is the upper aquifer and lower aquifer separated by the Corcoran Clay. Additionally, the GSP describes that east of the Corcoran Clay extent, the aquifer system is considered to consist of an upper semi-confined aquifer and a lower semi-confined aquifer;[144] however, the cross-sections show unconfined groundwater levels in the areas identified in the GSP as semiconfined.

The Plan does not explicitly identify data gaps and uncertainty concerning the hydrogeologic conceptual model as required by the GSP Regulations.[145] Department staff believe that a discussion regarding data gaps and uncertainty in the hydrogeologic

[139] Joint GSP, Section 2.2.2.1, p. 98.
[140] Joint GSP, Section 2.2.1.1, p. 91; Root Creek GSP, Section 3.1.2, p. 76.
[141] Joint GSP, Section 2.2.1.2, p. 91.
[142] Joint GSP, Section 2.2.2.3, pp. 102-104.
[143] Joint GSP, Appendix 2.E., pp. 1267-1321.
[144] Joint GSP, Section 2.2.1.1, p. 95.
[145] 23 CCR § 354.14(b)(5).

conceptual model, and plans to address data gaps is necessary, as lack of data and understanding of the physical characteristics of the subbasin may limit sustainable groundwater management (see Recommended Corrective Action 5).

5.2.2 Groundwater Conditions

The GSP Regulations require a written description of historical and current groundwater conditions for each of the six sustainability indicators and groundwater dependent ecosystems.[146]

Groundwater levels are currently declining across much of the Subbasin in both the unconfined and lower aquifer zones.[147] The current conditions are a continuation of historical trends of declining groundwater levels across much of the Subbasin that have been observed for at least the past 30 years.[148] In total, more than 500 hydrographs are included in the Plan covering varying timelines over the last 100 years. Hydrographs included in the Plan show two measurements per year over the well's entire period of record with the timeline beginning in 1945 or 1920.[149]

The Subbasin is also losing groundwater storage and has been since at least 1988 based on information provided in the Plan.[150] The Joint GSP includes a summary of various studies which utilized different specific yield values to estimate the total volume of groundwater storage loss ranging between 1,891,308 acre-feet to 3,073,376 acre-feet for the period 1988 to 2014 and 2,809,149 acre-feet to 4,564,868 acre-feet for the period 1988 to 2016.[151] This equates to an annual storage loss of 73,000 to 163,000 acre-feet per year since 1988.[152] The range in change in groundwater storage conditions result from five different specific yield estimates that vary from 5% to 12% for the Subbasin. The Joint GSP includes a summary table (Table 2-8) showing the total change of storage over two time periods: 1988 to 2014 and 1988 to 2016 based on five different specific yield values.[153]

The Plan identifies nitrate, total dissolved solid (TDS), and arsenic as the current key water quality constituents in the Subbasin. These three constituents were highlighted because they "have greater potential for presenting broader regional groundwater quality concerns extending beyond localized or site-specific contamination cases and are likely to reflect a range of potential contamination sources."[154] The New Stone GSP also states that salinity, chloride, specific conductance, and pesticides are constituents being detected in areas in the district; however, data available within and near the district indicates that levels of these constituents are generally below respective maximum

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[146] 23 CCR § 354.16 (a-f).
[147] Joint GSP, Section 2.2.2.1, pp. 97-100.
[148] Joint GSP, Figures 2-56 and 2-57, pp. 221-222.
[149] Joint GSP, Appendix 2.E.b, pp. 1129-1266.
[150] Joint GSP, Section 2.2.2.2, p. 101.
[151] Joint GSP, Section 2.2.2.2, pp. 101-102, Table 2-8, p. 102.
[152] Joint GSP, Section 2.2.2.2, pp. 101-102, Table 2-8, p. 102.
[153] Joint GSP, Table 2-8, p. 102.
[154] Joint GSP, Section 2.2.2.3, p. 102.

contaminant limits (MCLs) for drinking water. [155] The Root Creek GSP also included an evaluation of other constituents historically present in the GSP area, and states that the evaluation of historical results indicate that the area generally has acceptable groundwater quality for agricultural use and drinking water.[156] The Plan includes more than 50 maps displaying chemical concentrations for the key water quality constituents and other chemicals.[157]

Land subsidence has occurred and continues to occur in the Subbasin. The Joint GSP includes a written description detailing land subsidence over three time periods: 1926 to 1970, 2007-2011, and 2015-2017.[158] The discussion in the GSP focuses on the northwestern portion of the Subbasin where 1 to 2 feet of land subsidence occurred between 1926 and 1970, 0.5 to 1.0 feet occurred between 2007 and 2011, and 1.0 to 1.5 feet between 2015 and 2017.[159] The New Stone GSP states the subsiding area near El Nido is approximately 25 miles in diameter and its outer reach extends to the Plan area and the western area of the Subbasin.[160] United States Bureau of Reclamation monitoring point 1007R located on the western boundary of Plan area has indicated an annual subsidence rate ranging from 0.09 to 0.60 feet per year since December 2011 with the highest annual rate occurring from December 2012 through July 2014.[161] The Plan includes maps displaying both historical and current land subsidence.[162] Department staff provide information relevant to this in Section 4.3.

Interconnected surface water potentially exists in localized areas along the San Joaquin River within the Subbasin based on an analysis of comparing groundwater levels to the stream thalweg.[163] Based on this analysis, there were also additional portions of the San Joaquin River that were connected with groundwater historically (from 1958 to 1984) but may no longer be connected due to declining groundwater levels.[164] The Joint GSP states characterization of hydrogeologic conditions related to the potential for interconnected surface water is currently based on very limited data and, therefore, additional data collection and analyses are needed to update and refine the understanding of how surface water and GDEs may (or may not) be connected to the regional aquifers where groundwater pumping occurs.[165] Department staff provide information relevant to this in Section 4.4.

[155] New Stone GSP, Section 3.2.5, pp. 77-79.
[156] Root Creek GSP, Section 3.2.6, pp. 120-125.
[157] Joint GSP, Appendix 2.E, pp. 1268-1321; Root Creek GSP, Figures 3-27 through 3-29, pp. 121-123.
[158] Joint GSP, Section 2.2.2.4, p. 105.
[159] Joint GSP, Section 2.2.2.4, p. 105, Figures 2-67 through 2-70, pp. 232-235.
[160] New Stone GSP, Section 3.2.6.1, p. 82.
[161] New Stone GSP, Section 3.2.6.1, p. 82.
[162] New Stone GSP, Figures 3-23 and 3-24, pp. 84-85.
[163] Joint GSP (Redline), Section 2.2.2.5, p. 118.
[164] Joint GSP, Section 2.2.2.5, p. 105.
[165] Joint GSP (Redline), Section 2.2.2.5, p. 121.

The Plan identifies four areas within the Subbasin as “Potential GDE Units”.[166] The Joint GSP includes a technical memorandum that provides additional information about each of the four Potential GDE Areas including a series of maps, identification of potential GDE species, and a description of GDE conditions in the Subbasin.[167]

Overall, the Plan sufficiently describes the historical and current groundwater conditions throughout the Subbasin and the information included in the Plan substantially complies with the requirements outlined in the GSP Regulations.

5.2.3 Water Budget

GSP Regulations require a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current, and projected water budget conditions, and the change in the volume of water stored, as applicable.

The seven GSAs in the Subbasin use the data and analysis provided in the Technical Memorandum: Data Collection and Analysis (Davids engineering and Luhdorff & Scalmanini Consulting Engineers, July 2017) and the Draft Preliminary Basin Boundary Water Budget (Davids engineering and Luhdorff & Scalmanini Consulting Engineers, February 2018).[168] These documents were used to develop the Subbasin's water budget.[169] The water budget described in the Joint GSP presents a water budget for the entire Plan area, including annual water budget information for Gravelly Ford GSP, New Stone GSP, and Root Creek GSP; the Gravelly Ford GSP, New Stone GSP, and Root Creek GSP also reference the water budget information in the Joint GSP.[170] Detailed information is provided for all seven GSAs in Appendix 6.D of the Joint GSP.[171] An assessment of the information is provided below.

The water budgets contain a surface water system and a groundwater system (referred to as accounting centers) for the entire Subbasin. The Plan clearly lists the inflow, outflow, and change in storage components for each accounting center.[172] This framework is applied to the current, historical, and projected budgets.

The period 1989-2014 is used as the base period for both the historical and current water budget and represents average hydrologic conditions based on cumulative departure from mean precipitation.[173] The average annual change in storage is calculated as -34,200 acre-feet per year[174] for the historical budget. The overdraft estimate for the current water budget is -93,276 acre-feet, calculated using an average of historical

166 Joint GSP, Section 2.2.2.6, p. 107.
167 Joint GSP, Appendix 2.B, pp. 518-584.
168 Madera Subbasin Coordination Agreement, p. 12.
169 Joint GSP, Section 2.2.3.1, p. 114.
170 Joint GSP, Appendix 2.F, pp. 1322-1620.
171 Joint GSP, Appendix 6.D, pp. 2012-2175.
172 Joint GSP, Table 2-10, p. 117.
173 Joint GSP, Section 2.2.3.2, pp. 122-123, Figures 2-81 and 2-82, p. 124.
174 Joint GSP, Table 2-26, p. 159.

hydrologic conditions from 1989-2014 with 2015 land use data.[175] The information presented indicates that change in storage is positive only during wet years at a volume of 122,900 acre-feet. All other years indicate decreases in storage ranging from -82,700 to -230,400 acre-feet.[176]

Sustainable yield is calculated for the historical and projected water budgets.[177] As reported in the Plan, the historical sustainable yield for the Subbasin is 437,300 acre-feet per year.[178] The projected sustainable yield for the Subbasin is 439,300 acre-feet per year with a lower bound of 329,500 acre-feet per year and upper bound of 549,100 acre-feet per year.[179] The projected sustainable yield was calculated only for the sustainability period 2040-2090 with the reasoning that ongoing projects and demand management during the implementation period (2020-2039) will continually shift sustainable yield as project efficacy is evaluated.[180] The similarity of historical and projected sustainable yields suggests the sustainable yield during the implementation period would not differ appreciably from these estimates.

Department staff conclude the historical, current, and projected water budgets included in the Plan substantially comply with the requirements outlined in the GSP Regulations. The GSP provides the required historical, current, and future accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the Subbasin including an estimate of the sustainable yield of the Subbasin and projected future water demands.

5.2.4 Management Areas

The GSP Regulations provide the option for one or more management areas to be defined within a basin if the GSA has determined that the creation of the management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives, provided that undesirable results are defined consistently throughout the basin.[181]

No management areas were designated per the information provided in the Plan.

5.3 Sustainable Management Criteria

The GSP Regulations require each Plan to include a sustainability goal for the basin and to characterize and establish undesirable results, minimum thresholds, and measurable objectives for each applicable sustainability indicator, as appropriate. The GSP Regulations require each Plan to define conditions that constitute sustainable groundwater management for the basin including the process by which the GSA

[175] Joint GSP, Table 2-30, p. 163.
[176] Joint GSP, Table 2-33, p. 165.
[177] Joint GSP, Section 2.2.3.4, pp. 166-167.
[178] Joint GSP, Table 2-34, p. 167.
[179] Joint GSP, Table 2-35, p. 168.
[180] Joint GSP, Section 2.2.3.4, p. 167.
[181] 23 CCR § 345.20.

characterizes undesirable results and establishes minimum thresholds and measurable objectives for each applicable sustainability indicator.[182]

5.3.1 Sustainability Goal

The GSAs establish a sustainability goal for the Subbasin in the Coordination Agreement which is to "…implement a package of projects and management actions that will, by 2040, balance long-term groundwater system inflows and outflows based on a 50-year period representative of average historical hydrologic conditions."[183] The Joint GSP explains that during the 20-year implementation period a combination of recharge projects, replacing groundwater use with surface water, and demand reduction management actions are planned. These efforts will "increase groundwater inflows and decrease groundwater outflows to bring the groundwater system into balance by 2040 and will allow its operation to remain sustainable over a 50-year period representing average hydrologic conditions."[184]

Each GSP also provides additional specific information describing the goal for each GSP area. For example, the Gravelly Ford GSP describes the sustainability goal for the Subbasin as "…to minimize the listed undesirable results throughout the Subbasin by providing a Gravelly Ford GSP water supply that supports current cultivated acreage in the Plan area by developing an expanded surface water irrigation and recharge program, and groundwater monitoring and land elevation measurement program."[185] The New Stone GSP states that "[t]he goal for the GSP is to provide a tool for managing groundwater, basin-wide, on a long-term basis and to meet measurable objectives for each indicator by maintaining a sustainable yield, thus avoiding undesirable results."[186] The Root Creek GSP explains that the sustainability goal is to work collectively with the other GSAs within the Subbasin to "sustainably manage the groundwater resources of the basin while maintaining openness to the public and stakeholders such that local citizenry has a voice in the outcome."[187] Additionally, the goal of the Root Creek GSP is to "immediately reduce and eventually eliminate systematic overdraft within the [GSP] area.[188] While, specifying how each GSP will support the Subbasin sustainability goal within its' GSP area is an appropriate level of detail for each GSP, Department staff recommend the GSAs continue to coordinate and align this portion of each GSP to provide a more cohesive definition between the specific GSP goal and the sustainability goal for the Subbasin (see Recommended Corrective Action 2).

[182] 23 CCR § 354.22 *et seq*.
[183] Madera Subbasin Coordination Agreement, p. 34.
[184] Joint GSP, Section 3.1.2, p. 244.
[185] Gravelly Ford GSP, Section 3.1, p. 48.
[186] New Stone GSP, Section 4.1, p. 110.
[187] Root Creek GSP, Section 4.1, p. 157.
[188] Root Creek GSP, Section 1.2, p. 17.

5.3.2 Sustainability Indicators

Sustainability indicators are defined as any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results.[189] Sustainability indicators thus correspond with the six undesirable results – chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon, significant and unreasonable reduction of groundwater storage, significant and unreasonable seawater intrusion, significant and unreasonable 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[190] – but refer to groundwater conditions that are not, in and of themselves, significant and unreasonable. Rather, sustainability indicators refer to the effects caused by changing groundwater conditions that are monitored, and for which criteria in the form of minimum thresholds are established by the agency to define when the effect becomes significant and unreasonable, producing an undesirable result.

The following subsections consolidate three facets of sustainable management criteria: undesirable results, minimum thresholds, and measurable objectives. Information, as presented in the Plan, pertaining to the processes and criteria relied upon to define undesirable results applicable to the basin, as quantified through the establishment of minimum thresholds, are addressed for each sustainability indicator. However, a GSA is not required to establish criteria for undesirable results that the GSA can demonstrate are not present and are not likely to occur in a basin.[191]

5.3.2.1 Chronic Lowering of Groundwater Levels

The GSP Regulations require the minimum threshold for chronic lowering of groundwater levels to be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results.[192]

In the September 2022 Incomplete Determination, the Department identified deficiencies related to the sustainable management criteria for the chronic lowering of groundwater levels. The GSAs revised this portion of the Plan, and Department staff evaluate this sustainability indicator in Section 4.2 of this Staff Report. As presented above, Department staff concluded that the GSAs took sufficient action to correct this deficiency to warrant approving the Plan, but staff also provided recommended corrective actions based on the changes the Agencies have made to the sustainable management criteria for this sustainability indicator to further improve management during Plan implementation.

[189] 23 CCR § 351(ah).
[190] Water Code § 10721(x).
[191] 23 CCR § 354.26(d).
[192] 23 CCR § 354.28(c)(1).

5.3.2.2 Reduction of Groundwater Storage

The GSP Regulations require the minimum threshold for the reduction of groundwater storage to be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the basin's sustainable yield, calculated based on the basin's historical trends, water year type, and projected water use.[193]

The Plan states groundwater levels act as a proxy for the groundwater storage sustainability indicator and the sustainable management criteria for reduction in groundwater storage are the same as those established for chronic lowering of groundwater levels.[194] Department staff will evaluate and compare the groundwater level conditions and reduction of storage in Annual Reports submitted to the Department. Department staff expect the information will be reported on a per aquifer basis given the groundwater level monitoring network identifies which aquifer the representative monitoring site is monitoring.

5.3.2.3 Seawater Intrusion

The GSP Regulations require the minimum threshold for seawater intrusion to be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results.[195]

As stated in the Plan, seawater intrusion sustainability criteria are not applicable to the Subbasin, because it is located more than 70 miles inland and hydraulically disconnected from the ocean.[196]

5.3.2.4 Degraded Water Quality

The GSP Regulations require the minimum threshold for degraded water quality to be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum thresholds shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.[197]

The GSP states that "an undesirable result for degraded groundwater quality occurs when groundwater quality exceeds an established MCL and minimum threshold for arsenic, nitrate, or TDS [total dissolved solids] for a significant duration of time and at a significant number of representative monitoring sites and is the direct result of projects or management actions undertaken as part of the GSP implementation."[198] More

[193] 23 CCR § 354.28(c)(2).
[194] Joint GSP, Section 3.4.2, pp. 277-278.
[195] 23 CCR § 354.28(c)(3).
[196] Joint GSP, Section 3.2.6, p. 259.
[197] 23 CCR § 354.28(c)(4).
[198] Joint GSP, Section 3.4.4, p. 279.

specifically, a "significant duration of time" is defined as "a three-year monitoring period" and a "significant number of representative monitoring sites" is defined as "greater than 10 percent of representative groundwater quality monitoring wells exceeding a minimum threshold for a given constituent."[199] This definition is overly narrow. SGMA specifies that the significant and unreasonable effects are those "caused by groundwater conditions occurring throughout the basin" not just from groundwater management activities. By solely focusing on water quality impacts caused directly by the GSAs implementing an action, the GSP does not define undesirable results for degraded water quality in accordance with the SGMA. SGMA's definition of undesirable results includes "significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies."[200] As currently defined in the Plan, if, for instance, a minimum threshold exceedance occurs because of mobilization of naturally occurring constituents or migration of a contaminant plume to supply wells caused by groundwater pumping in the Subbasin, but the GSAs have not determined this to be a result of a project or management action, the GSAs would not identify this as an undesirable result. Staff consider this to be inconsistent with the intent of SGMA, which requires GSAs to ensure management of groundwater conditions in the Subbasin, including any action taken by the GSAs, will not significantly and unreasonably degrade water quality. Therefore, degraded water quality caused by groundwater pumping, changes in groundwater levels, changes in the direction of groundwater flow, or changes in horizontal or vertical movement of groundwater within the Subbasin should be considered in the assessment of undesirable results in the Subbasin. Department staff recommend the GSAs revise the definition of their overly-narrow definition of undesirable results such that groundwater pumping and other factors, whether due to action or inaction of the GSAs with respect to Subbasin management, is considered and not excluded in the undesirable result definition (see Recommended Corrective Action 6a).[201]

Significant and unreasonable degradation of water quality is defined as "when beneficial uses for groundwater are adversely impacted by constituent concentrations increasing to levels above the drinking water MCLs for one of the key constituents of interest …due to implementation of a GSP project or management action."[202] Though the definition provided appears to consider specific effects of degradation of groundwater quality, the GSP does not provide details that explain how the GSAs determined what "adversely impacted by constituent concentrations" means. Additionally, the GSP does not provide descriptions, supported by analysis, of the potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results. The GSAs should update the definition of undesirable results to include specific scenarios the GSAs are trying to avoid (e.g., additional cost to domestic well users for well treatment, decrease in water available

[199] Joint GSP, Section 3.4.4, p. 279.
[200] Water Code § 10721(x).
[201] 23 CCR § 354.26 (b)(2).
[202] Joint GSP, Section 3.4.4, p. 279.

for certain beneficial uses, etc.). Department staff recommend that the GSAs refine the definition to better describe the specific significant and unreasonable effects related to degraded water quality the GSAs are managing to avoid (see Recommended Corrective Action 6b).

The GSP provides a description of potential causes of an undesirable result, limited to direct effects of GSP projects or management actions, such as localized pumping clusters (which would particularly affect areas prone to elevated arsenic concentrations occurring at greater pumping water level depths)[203] and groundwater recharge which particularly affect areas of actively or formerly cultivated lands where high residual concentrations of nutrients, especially nitrogen, may exist.[204]

The GSP establishes the minimum thresholds for degraded water quality at the "[maximum contaminant level (MCLs)] for drinking water for identified key constituents (10 mg/L for nitrate as nitrogen; 500 mg/L for TDS; 10 ug/L for arsenic) or when existing or historical concentrations for the key constituents already exceed the MCL, the minimum threshold is set at the recent concentration plus 20 percent."[205] Measurable objectives are set at current constituent concentrations.[206] However, the GSP does not identify which wells have had exceedances in the past or provide the current constituent concentrations in the Plan. The GSP also states "significant and unreasonable degradation of water quality occurs when beneficial uses for groundwater are adversely impacted by constituent concentrations increasing to levels above the drinking water MCLs,"[207] but the GSP does not explain or justify setting minimum thresholds at 20 percent above MCLs, or demonstrate that these increased levels would not adversely impact beneficial uses and users of water. Department staff are not aware of specific concerns regarding degraded water quality that warrant immediate action based on what is provided in the Plan; however, staff believe the GSAs should identify the exact minimum threshold values what will be used and justify how establishing minimum thresholds at the higher of either MCLs or existing concentrations plus 20 percent does not constitute significant and unreasonable effects as defined by the GSP (i.e., "when beneficial uses for groundwater are adversely impacted by constituent concentrations) (see Recommended Corrective Action 6c).

5.3.2.5 Land Subsidence

SGMA defines the undesirable result for subsidence to be significant and unreasonable land subsidence that substantially interferes with surface land uses, caused by groundwater conditions occurring throughout the basin.[208] The GSP Regulations require the minimum threshold for land subsidence to be the rate and extent of subsidence that

[203] Joint GSP, Section 3.4.4, pp. 279-280.
[204] Joint GSP, Section 3.4.4, p. 280.
[205] Joint GSP, Section 3.3.4, p. 271.
[206] Joint GSP, Section 3.4.2.1, p. 253.
[207] Joint GSP, Section 3.4.4, p. 271.
[208] Water Code § 10721(x)(5).

substantially interferes with surface land uses and may lead to undesirable results.[209] Minimum thresholds for subsidence shall be supported by the identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including an explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects and maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.[210]

In the September 2022 Incomplete Determination, the Department identified deficiencies related to the sustainable management criteria for land subsidence. The GSAs revised this portion of the Plan and Department staff provide evaluation for this sustainability indicator in Section 4.3 of this Staff Report. As presented above, Department staff concluded the GSAs had taken sufficient actions to correct the deficiencies and provided additional recommended corrective actions based on the changes the Agencies have made to the sustainable management criteria for this sustainability indicator to further improve basin management as the Plan is implemented.

5.3.2.6 Depletions of Interconnected Surface Water

SGMA defines undesirable results for the depletion of interconnected surface water as those that have significant and unreasonable adverse impacts on beneficial uses of surface water and are caused by groundwater conditions occurring throughout the basin.[211] The GSP Regulations require that a Plan identify the presence of interconnected surface water systems in the basin and estimate the quantity and timing of depletions of those systems.[212] The GSP Regulations further require that minimum thresholds be set based on the rate or volume of surface water depletions caused by groundwater use, supported by information including the location, quantity, and timing of depletions, that adversely impact beneficial uses of the surface water and may lead to undesirable results.[213]

In the September 2022 Incomplete Determination, the Department identified deficiencies related to the sustainable management criteria of depletions of interconnected surface water. The GSAs revised this portion of the Plan and Department staff provide evaluation for this sustainability indicator in Section 4.4 of this Staff Report. As presented above, Department staff concluded the GSAs had taken sufficient actions to correct the deficiencies and provided additional recommended corrective actions based on the changes the Agencies have made to the sustainable management criteria for this sustainability indicator.

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[209] 23 CCR § 354.28(c)(5).
[210] 23 CCR §§ 354.28(c)(5)(A-B).
[211] Water Code § 10721(x)(6).
[212] 23 CCR § 354.16(f).
[213] 23 CCR § 354.28(c)(6).

5.4 Monitoring Network

The GSP Regulations describe the monitoring network that must be developed for each basin including monitoring objectives, monitoring protocols, and data reporting requirements. Collecting monitoring data of sufficient quality and quantity is necessary for the successful implementation of a groundwater sustainability plan. The GSP Regulations require a monitoring network of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.[214] Specifically, a monitoring network must be able to monitor impacts to beneficial uses and users,[215] monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds,[216] capture seasonal low and high conditions,[217] include required information such as location and well construction, and include maps and tables clearly showing the monitoring site type, location and frequency.[218] Department staff encourage GSAs to collect monitoring data as specified in the GSP, fill data gaps identified in the GSP prior to the first 5 year update,[219] update monitoring network information as needed, follow monitoring best management practices,[220] and submit all monitoring data to the Department's Monitoring Network Module immediately after collection including any additional groundwater monitoring data that is collected within the Plan area that is used for groundwater management decisions. Staff note that if GSAs do not fill their identified data gaps, the GSA's basin understanding may not represent the best available science for use to monitor basin conditions.

Each GSP identifies a distinct monitoring network that measures groundwater elevations for assessment of chronic lowering of groundwater levels. The Joint GSP identifies 37 monitoring wells with 11 wells in the Upper Aquifer, 22 wells in the Lower Aquifer, and four composite wells screened in both aquifers.[221] The Joint GSP acknowledges the spatial coverage of the monitoring network for the Upper Aquifer is limited to the southwestern portion of the GSP area.[222] The Gravelly Ford GSP states that two different groups of wells are currently being used for monitoring chronic lowering of groundwater levels; one with a network of 24 wells and another network of four wells from outside the GSP area to compare future measurements.[223] However, the Gravelly Ford GSP does not specify which aquifer the wells are monitoring. The New Stone GSP monitoring network includes six monitoring wells comprised of three California Groundwater Elevation Monitoring Program (CASGEM) monitoring sites and three district wells that will

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[214] 23 CCR § 354.32.
[215] 23 CCR § 354.34(b)(2).
[216] 23 CCR § 354.34(b)(3).
[217] 23 CCR § 354.34(c)(1)(B).
[218] 23 CCR §§ 354.34(g)-(h).
[219] 23 CCR § 354.38(d).
[220] Department of Water Resources, 2016, Best Management Practices and Guidance Documents.
[221] Joint GSP, Section 3.5.1, p. 281.
[222] Joint GSP, Section 3.5.1, p. 282.
[223] Gravelly Ford GSP, Section 3.5.1, pp. 57-58.

be monitoring the unconfined aquifer and confined aquifer respectively.[224] The Root Creek GSP states that the GSA will use the five wells in the monitoring network within the single aquifer that underlies the GSP area.[225]

The Plan proposes to use groundwater levels and the groundwater level monitoring network as a proxy for the loss of groundwater in storage monitoring network because changes in groundwater storage are directly dependent on changes in groundwater levels.[226]

The groundwater quality monitoring network in the Joint GSP consists of 12 monitoring sites selected from the GSP groundwater level monitoring network.[227] Of these wells, two are screened in the Upper Aquifer, eight in the Lower Aquifer, and two are composite wells screened in both.[228] Additionally, two domestic wells from the Irrigated Lands Regulatory Program, and thirteen public supply wells with ongoing monitoring conducted by other entities are also part of the representative monitoring sites but the GSP does not identify which aquifers the wells are completed in.[229] The Gravelly Ford GSP states groundwater quality samples will be collected from 24 wells throughout the district and the samples will be collected once a year.[230] The New Stone GSP states the GSA will use the three district wells that monitor the confined aquifer.[231] The Root Creek GSP states that degraded water quality will be monitored from 17 sites throughout the GSA's area of the Subbasin which includes municipal wells, monitoring wells associated with the Riverstone wastewater treatment plant, agricultural wells used in the GSP, and wells associated with CASGEM.[232] The Plan states that several agencies monitor and regulate water quality in the Subbasin and the GSAs will collect and review the data published by these agencies, which include the Regional Water Quality Control Board, Environmental Protection Agency, Department of Toxic Substance Control, Madera County, United States Geological Survey, and State Water Resources Control Board.[233]

The land subsidence monitoring network in the Joint GSP is comprised of six benchmark survey points monitored by the United States Bureau of Reclamation as part of the San Joaquin River Restoration Program (SJRRP) and one continuous GPS station monitored by UNAVCO as part of the Plate Boundary Observatory Project.[234] Two of the benchmark survey points are underlaid by the Corcoran Clay, where subsidence is of most concern. Representative monitoring site 1007R, a benchmark survey point which is located on the

[224] New Stone GSP, Section 5.2.1, pp. 133-134.
[225] Root Creek GSP, Section 5.2.1, p. 191.
[226] Joint GSP, Section 3.5.1.2, p. 286; Gravelly Ford GSP, Section 3.5, p. 59; New Stone GSP, Section 5.3.1, p. 138; Root Creek GSP, p. 196.
[227] Joint GSP, Section 3.5.1.4, p. 287.
[228] Joint GSP, Figure 3-2, p. 300.
[229] Joint GSP, Section 3.5.1.4, p. 287.
[230] Gravelly Ford GSP, Section 3.5.1, p. 58.
[231] New Stone GSP, Section 5.5.1, p. 139, Figure 5-1, p. 137.
[232] Root Creek GSP, Section 5.4.1, pp. 199-201.
[233] Root Creek GSP, Section 5.4.1, p. 199.
[234] Joint GSP (Redlined), Section 3.2.3.2, p. 279, Figure 3-10, p. 360.

western edge of the New Stone GSP area, has reported the most severe rate of recent subsidence in the Subbasin.[235] The Plan states that all SJRRP and UNAVCO sites will be used to monitor for subsidence in the area and monitoring stations outside the Subbasin will be used to provide regional context. The Root Creek GSP also provides a list of subsidence monitoring done by other agencies such as USGS, DWR, USACE which will be used to verify the Plan's monitoring network.[236] The Gravelly Ford GSP subsidence monitoring program will be expanded by the district to include observations on all the 24 monitoring sites in the GSP area, at a period of three to five years, with some wells observing the Lower Aquifer.[237] See Section 4.3.2 for further evaluation of the Plans sustainable management criteria and monitoring network for land subsidence.

Interconnected surface water is evaluated by monitoring groundwater levels at three wells[238] screened in the Upper Aquifer near the San Joaquin River. The Joint GSP explains the representative monitoring sites include a combination of irrigation and monitoring wells with data representing surface water-groundwater interconnection trends from 1989.[239] Streamflow data from gaging stations is also collected and will be used in future studies and evaluations of interconnected surface water, including generating data to better estimate groundwater basin conditions related to interconnected surface water[240] (also see Section 4.4.2).

The description of the monitoring in the Plan substantially complies with the requirements outlined in the GSP Regulations. Overall, the Plan describes in sufficient detail a monitoring network that promotes the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the Subbasin and evaluate changing conditions that occur through Plan implementation. The GSP provides a good explanation for the conclusion that the monitoring network is supported by the best available information and data and is designed to ensure adequate coverage of sustainability indicators. The Plan also describes existing data gaps and the steps that will be taken to fill data gaps and improve the monitoring network. Department staff consider the information presented in the Plan as satisfying the general requirements of the GSP Regulations regarding monitoring networks, but also provide recommended corrective actions related to managing and monitoring land subsidence (see Recommended Corrective Action 4).

[235] New Stone GSP (Redlined), Section 3.2.6.1, p. 99, Figure 5-2, p. 185.
[236] Root Creek GSP (Redlined), Section 5.5.1, pp. 266-267, Section 5.5.3, p. 268.
[237] Gravelly Ford GSP (Redlined), Section 3.5.1, p. 76, Section 3.5.4.2, p. 77.
[238] Joint GSP (Redlined), Figure 3-4, p. 352, Section 3.5.1.5, p. 336.
[239] Joint GSP (Redlined), Section 3.5.1.5, p. 336, Section 3.2.5, p. 288.
[240] Joint GSP (Redlined), Section 3.5.1.5, p. 336.

5.5 Projects and Management Actions

The GSP Regulations require a description of the projects and management actions the GSAs have determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.[241]

The Plan lays out the projects which were selected by the GSAs to achieve the Subbasin sustainability goal by 2040.[242] Generally, the projects are supply augmentation (i.e., recharge or conveyance enhancement) projects which source water from flood releases, Section 215 water, bypass flows, or water purchases. While the total cost of project implementation is not provided, the estimated costs provided in each individual GSP total to over $270,000,000 in capital costs and over $70,000,000 in annual costs; Department staff note that the GSAs have also included an estimated economic cost from reduced crop production resulting from demand management in the estimated annual operating cost, which is approximately $54,000,000 per year or over 75% of the total.[243] Many of the projects are currently being implemented, having been initiated by past efforts, or will be implemented by 2040. The total expected benefit is 215,840 acre-feet per year[244] at full implementation with the majority of the benefit deriving from a demand management program led by the Madera County GSA which will conserve 90,000 acre-feet per year. Madera County determined that projects were unlikely to generate enough benefit to offset the estimated current and projected future overdraft conditions and decided to implement a management action to gradually reduce groundwater pumping over the GSP implementation period.[245] The demand management effort started in 2020 with 2% demand reduction per year until 2025. Starting in 2026, the demand reduction increases to a 6% reduction rate until 2040.[246]

Since the submission of the Plan in 2020, the GSAs have provided Annual Reports to the Department that provide updates on progress, a brief overview of these efforts from Water Year 2019 to Water Year 2022 is provided in each revised GSP. A review of the Annual Reports submitted shows progress on a majority of the projects and enhancements of monitoring networks, which now collect more land subsidence, water quality, and groundwater level data; the GSAs also report efforts being made to collect more interconnected surface water data.[247]

A review of the projects presented in each GSP is provided below.

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[241] 23 CCR § 354.44 et seq.
[242] Joint GSP (Redlined), Section 4, pp. 361-431; Gravelly Ford GSP (Redlined), Section 4, pp. 83-37; Root Creek GSP (Redlined), Section 6, pp. 309-327; New Stone GSP (Redlined), Section 6, pp. 189-199.
[243] Joint GSP, Table 4-3, p. 312, Section 4.4.4.5, p. 352.
[244] Joint GSP, Tables 4-1 and 4-2, pp. 310-311.
[245] Joint GSP, Section 4.4.4, p. 347.
[246] Joint GSP, Section 4.4.4.2, p. 348.
[247] Joint GSP Water Year 2022 Annual Report, Table 7-1, pp. 56-57; Gravelly Ford GSP Water Year 2022 Annual Report, Section 2.4.3, pp. 18-19; New Stone GSP Water Year 2022 Annual Report, Section 3.1.2, p. 10; Root Creek GSP Water Year 2022 Annual Report, p. 26.

The Joint GSP describes each project and management action proposed by Madera Water District GSA, Madera Irrigation District GSA, City of Madera GSA, and Madera County GSA.[248] They are:

Madera Water District GSA

1. Surface Water Purchase Program

Madera Irrigation District GSA

1. Groundwater Recharge Basins
2. On-Farm Recharge (Flood-MAR)
3. Madera Irrigation District System Improvements and Programs
4. Madera Ranch Annexation

The City of Madera GSA

1. Berry Basin for groundwater recharge
2. The City of Madera Metering and Volumetric Billing program.

Madera County GSA

1. Water Purchase for Direct or In-Lieu Recharge (starts in 2025)
2. Import and Recharge of Millerton Flood Releases (Flood-MAR) (starts in 2025)
3. Chowchilla Bypass Flood Water Recharge Basins (starts in 2025)
4. Chowchilla Bypass Flood Water Recharge Basins (starts in 2040)
5. Management Action: Demand Management (starts in 2020)

The Joint GSP provides an estimate for implementing projects and management actions, which totals approximately $193,460,000 in capital costs and $69,550,000 in annual operating costs.[249] As noted above, the GSAs have included an estimated economic cost from reduced crop production resulting from demand management of approximately $54,000,000 per year in the total annual cost.[250] Based on information provided in the Joint GSP resubmittal and the 2022 Annual Report,[251] the GSA reports that a cumulative total benefit of over 63,000 acre-feet from projects and management actions to date, with a benefit of 7,300 acre-feet for the latest reported water year for the GSP area.[252] Demand management is described to potentially utilize a range of options including allocations, a water trading program, or easements to reduce groundwater demand. In 2022, Madera County took steps to develop a demand management study that was intended to result

[248] Joint GSP (Redlined), Section 4, pp. 361-341.
[249] Joint GSP (Redlined), Table 4-3, p. 366.
[250] Joint GSP (Redlined), Section 4.4.4.5, p. 409.
[251] Joint GSP Water Year 2022 Annual Report, Section 7.1, pp. 53-69.
[252] Joint GSP Water Year 2022 Annual Report, Table 7-2, p. 58.

in an acreage-based rate for extraction of groundwater within the GSA area. However, following an injunction issued by the Madera County Superior Court in December 2022, the Madera County GSA was ordered to refrain from imposing or collecting any new fees, rates, or GSP Project Fees enacted under Madera County Resolution 2022-086 against landowners in the Madera Subbasin.[253] Nonetheless, Department staff encourage the GSAs to continue efforts to develop and implement a successful management strategy to reduce groundwater pumping in the Subbasin, since the reduction of groundwater demand, as detailed in the Plan, is an essential part of achieving the sustainability goal for the basin. Department staff will closely monitor and track the implementation of the demand management program; delays in implementation due to litigation or funding are insufficient to justify delays in implementing demand reduction strategies that are needed to sustainably manage the basin.

The Gravelly Ford GSP[254] provides details for two projects which the GSA is currently implementing:

1. Recharge Program: this project is the continuation of the recharge program established by the Gravelly Ford Water District in 1961.
2. Increased Measurement, Sampling and Monitoring: this project is to continue data collection efforts.

The Gravely Ford GSP does not provide an estimate for projects and management actions; the cost of implementing the GSP is estimated to be $961,000.[255] Based on information in the 2022 Annual Report,[256] the GSA reports that a number of measurements (i.e., depth to groundwater) of private agricultural wells in the GSP area were made and the installation of measurement meters has started on those wells to increase data collection; but the GSAs were not able to discharge surface water into the existing recharge basins during the 2022 Water Year.

The New Stone GSP includes a brief description of one project that is "currently being considered by the [New Stone Water] District"[257] which is the:

1. Construct Chowchilla Bypass Turnout, New Canals, and Recharge Basins (Bypass Project)

The Bypass Project is in the "conceptual phase" and implementation will "depend on the availability of land for new recharge basins [which will also determine amount of recharge] and acquiring a source of funding"; the amount of recharge will depend on acres available for recharge facilities but the district has a 15,700 acre-feet appropriative water right.[258] The estimated cost over 20-years for implementing the project is $7,800,000 but no

[253] Joint GSP (Redlined), Section 4.10.5.4, p. 430.
[254] Gravelly Ford GSP, Section 4, pp. 64-66.
[255] Gravelly Ford GSP (Redlined), Section 5.3.1, p. 88.
[256] Gravelly Ford GSP Water Year 2022 Annual Report, Section 2.4.3, p. 18-19.
[257] New Stone GSP, Section 6.2, pp. 151-157.
[258] New Stone GSP, Section 6.2.1.2 through 6.2.1.6, pp. 152-153.

schedule is provided.[259] Management actions will be enacted "[i]f basin overdraft isn't mitigated"[260] and the GSP doesn't provide related cost of implementation or schedule estimates. Based on information in the 2022 Annual Report,[261] the GSA did not provide substantial updates on the project or management action progress for the 2022 Water Year—but the GSA did report three new wells were added to the monitoring network.

The Root Creek GSP[262] includes brief descriptions of three projects:

1. Expansion of the In-Lieu Pipeline (to fully utilize surface water allocations)
2. Intentional Recharge Projects
3. Agricultural Land Conversion (Development of Riverstone)
4. Monitoring Well Program – Interconnected Surface Water

The Root Creek GSP provides project cost estimates and projects 2 and 3 are currently being implemented. Additionally, though management actions are referenced,[263] no specific details are provided; the GSP references the continuation of programs that were enacted prior to SGMA related to the use and sustainable management of groundwater.[264] During 2022, the GSP states, a benefit of 4,500 acre-feet was realized from projects for the GSP area.[265]

The Plan adequately describes proposed projects and management actions in a manner that is generally consistent and substantially complies with the GSP Regulations.[266] The projects and management actions, which focus largely on recharge or conveyance projects and demand management, are directly related to the sustainable management criteria and present a generally feasible approach to achieving the sustainability goal of the Subbasin.

As projects and management actions are implemented, the Department expects that progress be included in Annual Reports and any addition or removal of project and management actions be documented in Periodic Evaluations.

5.6 Consideration of Adjacent Basins/Subbasins

SGMA requires the Department to "…evaluate whether a groundwater sustainability plan adversely affects the ability of an adjacent basin to implement their groundwater sustainability plan or impedes achievement of sustainability goals in an adjacent basin."[267] Furthermore, the GSP Regulations state that minimum thresholds defined in each GSP

[259] New Stone GSP, Table 7-3, p. 160.
[260] New Stone GSP, Section 6.3, p. 154.
[261] New Stone GSP Water Year 2022 Annual Report, Section 3.1, pp. 10-11.
[262] Root Creek GSP, Section 6.1 through 6.4, pp. 212-226.
[263] Root Creek GSP, Table 6-1, p. 213.
[264] Root Creek GSP, Section 6.5, p. 226.
[265] Root Creek GSP (Redlined), Section 6.7, pp. 326-327.
[266] 23 CCR §§ 354.44 (a), 354.44 (b), 354.44 (c), 354.44 (d).
[267] Water Code § 10733(c).

be designed to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.[268]

The Madera Subbasin has three adjacent basins; the Kings Subbasin, Delta-Mendota Subbasin, and the Chowchilla Subbasin, are all high-priority and required to be managed under a GSP. The Delta-Mendota Subbasin and Chowchilla Subbasins are critically overdrafted and currently have inadequate plans which the Department has referred to the State Water Resources Control Board under Chapter 11 of SGMA. The Kings Subbasin is to the south of the Madera Subbasin bordering the south bank of the San Joaquin River. The Kings Subbasin is designated critically overdrafted and the Kings Subbasin Plan has been approved by the Department.

The Plan states that the Madera Subbasin GSAs have met multiple times with GSAs in adjacent subbasins to ensure that implementation of the Madera Subbasin GSPs will not interfere with the ability of adjacent subbasins to also achieve sustainable groundwater management; however, further details are not provided in the Plan.[269] The Plan also qualitatively describes how minimum thresholds and measurable objectives may affect an adjacent basin, concluding that the Madera Subbasin Plan will not hinder the ability of an adjacent basin to be sustainable;[270] however, the evaluation is provided without specifics.

Based on information available at this time, Department staff have insufficient evidence to conclude that groundwater management in the Madera Subbasin will adversely affect the implementation of a plan or impede achievement of sustainability goals in an adjacent basin. Department staff encourage the GSAs to evaluate whether their Plan adversely affects the ability of an adjacent basin to implement their groundwater sustainability plan or impedes achievement of sustainability goals in an adjacent basin. Department staff will continue to review periodic evaluations to the Plan and Annual Reports to assess whether implementation of the Madera Subbasin GSP is likely to impact adjacent basins.

5.7 Consideration of Climate Change and Future Conditions

The GSP Regulations require a GSA to consider future conditions and project how future water use may change due to multiple factors including climate change.[271]

Since the GSP was adopted and submitted, climate change conditions have advanced faster and more dramatically. It is anticipated that the hotter, dryer conditions will result in a loss of 10% of California’s water supply. As California adapts to a hotter, drier climate, GSAs should be preparing for these changing conditions as they work to sustainably manage groundwater within their jurisdictional areas. Specifically, the Department

[268] 23 CCR § 354.28(b)(3).
[269] Joint GSP (Redlined), Executive Summary, p. 25.
[270] Joint GSP (Redlined), Section 3.2.1.4, p. 277, Section 3.2.2.4, p. 278, Section 3.2.4.4, p. 285, Section 3.2.5.4, p. 291, Section 3.3.1.5, p. 304, Section 3.3.2.3, p. 309, Section 3.3.3.3, p. 312, Section 3.3.4.3, p. 318, Section 3.3.5.3, p. 319.
[271] 23 CCR § 354.18.

encourages the GSAs to explore how the proposed groundwater level thresholds have been established in consideration of groundwater level conditions in the Subbasin based on current and future drought conditions. The Department encourages the GSAs to also explore how groundwater level data from the existing monitoring network will be used to make progress towards sustainable management of the Subbasin given increasing aridification and effects of climate change, such as prolonged drought. Lastly, the Department encourages the GSAs to continually coordinate with the appropriate groundwater users, including but not limited to domestic well owners and state small water systems, and the appropriate overlying county jurisdictions developing drought plans and establishing local drought task forces[272] to evaluate how the GSAs' groundwater management strategy aligns with drought planning, response, and mitigation efforts within the Subbasin.

[272] Water Code § 10609.50.

6 STAFF RECOMMENDATION

Department staff believe sufficient action has been taken by the GSAs to the deficiencies identified. Department staff recommend approval of the Plan with the required and recommended corrective actions listed below. The Plan conforms with Water Code Sections 10727.2 and 10727.4 of SGMA and substantially complies with the GSP Regulations. Implementation of the Plan will likely achieve the sustainability goal for the Madera Subbasin. The GSAs have identified several areas for improvement of its Plan and Department staff concur that those items are important and should be addressed as soon as possible. Department staff have also identified additional recommended corrective actions that should be considered by the GSAs for the first periodic assessment of its GSP. Addressing these recommended corrective actions will be important to demonstrate that implementation of the Plan is likely to achieve the sustainability goal. The recommended corrective actions include:

RECOMMENDED CORRECTIVE ACTION 1

Considering MID GSA has yet to adopt the Plan, by the first periodic evaluation, MID GSA should identify and list the specific projects and management actions that MID GSA will or may be responsible for implementing under the Revised Joint GSP and provide a parallel listing and detailed identification and discussion of the legal, contractual, or other authorities or arrangements that MID GSA is relying or will rely upon in adequately implementing the Plan including those projects or management actions to clearly demonstrate the feasibility of MID GSA implementing all projects and management actions.

RECOMMENDED CORRECTIVE ACTION 2

While the GSAs have established a framework for coordination of multiple GSPs that could serve as a basis to achieve Subbasin sustainability, it is vital that the GSAs continue their efforts to improve coordination and eliminate any remaining areas of disagreement that could delay Plan implementation or affect the likelihood of achieving sustainability. For example, the GSA should come to a consensus regarding the data and methods utilized to develop refined future water budgets for the entire Subbasin, and agreement regarding the availability and use of more detailed data as it becomes available from each GSP area. These efforts should be done with the ultimate goal that the contents of each GSP should represent a component of a cohesive, unified Plan that will achieve the sustainability goal in the Subbasin consistent with SGMA timelines and not be an isolated document only for a specific GSP area.

RECOMMENDED CORRECTIVE ACTION 3

The GSAs should revise the GSPs to include a discussion of the relationship between the management criteria for chronic lowering of groundwater levels and the other sustainability indicators, including an explanation of how the criteria, including interim milestones, were established to avoid undesirable results for each of the other sustainability indicators.

Recommended Corrective Action 4

Department staff recommend the following as it relates to land subsidence:

a. The GSAs should refine the description of undesirable results to clearly describe the significant and unreasonable conditions the GSAs are managing the Subbasin to avoid, as it relates to land subsidence. More specifically, the GSAs should reevaluate the quantitative metrics that define an undesirable result for subsidence. The reevaluation should consider localized subsidence conditions and the irreversibility of continued inelastic subsidence, especially in the area deemed of "greater subsidence concern." This is to say that the current quantitative metrics (i.e., 75 percent of the representative monitoring sites in the Subbasin exceed threshold levels for two consecutive years across the entire Subbasin) would not minimize or avoid inelastic subsidence in the most susceptible areas of the Subbasin – predominantly in the north-northwestern portion of the Subbasin which are describe as the areas of greater subsidence concern.

b. The GSAs should identify the cumulative amount of subsidence that, if exceeded, would substantially interfere with groundwater and land surface beneficial uses and users in the Subbasin. The Plan should explain how the rate and extent of any future subsidence permitted in the Subbasin may interfere with surface land uses. The Plan should also include additional details describing measures that consider and disclose the current and potentially lasting impacts of subsidence on land uses and groundwater beneficial uses and users.

   Additionally, the GSAs should provide specific details and schedule for projects or management actions that will be implemented to minimize or eliminate subsidence. The projects or management actions must be supported by best available information and science[273] and consider the level of uncertainty associated with the Subbasin.[274]

c. The GSAs should revise the GSPs to include a discussion of the relationship between the management criteria for land subsidence and the other sustainability indicators, including an explanation of how criteria, including interim milestones, were established to avoid undesirable results for each of the other sustainability indicators.

d. The GSAs should reevaluate or eliminate the application of the level of uncertainty as it relates to subsidence measurements according to standard professional practices. Establishment of sustainable management criteria should not allow for

[273] 23 CCR § 354.44 (c).
[274] 23 CCR § 354.44 (d).

subsidence in perpetuity based on the error of measurement. The GSAs should also consider incorporation of remotely sensed subsidence data (i.e., InSAR data) made available by the Department on an ongoing basis to monitor for subsidence in conjunction with the representative monitoring sites. For reference, the statewide vertical displacement measurements provided via the InSAR data present an error of 0.1 foot.

RECOMMENDED CORRECTIVE ACTION 5

The GSA should provide a discussion of the uncertainty concerning the hydrogeologic conceptual model and a description of hydrogeologic conceptual model data gaps.[275] For example, the GSP should include revisions to identify how many wells are completed below the bottom of the Subbasin, the amount of water that is extracted from these wells, and a description of changes to groundwater storage calculations for the Subbasin based on best available information.

RECOMMENDED CORRECTIVE ACTION 6

The GSAs must provide more detailed explanation and justification regarding the selection of the sustainable management criteria for degradation of water quality. Department staff recommend the GSAs consider and address the following:

a. The GSAs should revise the definition of undesirable results so that exceedances of minimum thresholds caused by groundwater extraction are considered in the assessment of undesirable results in the Subbasin.

b. The GSAs should provide a clear definition of what the Plan considers an undesirable result for degraded water quality by describing conditions that it would consider to be significant or unreasonable. For example, the Plan should—in addition to qualitative descriptions—quantify the specific potential effects to beneficial users and uses from undesirable results using best available data and science. This definition should be supported by information described in the basin setting, and other data or models as appropriate, as required by the GSP Regulations.[276]

c. The GSAs should identify which minimum threshold values—either the MCL or existing concentration plus 20 percent—will be used at which representative monitoring sites. Also, the GSAs should justify how establishing minimum thresholds at the higher of either MCLs or existing concentrations plus 20 percent does not constitute significant and unreasonable effects as defined by the GSP (i.e., “when beneficial uses for groundwater are adversely impacted by constituent concentrations).

[275] 23 CCR § 354.14(b)(5).
[276] 23 CCR § 354.26 (b)(1).

Appendix 1.A. DWR Recommended Corrective Actions and Corresponding Revisions to Plan Elements (§356.4(i))

Appendix 1.A.2. Summary of Revisions to Address Recommended Corrective Actions – Joint GSP 2025 Plan Amendment

Topic	Recommended Corrective Action	Section(s) Where Recommended Corrective Action was Primarily Addressed in the Joint GSP	How Recommended Corrective Action was Addressed
1. GSP Adoption by All GSAs	Add language to the Joint GSP explaining that all Joint GSP GSAs have adopted the Joint GSP and are committed to implementing it consistent with SGMA.	Section 1 (Introduction) Appendix 1.H (Adoption Resolutions)	Text has been added to Section 1 of the Joint GSP 2025 Plan Amendment to describe the adoption of the Joint GSP (March 2023 Revisions) by all four Joint GSP GSAs and their commitment to implementing the Plan consistent with SGMA. The adoption resolutions for all Joint GSP GSAs have been included in Appendix 1.H of the Joint GSP 2025 Plan Amendment.
2. Continued Coordination	The GSAs must continue to coordinate to eliminate areas of disagreement.	Executive Summary (GSP Development, Coordination, and Outreach) Section 1.3.3 (Coordination Among the GSAs) Appendix 1.J (Coordination Agreement Amendment)	Despite multiple GSPs in the Subbasin, the GSAs have worked continuously over the last several years to seek consensus, striving to bring consistency across the four GSPs with the express goal of eliminating inconsistencies and embracing shared tools and resources, all while working towards a common Subbasin sustainability goal. The GSAs have continued coordination efforts through many efforts, including (but not limited to): • Engagement of facilitation support services to assist the GSAs in working through and eliminating any areas of disagreement. Specific areas of assistance include intra-basin and inter-basin coordination support, governance development, and other stakeholder outreach and engagement support efforts. • Ongoing recurring meetings between the technical teams for each GSA (or group of GSAs in the case of the Joint GSP) to discuss methodologies and preferred technical approaches for addressing DWR's recommended corrective actions. These technical team meetings have served as the basis for reaching consensus and ensuring consistent policies, procedures, and methodologies and ultimately, consistent groundwater management across the Subbasin. • Recurring meetings between the Joint GSP GSAs to coordinate GSP implementation. • Updates and refinements to the Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) through coordination between all GSAs. To date, all GSAs have embraced the use of MCSim as a consistent methodology for determining historical and projected conditions within the Subbasin. MCSim continues to be supported broadly by the GSAs in the Subbasin and serves as a uniform and consistent basis for development of GSA water budgets, future subsidence estimates, and establishment of SMC in the 2025 Plan Amendment. • Development of a Domestic Well Mitigation Program (DWMP) memorandum of understanding (MOU) by the GSAs, made possible through facilitation and related services between the GSAs, including a DWR grant for Senate Bill (SB) 552 compliance. For purposes of the 2025 Plan Amendment, it is assumed that the facilitation and related services associated with the DWMP as set-forth above will result in complete development of the DWMP such that implementation can begin in 2025 as set-forth and agreed upon in the MOU. • Signing a new coordination agreement. Ongoing coordination efforts since Fall 2023 (prior to DWR's approval of the 2023 Revised Plan on December 21, 2023) are summarized in the executive summary and in Section 1.3.3 of the Joint GSP 2025 Plan Amendment.

Topic	Recommended Corrective Action	Section(s) Where Recommended Corrective Action was Primarily Addressed in the Joint GSP	How Recommended Corrective Action was Addressed
3. Groundwater Level Sustainable Management Criteria (SMC)	The GSAs must revise the GSPs to include a discussion of the relationship between the SMC for chronic lowering of groundwater levels and the other sustainability indicators, including an explanation of how the SMC, including interim milestones (IMs), were established to avoid undesirable results (URs) for each of the other sustainability indicators.	Section 3.2.1 (Measurable Objectives and Interim Milestones) Section 3.3.1 (Minimum Thresholds) Section 3.4 (Undesirable Results) Appendix 6.D (MCSim Updates) Appendix 6.E (1D Subsidence Modeling)	The Joint GSP 2025 Plan Amendment includes an updated explanation of how the groundwater level SMC, including IMs, were established to avoid URs for each of the other sustainability indicators and an explanation of how groundwater levels and subsidence are separate sustainability indicators with different SMC, and that the most restrictive SMC governs. MCSim has also been updated to incorporate the Integrated Water Flow Model (IWFM) subsidence module that became available after initial development of MCSim for the Initial Joint GSP. These updates allow direct simulation of the relationship between groundwater levels and subsidence across the Subbasin, including evaluation of the relationship between the SMC for groundwater levels and subsidence. The updated MCSim has been embraced by all Subbasin GSAs as a uniform and consistent basis for development of GSA water budgets, future subsidence estimates, and establishment of SMC in the 2025 Plan Amendment. The GSAs have further completed additional 1D subsidence modeling to characterize the relationship between groundwater levels and subsidence at specific locations with data. The Subbasin GSAs also conducted interviews with critical infrastructure owners and operators (Section 3.4.3) to assess their subsidence concerns and issues, and have also continued to coordinate development of the DWMP (see Sections 3.3.1.1 and 4.9.5). Through these efforts, the Subbasin GSAs are proactively working to ensure that the groundwater level SMC are not negatively impacting beneficial uses and users and other sustainability indicators.
4. Land Subsidence Updates	*See specific items below.*	*See specific items below.*	*See specific items below.*

4.a	Refine the description of URs:
	• Clearly describe the significant and unreasonable conditions the GSAs are managing the Subbasin to avoid.
	• Reevaluate the quantitative metrics that define a UR, considering:
	  ◦ Localized subsidence conditions and the irreversibility of continued inelastic subsidence, especially in an area deemed of "greater subsidence concern."
	  ◦ The current quantitative metrics (i.e., 75 percent of RMS) would not minimize or avoid inelastic subsidence in the most susceptible areas of the Subbasin – predominantly in the north-northwestern portion of the Subbasin.
		Section 3.4.3 (Undesirable Results)
		
		Table 3-16 (Documentation of interviews conducted with critical infrastructure owners and operators to identify critical infrastructure, reported and possible subsidence impacts)
		
		Section 4 (Projects and Management Actions)
			The Subbasin GSAs addressed these recommended corrective actions through the following updates:
			• Documentation of interviews conducted with critical infrastructure owners and operators (in summer 2024) to confirm identification of their critical infrastructure, document observed and possible impacts attributable to land subsidence, and assess the potential future impacts of land subsidence.
			• Updates to describe the significant and unreasonable conditions the GSAs are managing the Subbasin to avoid, informed by input gathered from critical infrastructure owners and operators and members of the public.
			• Reviewing and refining the quantitative metrics that define URs for subsidence, including identifying and defining the cumulative amount of subsidence that, if exceeded, would substantially impact groundwater and land surface beneficial uses and users. Quantitative metrics were also informed by input gathered from critical infrastructure owners and operators.
			• Description of Projects and Management Actions (PMAs) that will be implemented to minimize or eliminate subsidence.

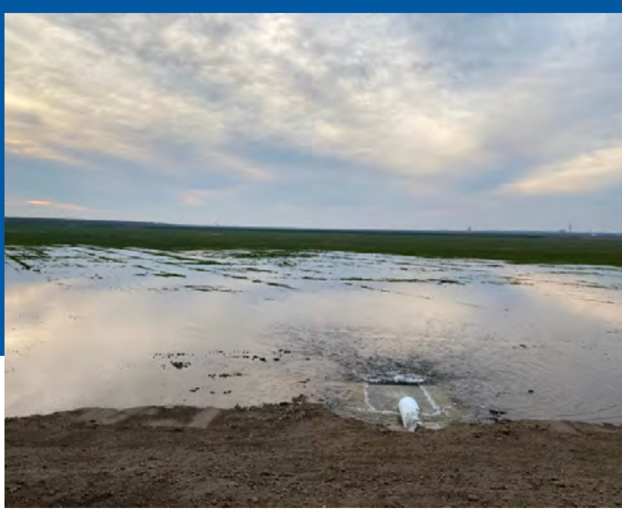
Topic	Recommended Corrective Action	Section(s) Where Recommended Corrective Action was Primarily Addressed in the Joint GSP	How Recommended Corrective Action was Addressed
4.b	Identify the cumulative amount of subsidence that, if exceeded, would substantially interfere with groundwater and land surface beneficial uses and users in the Subbasin. • Explain how the rate and extent of any future subsidence permitted in the Subbasin may interfere with surface land uses. • Describe the current and potentially lasting impacts of subsidence on land uses and groundwater beneficial uses and users.	Section 3.4.3 (Undesirable Results) Table 3-16 (Documentation of interviews conducted with critical infrastructure owners and operators to identify critical infrastructure, reported and possible subsidence impacts) Section 3.2.3 (Interim Milestones) Appendix 3.G (Infrastructure Sensitivity Assessment)	The Joint GSP GSAs conducted a detailed infrastructure sensitivity assessment (Appendix 3.G) and conducted interviews with critical infrastructure owners and operators (Section 3.4.3) to identify the cumulative amount of subsidence that, if exceeded, would substantially interfere with groundwater and land surface beneficial uses and users in the Subbasin. These efforts were documented in the Joint GSP 2025 Plan Amendment, and were used to re-evaluate critical infrastructure, the potential impacts of land subsidence, and the extent to which potential impacts are considered significant and unreasonable by the interviewed critical infrastructure owners and operators and members of the public. These discussions directly informed updates to quantitative metrics for tracking cumulative subsidence (i.e., IMs) to avoid interference with land uses and groundwater beneficial uses and users. Following the infrastructure sensitivity assessment and interviews, the Subbasin GSAs, with support from the agencies interviewed, are also proposing to establish a Subbasin Critical Infrastructure Operator Group. Although discussions are ongoing, the Critical Infrastructure Operator Group is planning to meet annually to provide updates on any potential critical infrastructure impacts related to subsidence, to coordinate ongoing PMA implementation, and to discuss any potential critical infrastructure mitigation concerns. These coordination efforts will help to identify cumulative subsidence concerns early and to spur action to avoid exceedances that would substantially interfere with groundwater and land surface beneficial uses and users in the Subbasin.
4.c	Revise the GSPs to include a discussion of the relationship between the SMC for land subsidence and the other sustainability indicators, including an explanation of how the SMC, including IMs, were established to avoid URs for each of the other sustainability indicators.	Section 3.2.3 (Measurable Objectives and Interim Milestones) Section 3.3.3 (Minimum Thresholds) Section 3.4 (Undesirable Results) Appendix 6.D (MCSim Updates) Appendix 6.E (1D Subsidence Modeling)	The Joint GSP 2025 Plan Amendment includes an updated explanation of how the subsidence SMC, including IMs, were established to avoid URs for each of the other sustainability indicators and an explanation of how groundwater levels and subsidence are separate sustainability indicators, and that the most restrictive SMC governs. MCSim has also been updated to incorporate the IWFM subsidence module that became available after initial development of MCSim for the Initial Joint GSP. These updates allow direct simulation of the relationship between groundwater levels and subsidence across the Subbasin, including evaluation of the relationship between the SMC for groundwater levels and subsidence. The updated MCSim has been embraced by all Subbasin GSAs as a uniform and consistent basis for development of GSA water budgets, future subsidence estimates, and establishment of SMC in the 2025 Plan Amendment. The GSAs have further completed additional 1D subsidence modeling to characterize the relationship between groundwater levels and subsidence at specific locations with data.
4.d	Reevaluate or eliminate the application of the level of uncertainty as it relates to subsidence measurements (i.e., clarify SMC so that subsidence can't continue into perpetuity).	Section 3.2.3 (Measurable Objectives) Section 3.4.3 (Undesirable Results) Section 4.9.5 and Appendix 3.H (Subsidence data gaps workplan)	Text has been added to clarify that the MO for subsidence of 0.00 feet/year was established with the goal of long-term avoidance of land subsidence, and that the consideration of uncertainty is not meant to allow for continued subsidence in the Subbasin. Rather, this is an acknowledgement that there may be instances where measurement uncertainty will indicate a rate of subsidence greater than the MO. The definition of undesirable results (as described in Section 3.4.3) will govern and, should an IM be exceeded or an undesirable result occur, a subsidence working group committee consisting of technical representatives of each Subbasin GSA as appointed by the Coordination Committee will be formed to define areas of the Subbasin subject to taking additional actions to eliminate subsidence. To address the need and interest in improving the understanding of subsidence in the Subbasin, the GSAs have also developed a workplan outlining future activities related to monitoring and understanding conditions relating to subsidence in the Subbasin. The subsidence workplan is described in Section 4.9.5 and included in Appendix 3.H of the Joint GSP 2025 Plan Amendment.

Topic	Recommended Corrective Action	Section(s) Where Recommended Corrective Action was Primarily Addressed in the Joint GSP	How Recommended Corrective Action was Addressed
4.e	Describe Projects and Management Actions (PMAs) that will be implemented to minimize or eliminate subsidence (with details/schedule).	Section 4 (Projects and Management Actions)	Additional text was added to indicate which specific PMAs will help to reduce the rate of active subsidence and/or minimize or prevent continuing subsidence.
5. Hydrogeologic Conceptual Model	Discuss the uncertainty concerning the Hydrogeologic Conceptual Model (HCM) and a description of the HCM data gaps.	Executive Summary (Approach to Achieving Sustainability) Section 2.2.2.7 (Uncertainty and Data Gaps in Hydrogeologic Conceptualization and Groundwater Conditions) Appendix 3.I (Subsidence and ISW Workplans)	Additional text was added to discuss the uncertainties related to the HCM, new information gathered about the HCM (e.g., additional description of principal aquifers, aquifer confinement, and updates related to new nested monitoring wells), and a description of HCM data gaps and how these have been or are being addressed. Certain data gaps and associated uncertainty are described in Section 2.2.2.7. Additional information about assessment of data gaps and related improvements to the monitoring network is provided in Section 3.5.4. The GSAs have also discussed, reviewed, and refined their subsidence and ISW Workplans to fill data gaps. Extensive work has also been completed during 2024 to update and refine MCSim, including refinements to the HCM that were informed by new monitoring well data and AEM data provided by DWR.
6. Water Quality	*See specific items below.*	*See specific items below.*	*See specific items below.*
6.a	Revise the definition of URs so that exceedances of minimum thresholds caused by groundwater extraction are considered in the assessment of undesirable results in the Subbasin.	Section 3.3.4 (Minimum Thresholds) Section 3.4.4 (Undesirable Results) Table ES-3 (SMC Summary)	Additional text was added to clarify the water quality undesirable results definition, with specific incorporation of overall Subbasin groundwater extraction (along with PMAs) as potential causes of groundwater quality degradation that the GSAs are responsible for. The definition recognizes "10 percent of RMS wells above the minimum threshold for the same constituent due to projects and/or management actions, or overall groundwater extraction, based on average of most recent three year period."
6.b	Clearly define what the Plan considers an UR for degraded water quality by describing conditions that it would consider to be significant or unreasonable. • Quantify the specific potential effects to beneficial users and uses from undesirable results using best available data and science. • Definition should be supported by information described in the basin setting, and other data or models as appropriate	Section 3.3.4 (Minimum Thresholds) Section 3.4.4 (Undesirable Results)	The Subbasin GSAs addressed these recommended corrective actions through the following updates: • Updates to more clearly describe the significant and unreasonable conditions the GSAs are managing the Subbasin to avoid, including specific adverse impacts related to groundwater quality (e.g., causing domestic/municipal supply wells to exceed MCLs). • Reviewing and refining the quantitative metrics that define URs for water quality.
6.c	Identify which minimum threshold values—either the MCL or existing concentration plus 20 percent—will be used at which representative monitoring sites.	Section 3.3.4 (Minimum Thresholds) Section 3.4.4 (Undesirable Results)	Additional text has been added to document the approach used to establish the MT values, as well as studies and reports reviewed that recognize that it is reasonable and technically justifiable to set MTs with respect to existing concentrations near or above the MCL, recognizing the uncertainty in individual sample measurement accuracy (i.e., setting the MT for groundwater quality RMS at either the MCL, or at the baseline concentration + 20% at locations where the existing concentrations are near or above the MCL). All four GSPs in the Subbasin have agreed to adopt the same consistent MT approach for the same key constituents (arsenic, nitrate, and TDS).

Topic	Recommended Corrective Action	Section(s) Where Recommended Corrective Action was Primarily Addressed in the Joint GSP	How Recommended Corrective Action was Addressed
			The Joint GSP 2025 Plan Amendment has also been updated to include all available groundwater quality data collected for the groundwater quality RMS to date. This information is being evaluated as part of the Periodic Evaluation to develop appropriate baselines for all groundwater quality RMS.
6.d	Justify how establishing minimum thresholds at the higher of either MCLs or existing concentrations plus 20 percent does not constitute significant and unreasonable effects as defined by the GSP.	Section 3.3.4 (Minimum Thresholds) Section 3.4.4 (Undesirable Results)	Additional text has been added to document the approach used to establish the MT values, as well as studies and reports reviewed that recognize that it is reasonable and technically justifiable to set MTs with respect to existing concentrations near or above the MCL, recognizing the uncertainty in individual sample measurement accuracy (i.e., setting the MT for groundwater quality RMS at either the MCL, or at the baseline concentration + 20% at locations where the existing concentrations are near or above the MCL).
Additional Action 1.	Interconnected Surface Water (ISW) Updates.	Section 2.2.2.5 (Groundwater - Surface Water Interaction) Section 2.2.2.7.4 (ISW Uncertainty and Data Gaps) Section 4.9.5 (ISW Stakeholder Coordination) Appendix 3.I. (ISW Data Gaps Workplan, and ISW Coordination MOU).	Though not specifically requested by DWR, the GSAs have taken the initiative to engage in ISW coordination with applicable GSAs in the Kings Subbasin, the United States Bureau of Reclamation (USBR), the Friant Water Authority (FWA), and the San Joaquin River Restoration Program (SJRRP). Since late 2023, representatives from the Subbasin and Kings Subbasin (McMullin Area GSA and North Kings GSA) have been meeting monthly with representatives from the USBR and FWA to better understand their issues and concerns related to ISW along the San Joaquin River. These discussions have led to more detailed analyses by USBR and FWA of total diversions, uses, and losses along portions of the San Joaquin River, and more detailed analyses by USBR related to the Holding Contracts and the groundwater pumping allowances and limitations that will need to be factored into any allowable groundwater pumping within proximity to the San Joaquin River The Subbasin GSAs also coordinated and developed an ISW workplan for the Subbasin as part of prior GSP development. Certain refinements were made to the ISW workplan following coordination with applicable GSAs in the Kings Subbasin to draw greater consistency between the adjacent subbasins. These updates have been made in the January 2025 Plan Amendment. No amendments have been made to the ISW SMC in the 2025 Plan Amendment. It is anticipated that the ISW SMC may be refined following review of DWR's forthcoming guidance for managing ISW depletion (anticipated Winter 2024/2025).
Additional Action 2.	PMA Updates.	4.9 (Implementation of Projects and Management Actions Since Initial GSP Development)	The Joint GSP GSAs have also provided an update on PMA planning and implementation since the Initial Joint GSP was completed and submitted in January 2020.

Appendix 1.B. 2025 Periodic Evaluation GSP Attachments

Appendix 1.B.1. Joint GSP 2025 Periodic Evaluation Elements



Madera Subbasin Joint Groundwater Sustainability Plan

Periodic Evaluation

January 2025

PREPARED FOR

City of Madera GSA
County of Madera GSA - Madera Subbasin
Madera Irrigation District GSA
Madera Water District GSA

PREPARED BY

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List of Abbreviations

AFY	acre-feet per year
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
CM GSA	City of Madera GSA
DWMP	Domestic Well Mitigation Program
DWR	California Department of Water Resources
EO	Executive Order
ETAW	evapotranspiration of applied groundwater
GFWD GSA	Gravelly Ford Water District GSA
GIS	geospatial information system
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
IRWM	Integrated Regional Water Management
ISW	Interconnected Surface Water
MC GSA	County of Madera GSA – Madera Subbasin
MID GSA	Madera Irrigation District GSA
MLRP	Multibenefit Land Repurposing Program
MOU	memorandum of understanding
MWD GSA	Madera Water District GSA
MWELO	Model Water Efficient Landscape Ordinance
NRCS	Natural Resources Conservation Service
NSWD GSA	New Stone Water District GSA
PMAs	projects and management actions
RCWD GSA	Root Creek Water District GSA
RMS	representative monitoring site
SB	Senate Bill
SCADA	supervisory control and data acquisition
SGMA	Sustainable Groundwater Management Act
USBR	United States Bureau of Reclamation
VLRP	Voluntary Land Repurposing Program
WY	water year

Executive Summary

The Madera Subbasin (Subbasin[1]) is a critically overdrafted subbasin subject to the requirements of the Sustainable Groundwater Management Act of 2014 (SGMA). The Subbasin is cooperatively managed by seven Groundwater Sustainability Agencies (GSAs) under four Groundwater Sustainability Plans (GSPs) and one Coordination Agreement. The four GSPs and Coordination Agreement are collectively referred to as the Plan for the Subbasin, and the seven GSAs are collectively referred to as the Subbasin GSAs.

Four GSAs have jointly developed one GSP that is referred to as the Joint GSP, including: City of Madera GSA (CM GSA), County of Madera GSA – Madera Subbasin (MC GSA), Madera Irrigation District GSA (MID GSA), and Madera Water District GSA (MWD GSA). These four GSAs are collectively referred to as the Joint GSP GSAs. The remaining three GSAs – Gravelly Ford Water District GSA (GFWD GSA), New Stone Water District GSA (NSWD GSA), and Root Creek Water District GSA (RCWD GSA) – have each developed their own GSPs.

The Subbasin GSAs have collaboratively developed one cohesive 2025 Periodic Evaluation for the Plan in alignment with the requirements of the GSP regulations, per the California Code of Regulations Title 23 (23 CCR) §356.4.

This document is the 2025 Periodic Evaluation GSP attachment for the Joint GSP, containing the 2025 Periodic Evaluation elements specific to the Joint GSP 2025 Plan Amendment and the Joint GSP GSAs. Other content related to the entire Subbasin and all four GSPs is contained in the Madera Subbasin 2025 Periodic Evaluation.

This document follows the same general structure as the Madera Subbasin 2025 Periodic Evaluation, with cross-referencing between documents as appropriate to capture all content pertinent to the Subbasin as a whole and to the Joint GSP 2025 Plan Amendment.

Content across the 2025 Periodic Evaluation includes the following, in alignment with 23 CCR §356.4:

- New Information Collected (§356.4(f))
- Groundwater Conditions Relative to Sustainable Management Criteria (§356.4(a))
- Status of Projects and Management Actions (§356.4(b))
- Basin Setting Evaluation Based on New Information or Changes in Water Use (§356.4(c)-(d))
- Monitoring Networks Evaluation (§356.4(e))
- GSA Authorities and Enforcement Actions (§356.4(g)-(h))
- Outreach, Engagement, and Coordination with other Agencies (§356.4(j))
- Other Information (§356.4(k))
- Summary of Proposed or Completed Revisions to Plan Elements (§356.4(i))

Please refer to the Madera Subbasin 2025 Periodic Evaluation for the Executive Summary overview of conditions in the Subbasin and Plan implementation activities by the Subbasin GSAs during the first Periodic Evaluation cycle from January 31, 2020 through January 31, 2025.

[1] Groundwater basin number 5-022.06, part of the San Joaquin Valley Groundwater Basin, as defined by DWR Bulletin 118 (DWR, 2003) and updated in 2016.

1 New Information Collected or Acquired (§356.4(f))

Please refer to the Madera Subbasin 2025 Periodic Evaluation for a summary of new information collected or acquired during this Periodic Evaluation cycle (per 23 CCR §356.4(f)). Updates are provided for the Subbasin as a whole.

2 Groundwater Conditions Relative to the Sustainable Management Criteria (§356.4(a))

Please refer to the Madera Subbasin 2025 Periodic Evaluation for a summary of groundwater conditions relative to the sustainable management criteria for the Subbasin during this Periodic Evaluation cycle (per 23 CCR §356.4(a)). Updates are provided for the Subbasin as a whole, with specific reference to groundwater conditions at representative monitoring sites (RMS) in the Joint GSP area for all applicable sustainability indicators.

3 Status of Projects and Management Actions (23 CCR §356.4(b))

The purpose of this section is to describe the Joint GSP GSAs' advancements in implementing projects and management actions (PMAs), and the benefits those PMAs have achieved for the Subbasin through the most recently completed Annual Report (WY 2023), including how those benefits are contributing to the Subbasin achieving its sustainability goal and operating within its sustainable yield. This Periodic Evaluation covers the first Periodic Evaluation cycle, during which Annual Reports have been completed for WY 2019 through WY 2023. Thus, PMA implementation efforts by the Joint GSP GSAs described in this section are focused on this period. Efforts by the other GSAs in the Subbasin are described in their respective Periodic Evaluation attachments.

The contents of this section are organized as follows:

- **Section 3.1** provides a summary and status update for the Joint GSP GSAs' PMA implementation efforts during this Periodic Evaluation cycle.
- **Section 3.2** provides a summary of the benefits and costs of PMAs during the first Periodic Evaluation cycle.
- **Section 3.3** provides a brief description of how the GSAs are tracking, administering, and reporting PMA implementation in the Subbasin.

3.1 Summary and Status of PMA Implementation

PMAs that are being planned, developed, or implemented by the Joint GSP GSAs are listed and summarized in **Table 3-1**. **Table 3-1** includes many PMAs that were included in the 2020 Initial Joint GSP, as well as other PMAs that have been added or refined during this Periodic Evaluation cycle. **Table 3-1** provides a brief description of each PMA, its implementation status as of WY 2023 (the most recently completed Annual Report during this Periodic Evaluation cycle), the anticipated schedule for implementation, and a brief discussion of the PMA status and related activities during this Periodic Evaluation cycle. The status of PMAs is generally defined as follows:

- **Implemented**: Active efforts to operate the PMA have begun, though benefits may or may not have been achieved to date (e.g., benefits may not have occurred if water has not been available for recharge since a PMA became operable).
- **In Progress**: Active efforts needed to initiate the PMA have begun (e.g., permitting), though development has not reached the point of operability.
- **Planned**: Early conceptual development is still in progress, though active efforts to initiate or operate the PMA have not begun.

Table 3-1 has been assembled from the Joint GSP Annual Reports prepared during this Periodic Evaluation cycle. Additional discussion of the status of PMAs for each Joint GSP is provided in **Sections 3.1.2** through **3.1.5**, and in the Joint GSP Annual Reports. Updates to these PMAs are also described in the Joint GSP 2025 Plan Amendment (Section 4.9). Updates will continue to be provided each year in the Joint GSP Annual Reports and in subsequent Periodic Evaluations and Plan Amendments, as necessary.

The GSAs have made significant progress in implementing PMAs, as evidenced by **Table 3-1**, the PMA summaries for each Joint GSP GSA (see **Sections 3.1.2 through 3.1.5**), and the benefits achieved thus far (see **Section 3.2**). Most PMAs proposed in the 2020 Initial Joint GSP are still applicable, and the Joint GSP GSAs have made considerable strides to implement those PMAs. The Joint GSP GSAs have also identified several new PMAs or made substantial refinements to planned PMAs during this Periodic Evaluation cycle. As of the WY 2023 Annual Report (the most recently completed Annual Report during this Periodic Evaluation cycle), updates were reported for nearly 30 PMAs developed by the Joint GSP GSAs. Benefits of PMA implementation are discussed in **Section 3.2**.

3.1.1 Adaptive Management Approach

The Joint GSP GSAs recognize that this Periodic Evaluation cycle included very wet conditions and substantial recharge in 2023. The Subbasin GSAs are planning PMAs and other GSP implementation efforts with the expectation that landmark wet years, such as 2023, will not occur again prior to 2040 (see Section 4.3.2 of the Madera Subbasin 2025 Periodic Evaluation). The Subbasin GSAs are committed **t**o adaptive management of groundwater resources through their suite of identified PMAs. As PMAs are implemented and monitored, the timelines of other PMAs and the volume of demand management necessary to achieve sustainability will be reviewed. If adjustments are needed to achieve the sustainability goal for the Subbasin, PMA implementation efforts will be evaluated and adjusted. Already, changes to PMA implementation have been informed by changing conditions and new understanding of the Subbasin. For instance, MC GSA has refined its demand reduction targets as part of its demand management program based on new understanding of overdraft in the MC GSA since the 2020 Initial Joint GSP was developed, increasing targets from 90,000 AFY to 113,000 AFY. MID GSA has also refined its PMAs, working to hasten recharge projects and incentives for surface water use to support groundwater sustainability, consistent with the Subbasin GSAs' adaptive management commitment. Each Annual Report represents an important milestone and recurrent opportunity for the GSAs to collectively review groundwater conditions in the Subbasin and report on the status of Joint GSP implementation efforts.

Table 3-1. Summary of PMA Implementation as of the Water Year 2023 Annual Report.

GSA	PMA Name	PMA Description	PMA in 2020 Joint GSP	PMA Status as of WY 2023	Planned Start Year *(Actual, if Earlier)*	Discussion of PMA Status and Implementation During this Periodic Evaluation Cycle as of the WY 2023 Annual Report
MWD	Expanded Surface Water Purchase	Expand ability to purchase additional surface water supply, including upgrades to conveyance infrastructure.	Yes	In Progress	2023	MWD GSA has continued work to implement the expanded surface water purchase project. A large component of this has been MWD's work on the Madera Lake Project, which will construct the infrastructure needed to allow additional surface water from MID or other sources to be brought into MWD through Madera Lake. In early 2022, MWD applied for and was awarded $3.7 million in Proposition 68 funding from DWR for development and construction of the Madera Lake Project. In 2022, MWD initiated various permitting processes and circulated CEQA documents for the Madera Lake Project. As of the end of WY 2023, MWD was continuing to pursue the required permits. MWD also purchased additional surface water in WY 2021-2023 (benefits of this additional surface water are quantified in WY 2023). MWD plans to purchase additional surface water when it is available.
MID	Rehab Recharge Basins	Rehabilitate and upgrade recharge facilities, including metering.	Yes	Implemented	2016	MID rehabilitated and expanded the capacity of its recharge basins. The capacity was expanded by approximately 130,000 cubic yards (approximately 83 AF) as of the end of WY 2023, resulting in higher recharge potential in wet years. Little to no recharge occurred in 2020-2022 due to drought conditions and limited surface water availability, although MID recharged nearly 3,700 AF of water in WY 2019 and nearly 5,300 AF of water in WY 2023.
MID/MC	Ellis Basin	Cooperatively operate Ellis Basin for recharge.	Yes	Implemented	2016	MID and MC continued to cooperatively operate Ellis Basin for recharge, but no recharge occurred in 2020-2022 due to drought conditions and limited surface water availability, or in 2023 due to maintenance. MC completed recharge basin improvements and maintenance in 2022, and CM conducted maintenance in 2023 to remove sediment and improve drainage.
MID/CM	Berry Basin	Cooperatively operate Berry Basin for recharge.	Yes	Implemented	2018	MID and CM continued to cooperatively operate Berry Basin for recharge. No recharge occurred in 2020-2022 due to drought conditions and limited surface water availability, while some recharge occurred in WY 2019 and WY 2023. MID and CM recharged more than 400 AF of water in 2023 (benefits are split between MID and CM).
MID	Allende Basin	Operate Allende Basin for recharge.	Yes	Implemented	2019	MID continued to operate Allende Basin for recharge, however little to no recharge occurred in 2020-2022 due to drought conditions and limited surface water availability. MID recharged more than 3,000 AF of water in 2019 and nearly 5,000 AF of water in 2023.
MID/CM	Additional Recharge Basins with City of Madera	Cooperatively operate additional basins for recharge, including Golf Course Basin and Airport Basin.	No (Added)	Implemented	2021	MID developed and operated additional recharge basins in coordination with CM beginning in 2021. MID and CM are jointly developing the Golf Course Basin. In 2021, MID facilities were connected to the Golf Course Basin in the CM for future groundwater recharge benefiting MID and CM. More than 1,200 AF of water was recharged in 2023 in basins jointly operated by MID and CM, including the Golf Course, Absire, Stadium, Mitchell, and Mosesian Basins (benefits are split between MID and CM).
MID	Additional Recharge Basins Phase 1	Construct and operate additional recharge basins.	Yes	Implemented	2030 *(Implemented beginning 2021)*	MID began developing additional recharge basins in 2021 that were successfully used for recharge in 2023. MID acquired three (3) parcels in 2021 (approximately 73 acres) and developed recharge basins on those parcels in 2022. More than 6,700 AF of water was recharged in those additional recharge basins in 2023.
MID	Additional Recharge Basins Phase 2	Construct and operate 260 acres of additional recharge basins.	Yes	In Progress	2040 *(In Progress as of 2023)*	MID is developing additional recharge basins ahead of schedule. MID acquired two parcels for new recharge basins in 2023, totaling approximately 45 acres.
MID	On-Farm Recharge	Deliver available flood water to agricultural or other suitable land for recharge.	Yes	Implemented	2015	MID has constructed infrastructure to redirect flood waters to suitable farmland for recharge. MID is also offering financial incentives to promote participation in recharge program. Approximately 3,000 AF of recharge occurred in 2019, although little to no on-farm recharge occurred in 2020-2022 due to drought conditions and limited surface water availability. Wet conditions in 2023 allowed MID to offer landowners on-farm recharge opportunities throughout the year. Water was available from $0/AF to $10/AF to promote on-farm recharge. Substantial volumes of on-farm recharge occurred in 2023, with estimates in excess of 38,000 AF (benefits are split between Phase 1 and 2).
MID	Phase 2 On-Farm Recharge	Expand delivery of available flood water to agricultural or other suitable land for recharge.	Yes	Implemented	2025 *(Implemented beginning 2023)*	MID has expanded the on-farm recharge program beginning in 2023. Many more MID landowners are taking advantage of this opportunity when it is available. MID has also partnered with the NRCS and U.S. Department of Interior's WaterSMART Initiative for funding of projects related to on-farm recharge and MID's Incentive Program (see below). $1.5 million was made available in 2022, and another $2.4 million was made available in fall 2023. Substantial volumes of on-farm recharge occurred in 2023 (benefits are split between Phase 1 and 2).
MID	MID Pipeline	Rehabilitate aging pipelines to reduce losses.	Yes	Implemented	2016	MID replaced 5,350 feet of pipeline in 2021, in addition to other rehabilitation prior to WY 2019. MID continues to see in-lieu recharge benefits from improvements made through this PMA.
MID	WaterSMART Pipeline	Rehabilitate additional pipelines to reduce losses and allow MID to deliver water later in the irrigation season.	Yes	Implemented	2019	MID continues to see in-lieu recharge benefits from improvements made through this PMA.

GSA	PMA Name	PMA Description	PMA in 2020 Joint GSP	PMA Status as of WY 2023	Planned Start Year *(Actual, if Earlier)*	Discussion of PMA Status and Implementation During this Periodic Evaluation Cycle as of the WY 2023 Annual Report
MID	WaterSMART SCADA	Expand SCADA to improve MID water management, reduce losses, and allow MID to deliver water later in the irrigation season.	Yes	Implemented	2019	MID received WaterSMART grant funding from the USBR in 2021 that is being used for installation of additional SCADA, automated gates, and new meters. Other improvements made since this PMA began in 2019 are still in use. MID continues to benefit from improvements made through this PMA.
MID	Water Supply Partnerships	Identify and purchase or exchange additional water supplies from partnering districts.	Yes	In Progress	2025 *(In Progress as of 2022)*	MID is working to establish water supply partnerships with local landowners to improve MID water management to reduce water loss and reduce groundwater pumping. MID is also working with other districts with Friant contracts to develop water supply partnerships.
MID	Incentive Program	Develop incentive structures to encourage more MID growers to utilize surface water supplies instead of groundwater.	Yes	Implemented	2022	MID is continuing various efforts to develop incentive structures to encourage more MID growers to utilize surface water supplies instead of groundwater. These include grant-funded efforts to educate and support local MID growers to facilitate irrigation using surface water rather than groundwater. MID also uses financial incentives to encourage landowners to participate in these programs and projects. In wet years, MID implements the Incentive Program as part of the On-Farm Recharge Program (above). Since 2021, MID has conducted public outreach to educate growers on the benefits of surface water use and to encourage landowners to use available surface water through existing turnouts or installation of new turnouts. Since 2022, MID has partnered with the NRCS and U.S. Department of Interior's WaterSMART Initiative and was selected as a pilot program area for investigating the benefits of implementing new recharge practices. Through this program, $1.5 million in funding was made available to MID landowners in 2022 and another $2.4 million was made available in fall 2023 for projects that conserve water and promote the use of surface water, such as on-farm recharge, recharge basins, or other supporting practices. MID has conducted public outreach and hosted workshops to promote the program and offered financial incentives to encourage landowner participation and surface water use. More than 25 parcels in MID have participated in recharge activities.
MID	Demand Reduction	Detach from MID or remove agricultural land from production.	No (Added)	Implemented	2019	MID has acquired more than 118 acres of irrigated parcels and took those out of production for conversion to recharge basins since adoption of the 2020 Initial Joint GSP. MID also detached 320 acres from MID GSA, with ongoing benefits to demand in MID GSA.
MID	Grazing Land Annexation	Annexation of grazing land to increase sustainable yield for the MID GSA.	No (Added)	Implemented	2020	MID annexed parcel APN 044-192-009 into the District area, increasing sustainable yield for the MID GSA. Grazing land is available for recharge, with ongoing benefits since WY 2020.
MID	Water User Software Platform (UI)	Software platform for MID landowners that provides information on current and historical water use	No (Added)	Implemented	2020	MID has continued implementing this PMA throughout this Periodic Evaluation cycle.
MID	Intensive Groundwater Use Policy	Policy related to intensive groundwater use for a purpose other than agriculture.	No (Added)	Implemented	2019	MID has continued implementing this PMA throughout this Periodic Evaluation cycle.
CM	Meters and Volumetric Pricing	Install water meters and implement a volumetric billing process for single-family users to promote water conservation.	Yes	Implemented	2015	CM is continuing efforts to identify and install water meters to reduce water use. The installation of water meters is greater than 97% complete. In 2022, CM identified 646 additional residential, industrial, commercial, and institutional locations to be metered. Plans, specifications, and estimates were prepared for meter installation, and CM proceeded with installation of 46 automatic meter reading (AMR) meters ranging from 3 to 10 inches in 2023. Additional meters are being installed in subsequent years.
CM/MID	Berry Basin	Cooperatively operate Berry Basin for recharge.	Yes	Implemented	2018	CM and MID continued to cooperatively operate Berry Basin for recharge. No recharge occurred in 2020-2022 due to drought conditions and limited surface water availability, while some recharge occurred in WY 2019 and WY 2023. MID and CM recharged more than 400 AF of water in 2023 (benefits are split between MID and CM).
CM/MID	Additional Recharge Basins	Cooperatively operate additional basins for recharge, including Golf Course Basin and Airport Basin.	No (Added)	Implemented	2021	MID developed and operated additional recharge basins in coordination with CM beginning in 2021. Updates to this PMA are described above.
MC/MID	Ellis Basin	Cooperatively operate Ellis Basin for recharge.	Yes	Implemented	2016	MID and MC continued to cooperatively operate Ellis Basin for recharge, but no recharge occurred in 2020-2022 due to drought conditions and limited surface water availability, or in 2023 due to maintenance. MC completed recharge basin improvements and maintenance in 2022, and CM conducted maintenance in 2023 to remove sediment and improve drainage.
MC	Water Imports Purchase	Develop partnerships and import additional water into Madera County for direct or in-lieu recharge.	Yes	In Progress	2025	MC requested a change in place of use in 2019 and has since had multiple meetings with USBR.
MC	Millerton Flood Release Imports	Request CVP Section 215 flood water when available for recharge	Yes	In Progress	2025	MC requested a change in place of use in 2019 and has since had multiple meetings with USBR. MC has written a separate letter requesting Section 215 water to be made available for use in MC.

GSA	PMA Name	PMA Description	PMA in 2020 Joint GSP	PMA Status as of WY 2023	Planned Start Year *(Actual, if Earlier)*	Discussion of PMA Status and Implementation During this Periodic Evaluation Cycle as of the WY 2023 Annual Report
MC	Chowchilla Bypass Flood Flow Recharge Phase 1	Construct and operate diversion and conveyance facilities and basins.	Yes	In Progress	2025	MC is continuing efforts to construct and operate infrastructure for recharge as part of the Chowchilla Bypass Flood Flow Recharge program. Phase 1 efforts during this Periodic Evaluation cycle have primarily been focused on identifying project funding and conducting surveying, design, and required permitting, CEQA, and regulatory processes. MC GSA applied for and was awarded grant funding from DWR in 2021 to fund Phase 1 project development. Grant funds are being used to support Phase 1 planning and design of infrastructure for diversions, deliveries, and recharge of flood water from Millerton Reservoir and purchased water. Surveying and 60% of designs were completed in 2022. Final designs, planning efforts, and permitting have continued, although delays in CEQA and permitting processes have created schedule challenges. MC GSA has continued moving forward with permitting and CEQA-related efforts, after which the MC GSA anticipates completion of design documents and initiation of the construction bid process. The MC GSA has also planned to submit a request for a grant agreement extension to support project completion. This project has been developed in close coordination with RCWD and participating landowners. Despite delays in CEQA and permitting, substantial recharge occurred under the provisions of EO N-4-23 in 2023, in excess of 42,000 AF in the Subbasin.
MC	Chowchilla Bypass Flood Flow Recharge Phase 2	Construct and operate additional diversion and conveyance facilities and basins.	Yes	In Progress	2040	MC is continuing efforts to construct and operate infrastructure for recharge as part of the Chowchilla Bypass Flood Flow Recharge program. As part of Phase 2, MC has begun creating designs for additional infrastructure for the Chowchilla Bypass. MC began early planning for Phase 2 in 2020-2021, resulting in refined costs and benefits that were considered as part of the MC GSA rate study. MC GSA applied for and was awarded grant funding from DWR in 2022. Grant funds are being used to support Phase 2 planning and design of infrastructure for diversions, deliveries, and recharge of flood water from the Chowchilla Bypass. Conceptual plans have been developed for a new project location that will include a recharge basin and infrastructure to support Flood-MAR. The MC GSA is proceeding with 30% and 60% designs, and initiating required permitting processes. This project has been developed in close coordination with participating landowners. MC is conducting additional planning and coordinating with a group of farmers and other agencies in western Subbasin that have applied for a water right on the Chowchilla Bypass.
MC	Demand Management	Reduce consumptive water use through actions such as water-stressing crops, shifting to lower water-using crops, reducing evaporation losses, and reducing irrigated acreage.	Yes	In Progress	2020	MC GSA has completed, developed, and/or begun implementing numerous actions to support implementation of its demand management program. Related efforts include: • Water Market: MC conducted a water market study through funding from a USBR WaterSMART grant. The water market strategy was created through a collaborative process with participating stakeholders in 2020-2021, including workshops and interviews. A virtual pilot water market simulation was conducted between January 2021 and November 2021 to test the strategy's effectiveness. The final report was finished in 2022. • Land Repurposing Efforts: MC developed a Voluntary Land Repurposing Program (VLRP) through a stakeholder-driven process in 2020-2022, resulting in approval of rules and criteria for implementing the VLRP in December 2022. The MC GSA received grant funding to support VLRP development, and was also awarded a $9.3 million grant from DWR in 2022 for LandFlex which has been used to support VLRP implementation. MC is also planning land repurposing projects through the Multibenefit Land Repurposing Program (MLRP). These efforts are collectively supporting protection of productive agricultural land and incentivizing water use reduction in other areas through land conversion and repurposing for other lower water demand and multi-benefit uses. • Groundwater Allocation: The MC GSA has developed, approved, and begun enforcing groundwater allocations and penalties. Additional information is provided in Section 6.1.2. • Demand Measurement and Verification Projects: MC began implementing a demand measurement program in 2020-2021 to monitor water use throughout MC using a satellite imagery-based monitoring approach. This program evolved into the current MC demand measurement program and verification project. The MC GSA is monitoring demand using the three approved demand measurement options currently available to growers in the MC GSA for allocation enforcement. Since 2022, the MC GSA evaluated and compared data from all three approaches, developed methods and approaches for fairly and accurately using this data to track and enforce the allocation, and sought ways to increase grower engagement, education, and outreach. Initial data shows promising reductions in ETAW and irrigated areas in the MC GSAs across the Chowchilla, Delta-Mendota, and Madera Subbasins. The precise benefits of the groundwater allocation to the Subbasin groundwater system are still being quantified and will be given in future reports as more data is collected. • Rate Study: MC GSA completed a rate study, completed a Proposition 218 process, and approved a rate package to fund GSP implementation (MC GSA is currently restrained from imposing and/or collecting associated fees due to an injunction issued by the Madera County Superior Court in December 2022).
GFWD	*See GFWD GSA GSP 2025 Periodic Evaluation Elements for information on GFWD PMAs.*					
NSWD	*See NSWD GSA GSP 2025 Periodic Evaluation Elements for information on NSWD PMAs.*					
RCWD	*See RCWD GSA GSP 2025 Periodic Evaluation Elements for information on RCWD PMAs.*					

3.1.2 MID GSA PMAs

The MID GSA has fast-tracked many of its PMAs during this Periodic Evaluation cycle, and has worked to refine the details of planned PMAs from the 2020 Initial Joint GSP. Sixteen dedicated recharge basins are now being utilized by MID, including those operated in partnership with other GSAs, and MID has acquired parcels to develop additional recharge basins. Locations of recharge areas in the MID GSA and other areas of the Subbasin are shown in **Figure 3-1**. MID plans to continue operating all recharge basins in future years when surface water is available. Drought conditions during this Periodic Evaluation cycle from 2020-2022 led to reduced surface water supplies and limited the amount of recharge that occurred in these basins during those years, but MID was able to recharge large volumes of surface water in WY 2019 and particularly WY 2023.

MID continues to administer a multi-phased on-farm recharge program and incentivizes the use of surface water, whenever it is available. Outreach remains a major component of the incentive program. Wet conditions in 2023 allowed MID to offer landowners on-farm recharge opportunities throughout the year as well as low-cost water ($0/AF to $10/AF) to promote on-farm recharge.

MID has also partnered with the Natural Resources Conservation Service (NRCS) and U.S. Department of Interior's WaterSMART Initiative, and was selected as a pilot program area for investigating the benefits of implementing new recharge practices. Through this program, $1.5 million in funding was made available to MID landowners in 2022 and another $2.4 million was made available in fall 2023 for projects that conserve water and promote the use of surface water, such as on-farm recharge, recharge basins, or other supporting practices. MID has conducted public outreach, hosted workshops, and offers financial incentives to promote program participation within MID. The program has been a success, with more than 25 parcels in MID participating in recharge activities.

MID has continued benefitting from various infrastructure improvements proposed in the 2020 Initial Joint GSP which are improving MID's water management, reducing system losses, and enhancing flexibility of surface water deliveries to growers who would otherwise use groundwater. MID has also continued localized demand reduction efforts, and has made progress on developing water supply partnerships with partners outside of the Subbasin. The MID GSA's projects are ahead of schedule.

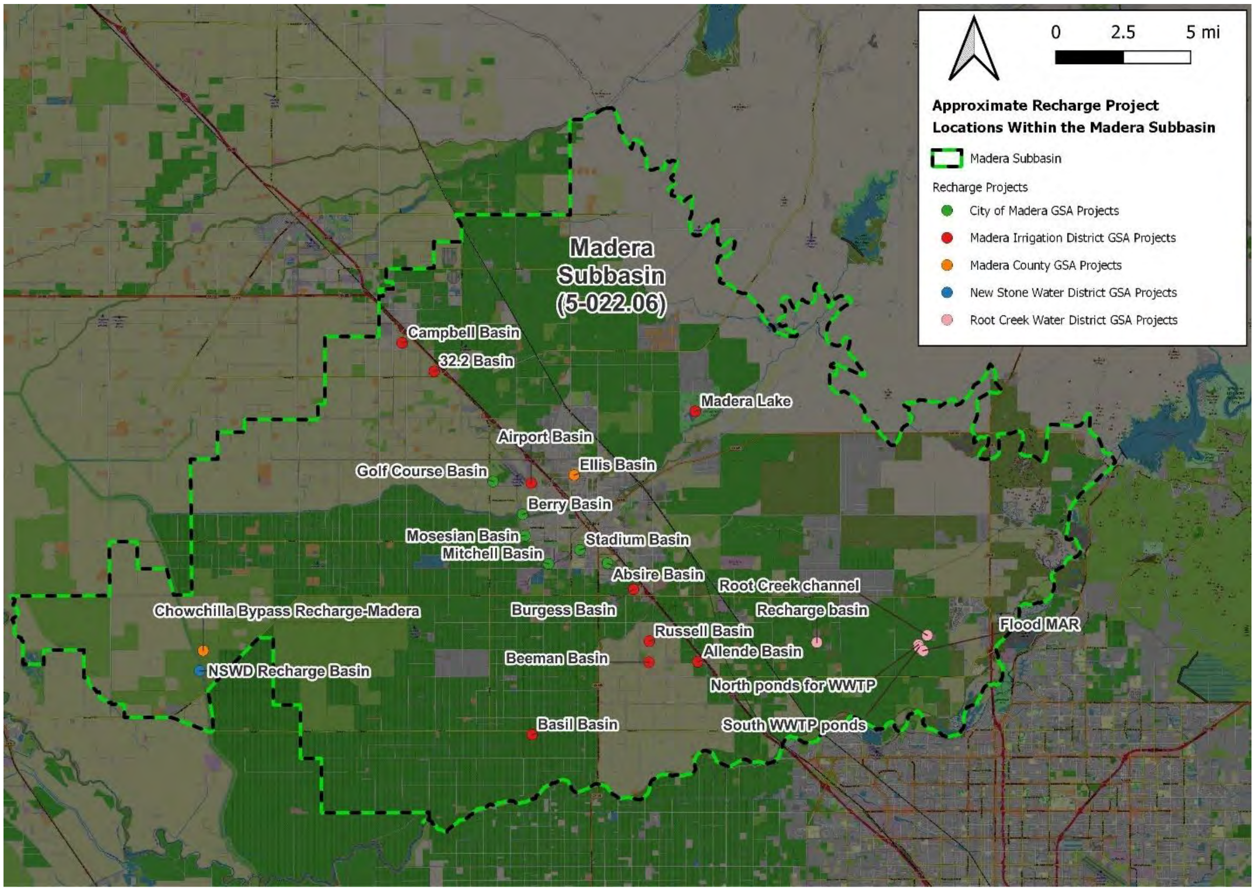

Figure 3-1. Approximate Locations of Reported Recharge Projects in the Subbasin as of the Water Year 2023 Annual Report.

3.1.3 MC GSA PMAs

Since adoption of the 2020 Initial Joint GSP, MC GSA has completed multiple planning studies and a rate study to fund Joint GSP implementation, initiated planning and design for a recharge program, and completed work to support the implementation and enforcement of a substantial demand management program. Many of these efforts are associated with MC GSA authorities and actions described in **Section 6.1**.

MC GSA has engaged in a variety of recharge projects and related planning efforts during this Periodic Evaluation cycle, including:

- Operation of the Ellis Basin for recharge, in cooperation with MID (**Figure 3-1**). Site improvements have been made, and MC GSA plans to continue recharge efforts in the future.
- A recharge planning study conducted to refine the costs, benefits, and schedule for constructing additional basins and to support additional flood managed aquifer recharge (Flood-MAR). This study has resulted in the development of the Chowchilla Bypass Flood Flow Recharge Program, which is being funded through two Proposition 68 grants from DWR. Design efforts and all applicable CEQA and permitting efforts for the first projects in the Chowchilla Bypass Flood Flow Recharge Program have occurred throughout this Periodic Evaluation cycle. Following some

delays in permitting and regulatory processes, construction is anticipated during the upcoming Periodic Evaluation cycle (January 2025 through January 2030).

- Outreach and coordination of recharge efforts and reporting in 2023 related to Executive Order (EO) N-4-23, which allows for flood waters to be used for groundwater recharge in certain circumstances. Recharge efforts are coordinated together with the emergency recharge plan. Substantial recharge occurred under EO N-4-23 in 2023, in excess of 42,000 AF. The majority of this water was diverted from various locations along the Chowchilla Bypass (**Figure 3-1**).
- The Fairmead Groundwater Resilience Project, with grant funding as part of the California Resilience Challenge. MC GSA has developed concept plans with various options for recharge projects and a monitoring framework. Community meetings have been held to gather feedback and guide project development.

As a primary element of its efforts to achieve groundwater sustainability, MC GSA has also continued steps toward implementation of a demand management program that will oversee a managed reduction in the volume of groundwater consumed by irrigated agriculture over the 20-year GSP Implementation Period. The MC GSA has refined its demand reduction targets based on new understanding of overdraft in the MC GSA since the 2020 Initial Joint GSP was developed, increasing targets from 90,000 AFY to 113,000 AFY. These refinements are consistent with the Subbasin GSAs' adaptive management commitment. To implement this overall demand management program, MC GSA has:

- Conducted a water market study through funding from a USBR WaterSMART grant. The water market strategy was created through a collaborative process with participating stakeholders in 2020-2021. Workshops and interviews were held to identify an acceptable strategy that maximizes economic benefits to the regional economy, and a virtual pilot water market simulation occurred with 57 participants across the Madera and Chowchilla Subbasins between January 2021 and November 2021 to test its effectiveness. The final report was completed in 2022.
- Implemented a Voluntary Land Repurposing Program (VLRP), which aims to identify and protect productive agricultural land while incentivizing the conversion of other irrigated agricultural land for other lower water demand uses. The MC GSA developed the VLRP through a stakeholder-driven process in 2020-2022, resulting in approval of rules and criteria for implementing the VLRP in December 2022. The MC GSA received grant funding to support VLRP development, and was also awarded a $9.3 million grant from DWR in 2022 for LandFlex which has been used to support VLRP implementation. MC GSA is also planning land repurposing projects through the Multibenefit Land Repurposing Program (MLRP). These efforts are collectively supporting protection of productive agricultural land and incentivizing water use reduction in other areas through land conversion and repurposing for other lower water demand and multi-benefit uses.
- Developed a groundwater allocation framework, allocation measurement and enforcement methods, allocation penalties, appeals processes, and recharge credit policies. Groundwater use is being tracked against the groundwater allocation on the basis of evapotranspiration of applied groundwater (ETAW) (i.e., water lost from the groundwater system). MC GSA has been enforcing the approved allocation since 2022. Information on all these topics is provided in **Section 6.1.2.**
- Continued implementing a demand measurement program and verification project. The Madera Verification Project began in 2022 to analyze the consistency of allocation measurement methods to ensure that the allocation is accurately, effectively, and equitably enforced. As described in **Section 6.1.2**, the MC GSA is monitoring demand using the three approved demand measurement options that are currently available to growers in the MC GSA for allocation enforcement: two approaches based on satellite imagery (IrriWatch and Land IQ), and the use of approved

flowmeters. Through the Madera Verification Project, MC GSA has evaluated and compared data from all three approaches, developed methods and approaches for fairly and accurately using this data to track and enforce the allocation, and sought ways to increase grower engagement, education, and outreach. The MC GSA has worked with outside consultants to conduct the Madera Verification Project since 2022, but – through cost savings decisions – the MC GSA has hired a Water Resource Specialist who assumed all field work responsibilities in 2024. MC GSA staff will continue to conduct allocation verification efforts, as needed, to ensure the allocation continues to be enforced accurately and fairly. Initial data shows promising reductions in ETAW and irrigated areas in the Madera County GSAs across the Chowchilla, Delta-Mendota, and Madera Subbasins (**Figure 3-2**). As part of independent technical analysis in support of implementing the Madera County GSAs' allocation (not part of the Joint GSP development and/or revision process), the estimated irrigated area in the MC GSA within the Subbasin, specifically, decreased by more than 10,000 acres from 2020 to 2023. These independent technical analyses identified irrigated areas as any land with ETAW equal to or exceeding 12 inches (i.e., actively irrigated land, based on available data). The precise benefits of the groundwater allocation to the Subbasin groundwater system are still being quantified and will be given in future reports as more data is collected.

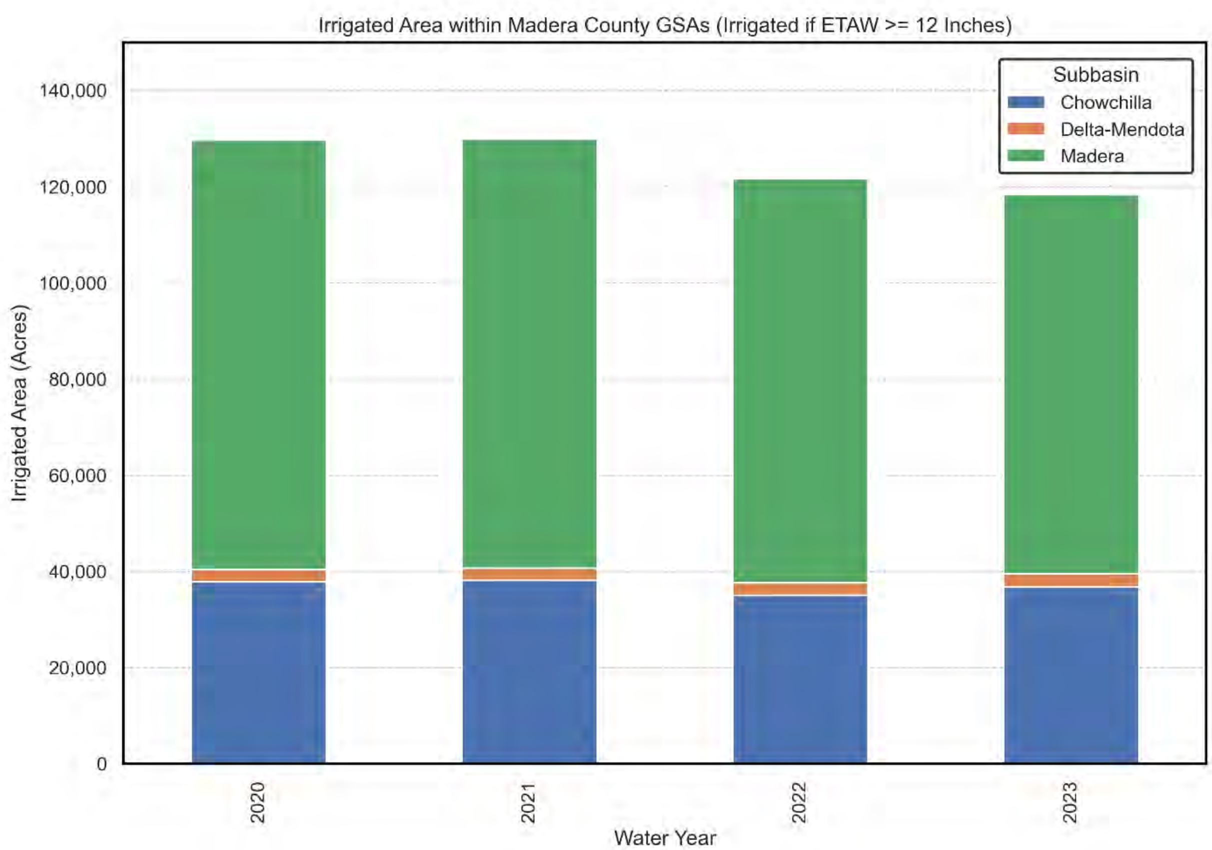

Figure 3-2. Estimated Irrigated Area within the Madera County GSAs in the Chowchilla, Delta-Mendota, and Madera Subbasins (2020-2023).

In addition to these PMA-related efforts, the MC GSA took strides to fund GSP implementation by completing a Proposition 218 process in 2022 that led to approval of an acreage-based rate for irrigated lands within the MC GSA in the Subbasin. The rate was intended to fund implementation of specific GSP-defined projects, including recharge facilities, water purchases, land repurposing, and domestic well mitigation programs. However, a preliminary injunction was issued by the Madera County Superior Court in December 2022. The preliminary injunction remains in place as of fall 2024, although Madera County has filed a motion to dismiss the lawsuit. In the meantime, the MC GSA is continuing GSP implementation and is seeking ways to reduce implementation costs (e.g., grants, refinements) with stakeholder input and discussion. Continued implementation of the allocation program is not delayed. While projects have been developed and are planned to support groundwater sustainability by adding water to the Subbasin, demand management is also being implemented to fully achieve the sustainable yield for the MC GSA area, consistent with the Subbasin GSAs' adaptive management commitment. Together, the combination of PMAs implemented by the MC GSA will achieve the sustainable yield for the MC GSA area. Additional information on MC GSA SGMA-related funding efforts is described in **Sections 6.1 and 8.2**.

3.1.4 CM GSA PMAs

The CM GSA has continued efforts on a project to install water meters and implement a volumetric billing process and rate structure for single-family users to promote water conservation. The project is nearing completion, as the CM proceeds with actions to install water meters on the remaining unmetered water connections. This effort has been funded, in part, by a Proposition 1 Round 1 Integrated Regional Water Management (IRWM) grant.

The CM has also continued working cooperatively with MID to operate and develop several recharge basins (**Figure 3-1).** As of 2023, six recharge basins are operated cooperatively by the CM and MID, including the Berry Basin, the Golf Course Basin, and four additional City Basins. Wet conditions in spring 2023 facilitated substantial recharge in the basins.

3.1.5 MWD GSA PMAs

MWD GSA has continued its efforts to implement the expanded surface water purchase project proposed in the 2020 Initial Joint GSP. As part of this project, MWD has continued to move forward with the Madera Lake Project, which will construct the infrastructure needed to allow additional surface water from MID or other sources to be brought into MWD through Madera Lake. Efforts during this Periodic Evaluation cycle have included planning, design, California Environmental Quality Act (CEQA) processes, and various permitting processes required for project implementation through the USACE, Regional Water Quality Control Board, and the California Department of Fish & Wildlife. In 2022, MWD was awarded approximately $3.7 million in grant funding through DWR's SGM Grant Program that is being used to support this effort. MWD GSA has also continued to purchase additional surface water in years it is available to facilitate in-lieu recharge and preserve groundwater supplies.

3.1.6 Jointly Implemented PMAs

The Joint GSP GSAs have also furthered development of several jointly-implemented PMAs, as described in Section 4.9.5 of the Joint GSP 2025 Plan Amendment. Those include, in brief:

- **Domestic Well Mitigation Program (DWMP)**: A key element of the Joint GSP is a proposed DWMP to mitigate undesirable results for domestic well users that are significantly and adversely impacted by groundwater levels during the GSP implementation period while the GSAs implement other projects and management actions to achieve and maintain sustainability. Since 2022, the GSAs have continued coordination efforts to develop the DWMP for implementation, as needed. To date, the GSAs have developed a MOU that describes, among other things, the responsibilities and principles that will guide administration of the program (Appendix 3.E of the Joint GSP 2025 Plan Amendment). Refinements to the DWMP have been made with consideration of DWR's guidance document pertaining to "Considerations for Identifying and Addressing Drinking Water Well Impacts" (DWR, 2023). The MC GSA has also been awarded a $125,000 grant from DWR that, in part, provides facilitation and related services in connection with the DWMP. For purposes of the 2025 Plan Amendment, it is assumed that the facilitation and related services associated with the DWMP as set-forth above will result in complete development of the DWMP such that implementation can begin in 2025 as set-forth and agreed upon in the MOU.
- **Subsidence Workplan Development and Implementation:** Discussed in Section 5.4 of the Madera Subbasin 2025 Periodic Evaluation.
- **ISW Stakeholder Coordination**: Discussed in **Sections 5.5 and 7.3.2** of the Madera Subbasin 2025 Periodic Evaluation.

3.2 Benefits and Costs of PMA Implementation

The benefits of PMA implementation to the Subbasin are summarized for each of the Joint GSP GSAs in **Table 3-2 and Figure 3-3**, and for each individual PMA in **Table 3-3**. **In total, approximately 86,900 AFY of reported benefits occurred, on average[2], in years when PMA implementation was feasible as of WY 2023** (the most recently completed Annual Report during this Periodic Evaluation cycle). **This represents approximately 43% of the total estimated average benefits at 2040** (**Table 3-2**) not including early benefits achieved through enforcement of MC GSA's groundwater allocation. Drought conditions in 2020-2022 led to reduced surface water supplies and limited the amount of direct and in-lieu recharge that occurred in those years. However, the GSAs were able to recharge large volumes of surface water in WY 2019 and particularly in WY 2023 under the provisions of EO N-4-23.

As described in the Joint GSP 2025 Plan Amendment, PMAs have been focused on supporting groundwater conditions with respect to all applicable sustainability indicators primarily by increasing recharge, reducing groundwater pumping, and/or reducing demand. These mechanisms directly support the GSAs' efforts to avoid undesirable results and achieve and maintain sustainable conditions with respect to groundwater levels, groundwater storage, groundwater quality, land subsidence, and interconnected surface water. Consequently, the suite of identified PMAs are also anticipated to benefit groundwater conditions for all beneficial uses and users in the Subbasin.

[2] Averages were calculated based on reported PMA benefits in *only those years when implementation was feasible* during this Periodic Evaluation cycle.

Estimated and reported costs for PMA implementation are summarized in **Table 3-4**. The Joint GSP GSAs are responsible for tracking and reporting the benefits and costs of their PMAs each year in the Joint GSP Annual Report. PMA implementation is being funded through a combination of grant funds, allocation penalties (in MC GSA), assessments, fees, charges, and/or other funding mechanisms related to agency services. The MC GSA also completed a Proposition 218 process in 2022 that led to an approved rate for funding GSP implementation; howev42er, following a lawsuit and preliminary injunction issued by the Madera County Superior Court in December 2022, the MC GSA is currently restrained from imposing and/or collecting related fees. A discussion of all funding and fee-related actions by the Joint GSP GSAs is provided in **Section 6**.

Table 3-2. Summary of Benefits to the Subbasin from PMA Implementation by the Joint GSP GSAs, Estimated Average at 2040 and Average Reported as of the Water Year 2023 Annual Report.

GSA	Estimated Average Benefit of all PMAs at 2040 (AFY, rounded)[1]	Average Reported Benefit of all PMAs in Years Implementation Occurred[2] (WY 2019-2023) (AFY, rounded)	Average Reported Benefit as a Percent of Estimated Average Benefit at 2040 (%)	Agricultural Demand Reduction[3]
MWD	2,810	2,140	76	-
MID	49,170	38,540	78	💧
MC	145,090	42,130	29	💧💧💧💧💧
CM	4,000	4,120	103	-
Total	201,070	86,930	43	

[1] Estimates developed for full PMA implementation. For PMAs described in the 2020 Initial Joint GSP, the estimated average annual benefit at 2040 is summarized from the Joint GSP. Some PMAs have been modified since the 2020 Initial Joint GSP was adopted, so these totals may not equal the totals reported in the 2020 Initial Joint GSP.
[2] Averages were calculated based on reported PMA benefits in *only those years when implementation was feasible* during this Periodic Evaluation cycle. Reported benefits are consistent with the water budgets in the Annual Reports completed during this Periodic Evaluation cycle, and do not otherwise change the Subbasin water budget as reported in the Annual Reports.
[3] Symbols are representative of the relative magnitude of agricultural demand reduction anticipated from PMA implementation, and are not intended to indicate a specific volume of agricultural demand reduction.

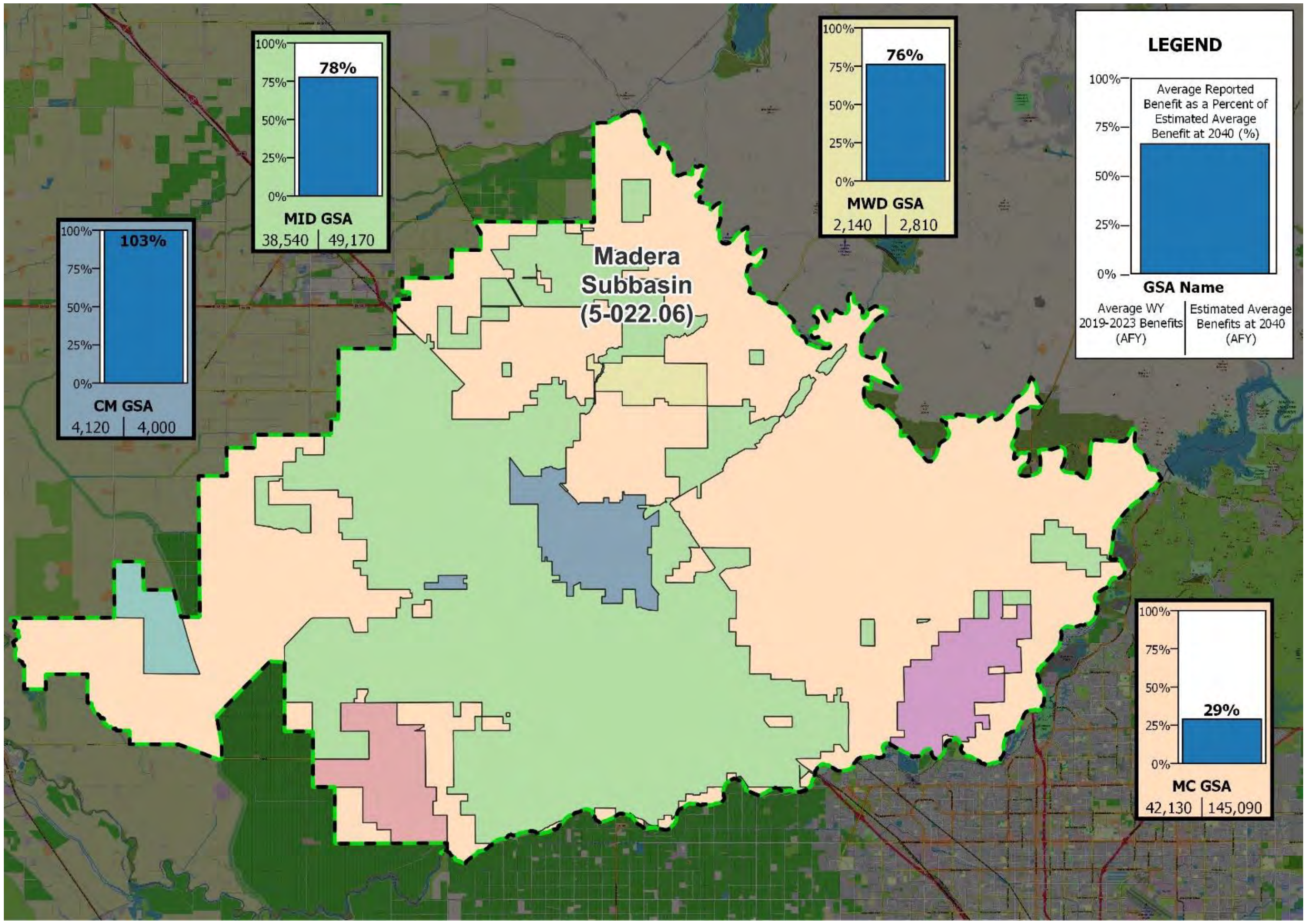

Figure 3-3. Summary of Benefits to the Subbasin from PMA Implementation by the Joint GSP GSAs (Average Reported Benefits as of the Water Year 2023 Annual Report[1] as a Percentage of the Estimated Average Benefits at 2040).

[1] Averages were calculated based on reported PMA benefits from Annual Reports in only those years when implementation was feasible during this Periodic Evaluation cycle (Table 3-2). Reported benefits are consistent with the water budgets in the Annual Reports completed during this Periodic Evaluation cycle, and do not otherwise change the Subbasin water budget as reported in the Annual Reports.

Table 3-3. Benefits to the Subbasin from PMA Implementation, Estimated and Reported as of the Water Year 2023 Annual Report.

GSA	PMA Name	PMA Status as of WY 2023	PMA Mechanism	Estimated Average Benefit at 2040 (AFY, rounded)[1]	Average Reported Benefit in Years Implementation Occurred[2] (WY 2019-2023) (AFY, rounded)	Reported Benefit[3] (WY 2019) (AFY)	Reported Benefit[3] (WY 2020) (AFY)	Reported Benefit[3] (WY 2021) (AFY)	Reported Benefit[3] (WY 2022) (AFY)	Reported Benefit[3] (WY 2023) (AFY)
MWD	Expanded Surface Water Purchase	In Progress	Reduce Groundwater Pumping	2,810	2,140	-	-	-	0	4,283
MID	Rehab Recharge Basins	Implemented	Increase Recharge	5,030	1,850	3,683	229	0	43	5,277
MID/ MC	Ellis Basin	Implemented	Increase Recharge	120	30	153	0	0	0	0
MID/ CM	Berry Basin	Implemented	Increase Recharge	20	140	465	0	0	0	221
MID	Allende Basin	Implemented	Increase Recharge	1,050	1,620	3,088	31	0	0	4,967
MID/ CM	Additional Recharge Basins with City of Madera	Implemented	Increase Recharge	630	630	-	-	-	-	632
MID	Additional Recharge Basins Phase 1	Implemented	Increase Recharge	5,470	2,250	-	-	0	0	6,753
MID	Additional Recharge Basins Phase 2	In Progress	Increase Recharge	21,890	-	-	-	-	-	-
MID	On-Farm Recharge	Implemented	Increase Recharge	510	4,430	3,000	0	0	0	19,161
MID	Phase 2 On-Farm Recharge	Implemented	Increase Recharge	1,690	19,160	-	-	-	-	19,161
MID	MID Pipeline	Implemented	Reduce Evaporation and Groundwater Pumping	420	420	420	420	420	420	420
MID	WaterSMART Pipeline	Implemented	Reduce Evaporation and Groundwater Pumping	880	880	880	880	880	880	880

GSA	PMA Name	PMA Status as of WY 2023	PMA Mechanism	Estimated Average Benefit at 2040 (AFY, rounded)[1]	Average Reported Benefit in Years Implementation Occurred[2] (WY 2019-2023) (AFY, rounded)	Reported Benefit[3] (WY 2019) (AFY)	Reported Benefit[3] (WY 2020) (AFY)	Reported Benefit[3] (WY 2021) (AFY)	Reported Benefit[3] (WY 2022) (AFY)	Reported Benefit[3] (WY 2023) (AFY)
MID	WaterSMART SCADA	Implemented	Reduce Evaporation and Groundwater Pumping	1,230	1,230	1,230	1,230	1,230	1,230	1,230
MID	Water Supply Partnerships	In Progress	Reduce Groundwater Pumping	3,990	10	-	50	0	0	0
MID	Incentive Program	Implemented	Reduce Groundwater Pumping	5,010	4,580	22,900	0	0	0	0
MID	Demand Reduction	Implemented	Reduce Demand	1,020	1,100	1,020	1,020	1,020	1,180	1,260
MID	Grazing Land Annexation	Implemented	Increase Sustainable Yield	210	210	-	206	206	206	206
MID	Water User Software Platform (UI)	Implemented	Education / Outreach	-	-	-	-	-	-	-
MID	Intensive Groundwater Use Policy	Implemented	Reduce Groundwater Pumping	-	-	-	-	-	-	-
CM	Meters and Volumetric Pricing	Implemented	Reduce Groundwater Pumping	3,350	3,350	3,350	3,350	3,350	3,350	3,350
CM/ MID	Berry Basin	Implemented	Increase Recharge	20	140	465	0	0	0	221
CM/ MID	Additional Recharge Basins	Implemented	Increase Recharge	630	630	-	-	-	-	632
MC/ MID	Ellis Basin	Implemented	Increase Recharge	120	30	153	0	0	0	0
MC	Water Imports Purchase	In Progress	Reduce Groundwater Pumping	3,610	-	-	-	-	-	-

GSA	PMA Name	PMA Status as of WY 2023	PMA Mechanism	Estimated Average Benefit at 2040 (AFY, rounded)[1]	Average Reported Benefit in Years Implementation Occurred[2] (WY 2019-2023) (AFY, rounded)	Reported Benefit[3] (WY 2019) (AFY)	Reported Benefit[3] (WY 2020) (AFY)	Reported Benefit[3] (WY 2021) (AFY)	Reported Benefit[3] (WY 2022) (AFY)	Reported Benefit[3] (WY 2023) (AFY)
MC	Millerton Flood Release Imports	In Progress	Reduce Groundwater Pumping	7,060	-	-	-	-	-	-
MC	Chowchilla Bypass Flood Flow Recharge Phase 1[4]	In Progress	Increase Recharge	3,900	42,100	-	-	-	-	42,100
MC	Chowchilla Bypass Flood Flow Recharge Phase 2[4]	In Progress	Increase Recharge	17,400	-	-	-	-	-	-
MC	Demand Management[5]	In Progress	Reduce Groundwater Pumping	113,000	-	-	-	-	-	-
GFWD	*See GFWD GSA GSP 2025 Periodic Evaluation Elements for information on GFWD PMAs.*									
NSWD	*See NSWD GSA GSP 2025 Periodic Evaluation Elements for information on NSWD PMAs.*									
RCWD	*See RCWD GSA GSP 2025 Periodic Evaluation Elements for information on RCWD PMAs.*									
Total				201,070	86,930	40,807	7,416	7,106	7,309	110,754

[1] Estimates developed for full PMA implementation. For PMAs described in the 2020 Initial Joint GSP, the estimated average annual benefit at 2040 is summarized from the Joint GSP. Some PMAs have been modified since the 2020 Initial Joint GSP was adopted, so these totals may not equal the totals reported in the 2020 Initial Joint GSP.
[2] Averages were calculated based on reported PMA benefits in *only those years when implementation was feasible* during this Periodic Evaluation cycle. Reported benefits are consistent with the water budgets in the Annual Reports completed during this Periodic Evaluation cycle, and do not otherwise change the Subbasin water budget as reported in the Annual Reports.
[3] Reported benefits noted in this table are as reported by the GSAs in the Annual Reports and do not include any reductions for recharge water applied that meets in-lieu consumptive use needs or other losses that may occur unless otherwise adjusted by the GSAs.
[4] Since the 2020 Initial Joint GSP was adopted, the Chowchilla Bypass Flood Flow Recharge Project Phases 1 and 2 have been further refined into a series of five recharge projects that are expected to undergo planning/design and construction between 2021 and 2030. Phase 1 now corresponds to Project 1, with a revised estimated average annual benefit at 2040 of approximately 3,900 AF per year (11,200 AF in years water is available). Phase 2 now corresponds to Projects 2 through 5, with a revised combined estimated average annual benefit at 2040 of 36,500 AF per year (104,400 AF in years water is available). These anticipated benefits are for full project implementation and have been refined from the initial benefits identified during GSP development. However, benefits have been achieved as of the WY 2023 Annual Report through diversions under the provisions of provisions of EO N-4-23, consistent with the WY 2023 Annual Report water budget.
[5] Initial data shows promising reductions in ETAW and irrigated areas in the MC GSA (see Section 3.1.3 and Figure 3-2); however, the precise benefits of the groundwater allocation to the Subbasin groundwater system were still being quantified as of the WY 2023 Annual Report. Updates will be given in future reports as more data is collected.

Table 3-4. Costs of PMA Implementation, Estimated and Reported as of the Water Year 2023 Annual Report.

GSA	PMA Name	PMA Status as of WY 2023	Estimated Annual Operating Costs at 2040 ($)[1]	Estimated Capital Costs at 2040 ($)[1]	Reported Capital Costs as of WY 2023 ($)	Reported Capital Costs (WY 2019)	Reported Capital Costs (WY 2020)	Reported Capital Costs (WY 2021)	Reported Capital Costs (WY 2022)	Reported Capital Costs (WY 2023)
MWD	Expanded Surface Water Purchase	In Progress	$900,000	$14,900,000						
MID	Rehab Recharge Basins	Implemented	$430,000	$60,000	$60,000	$60,000				
MID/MC	Ellis Basin	Implemented	$20,000	$20,000	$20,000	$20,000				
MID/CM	Berry Basin	Implemented	$0	$20,000	$20,000	$20,000				
MID	Allende Basin	Implemented	$70,000	$200,000	$200,000	$200,000				
MID/CM	Additional Recharge Basins with City of Madera	Implemented	-	-						
MID	Additional Recharge Basins Phase 1	Implemented	$240,000	$1,000,000	$2,158,000			$2,158,000		
MID	Additional Recharge Basins Phase 2	In Progress	$3,750,000	$14,200,000	$1,600,000					$1,600,000
MID	On-Farm Recharge	Implemented	$50,000	$0						
MID	Phase 2 On-Farm Recharge	Implemented	$190,000	$0						
MID	MID Pipeline	Implemented	$0	$560,000	$640,000			$320,000	$320,000	
MID	WaterSMART Pipeline	Implemented	$0	$1,300,000						
MID	WaterSMART SCADA	Implemented	$0	$1,200,000						
MID	Water Supply Partnerships	In Progress	$2,500,000	$0						

GSA	PMA Name	PMA Status as of WY 2023	Estimated Annual Operating Costs at 2040 ($)[1]	Estimated Capital Costs at 2040 ($)[1]	Reported Capital Costs as of WY 2023 ($)	Reported Capital Costs (WY 2019)	Reported Capital Costs (WY 2020)	Reported Capital Costs (WY 2021)	Reported Capital Costs (WY 2022)	Reported Capital Costs (WY 2023)
MID	Incentive Program	Implemented	$3,080,000	$0	$151,000				$62,000	$89,000
MID	Demand Reduction	Implemented	$110,000	$12,000	$12,000	$12,000				
MID	Grazing Land Annexation	Implemented	-	-						
MID	Water User Software Platform (UI)	Implemented	-	-						
MID	Intensive Groundwater Use Policy	Implemented	-	-						
CM	Meters and Volumetric Pricing	Implemented	$0	$11,000,000	$1,253,906				$281,860	$972,046
CM/MID	Berry Basin	Implemented	$0	$20,000						
CM/MID	Additional Recharge Basins	Implemented	-	$50,000	$50,000			$50,000		
MC/MID	Ellis Basin	Implemented	$20,000	$20,000						
MC	Water Imports Purchase	In Progress	$2,490,000	$300,000						
MC	Millerton Flood Release Imports	In Progress	$450,000	$31,900,000						
MC	Chowchilla Bypass Flood Flow Recharge Phase 1	In Progress	$800,000	$6,570,000	$257,000			$9,000	$248,000	
MC	Chowchilla Bypass Flood Flow Recharge Phase 2	In Progress	$700,000	$105,200,000						

GSA	PMA Name	PMA Status as of WY 2023	Estimated Annual Operating Costs at 2040 ($)[1]	Estimated Capital Costs at 2040 ($)[1]	Reported Capital Costs as of WY 2023 ($)	Reported Capital Costs (WY 2019)	Reported Capital Costs (WY 2020)	Reported Capital Costs (WY 2021)	Reported Capital Costs (WY 2022)	Reported Capital Costs (WY 2023)
MC	Demand Management	In Progress	$53,900,000	$0						
GFWD	*See GFWD GSA GSP 2025 Periodic Evaluation Elements for information on GFWD PMAs.*									
NSWD	*See NSWD GSA GSP 2025 Periodic Evaluation Elements for information on NSWD PMAs.*									
RCWD	*See RCWD GSA GSP 2025 Periodic Evaluation Elements for information on RCWD PMAs.*									
			Total	$188,532,000	$6,371,906	$312,000	$0	$2,487,000	$911,860	$2,661,046

[1] Estimated costs for full PMA implementation as reported in the 2020 Initial Joint GSP or based on available data and refinements during this Periodic Evaluation cycle. Costs are in 2019 dollars.

3.3 Tracking, Administering, and Reporting

Like all GSAs in the Subbasin, the Joint GSP GSAs are each implementing and administering their own proposed PMAs, or are coordinating directly with partnering agencies and other project proponents, as applicable. The Joint GSP GSAs are responsible for tracking and reporting progress on their PMAs. Updates on the progress of all PMAs that are being implemented or developed by the Joint GSP GSAs are collected and reported each year in the Joint GSP Annual Report. The Subbasin GSAs have also developed a shared data management system. Moving forward, the Joint GSP GSAs also anticipate reporting updates to DWR directly and formally through the new PMA Module within DWR's SGMA Portal (made available in Fall 2024).

Each Joint GSP GSA is also responsible for publicly noticing and engaging interested parties regarding their proposed PMAs. Many PMAs in the Joint GSP area are being implemented or developed hand-in-hand with robust communication and outreach efforts, especially those that are most impactful to stakeholders, such as MID's incentive program and on-farm recharge efforts, or MC GSA's demand management program. Specific outreach activities related to PMAs are described in further detail in Section 7.1 of the Madera Subbasin 2025 Periodic Evaluation. In addition to the Joint GSP GSAs' outreach activities related to specific PMAs, the Annual Report contains updates on PMAs and is made publicly available each spring.

4 Basin Setting Evaluation Based on New Information or Changes in Water Use (23 CCR §356.4(c)-(d))

Please refer to the Madera Subbasin 2025 Periodic Evaluation for a summary of the Subbasin GSAs' evaluation of the basin setting based on new information or changes in water use (per 23 CCR §356.4(c)-(d)). Updates are provided for the Subbasin as a whole, with specific reference to content in the Joint GSP 2025 Plan Amendment.

5 Monitoring Networks Evaluation (23 CCR §356.4(e))

Please refer to the Madera Subbasin 2025 Periodic Evaluation for a summary of the Subbasin GSAs' evaluation of the Subbasin monitoring networks during this Periodic Evaluation cycle (per 23 CCR §356.4(e)). Updates are provided for the Subbasin as a whole, with specific reference to RMS in the Joint GSP area for all applicable sustainability indicators.

6 GSA Authorities and Enforcement Actions (23 CCR §356.4(g)-(h))

The purpose of this section is to document any authorities (e.g., regulations or ordinances) and enforcement or legal actions that the Joint GSP GSAs have established or exercised during the first Periodic Evaluation cycle in furtherance of the sustainability goal for the Subbasin. This section also describes other policies, regulations, and orders at the local, state, and/or federal level that have impacted SGMA implementation in the Subbasin.

Actions by each of the Joint GSP GSAs are described first, followed by a summary of applicable local, state, and/or federal policies, regulations, and orders. Actions by the other GSAs in the Subbasin are described in their respective Periodic Evaluation attachments.

6.1 Authorities and Actions by the Joint GSP GSAs

6.1.1 MID GSA

The MID GSA has enacted, or continued to enact, several resolutions and/or policies in furtherance of the Subbasin sustainability goal during this Periodic Evaluation cycle, including:

- **Intensive Groundwater Use Policy** (adopted 10/15/2019): This policy continued to apply to all applicable development within the MID GSA during the first Periodic Evaluation cycle. Further discussion of this policy is provided in the Joint GSP 2025 Plan Amendment Section 4.9. The policy is specifically applicable for any person or entity in the MID GSA that intends to use groundwater for a purpose other than agriculture, defined as the growing of crops. Under this policy, permits are required for any "intensive groundwater use," defined as:
    - A new or expanded groundwater use (after the policy adoption date), not including the growing of crops, and groundwater demands greater than historic demands in the MID GSA; OR
    - Any other use of groundwater that, in the absence of appropriate permit terms and conditions, would, in the opinion of the MID GSA, have the potential to unreasonably interfere with the MID GSA's ability to comply with SGMA or the Joint GSP, or would adversely impact the water supplies available to the MID GSA's agricultural water users.

  The terms of this policy help to ensure that allowable groundwater use within the MID GSA area would not be inconsistent with the Joint GSP and would not decrease the likelihood of achieving the sustainability goal for the Subbasin.

- **Joint GSP Adoption Resolution** (for the 2023 Revised Joint GSP; adopted 04/16/2024): In resolution 2024-GSA01, the MID GSA formally adopted the 2023 Revised Joint GSP. This resolution is included in Appendix 1.H of the Joint GSP 2025 Plan Amendment.

There have been no noted funding or fee actions in the MID GSA during this Periodic Evaluation cycle specifically related to Joint GSP implementation. MID continues to fund efforts related to the MID GSA and Joint GSP implementation primarily through assessments, charges, and/or other funding mechanisms related to MID services. MID has also partnered with the Natural Resources Conservation Service (NRCS) and U.S. Department of Interior's WaterSMART Initiative, which has made pilot program funds available in MID for recharge projects such as on-farm recharge, recharge basins, or other supporting practices. $1.5 million was made available in 2022, and another $2.4 million was made available in fall 2023. Landowners in MID can apply for these funds through the NRCS to support conservation practices and infrastructure improvements. These efforts are described in **Section 3** of this Periodic Evaluation and in Section 4.9 of the Joint GSP 2025 Plan Amendment.

The MID GSA is not implementing an allocation program, as other PMAs are being implemented in the MID GSA to support groundwater sustainability (described in **Section 3** of this Periodic Evaluation and in Section 4.9 of the Joint GSP 2025 Plan Amendment). MID does not collect groundwater extraction data from landowners at this time. However, MID does continue to collect groundwater-related data at MID wells, as well as surface water-related data at MID diversion and delivery points. All relevant data is reported or considered during development of the Joint GSP Annual Report each year.

6.1.2 MC GSA

The MC GSA has developed and enacted several resolutions and policies in furtherance of the Subbasin sustainability goal during this Periodic Evaluation cycle, including those supporting its groundwater allocation and demand management program. Applicable resolutions that have been adopted by the MC GSA are available at: https://www.maderacountywater.com/resolutions/. These documents define the guiding principles, rules, and regulations of the MC GSA for efforts that are underway to address groundwater sustainability issues in the MC GSA. These efforts are also described in Section 4.9 of the Joint GSP 2025 Plan Amendment.

Notable resolutions, policies, and actions relevant to this Periodic Evaluation cycle include:

Groundwater Allocation Resolutions and Related Actions:
The MC GSA adopted a groundwater allocation approach in calendar year 2020 following extensive community outreach. The allocation and associated penalties are being enforced in the MC GSAs (within the Chowchilla, Madera, and Delta-Mendota Subbasins) through measurements of groundwater demand by approved measurement methods. MC GSA has included certain refinements to the allocation framework over time, including the adoption of penalties, through the resolutions discussed below. MC GSA has also developed a recharge policy that would credit recharge benefits to the allocation of areas where recharge occurred.

Specific resolutions, policies, and actions that have been taken to develop and implement the groundwater allocation are described below.

- **Allocation Framework and Resolutions**: In 2020-2021, the MC GSA developed an allocation framework through a series of public meetings with the MC GSA Advisory Committee. Subsequently, and at the recommendation of the Advisory Committee, the MC GSA Board of Directors adopted the allocation framework through the following resolutions:
    - Resolution 2020-166 (adopted 12/15/2020) adopts a groundwater allocation approach.
    - Resolution 2021-069 (adopted 06/08/2021) establishes groundwater allocation amounts for 2021-2025 and allows for the creation of "farm units." Farm units – commonly operated or managed lands that are grouped and considered together in enforcement of the allocation – provide flexibility and reflect real-world farming conditions in which resources are shared. Farm units are currently allowed to be changed at the end of the calendar year, and never-irrigated lands are currently allowed to opt-in in November of each year.
    - Resolution 2021-113 (adopted 08/17/2021) establishes groundwater allocation refinements including allowing for the possibility that unused allocations may be carried

over, if it is found that doing so will not jeopardize the objectives of the GSP.

- **Allocation Measurement and Enforcement**: In 2022, MC GSA adopted measurement methods for tracking and enforcing the groundwater allocation (Resolution 2022-192, adopted 12/20/2022). MC GSA has been enforcing the approved allocations since 2022. Three approved demand measurement options are available to growers in the MC GSA for allocation enforcement:
    - IrriWatch (a daily irrigation scheduling and crop production information service that uses Surface Energy Balance Algorithm for Land (SEBAL) model outputs to quantify actual consumptive water use from satellite imagery)
    - Land IQ (similar to IrriWatch, quantifying consumptive water use from land use and satellite imagery)
    - Use of approved flowmeters that are installed correctly and calibrated regularly. Although MC GSA is not responsible for installing flowmeters, MC GSA has adopted pre-approval processes for the use of private meters as a means of allocation tracking and enforcement. (Resolution 2022-145, adopted 09/27/2022). The adopted processes are intended to ensure correct installation and maintenance of flowmeters and their accuracy.

  Enforcement of the allocation continues to incorporate adjustments to account for recharge credits, land repurposing (fallowing) credits, and successful allocation appeals. These topics are described later in this section.

- **Allocation Penalties:** In 2022, MC GSA approved penalties for exceeding the allocation through Resolution 2022-145 (adopted 09/27/2022). Penalties in the Subbasin begin at $100 per AF for farm units in calendar year 2023, increasing by $100 per AF each subsequent year up to a maximum of $500 per AF, for the total volume extracted in excess of the authorized amount. These penalties are specific to the Subbasin, and may differ from penalties in the Chowchilla and Delta-Mendota Subbasins.

- **Allocation Appeals**: The MC GSA has allowed and developed an appeals process for growers who have selected to use the IrriWatch and Land IQ approaches, although there is no appeals process for those using approved flowmeters. In 2023, MC GSA revised the rules for appealing the determination of use of the groundwater allocation through Resolution 2023-150 (adopted 11/07/2023). MC GSA expects to reevaluate measurement options for the program moving forward in 2025.

- **Recharge Credit Policies:** MC GSA has developed a recharge policy that would credit recharge benefits to the allocation of areas where recharge occurred. In 2024, MC GSA approved policies related to recharge with surface water that is purchased, and related to recharge with water taken under Executive Order (EO) N-4-23, which was subsequently codified through California Water Code Section 1242.1. Both policies have a “floor” of a 75% recharge credit and a "ceiling" of 90% recharge credit depending on data specific to the land on which the recharge occurred. The recharge credit is limited to the aquifer in which recharge occurred.
    - Resolution 2024-030 (adopted 03/19/2024) adopted recharge credit policies for the Madera, Chowchilla, and Delta-Mendota Subbasins.

- **Allocation Verification Efforts:** Since 2022, the MC GSA has conducted the Madera Verification Project to analyze the consistency of measurements from flowmeters to the demand estimates developed from the IrriWatch and Land IQ remote sensing measurements. Through the Madera Verification Project, the MC GSA has conducted extensive outreach among growers in the Chowchilla, Madera, and Delta-Mendota Subbasins who will be directly impacted by the demand measurement efforts. Through these outreach efforts, the MC GSA has gained substantial feedback and made changes to the demand measurement program to ensure that it is locally accurate, effective, and equitable to growers. Additional information about the Madera Verification Project is discussed in **Section 3** and in the Annual Reports.

Land Repurposing Resolutions and Related Actions:

- **Voluntary Land Repurposing Program (VLRP):** MC GSA developed the VLRP through a stakeholder-driven process in 2020-2022. The VLRP aims to develop criteria for identifying and prioritizing agricultural land for protection, and to develop an incentive structure for agricultural landowners to rest, retire, restore, or permanently protect their land via various types of water-centric conservation easements. Additional information about this process are discussed in **Section 3** and in the Annual Reports. In fall-winter 2022, the MC GSA conducted four public workshops, as well as multiple meetings and interviews, to review the VLRP development process as well as eligibility criteria, monitoring strategies, contracting processes, incentives, land management strategies, and other planned contract provisions. Rules and criteria for implementing the VLRP were approved by the MC GSA in December 2022 (Resolution 2022-194, adopted 12/20/2022).

- **Targeted Land Repurposing Program (LandFlex):** The MC GSA in the Subbasin was awarded a $9.3 million grant from DWR in 2022 for LandFlex, in coordination with the California Department of Food and Agriculture (Resolution 2023-056, adopted 04/18/2023). This funding is being used to support implementation of the VLRP. The MC GSA is working to incorporate this information into implementation of the allocation framework (described above) to ensure that participating landowners are receiving credit for land fallowing under the VLRP.

- **Multibenefit Land Repurposing Program (MLRP):** Madera County has completed and adopted a plan for land repurposing projects through available funding under the California Department of Conservation's Multi-Benefit Land Repurposing Program (MLRP) grant program (Resolution 2024-120, adopted 10/1/2024). The MLRP aims to assist growers who are seeking to convert irrigated agricultural land to a less water intensive use, supporting and incentivizing projects that save water, make business sense, and create additional benefits for local communities and the environment. Total funding of $7 million is available for projects throughout any GSA within Madera County. As of late 2024, Madera County is soliciting pre-applications for interested participants and is hosting informational workshops.

Other Resolutions Related to Joint GSP Implementation:

- **Joint GSP Adoption Resolution** (for the 2023 Revised Joint GSP; adopted 03/21/2023): In resolution 2023-045, the MC GSA formally adopted the 2023 Revised Joint GSP. This resolution is included in Appendix 1.H of the Joint GSP 2025 Plan Amendment.

Funding and Fee Resolutions and Related Actions: The MC GSA has adopted the following funding-related resolutions that are applicable during this Periodic Evaluation cycle:

- **Administrative Fee:** The MC GSA collects an administrative fee of approximately $20-30 per acre for irrigated acres within the GSA that is used for SGMA-related administration and planning efforts. Resolution 2019-172 (adopted 11/12/2019) approved the GSA administrative fee for the Madera, Chowchilla, and Delta-Mendota Subbasins. While the administrative fee is useful for supporting SGMA implementation, these funds cannot be used for implementation of PMAs.

- **Proposition 218 Process:** In 2022, a Proposition 218 process was completed that led to approval of an acreage-based rate for irrigated lands within the MC GSA in the Subbasin. The rate was intended to fund implementation of specific GSP-defined projects, including recharge facilities, water purchases, and domestic well mitigation programs. Resolution 2022-086 (adopted 06/21/2022) approved the GSP implementation-related rate for the Subbasin. However, following a lawsuit and preliminary injunction issued by the Madera County Superior Court in December 2022, Madera County was ordered to refrain from imposing and/or collecting any fees, rates, and/or GSP-related PMA fees enacted under Resolution 2022-086 against landowners in the Subbasin. As of fall 2024, the preliminary injunction remains in place, although Madera County has filed a motion to dismiss the lawsuit. Regardless of the outcome, the MC GSA is continuing GSP implementation and is seeking ways to reduce the implementation costs (e.g., grants, refinements) with stakeholder input and discussion. Updates regarding the injunction will be provided in future Annual Reports. Also, continued implementation of the allocation program, discussed previously, is not delayed.

- **Allocation Penalties:** In 2022, the MC GSA approved a penalty for groundwater extraction above the allocation that is being imposed as of 2023 (Resolution 2022-145, described above). Funds generated from these penalties are also available to support GSP implementation moving forward, as directed by the GSA Board, which has indicated an inclination to fund domestic well mitigation first as a top priority.

6.1.3 CM GSA

The CM GSA has enacted the following resolution in furtherance of the Subbasin sustainability goal during this Periodic Evaluation cycle:

- **Joint GSP Adoption Resolution** (for the 2023 Revised Joint GSP; adopted 03/20/2023): In resolution 23-33, the CM GSA formally adopted the 2023 Revised Joint GSP. This resolution is included in Appendix 1.H of the Joint GSP 2025 Plan Amendment.

There have been no noted funding or fee actions in the CM GSA during this Periodic Evaluation cycle specifically related to Joint GSP implementation. CM continues to fund efforts related to the CM GSA and Joint GSP implementation primarily through assessments, charges, and/or other funding mechanisms related to CM water distribution services.

The CM GSA is not implementing an allocation program, as other PMAs are being implemented in the CM GSA to support groundwater sustainability (described in **Section 3** of this Periodic Evaluation and in Section 4.9 of the Joint GSP 2025 Plan Amendment). The CM GSA does not collect groundwater extraction data from landowners at this time. However, the CM does continue to collect groundwater-related data at CM-operated wells. Groundwater wells operated by the CM for urban water use are 100% metered. The CM GSA is also continuing to implement its "Meters and Volumetric Pricing" project described in **Section 3** of this Periodic Evaluation and in Section 4.9 of the Joint GSP 2025 Plan Amendment. This project is upgrading meters across the CM water distribution system. All relevant data is reported or considered during development of the Joint GSP Annual Report each year.

6.1.4 MWD GSA

The MWD GSA has enacted the following resolution in furtherance of the Subbasin sustainability goal during this Periodic Evaluation cycle:

- **Joint GSP Adoption Resolution** (for the 2023 Revised Joint GSP; adopted 03/21/2023): In this resolution, the MWD GSA formally adopted the 2023 Revised Joint GSP. This resolution is included in Appendix 1.H of the Joint GSP 2025 Plan Amendment.

There have been no noted funding or fee actions in the MWD GSA during this Periodic Evaluation cycle specifically related to Joint GSP implementation. MWD continues to fund efforts related to the MWD GSA and Joint GSP implementation primarily through assessments, charges, and/or other funding mechanisms related to MWD services.

The MWD GSA is not implementing an allocation program as other PMAs are being implemented in the MWD GSA to support groundwater sustainability (described in **Section 3** of this Periodic Evaluation and in Section 4.9 of the Joint GSP 2025 Plan Amendment). The MWD GSA does not collect groundwater extraction data from landowners, as there are no privately-owned agricultural production wells and only two domestic wells within the MWD GSA area. All production wells within the MWD GSA are owned by MWD and are 100% metered. MWD continues to collect groundwater-related data at MWD wells, as well as surface water-related data at MWD diversion and delivery points. All relevant data is reported or considered during development of the Joint GSP Annual Report each year.

6.2 Applicable Policies, Regulations, and Orders at the Local, State, and/or Federal Level

SGMA implementation in the Subbasin has been impacted, to varying degrees, by activities, regulations, and orders outside of SGMA at the local, state, and/or federal level. Those that have most significantly impacted SGMA implementation include the following:

<u>Executive Order (EO) N-7-22 Action 9 and Impacts to Groundwater Well Permitting</u>

- **Context:** On March 28, 2022, Governor Newsom issued EO N-7-22 as a means of providing response to and mitigation of drought impacts. EO N-7-22 requires additional review of well permits by local jurisdictions and GSAs in groundwater subbasins subject to SGMA that are classified as medium or high priority. Both existing wells seeking alteration, and proposed wells, must first determine that extraction of groundwater from the proposed well is not likely to interfere with the production and functioning of existing nearby wells, and will not likely cause subsidence that would adversely impact or damage nearby infrastructure. Requirements under EO N-7-22 are intended to ensure that proposed wells are not inconsistent with achieving the sustainability goal established in any GSP.

- **Impacts to Subbasin:** As described in Section 2.1.3.3 of the Joint GSP 2025 Plan Amendment, the Madera County Environmental Health Division is entrusted with all permitting and enforcement for the construction, reconstruction, and destruction of wells in Madera County, including the entire Subbasin. Wells under their oversight include, but are not limited to, agricultural wells, observation/monitoring wells, community water supply wells, and individual domestic water supply wells. Well permitting processes in Madera County were consistent with all applicable requirements under EO N-7-22, and are helping to ensure that proposed wells are not inconsistent with achieving the sustainability goal for the Subbasin.

Senate Bill (SB) 122 and Impacts to Recharge Efforts

- **Context**:
  - SB122 was signed into law on July 10, 2023, formalizing and refining certain provisions under EO N-4-23 (issued in March 2023) that allow recharge of flood waters in certain circumstances, in absence of an approved water right. SB122 provides a pathway for diversion of flood waters for recharge if, among other requirements and considerations, a local or regional agency with flood control or flood risk responsibilities has given notice that flows downstream of the proposed diversion are at imminent risk of flooding and inundation of land, roads, or structures.
  - SB 1390 was later proposed in the 2024 legislative session, and was intended to address some ambiguities associated with SB122 (as codified in Water Code Section 1242.1) for diversions of flood flows to recharge. Proposed refinements included changes to requirements related to flood control or flood risk planning, and proposed language related to protection of the Delta as part of conditions for diversion. Although the bill did not pass in 2024, it is reasonably foreseeable that additional legislation pertaining to recharge efforts will be proposed in coming legislative sessions. The GSAs will engage in those discussions at that time.

- **Impacts to Subbasin**:
  - The provisions of EO N-4-23 and SB122 have already been very beneficial in supporting groundwater sustainability in the Subbasin, with substantial recharge occurring in 2023 under their allowances. Flood diversions are critical to maximizing recharge and thus SB122 is an essential component or tool to use in making diversions. Without the flexibility afforded by flood diversion under SB122, projects are limited to restrictions imposed by water rights. Moving forward, SB122 and any future clean-up legislation is expected to significantly streamline recharge efforts in the GSAs during flood flows, particularly along the Chowchilla Bypass, while also benefitting local and regional flood protection.
  - Nevertheless, the GSAs have identified certain potential challenges for PMA implementation associated with legal and regulatory interpretations of SB122, specifically related to considerations for new permanent infrastructure construction and its eligibility for use in flood diversions under SB122 (Water Code Section 1242.1). Some interpretations of SB122 are that the intent of the legislation was to prevent installation of new infrastructure during the flood season expressly for diverting water under SB122. In this interpretation, water users can still install permanent infrastructure (going through all appropriate regulatory processes with applicable permitting agencies) and then use that infrastructure to divert flood waters under SB122, among its other uses. Differing interpretations by some permitting agencies when applying SB122 take a stricter stance on new infrastructure, suggesting that new diversion facilities are more broadly not to be constructed in association with SB122.

Land Use Topics

- As described in Section 2.1.3 of the Joint GSP 2025 Plan Amendment, the Subbasin lies entirely within Madera County and the Madera County General Plan is applicable to land use within the entire Subbasin. Additionally, the City of Madera General Plan is applicable to land in the boundaries of the City of Madera. Madera County and City of Madera policies related to land use are described therein. Implementation of proposed land use developments under both General Plans is expected not to adversely impact groundwater sustainability in the Subbasin. Madera County has a net zero ordinance that requires developers to bring in enough water supply for the development such that it does not increase demand. Similarly, new developments in the City of Madera are required to follow the Model Water Efficient Landscape Ordinance (MWELO)[3], and are thus expected to reduce water demands.
- In addition to applicable General Plan policies, PMAs are expected to contribute to land use changes in the Subbasin (e.g., conversion of parcels to recharge basins, land use changes associated with the VLRP, MLRP, and demand management.

[3] The MWELO increases water efficiency standards for new and retrofitted landscapes by encouraging more efficient irrigation systems, graywater usage, and onsite storm water capture, and by limiting the portion of landscapes that can be covered in turf. See Section 2.1.3 of the Joint GSP 2025 Plan Amendment.

7 Outreach, Engagement, and Coordination with other Agencies (23 CCR §356.4(j))

Please refer to the Madera Subbasin 2025 Periodic Evaluation for a summary of the Subbasin GSAs' outreach, engagement, and coordination with other agencies during this Periodic Evaluation cycle (per 23 CCR §356.4(j)). Updates are provided for the Subbasin as a whole, including activities conducted specifically by the Joint GSP GSAs.

8 Other Information (23 CCR §356.4(k))

Please refer to the Madera Subbasin 2025 Periodic Evaluation for a summary of other information relevant to Plan implementation for the Subbasin during this Periodic Evaluation cycle (per 23 CCR §356.4(k)). Updates are provided for the Subbasin as a whole.

9 Summary of Proposed or Completed Revisions to Plan Elements (23 CCR §356.4(i))

Please refer to the Madera Subbasin 2025 Periodic Evaluation for a summary of proposed and completed revisions to Plan elements (per 23 CCR §356.4(i)). Updates are provided for the Subbasin as a whole.

The 2025 Plan Amendment accompanying the 2025 Periodic Evaluation has been amended to address recommended corrective actions identified by DWR in their December 2023 approval of the 2023 Revised Plan. The 2025 Plan Amendment – including all four amended GSPs and the Coordination Agreement – was adopted before the January 2025 submittal.

Specific revisions to the Plan elements that were completed as part of the 2025 Plan Amendment are identified in ***Appendix 1.A.2*** *of the Madera Subbasin 2025 Periodic Evaluation, with reference to revisions in specific sections of the Joint GSP 2025 Plan Amendment.*

10 References

DWR, 2023. Guidance for Sustainable Groundwater management Act Implementation: Considerations for Identifying and Addressing Drinking Water Well Impacts. March 2023.

Appendix 1.B. 2025 Periodic Evaluation GSP Attachments

Appendix 1.B.2. GFWD GSA GSP 2025 Periodic Evaluation Elements

GRAVELLY FORD WATER DISTRICT

GROUNDWATER SUSTAINABILITY PLAN 2025 PERIODIC EVALUATION

JANUARY 2025

GROUNDWATER SUSTAINABILITY PLAN 2025 PERIODIC EVALUATION

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January 2025

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Project #240102

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Appendices

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List of Acronyms

af	Acre Feet/Acre Foot
CDEC	California Data Exchange Center
CIMIS	California Irrigation Management Information System
DWP	Domestic Well Program
DWR	Department of Water Resources
DTW	Depth to Water
ET_0	Evapotranspiration
GFWD	Gravelly Ford Water District
GRF	Gravelly Ford
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HCM	Hydrogeologic Conceptual Model
IM	Interim Milestone
IWFM	Integrated Water Flow Model
ISW	Interconnected Surface Water
KDSA	Kenneth D. Schmidt and Associates
LSCE	Ludorff-Scalmanini Consulting Engineers
MCL	Maximum Contaminant Level
MCSim	Madera-Chowchilla Groundwater Surface Water Simulation Model
MID	Madera Irrigation District
MO	Measurable Objective
MOU	Memorandum of Understanding
MT	Minimum Threshold
NRCS	Natural Resources Conservation Service
RMS	Representative Monitoring Site
SCADA	Supervisory Control and Data Acquisition
SGMA	Sustainable Groundwater Management Act
SJR	San Joaquin River
SJRRP	San Joaquin River Restoration Project
SMC	Sustainable Management Criteria
SWRQB	State Water Resources Control Board
TDS	Total Dissolved Solids
URF	Unreleased Restoration Flows
USBR	United States Bureau of Reclamation

SECTION 1 - EXECUTIVE SUMMARY

Gravelly Ford Water District (GFWD; District) was formed in 1961 to be eligible for surface water from the United States Bureau of Reclamation (USBR). The District serves approximately 8,300 acres of unincorporated Madera County territory. The primary land uses are grape vineyards, nut tree groves, and on-farm rural residences. The San Joaquin River borders a portion of the District to the south, and Cottonwood Creek flows west through the northern portion of the District. The District is bisected by the Gravelly Ford Canal, which runs north to south.

GFWD is a groundwater sustainability agency (GSA) in the Madera Subbasin. The Madera Subbasin has seven separate GSAs and four individual GSPs. The Madera Subbasin Joint GSP (Groundwater Sustainability Plan) includes Madera Water District, Madera Irrigation District, the City of Madera, and Madera County. This accounts for the majority of the Madera Subbasin. Gravelly Ford Water District, Root Creek Water District, and New Stone Water District have elected to write, analyze, and update their own GSPs; however, all GSAs have agreed to use the Madera Subbasin Joint GSP and their modeling efforts to describe the Subbasin conditions as a whole. It should also be noted that the original GSPs for each of the Plan Areas were submitted in 2020, and amendments to the GSPs were submitted in 2023. The Madera Subbasin Technical Committee is currently in the process of drafting changes to the current Plans to be amended in 2025.

The purpose of this Periodic Evaluation is to analyze the GFWD GSP Amended 2023 as it relates to Department of Water Resources (DWR) the approval letter Recommended Actions (see Appendix B), groundwater conditions during the implementation period, and implementation of projects and management actions. This document will also address proposed changes in the GFWD GSP Amended 2025, including the changes to the GFWD monitoring network and sustainable management criteria (SMC). Changes to the SMC are Subbasin-wide and will be described in more detail in the Madera Subbasin Joint GSP Amended 2025. This document also outlines the progress the District has made during the implementation period with regard to implementing and expanding its monitoring network, raising funds for implementation of projects and management actions, and operations of projects and management actions already in place.

Based on the analysis of the GFWD GSP Amended 2023, the District is seeing groundwater levels recover back to the spring 2015 measurements taken for each of the agricultural wells and representative monitoring site (RMS) wells in most areas. Subsidence is also within the expected range. It is projected that the District will be within the sustainable range by the end of the implementation period.

SECTION 2 - NEW INFORMATION COLLECTED

In the nearly five years since the original GFWD GSP and accompanying Joint GSP were submitted in January 2020, additional resources and data have been developed and analyzed. This information allows GSAs to analyze their GSPs, monitoring programs, HCMs (Hydrogeologic Conceptual Model), and changes in groundwater conditions and relate that information to sustainable groundwater management in the GSA. Some information and data have informed changes to the GFWD GSP Amended 2025 and associated programs.

The District and their Madera Subbasin GSA partners continue to collect data for annual reporting and to steer GSP implementation. However, there have been necessary changes, and the need to obtain new information or alter existing information is detailed in this section. Below is a summary of new information that has been collected and how it has been used or could be used. It should be noted that this may not be an exhaustive list of all information available, and the mentions below are for informational purposes only.

2.1 - Model Update

The Madera Subbasin Technical Committee (Technical Committee) consists of technical representatives for each Madera Subbasin GSP, including Ludorff-Scalmanini Consulting Engineers (LSCE), the technical consultant hired to model groundwater conditions in the Subbasin. LSCE is the same consultant that modeled groundwater conditions for the previous iterations of the Madera Subbasin Joint GSP. The Madera-Chowchilla Groundwater Surface Water Simulation Model (MCSim) is a numerical groundwater flow model based on the Integrated Water Flow Model (IWFM) code developed and maintained by the California Department of Water Resources (DWR). An update of MCSim (MCSim_v2), was completed for the first plan amendment to the Madera Subbasin Joint GSP Amended 2025. According to LS, changes to the model include:

- Updates to the model code for the MCSim.
- Adding the subsidence package to the model. There have also been refinements to the extent of the Corcoran Clay. This subsidence data has been added to the model between the years of 2015 – 2024. Subsidence is being projected until 2090.
- Additional refinements to groundwater conditions and the hydrogeological conceptual model include refinements to the bedrock for simulation, refinements of the texture model, refinement of the texture model, addition of subsidence package, extension of historical simulation, update of boundary conditions, addition of calibration points, model recalibration, refined projected hydrology.
- LSCE also refined projected and proposed projects and management actions for projections and simulations.
- Changes to representative water years and the simulation period include a historical period update from 1989-2015 (v1) to 1989-2023 (v2) and recalibration. The sustainability period (2040-2090) updated the representative hydrology from 1965-2015 (v1) to 1973-2023 (v2).

A detailed description of the updates to and recalibration of MCSim_v2 is included in the Madera Subbasin Joint GSP Amended 2025.

2.2 - New Monitoring Data

The District has been monitoring SMCs since the development stages of the GSP. This data has been reported annually. The analysis of the data is explained further in Section 3. The remainder of this section focuses on changes to the monitoring network as a result of the available data and any data gaps within the District. An additional analysis of the monitoring network is in Section 6.

The District has made significant changes to the existing monitoring network. GFWD is a small water district within the Madera Subbasin and only makes up a small percentage of the Subbasin. Prior to the implementation of the Sustainable Groundwater Management Act (SGMA) the District had no official groundwater monitoring program. However, the District has historically reviewed monitoring data from other agencies including USBR, DWR, SWRCB (State Water Resources Control Board), and nearby water districts and water quality monitoring programs.

The District developed a groundwater monitoring plan that utilized the historical data of two wells within the District that were monitored by DWR. Unfortunately, DWR has not taken a water level measurement from either of the wells selected since 2019. Because DWR no longer measures these wells, the District selected new representative wells. The District does not have a good way to compare current water level data from District agricultural wells with long-term historical data. It should be noted that these are not dedicated monitoring wells and will not be referred to as “monitored” wells rather than “monitoring” wells. The District will now be using agricultural wells 201, 202, 203, 206, 213, and 224 as representative monitored wells for the purposes of annual reporting. The Madera Subbasin also monitors a site within the District (MSB06). They also collect data from subsidence monitoring stations that lie on the border of the northeastern portion of the District. GFWD plans to review relevant data acquired by the Madera Subbasin and compare results to data gathered by the District. Additional details about the monitored wells for water levels in the District can be found in Section 6 of this document and the GFWD GSP Amended 2025.

The District has also implemented an internal subsidence monitoring network. The District is currently monitoring subsidence at agricultural wells. The District is using the same agricultural wells to monitor water levels and subsidence. Additional details about the subsidence monitoring in the District can be found in Section 6 and the GFWD GSP Amended 2025.

The District has not had any known issues with groundwater quality for irrigation, so implementing an internal water quality monitoring network has been a lower priority. It was determined that the District would monitor water quality at domestic wells rather than at the same wells measured for subsidence and water levels for the purposes of annual reporting. Additional details about water quality monitoring in the District can be found in Section 6 of this document and the GFWD GSP Amended 2025.

The Subbasin is working with neighboring subbasins on the interconnectedness of surface waters from the San Joaquin River (SJR) and wells in subbasins adjacent to the San Joaquin River.

2.3 - New Reports

Electromagnetic Survey

The electromagnetic survey supplements existing geological data. As the data is refined, the District will review the results and apply them to the GSP accordingly.

A Guide to Water Quality Requirements under SGMA

This report is intended to assist GSAs in implementing a groundwater quality monitoring program. It outlines the need to understand regulatory authority and groundwater quality standards to develop SMCs, the need for coordination with regulatory agencies and RWQCB, the need to assess groundwater conditions to identify water quality issues, and the need to determine an approach for monitoring and understanding the effects of projects and management actions on groundwater quality.

ISW Guidance

In February 2024, DWR released guidance on Interconnected Surface Water (ISW), which includes definitions and explanations of what constitutes ISW, how to determine if wells are interconnected, what constitutes depletions, and how depletions can be managed. This guidance document is the first of three intended to assist GSAs in identifying ISW. The following two guidance documents aim to assist in quantifying the depletions of ISWs. These guidance documents were published in September of 2024 and will be reviewed and consulted with the development of the 2025 Annual Report. Generally, these two newly released documents cover techniques and examples of estimating depletions of interconnected surface water due to groundwater use.

2.4 - New Interagency Coordination

Domestic Well Program

The Domestic Well Program memorandum of understanding (MOU), dated March 21, 2023, outlines the intent to establish a Domestic Well Program (DWP). The Joint Subbasin DWP MOU identifies the DWP development process. The intention was to develop the DWP within the first five years of the GSP implementation by 2025. However, the MOU was not officially adopted until March of 2023. Currently, no DWP has been presented to the GSAs and the status of the DWP is unknown. GFWD agrees with the need for a DWP; however, the District prefers to address domestic well issues internally due to the nature of the District. It also wants to ensure that parameters for eligibility in the DWP are clearly defined to ensure that affected domestic wells are truly being affected by the sustainable management criteria as defined in the GFWD GSP Amended 2025.

Coordination Agreement

The original coordination agreement for the GSAs within the Madera Subbasin expired on December 31, 2024. A coordination agreement signed by all parties within the Madera

Subbasin is required prior to the submittal 2025 Groundwater Sustainability Plan Periodic Evaluation. The final coordination agreement is attached to this document and can be reviewed in Appendix A.

Interconnected Surface Water MOU
The Madera Subbasin is in discussions with the Kings Subbasin to develop an MOU regarding interconnected surface waters along the San Joaquin River. This MOU is still in draft form and was included in the Madera Subbasin Joint GSP Amended 2025.

2.5 - New Funding Sources

Grants and Financial Assistance for Implementation
The District has applied for several grants since submitting the original GFWD GSP in 2020. The District applied for grant funding from DWR for SGMA project implementation in 2022 but was not awarded. More recently the District has applied for grant money from USBR's WaterSMART Program. The District applied for grants for both the Automatic SCADA Radial Gate Design Project and the Agricultural Well Metering Program. Additional information on grant applications and proposed projects for funding can be found in Section 4 and the GFWD GSP Amended 2025. The District also encourages landowners and growers to apply for Natural Resource Conservation Service (NRCS) programs and grants.

Proposition 218 Fee Assessment
Gravelly Ford Water District has historically levied volumetric water charges and land-based assessments to recover the District's expenses. On July 15, 2024, the property owners within the District voted to approve levying a new special assessment for the District as Resolution 2024-07. The assessment to be levied is $41.18 per acre for the 2024-2025 Fiscal Year, with a maximum of $90 per acre in perpetuity. A large portion of the funding is for surface water purchases for recharge and infrastructure to expand the District's Recharge Program and increase irrigation efficiency.

2.6 - Determinations/New Legislation/Policy/Lawsuits

There have been several decisions, policies, and lawsuits that have the potential to set precedence for the future of SGMA. These decisions will impact the understanding and subsequent implementation of SGMA. Many of the examples listed below are still being legislated, and the exact effects on GSAs are unknown. The following is a sample of potential legal decisions that could change the implementation and understanding of SGMA. This is a summary only and not an exhaustive list of all current and future legal decisions, and the final effects to SGMA are unknown.

DWR has finished the analysis of the initial 2020 GSP submissions for critically overdrafted subbasins and determined each GSP compliance with SGMA. The analyses of GSPs submitted in 2020 were accompanied by a determination that included a list of deficiencies and recommended actions. These recommended actions were a list of suggestions for compliance with and improvements to the GSPs if applicable. These recommended actions are intended to guide the evolution of the GSP and the interpretation of SGMA requirements.

See Section 2.7 for a list of recommended actions that accompanied the Madera Subbasin Joint GSP Amended 2023 approval.

AB 828 is a new California policy that states, “This bill would prohibit a groundwater sustainability agency from imposing a fee upon a small community water system serving a disadvantaged community or *imposing a fee for* managed wetland purposes, provided the water use for each user does not increase above the extractor’s average annual extraction from 2015 to 2020, inclusive, as determined by a groundwater sustainability agency using recognized methods to establish average groundwater use. The bill would prohibit these provisions from applying to a groundwater basin with a groundwater sustainability plan that has been approved by the department after January 1, 2025.” This policy was sent to the Governor on September 10, 2024. It is unknown how implementation of this bill would affect SGMA implementation as it relates to project implementation and funding. Bill Text: CA AB828 | 2023-2024 | Regular Session | Amended | LegiScan

There have been multiple lawsuits that may affect the interpretation and implementation of SGMA. Some of the lawsuits most likely to affect the Madera Subbasin include California United Water Coalition vs. Madera County regarding the implementation of fees on groundwater usage and Kings County Farm Bureau vs. the SWRCB regarding the requirement of farmers to meter and report their groundwater usage. These actions are not yet settled. These suits have the potential to affect SGMA implementation and the GSA's ability to manage their Plan Areas.

2.7 - New DWR Data

2.7.1 - Recommended Corrective Actions

On September 22, 2022, after a thorough review of the initial 2020 Joint and individual GSPs, DWR issued a staff report and findings determining that the initial 2020 Joint and individual GSPs submitted by the District were incomplete. The Department provided corrective actions in this report that assisted GFWD and other GSAs in the Subbasin in addressing deficiencies in their Plans. The District was given 180 days to address deficiencies within the Plan in coordination with the other GSAs in the Subbasin. The District and partner GSAs resubmitted the revised GSPs with redlines to DWR on March 21, 2023, for subsequent review.

On December 21, 2023, DWR issued a second staff report and statement of findings based on the review of the resubmitted GSPs. This report determined that the Joint GSP Amended 2023 was approved, and sufficient actions had been taken to correct the deficiencies detailed in the September staff report. However, the most recent staff report identified additional corrective actions that will “enhance the GSP and facilitate future evaluations.” The full DWR approval letter for the Madera Subbasin is attached as Appendix B. The recommended corrective actions generally focus on the following:

1. Providing a detailed explanation specifically discussing and identifying Madera Irrigation District (MID) GSA’s legal, contractual, or other authorities or

arrangements to implement its obligations under the Madera Subbasin Joint GSP in the next periodic evaluation.

As of April 2024, all Madera Subbasin GSAs have adopted the Madera Subbasin Joint GSP Amended 2023 and are implementing both the Joint and individual plans consistent with the requirements of SGMA. More information on MIDs GSP implementation can be found in the Madera Subbasin Joint GSP 2025 Periodic Evaluation and Madera Subbasin Joint GSP Amended 2025.

2. Continuing efforts to further coordinate the GSPs and groundwater management.

   The existing Madera Subbasin coordination agreement expires on December 31, 2024. The Technical Committee has discussed the need to renew it prior to that date. The coordination agreement is attached to this document as Appendix A.

   Additionally, the GSAs, through the Technical Committee and appointed Facilitator, have been working to standardize all data, definitions, and approaches. The Technical Committee meets biweekly to refine GSP requirements and methodologies, define sustainable management criteria, and respond to corrective actions.

   The Technical Committee is also working with Madera County and the Facilitator to develop and implement the Domestic Well Mitigation Program. The County has received a grant to plan and implement the program. It should be noted that the District intends to cooperate with the requirements of the program. However, the program is still under development, and requirements for participation, such as age and depth of wells, eligible replacement costs and depreciation, and costs to Districts and GSAs for participation, have yet to be established. It is the intent of GFWD to privately assist landowners in well replacement if it is clear that well/pump failure is a result of changes in groundwater conditions.

   Additionally, the GSAs are in agreement to use one groundwater model for the Subbasin and water budgets. However, it should be noted that GFWD has been and will continue to perform independent water budgets and assessments for groundwater conditions for the District. This is intended to check the model on a small district scale and inform the model of future projections. As the District's monitoring network grows to include groundwater pumping, this independent groundwater condition assessment will provide more accurate and real-time data for the benefit of the groundwater model.

3. Sufficiently describing the effect of chronic lowering of groundwater level interim milestones on other sustainability indicators.

   Section 3.2.2 of the GFWD GSP 2025 Periodic Evaluation addresses the effects of chronic groundwater lowering on other SMCs. It is generally understood that chronic groundwater lowering can potentially affect other sustainability indicators. This periodic evaluation will discuss these effects on other sustainability indicators in Section 3, and changes will be reflected in the GFWD GSP Amended 2025.

4. Re-evaluating the quantitative metrics that constitute undesirable results due to land subsidence and sufficiently describing the effect and extent of land subsidence interim milestones that allow continued subsidence during the GSP implementation period. Identify the cumulative amount of subsidence that will interfere with groundwater users. Detail projects and schedules to combat subsidence. Discuss relationships between SMCs and management criteria for subsidence and re-evaluate uncertainty in subsidence measurements.

   The Madera Subbasin Technical Committee has discussed the issue of subsidence in depth. Unfortunately, there is a significant lack of historical data that reduces certainty in the effects of the climate and groundwater levels on subsidence. This leaves a significant level of uncertainty in projections. Another issue that has been discussed by the Technical Committee is residual subsidence. This is the continued subsidence that occurs after groundwater pumping has been reduced; or during a significantly wet year, when surface water is the primary source of water use and pumping remains below the sustainable yield. Additional discussion including the changes to undesirable results and interim milestones will be addressed in the GFWD GSP Amended 2025.

5. Describing data gaps in the hydrogeologic conceptual model.

   The Madera Subbasin will need to analyze the Joint Subbasin HCM as a part of their Madera Subbasin Joint GSP Amended 2025. An analysis of data gaps for the preparation of the Hydrogeological Conceptual Model for the Gravelly Ford Water District was performed in 2018 by Kenneth D. Schmidt and Associates (KDSA). Generally, these data gaps remain unchanged. KDSA has identified the following data gaps:

   - Groundwater pumpage.
   - Aquifer characteristics, mainly transmissivity which would be determined using pump tests along the GSA boundary. This will allow the determination of groundwater inflows and outflows.
   - Domestic well canvassing and construction information.
   - Domestic well water quality sampling.
   - Surface water monitoring.

6. Sufficiently detailing the degraded water quality undesirable results and explaining the rationale to allow potential further degradation.

   The District has yet to integrate water quality into their monitoring network. Currently the District plans to follow the guidance from DWR and implement SMCs as determined by the Technical Committee. These water quality SMC parameters will be available in the 2025 Updated Joint Madera Subbasin GSP. It should also be noted that the District will need to obtain groundwater quality information for several years to establish a baseline. This baseline will be used to determine SMCs for future iterations of the GSP.

2.8 - Updated GFWD GSA Boundary

GFWD and GFWD GSA updated their boundary by adding 390 acres to the southeast, near the SJR, previously in the "white area," on January 22, 2020, and removing 411 acres owned by MID to the north, on September 23, 2020. The result was a reduction in acreage from 8,317 acres to 8,295 acres. See Figures 2-1, 2-2, and 2-3 for a comparison of the old District boundary to the new District boundary.

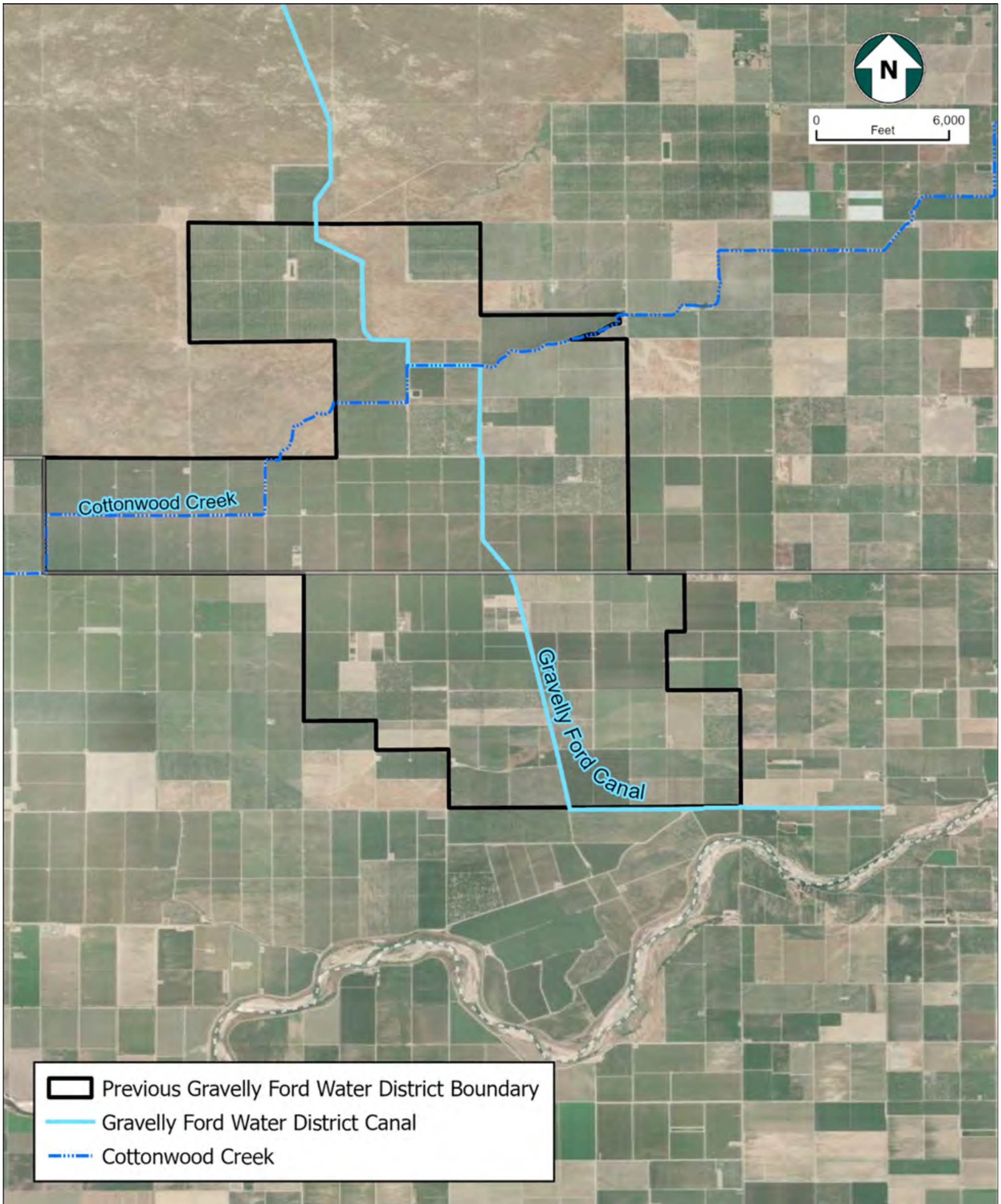

Figure 2-1
Previous GWFD GSA Boundary

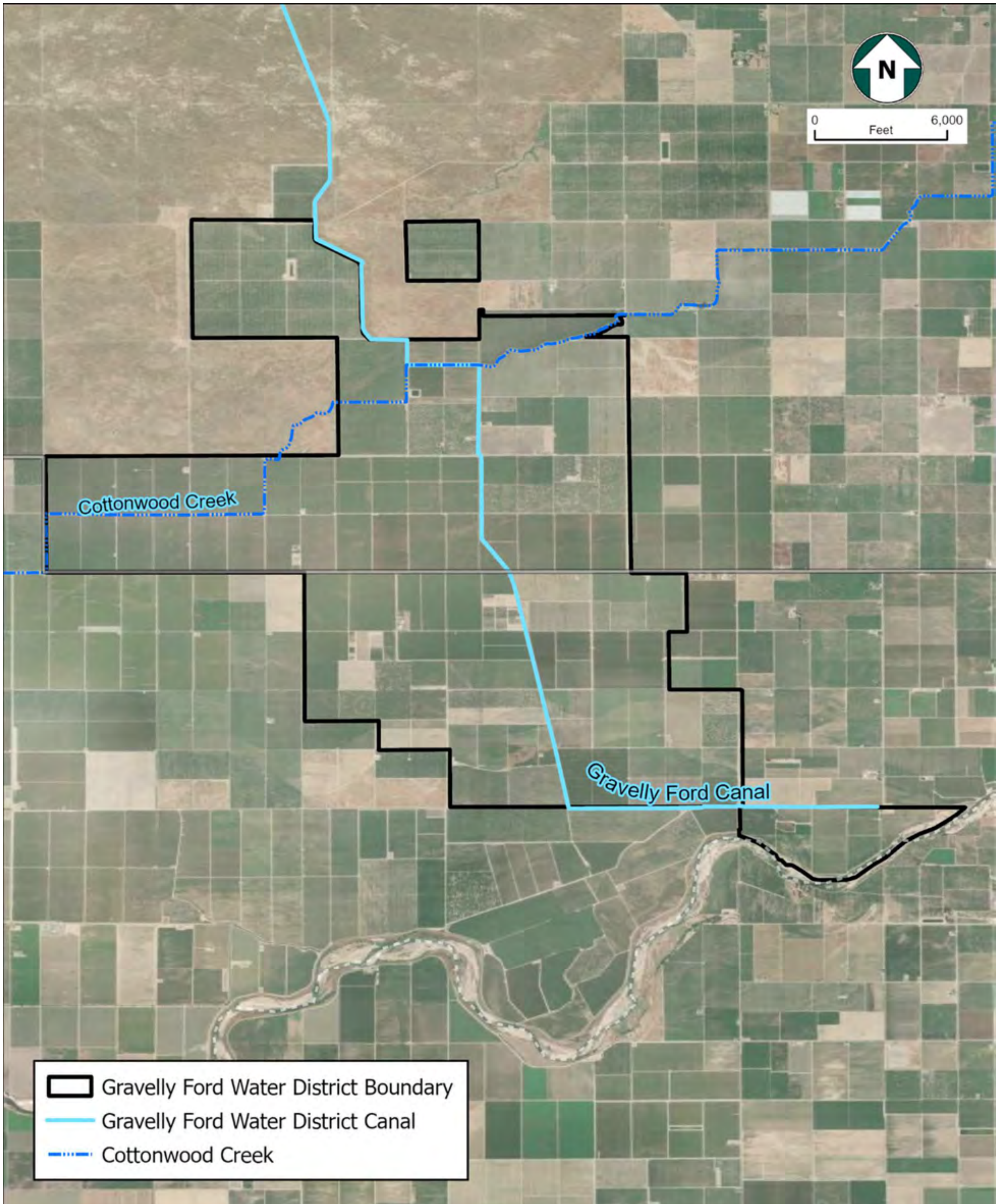

Figure 2-2
Updated GFWD GSA Boundary

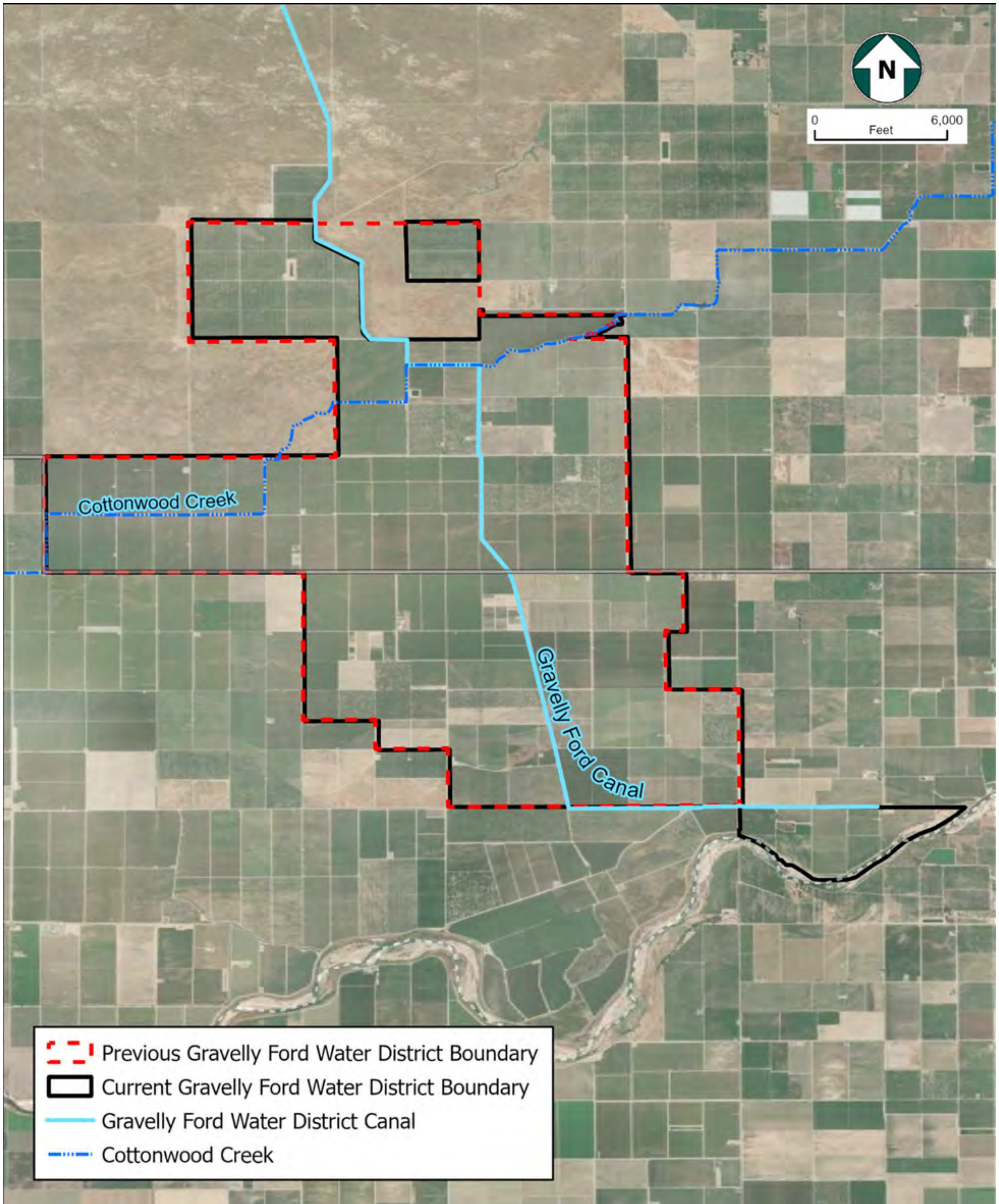

Figure 2-3
Updated GFWD GSA Boundary

SECTION 3 - GROUNDWATER CONDITIONS RELATIVE TO SUSTAINABLE MANAGEMENT CRITERIA

This section contains a summary of groundwater conditions over the implementation period since the submission of the original 2020 GFWD GSP. It also summarizes these conditions as they relate to the SMC established in the GFWD GSP Amended 2023 and the proposed new SMCs developed by the Technical Committee.

The GSP Approval Determination Letter, dated December 21, 2023, outlined several recommended actions. These recommendations, as they relate to SMC and GFWD's plans for implementation, will be addressed in this section. Additional information as it relates to the entire Madera Subbasin groundwater conditions and SMCs can be found in the GFWD GSP Amended 2025 and the Madera Subbasin Joint GSP Amended 2025.

Table 3-1
Sustainable Management Criteria – Madera Subbasin Joint GSP Amended 2023

Sustainability Indicator	Minimum Threshold	Measurable Objective	Undesirable Result (after 2040)[1]
Chronic Lowering of Groundwater Levels	Set equal to the fall 2015 measurement, if that observed data point is available at the RMS. Otherwise, set equal to the expected fall 2015 groundwater level determined from MCSim results, with adjustment, if necessary, to account for the offset between historical observed and modeled data.	Set equal to the fall 2010 measurement, if that observed data point is available at the RMS. Otherwise, set equal to the expected fall 2010 groundwater level determined from MCSim results, with adjustment, if necessary, to account for the offset between historical observed and modeled data.	Same 30 percent of RMS wells within the Subbasin below minimum threshold for two consecutive fall measurements.
Reduction of Groundwater Storage	Same as MTs for chronic lowering of groundwater levels. (Groundwater levels used as a proxy.)	Same as MOs for chronic lowering of groundwater levels. (Groundwater levels used as a proxy.)	Same 30 percent of RMS wells below minimum threshold for two consecutive fall measurements. (Groundwater levels used as a proxy.)
Land Subsidence	0 feet/year, subject to uncertainty of +/-0.16 feet/year	0 feet/year, subject to uncertainty of +/-0.16 feet/year	Average subsidence greater than 75 percent of RMS exceeding minimum threshold for two consecutive years.
Seawater Intrusion	Not Applicable	Not Applicable	Not Applicable

Sustainability Indicator	Minimum Threshold	Measurable Objective	Undesirable Result (after 2040)[1]
Degraded Water Quality	Nitrate = 10 mg/L or existing level plus 20% (whichever is greater) Arsenic = 10 µg/L or existing level plus 20% (whichever is greater) TDS = 500 mg/L or existing level plus 20% (whichever is greater)	Current constituent concentrations	10 percent of RMS wells above the minimum threshold for the same constituent due to projects and/or management actions or overall groundwater extraction based on average of most recent three-year period
Depletion of Interconnected Surface Water	A percent of time surface water is connected to shallow groundwater that is equal to historical conditions for a similar climatic/hydrologic period.	A percent of time surface water is connected to shallow groundwater that is equal to historical conditions for a similar climatic/hydrologic period.	Greater than 30 percent of RMS wells below minimum threshold for two consecutive annual five-year rolling average annual evaluations

3.1 - General Climate Information

The District tracks precipitation and evapotranspiration climate data at several California Irrigation Management Information System (CIMIS) stations. The nearest station to the District is Station number 7 – Firebaugh/Telles; however, they also track data at nearby stations 105 – Westlands and 124 – Panoche to ensure the quality of data and, on occasion, to supplement data that is missing. This data is used to estimate crop consumptive use and effective precipitation. Both are used to calculate the District water budget/balance. Moving forward, at the direction of hydrogeologist Ken Schmidt, the District will also track and use precipitation from the Fresno Airport weather station for calculating the water budget due to the consistency of data.

The water year type is a tool used by surface water managers to determine surface water allocations from water projects such as the Central Valley Project, which allocates surface water from the SJR. These water year types and the associated climate factors are also used to calibrate the groundwater model for the Madera Groundwater Subbasin and project groundwater level data and other SMCs. See Table 3-2 for precipitation data and respective water year type designations.

Table 3-2
GFWD Climate Data

District Climate Data			
Year	Station 7 - Firebaugh/Telles Precipitation (in)	CDEC Water Year Type Designation	National Weather Service Average Annual San Joaquin Valley Precipitation (in)
2020	6.49	Dry	4.44
2021	7.26	Critical	8.22
2022	6.37	Critical	5.43
2023	13.02	Wet**	11.54
2024	8.28*	Above Normal**	7.4*

*2024 data through August 2024 only
** Estimated water year based on historic trends
CDEC Water Year Type Dataset - Dataset - California Natural Resources Agency Open Data
Central and Southern San Joaquin Valley Climate Graphs (weather.gov)
CIMIS (ca.gov)

3.2 - Groundwater Levels

During the GSP development process, the District monitored two CASGEM wells that were measured by DWR to establish historic groundwater level trends. These wells are shown in the original GFWD GSP submitted in 2020 as Figures 3-1 and 3-2 and in the most recent annual report. They also show minimum thresholds and interim milestones identified in the original 2020 GFWD GSP. DWR is no longer measuring these wells, so the District is unable to directly compare current groundwater conditions to historic trends. However, it should be noted that water levels continued to decline at these wells until 2017, beyond the 2015 water level minimum threshold (MT) established in the 2023 Updated GSP. The District is currently using wells 201, 202, 203, 206, 213, and 224 to represent groundwater conditions in the District. The water level hydrographs for the representative monitored wells show spring 2015 water level measurements and spring and fall measurements from 2020 to the present.

It can be seen in Figures 3-1 through Figure 3-7 that water levels vary across the District. Water levels are within a sustainable range at all sites. Even considering there have been several dry years since the beginning of the implementation period. All but one of the representative wells have water levels at or above the fall 2015 MT. Due to the relative stability in groundwater levels the District is on track to meet sustainability by the end of the implementation period. See Figures 3-1 through 3-6 for hydrographs of all the representative monitored wells. It should be noted that Well 213 requires additional analysis to determine SMCs as there were no readily available water levels for either spring or fall of 2015. The District is currently in contact with the contractor responsible for taking well measurements during this time and will be attempting to obtain any historical data available. This data will be added to establish historic trends for the updated monitoring network if available. See Figure 6-1 and 6-2 for monitoring locations within GFWD.

Figure 3-1
Water Level Hydrograph Well 201

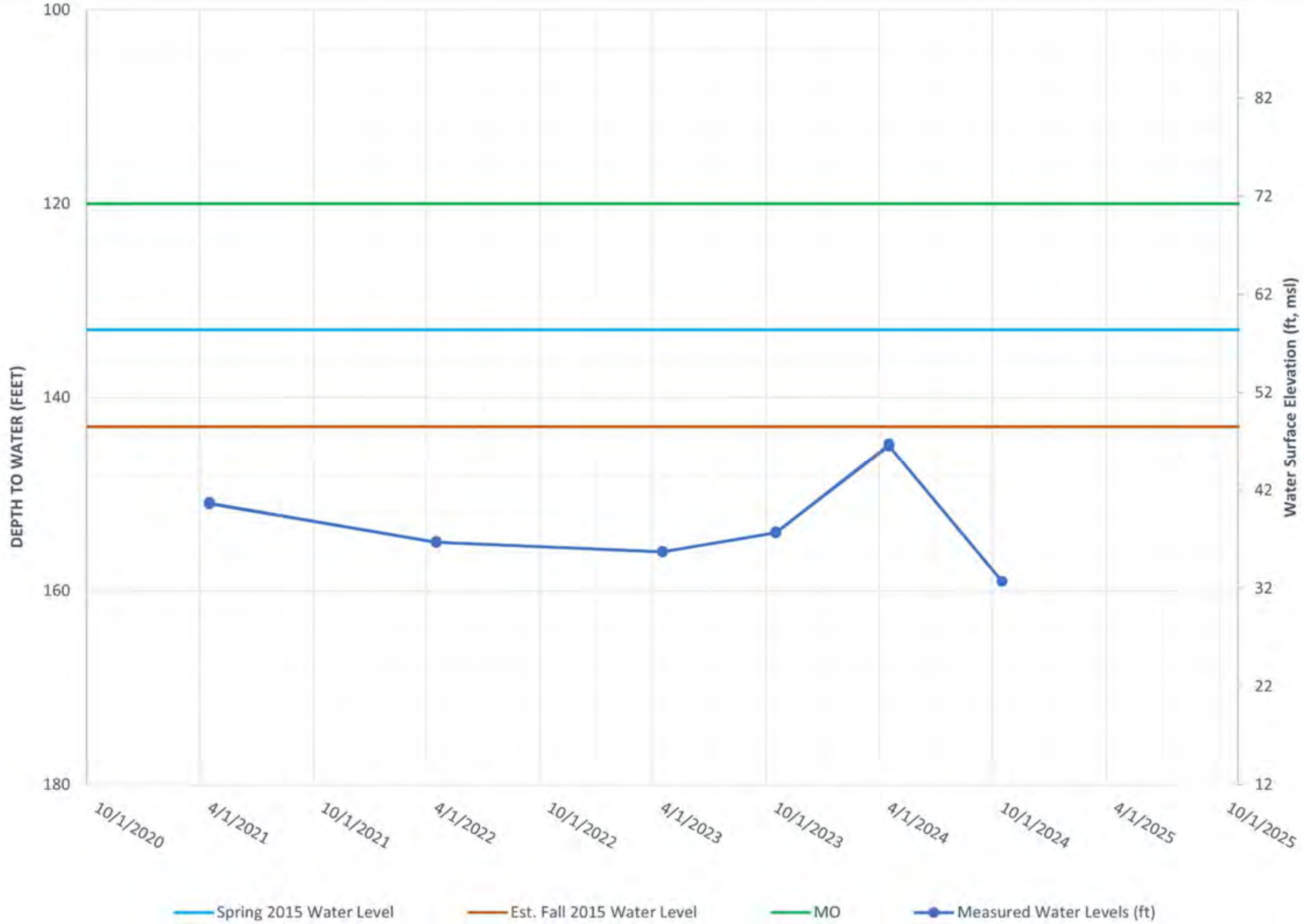

Figure 3-2
Water Level Hydrograph Well 202

Figure 3-3
Water Level Hydrograph Well 203

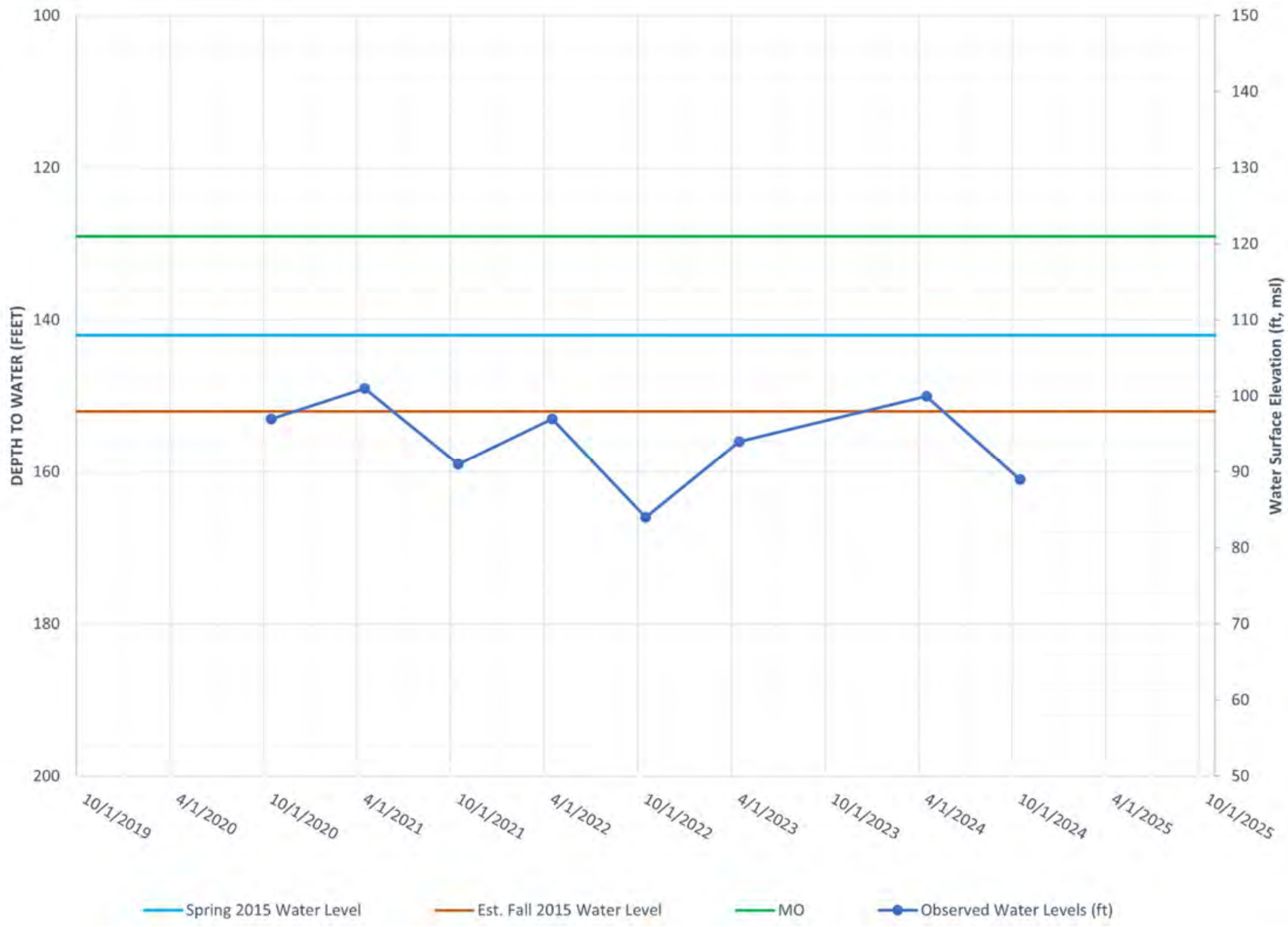

Figure 3-4
Water Level Hydrograph Well 206

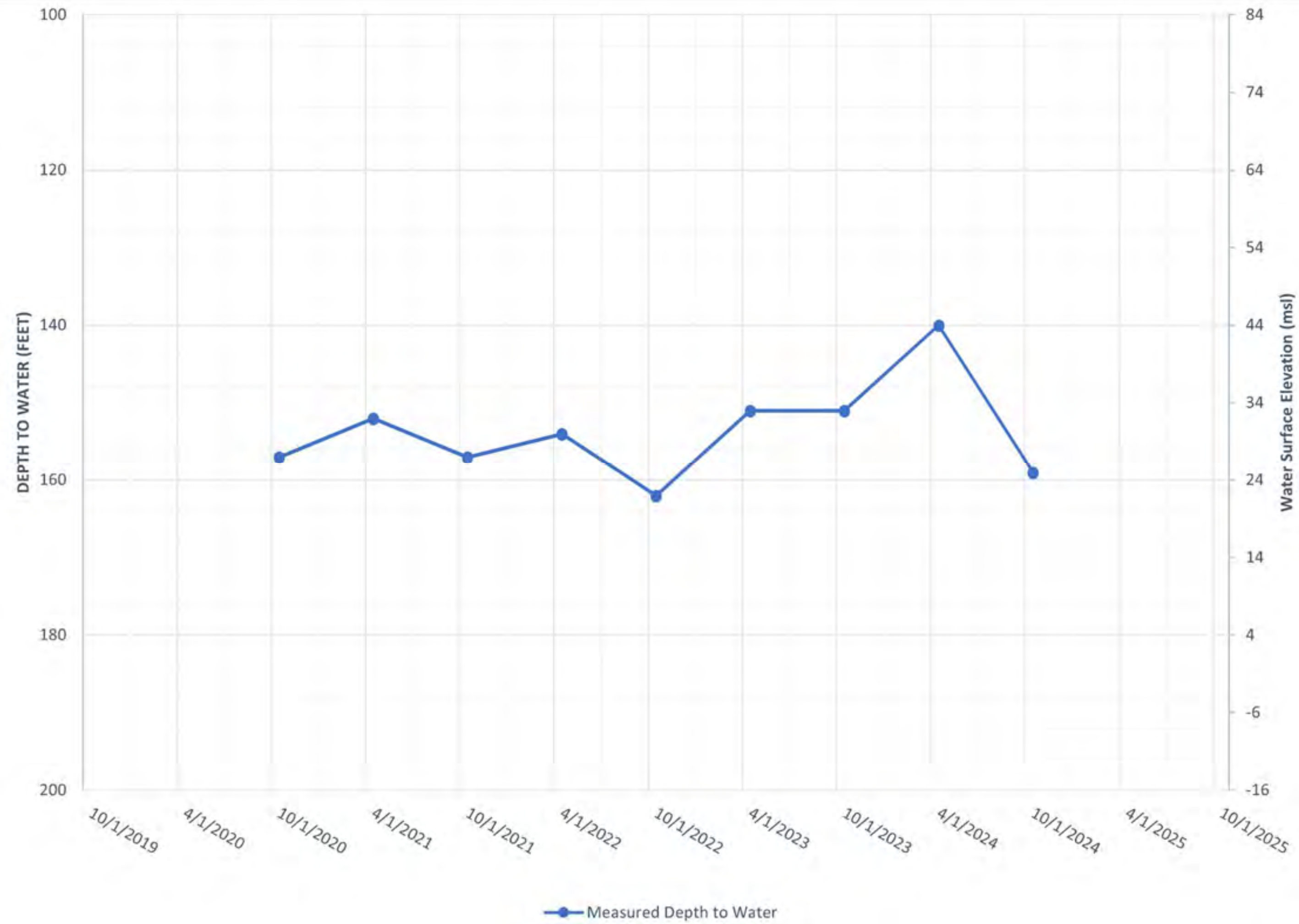

Figure 3-5
Water Level Hydrograph Well 213

Figure 3-6
Water Level Hydrograph Well 224

3.2.1 - SUSTAINABLE MANAGEMENT CRITERIA EVALUATION

While GFWD adopted the 2023 Updated Madera Subbasin Joint GSP Amended 2023 and submitted edits to its own GSP in 2023, the District still needed to quantify the SMC for its new monitoring network for groundwater levels. The District used data from both its own monitoring network and the Madera Subbasin monitoring network to establish MTs and measurable objectives (MOs) for the new representative monitoring network. The District has data for water levels at the representative monitoring network in the spring of 2015, but not fall. Spring 2015 water levels were compared to seasonal variability for critically dry years in the District. This resulted in an additional 10 feet being added to the spring 2015 water levels to simulate fall 2015 groundwater conditions. See Figures 3-1 through 3-6 for hydrographs showing estimated fall 2015 DTW.

MOs were developed using SMCs from nearby wells in the Madera Subbasin monitoring network. It can be seen in Table 3-3 that the MTs for nearby wells in the Madera Subbasin are 23-25 feet deeper than the MOs. Based on the difference between MOs and MTs at wells in and near the District, an additional 23 feet was added to the MT for each representative well in the monitoring network. See Figures 3-1 through 3-6 for hydrographs showing estimated fall 2015 depth to water (DTW), MTs, MOs, and measured water levels.

Table 3-3
Joint Subbasin Groundwater Level SMCs

	Surface Elevation	Measurable Objective	Interim Milestone 2025	Interim Milestone 2030	Interim Milestone 2035	Minimum Threshold
MCW RMS-4	208	118	159	163	150	141
MCW RMS-5	340	277	328	334	302	302
Site 6 Future	-	-	-	-	-	-

All values are in feet and with the exception of surface elevation, are depth to water.

Table 3-4
Joint Subbasin Groundwater Level SMCs

Representative Well	Measurable Objective	Interim Milestone 2025	Interim Milestone 2030	Interim Milestone 2035	Minimum Threshold
201	149	190	194	181	172
202	120	161	165	152	143
203	119	160	164	151	142
206	129	170	174	161	152
213	TBD	TBD	TBD	TBD	TBD
224	76	117	121	108	99

Measurable Objectives
It was decided by the Technical Committee for GSP amendments in 2023 that fall 2010 groundwater levels represent Madera Subbasin conditions prior to the pre-2012 to 2015 drought period. Fall 2010 groundwater levels are considered a reasonable benchmark for the level at which fall groundwater levels will fluctuate under sustainable conditions after 2040. As stated previously, the wells that were originally selected as historic representative monitoring wells are no longer being monitored so the District used nearby Madera Subbasin representative monitoring wells shown in Table 3-2. Measurable objectives in wells analyzed were 23-25 feet above the minimum thresholds. GFWD used this information and set MTs for wells in the District using estimated fall 2015 water levels for each representative monitoring well and adding 23 feet. See Table 3-3. It should be noted that there may be more variable water levels in the shallow aquifer.

Interim Milestones
Interim milestones shown in Table 3-3, for the Madera Subbasin representative wells were used to develop interim milestones (IMs) for the GFWD representative monitoring wells. MCW RMS-4 is representative of wells accessing the lower aquifer while MCW RMS-5 is more representative of wells in the upper aquifer. As shown in Table 3-2, the lower aquifer shows less variability in water levels than the upper aquifer. Most of the wells being monitored display trends above the MTs and nearing the MO. Some fluctuated between the MO and MT but are trending up, and a couple are at the MT but were trending below the MT until spring 2024 water levels were taken. IMs for wells are at or below the MT; therefore, all wells are on track for sustainability by the end of the implementation period.

Minimum Thresholds
Minimum thresholds were reassessed because of the incomplete DWR letter dated September 22, 2022. It was decided that water level MTs would be set to fall 2015 levels. The hydrographs shown in Figures 3-1 through 3-6 show water levels as they relate to the spring 2015 water levels and estimate fall 2015 water levels based on seasonal variability. All representative monitored wells are at or above the MTs as of spring 2024.

Undesirable Results
According to the Madera Subbasin Joint GSP Amended 2023, undesirable results are exceedances of the 30% of Subbasin-wide RMS wells below the MT after 2040. GFWD is projected to be in compliance with water levels at or above the MT by the end of the implementation period, and there are no anticipated significant and unreasonable effects for any sustainability indicators during the implementation period within the District. The sustainable management criteria is currently being updated for the Madera Subbasin Joint GSP Amended 2025. Any changes to SMCs will be addressed further there.

Effects on Beneficial Uses/Users
There have been no documented effects to beneficial users within the District. See Section 3.2.2 below for the effects of groundwater levels on other SMCs.

3.2.2 - DWR Recommended Actions – Effects Of Groundwater Levels on Other SMCs

DWR provided the following recommended corrective action as it relates to groundwater levels. "Sufficiently [describe] the effect of chronic lowering of groundwater level interim milestones on other sustainability indicators."

Change in Groundwater Storage
Considering water levels serve as a proxy for change in groundwater storage, especially as it relates to the Madera Subbasin, it is safe to say that changes in groundwater levels directly correlate with changes in groundwater storage in the upper aquifer, at least on paper. It should be noted that a majority of the wells in the District are composite wells, which means that they draw groundwater from both the upper and lower aquifers.

The volume of groundwater can be calculated as the thickness of the saturated zone, which is the average elevation of the groundwater levels above the base of bedrock, and the specific yield of the various strata. The thickness of the saturated zone is quantified using groundwater level measurements. As water levels decline, groundwater storage is reduced. It should be noted that changes in groundwater storage in the lower aquifer are also affected by subsidence.

Water Quality
Water quality can be significantly impacted by groundwater levels. Most of the wells in the District are composite; they are perforated in both the upper and lower aquifer. Both aquifers may have their own groundwater quality issues. The upper aquifer can have water quality issues that are from anthropogenic causes such as industrial and commercial operations. Water quality issues in the lower aquifer are often from natural sources such as naturally occurring arsenic. Changes in groundwater levels can cause contaminant plumes to migrate in both the upper and lower aquifer.

Subsidence
Subsidence is the compaction of the pore space in various aquifer strata. As water is drawn from the strata, the pore spaces become void. In coarser layers, these voids remain and are refilled with water as groundwater levels rise. In finer strata these voids may compact, decreasing the thickness of that layer, shifting the entire profile of the aquifer, and lowering the ground surface elevation, a phenomenon known as subsidence.

The change in groundwater storage is a quantified volume of groundwater added to or removed from a specified boundary. This quantity is indirectly measured using values for water levels, specific yield (percentage of water in the soil structure), and boundary area. This value can be attributed to changes in groundwater storage in the upper aquifer. Similarly, changes in groundwater storage in the lower aquifer are indirectly measured using subsidence (change in the ground surface elevation) within a defined boundary.

Inelastic subsidence is the permanent change in ground surface elevation due to the dewatering of the pore space in aquifer strata. Inelastic subsidence often occurs in clay. The lower aquifer in the Madera Subbasin is susceptible to inelastic subsidence under the Corcoran Clay, the confining clay layer that separates the upper and lower aquifers in the Subbasin. The Corcoran Clay lies below the entire GFWD.

Data is lacking on the specifics of the effects of groundwater levels on subsidence in the District. Unknown effects include the effects of groundwater gradients in and out of the District, the effects of the groundwater recovery period, and the quantity of pumping. Because pumping from the lower aquifer is known to be a cause of subsidence, the District monitors both groundwater levels and subsidence directly at active agricultural well sites and plans to monitor groundwater pumping in the future to further understand the effects of irrigation on groundwater levels and subsidence.

Interconnected Surface Water

Interconnected surface water is groundwater that is hydraulically connected to bodies of water on the land surface such as rivers, creeks, and lakes. See Figure 3-7 from the DRW guidance document "Depletions of ISW: An Introduction," depicting scenarios of interconnection between wells and surface water. Interconnectivity is a function of horizontal and vertical proximity to a surface water body as well as any potential confining layers and soil types. Shallow wells near the water bodies, in coarse soil layers, will have the biggest impact on interconnected surface waters. It is unknown the depth and extent of the saturated zone from the SJR, which would be the only interconnected surface water within the District.

Groundwater pumping from interconnected wells can cause depletion of interconnected surface waters. The District and the greater Subbasin are working with adjacent subbasins to determine the extent and depth of the interconnected surface water. The combined efforts will allow the District to determine depletions of interconnected surface water, if any, caused by groundwater pumping.

Figure 5: Considerations and interpretation of ISW based on five example cases of nearby groundwater elevation data

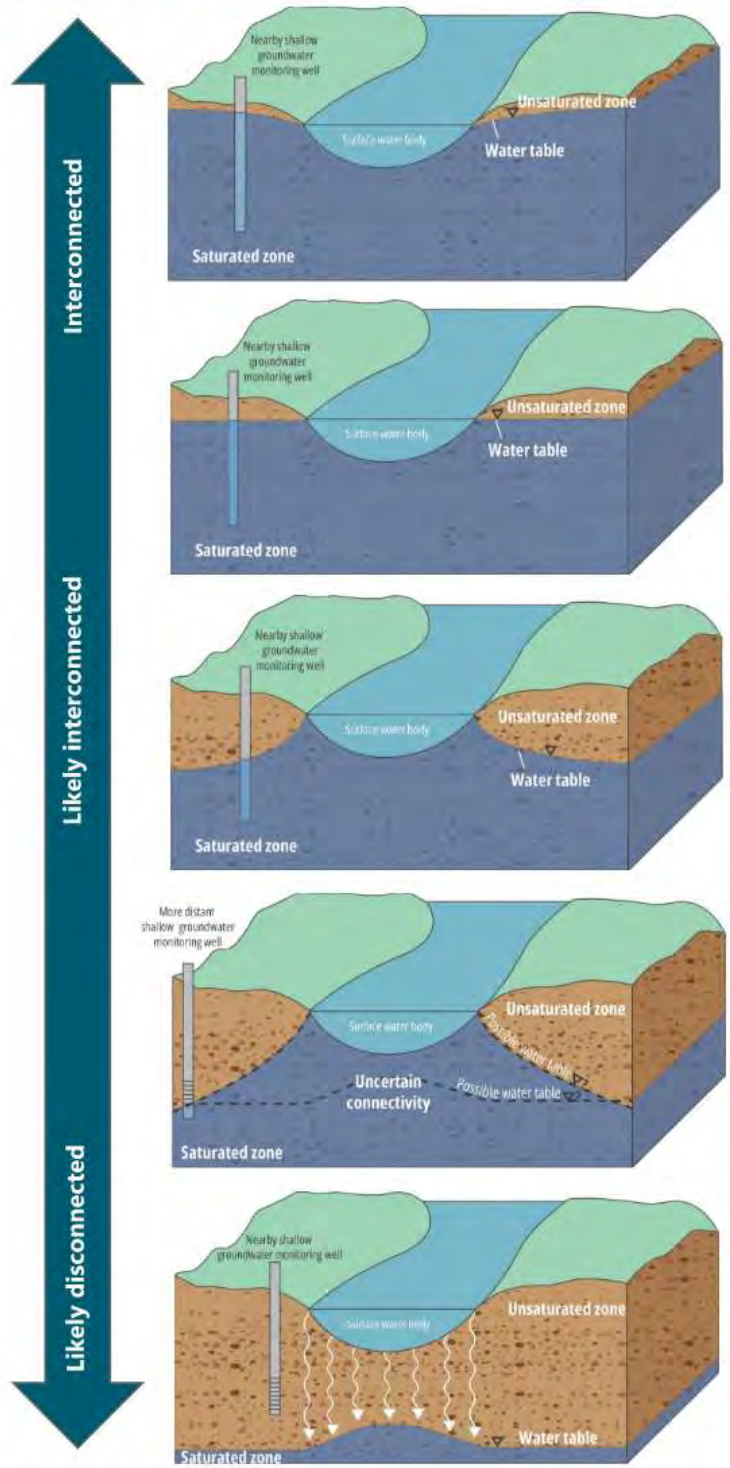

Figure 5a: a stream and a nearby shallow monitoring well with a groundwater elevation above the bottom of the streambed and above the elevation of the surface water, strongly suggesting an ISW.

Figure 5b: a stream and a nearby shallow monitoring well with a groundwater elevation above the bottom of the streambed and similar to the elevation of the surface water, suggesting an ISW.

Figure 5c: a stream and a nearby shallow monitoring well with a groundwater elevation similar to the bottom of the streambed, suggesting a likely ISW.

Figure 5d: a stream and a more distant shallow monitoring well with a groundwater elevation below the bottom of the streambed. Without additional data it is difficult to determine if the stream is an ISW.

Figure 5e: a stream and a nearby shallow monitoring well with groundwater elevation substantially below the bottom of the streambed, suggesting a disconnected stream, not an ISW.

Figure 3-7
Interconnected Surface Water Guidance

3.3 - Change in Groundwater Storage

KDSA calculated average changes in groundwater storage for the 2020 GFWD GPS over an area of 8,500 acres. Based on his report, an average water-level decline of 0.9 feet per year, using an average specific yield of 0.12 feet per year, the unconfined groundwater overdraft averaged about 900 acre-feet per year in the GSA. There was an additional reduction in storage of 700 acre-feet per year due to the collapse of the clay layers.

3.3.1 - Sustainable Management Criteria Evaluation

Groundwater storage is a function of groundwater levels and subsidence at a specific point in time. However, groundwater storage is dynamic and heavily influenced by groundwater gradients and hydraulic conductivity which determines the rate at which groundwater flows into and out of the District and greater Subbasin. As stated in the analysis by KDSA, the collapse of the clay layer also contributes to a reduction in groundwater storage. Therefore, groundwater elevations and subsidence will be used to calculate both permanent and variable changes in groundwater storage within the District.

Figure 3-8 below illustrates changes in groundwater storage in the upper aquifer within the District. Changes in fall well levels between 2014 and 2023 were used to estimate groundwater storage in the upper aquifer (when available). Cumulative changes in groundwater storage are shown relative to changes in groundwater levels. Changes in water levels can change drastically from year. However, the graph shows groundwater storage recovering back to pre-2015 levels.

There is not enough data at the new monitoring points to develop meaningful figures for the change in groundwater storage as it relates to subsidence. The District has implemented a subsidence monitoring plan at the new monitoring sites. As data is gathered the District will be able to analyze the effects of groundwater levels on subsidence and track changes in groundwater storage.

It should be noted that these methods analyze the physical water levels and changes in ground surface elevation as they relate to changes in groundwater storage at a specific point in time. They do not take into account changes in gradient outside the District boundary. Nor do they account for surface water imported into the District for groundwater recharge.

Lastly, subsidence does not occur in all areas of the Subbasin equally nor do portions of the Subbasin have a confining layer such as the Corcoran Clay that is susceptible to inelastic subsidence as described above. Because of this, the Madera Subbasin Joint GSP Amended 2023 set sustainable management criteria for groundwater storage to coincide with groundwater levels (see Figure 3-8). Since groundwater levels are used for a proxy for water storage, evaluation of SMCs should reference groundwater levels in Section 3.2.

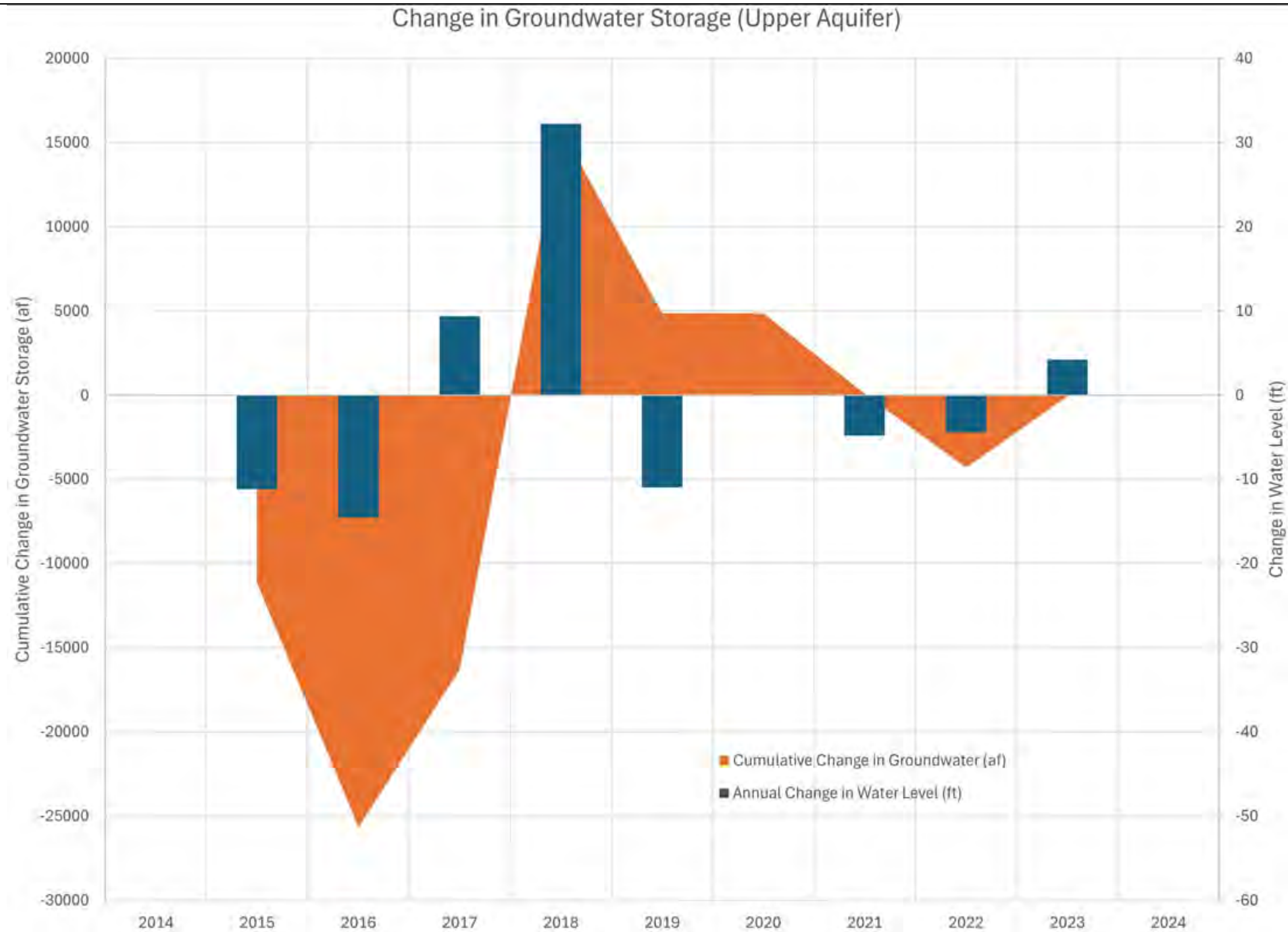

Figure 3-8
Change in Groundwater Storage vs. Change in Groundwater Level

Measurable Objectives
See Section 3.2.1 for SMC evaluation of groundwater levels.

Interim Milestones
See Section 3.2.1 for SMC evaluation of groundwater levels.

Minimum Thresholds
See Section 3.2.1 for SMC evaluation of groundwater levels.

Undesirable Results
See Section 3.2.1 for SMC evaluation of groundwater levels.

Effects on Other Sustainability Indicators
According to the guidance released by DWR. Interconnected Surface Waters can be affected by changes in groundwater storage due to changes in gradient and soil structure caused by changes in water levels and subsidence.

The District is working with the Madera Subbasin and the adjacent subbasins to establish criteria for locating, monitoring, and calculating changes in interconnected surface waters. See the draft interconnected surface water MOU included in the Madera Subbasin Joint GSP Amended 2025 for additional details on proposed coordination between agencies.

Effects on Beneficial Uses/Users
There are no recorded effects to beneficial users in the District.

3.3.2 - DWR Recommended Actions

DWR provided the following recommended corrective action as it relates to Change in Groundwater Storage. "Sufficiently [describe] the effect of chronic lowering of groundwater level interim milestones on change in Groundwater Storage."

GFWD does not experience declining water levels to the same degree as other areas of the Subbasin. There was a downward trend that matches the overall trend for the Subbasin, but according to recent water level measurements, water levels are recovering. Additionally, the District experiences effects from the Subbasin as a whole; therefore, declining water levels should not be a reflection of GFWD. See Section 3.2.2 for a summary of the effects of groundwater levels on groundwater storage.

3.4 - Water Quality

3.4.1 - Sustainable Management Criteria Evaluation

Because water quality for irrigation is not known to be an issue in the District, implementation of a groundwater level and subsidence monitoring program was prioritized. The District plans to sample groundwater from domestic wells. The wells will be sampled for determination of nitrates, arsenic, and total dissolved solids (TDS) as required by the Madera Subbasin sustainable management criteria, and it will also be sampled for DBCP, 1,2,3-TCP, and gross alpha activity once every three years as part of its comprehensive drinking water sample suite. The Madera Subbasin also measures water quality at a monitoring well (MSB06) located in the District. See the monitoring network included in the Madera Subbasin Joint GSP Amended 2025. Once every five years the Madera Subbasin collects samples for a comprehensive suite of water quality constituents at the monitoring well mentioned above. If, during periodic measurements, it is found that the constituents mentioned are found to exceed the water quality maximum contaminant levels (MCLs), the District will reassess their groundwater quality monitoring plan. Because the District does not yet have water quality results the SMCs below are only summarized

<u>Measurable Objectives</u>
The District aims to keep groundwater quality at current concentrations in alignment with the Joint Madera Subbasin 2023 Updated GSP. The District plans to take water samples at domestic wells as discussed above.

<u>Interim Milestones</u>
According to the Joint Madera Subbasin 2023 Updated GSP, the interim milestones for the measurable objectives are the same. See above for a discussion of groundwater quality MOs.

<u>Minimum Thresholds</u>
The minimum thresholds below are adopted from the Joint Madera Subbasin 2023 Updated GSP. As stated above, the District prioritized water level and subsidence monitoring so there is no data to report for the water quality constituents below. The District will report groundwater quality in the 2024 GSP Annual Report.

- Nitrate = 10 mg/L or existing level plus 20% (whichever is greater)
- Arsenic = 10 µg/L or existing level plus 20% (whichever is greater)
- TDS = 500 mg/L or existing level plus 20% (whichever is greater)

<u>Undesirable Results</u>
Undesirable results are defined as “10 percent of Subbasin-wide RMS wells above the minimum threshold for the same constituent due to projects and/or management actions, based on the average of the most recent three-year period” after the implementation period has ended in 2040. The District will assess the likelihood of avoiding undesirable results in future annual reports.

<u>Effects on Other Sustainability Indicators</u>
It is unlikely that water quality could affect other sustainability indicators. It is possible that poor water quality could affect the amount of groundwater pumping which could potentially affect water levels. However, there is no evidence that this will be the case in the District now or in the future.

<u>Effects on Beneficial Uses/Users</u>
There have been no documented effects to beneficial users within the District.

3.4.2 - DWR Recommended Actions

DWR provided the following recommended corrective action as it relates to degraded water quality. "Sufficiently [detail] the degraded water quality undesirable results and [explain] the rationale to allow potential further degradation."

The District is working with the Madera Subbasin Technical Committee to address DWRs recommended corrective actions from the December 2023 Approval Determination. DWR is requesting that the Subbasin analyze SMCs for water quality, especially as they relate to undesirable results and conditions that would be considered significant and unreasonable. DWR also requested justification of MT and their effects on sustainability.

The District's goal is to prevent domestic users from consuming poor-quality water. As stated above, the District plans to implement their own groundwater quality data into its groundwater monitoring program. The Technical Committee is currently meeting to address DWR's concerns and plans to address them in the Madera Subbasin Joint GSP Amended 2025.

3.5 - Land Subsidence

Land subsidence and the District's plans to monitor subsidence in the GSA are explained in detail in Section 3.3 – Change in Groundwater Storage. Generally, subsidence is caused by loss of pore space in the clay layers of the lower aquifer. There are many factors that contribute to subsidence such as groundwater pumping and groundwater flow into and out of the District.

3.5.1 - Sustainable Management Criteria Evaluation

The District has measured subsidence at the operational agricultural wells three times since the development of the original 2020 GFWD GSP. Since the development of the original GSP, the District has analyzed the network of wells and selected a sampling of wells that represent the conditions of the District and are strategically located throughout the GSA (See Section 6 – Monitoring Network). See Table 3-5 for subsidence measurements between December 2019 and July 2021. Average annual subsidence over the entire District was about 0.15 foot/year.

Table 3-5
Subsidence Measurements

PT NO.	Elevation (as of 12/12/2019)	Elevation (as of 7/29/2021)	Elevation (as of 10/15/2024)	Total Subsidence in Feet
201	187.147	186.777	186.155	-0.992
202	191.784	191.471	190.804	-0.98
203	200.319	200.319	199.728	-0.591
206	183.957	183.957	183.00	-0.957
213	183.815	183.815	182.983	-0.832
224	203.792	203.792	203.50	-0.292

Subsidence near the SJR (Well 224) is significantly less than subsidence at wells further from the SJR. It should also be noted that water levels at this well are also significantly higher than the others in the monitoring network. When omitting Well 224 from the average, the annual subsidence rate increases to 0.17 feet/year.

Measurable Objectives

The MO for subsidence is 0 feet/year by 2040. The District is working on projects to bring and store surface water in the District with the goal of alleviating subsidence in the area. As described previously in the section on changes in groundwater storage. It is important to note that there are external factors that could affect subsidence in the Subbasin. GSAs are working together to understand cross-boundary impacts on groundwater and subsidence in particular.

Interim Milestones

The interim milestones are established at five-year intervals over the implementation period from 2020 to 2040, at years 2025, 2030, and 2035. Interim milestones were established in the Madera Subbasin Joint GSP Amended 2023 for two loosely defined areas: the "Area of Concern," which generally resides in the northeastern portion of the Subbasin, and the rest of the Subbasin.

IMs for the areas of concern were set to the following:

- 2025: -0.60 feet/year
- 2030: -0.40 feet/year
- 2035: -0.20 feet/year
- 2040: 0.00 feet/year

IMs for the rest of the Subbasin were set to the following:

- 2025: -0.20 feet/year
- 2030: -0.13 feet/year
- 2035: -0.07 feet/year
- 2040: 0.00 feet/year

DWR recommended corrective actions related to IMs in particular. They questioned the continued rate of subsidence, which could potentially add up to 6 feet of additional subsidence in some areas. Because of this, IMs will be updated in the 2025 GSPs for the Madera Subbasin. Averages to date show GFWD to be within a sustainable range according to the more restrictive IMs for the "rest of the Subbasin."

Minimum Thresholds

Per the Madera Subbasin Joint GSP Amended 2023, "The land subsidence minimum threshold is set at a rate of 0 feet/year +/- 0.16 feet/year." DWR has also called into question the accuracy and associated uncertainty in subsidence measurements taken by the San Joaquin River Restoration Project (SJRRP). They have also inquired about the choice to not use Interferometric Synthetic Aperture Radar (InSAR) data for analyzing subsidence. It is important to note that all instruments have some error, and it is important to determine how that error will be interpreted. All SMCs for subsidence will be addressed in the 2025 GSP Updates. GFWD will be measuring subsidence in the

GSA independently. However, the District plans to tie survey points at the selected wells to the benchmarks used at the locations used by the Subbasin.

Undesirable Results

Undesirable results are defined as Subbasin-wide exceedances of the MTs in 75% of wells after 2040. DWR also questioned this, asking why 75% of wells were in exceedance. The Technical Committee will be analyzing undesirable results along with other SMCs for subsidence as part of the Madera Subbasin Joint GSP Amended 2025. Due to the lack of data, it is difficult to assess the likelihood of undesirable results for subsidence. The District has only a single rate based on 2 measurements in 2019 and 2021.

Effects on Other Sustainability Indicators

As stated in Section 3.3, groundwater storage is affected by subsidence. As the clay layers are compacted, the available groundwater storage within each layer is reduced, and this reduction is often permanent.

Effects on Beneficial Uses/Users

There are no known effects to beneficial users in the GSA.

3.5.2 - DWR Recommended Actions

DWR provided the following recommended corrective action as it relates to land subsidence. "[Reevaluate] the quantitative metrics that constitute undesirable results due to land subsidence and sufficiently [describe] the effect and extent of land subsidence interim milestones that allow continued subsidence during the GSP implementation period."

As stated above, the Technical Committee is analyzing subsidence SMC and updates to the criteria will be provided in the 2025 GSP Updates.

3.6 - Interconnected Surface Water

Interconnected surface waters are described in more detail in Section 3.2.2 as it relates to groundwater levels. The Subbasin and neighboring subbasin are working on establishing criteria for monitoring, analyzing, and managing interconnected surface waters. Because additional coordination and data are needed, SMCs are loosely defined. Below is a summary of the SMCs. Due to the need for additional data and coordination, it is unlikely that SMCs for ISWs will be updated in the 2025 Joint Subbasin GSP. It also should be noted that percentages of wells below minimum thresholds are cumulative for the Subbasin and not the District.

The Madera Subbasin Joint GSP Amended 2025 provides additional information on the monitoring network for ISW in the Madera Subbasin. The District does not monitor any wells GFWD for ISW. For additional details on proposed coordination between agencies on ISW, see the draft interconnected surface water MOU included in the Madera Subbasin Joint GSP Amended 2025.

3.6.1 - Sustainable Management Criteria Evaluation

Measurable Objectives

"A percent of time surface water is connected to shallow groundwater that is equal to historical conditions for a similar climatic/hydrologic period."

Interim Milestones

N/A

Minimum Thresholds

"A percent of time surface water is connected to shallow groundwater that is equal to historical conditions for a similar climatic/hydrologic period."

Undesirable Results

"Greater than 30 percent of [Subbasin-wide] RMS wells below the minimum threshold for two consecutive annual five-year rolling average annual evaluations"

Effects on Other Sustainability Indicators

It is safe to assume that where interconnected waters exist, they have direct effects on groundwater levels and changes in groundwater storage in the upper aquifer as they relate to gaining and losing ISWs.

Effects on Beneficial Uses/Users

There are no recorded effects to beneficial users as they relate to the depletion of ISW.

3.6.2 - DWR Recommended Actions

None

3.7 - Projected Sustainability Achievement

According to the analysis of the SMCs above, GFWD is on track to meet sustainability goals by 2040. The District will continue to monitor groundwater levels and subsidence and add groundwater quality to their monitoring program. The District and GSA partners in the Subbasin will continue to analyze SMCs to ensure sustainability.

3.7.1 - Potential Effects to Sustainability

Environmental

Continued drought and increasing temperatures have the potential to affect sustainability. The District experienced a wet year in 2019 while drafting the original GSP; however, 2020 through 2022 were all critical or drought years during the initial 5-year implementation period. During these years the District received no surface water deliveries. 2023 can be assumed to be wet year as the District received approximately 20,000 af of water. In addition to drought, the Central Valley is experiencing record-breaking temperatures that put additional stress on agricultural crops and water resources.

Additional effects to sustainability include movement of the bed of the San Joaquin River (SJR; River) and seepage/losses in the SJR before the GFR turnout, where the GFWD pumps water from the River. The changing geology of the riverbed restricts the District's ability to pump water from the SJR into the GFWD canal that distributes water for irrigation and recharge. The movement of the bed of the SJR has altered the flowline of the River. It has also been found that there is significant groundwater seepage along the river adjacent to GFWD. While this could benefit groundwater recharge in the area, it could also limit available surface water that the District could divert for recharge within their GSA boundary.

Political/Legal

While politics clearly impacts policy, it is not beneficial to speculate on what those policies may be or how they may change in the future. However, Section 2.6 summarizes some current policy changes/legal actions that may affect sustainability. Some current lawsuits may set precedents that could affect sustainability, SGMA implementation, and existing policies that govern surface waters.

Policy as it relates to sustainable groundwater management, include allocations to the Friant Dam Holding Contracts and the San Joaquin River Restoration Settlement (Settlement). Holding contracts govern access and allocations of surface waters from the Friant Dam. The District holds a contract with USBR for 14,000 af of Class 2 Water for irrigation purposes from the Friant Dam. The Settlement is an agreement with USBR regarding flow rates in the San Joaquin River from Friant Dam to the Merced River. The Restoration Program restored Reach 2B for fish passage, which could potentially increase net groundwater inflow where water is now present.

Lawsuits include the California United Water Coalition vs Madera County. This lawsuit was brought against Madera County over land assessments that require landowners to pay a per-acre assessment that was set using a Proposition 218 election. The farmers' coalition argued that the 218 election was improperly conducted. This could affect local GSAs' ability to tax landowners for SGMA implementation and the methods by which these taxes are determined.

Another lawsuit that could alter the future on SGMA implementation is the Kings County Farm Bureau vs the California SWRCB. This lawsuit put a temporary restraining order in place preventing the enforcement of groundwater restrictions on farmers in Kings County. While this lawsuit is not within the Madera Subbasin, the effects could have an impact to all subbasins if the hold on groundwater pumping remains in effect.

Adjacent Basins/GSAs

While GWFD and their partner GSAs within the Madera Subbasin work diligently to coordinate with each other and neighboring subbasins, it is important to express the complexity of the situation. Madera Subbasin is made up of seven GSAs, drafting four separate GSPs. Each GSA has different needs and priorities. The same is true for neighboring subbasins. While the group strives to meet all agency needs, there are always compromises that must be made and decisions that are challenging to implement.

GFWD has the advantage of being located adjacent to the SJR and having access to surface water during wet years. The District has been working to implement a conjunctive use program long before SGMA was enacted. Other GSAs and subbasins are not as fortunate, and sustainability may find implementation of SGMA more complicated. The challenges that neighboring subbasins and GSAs face effect groundwater conditions in the GFWD GSA boundary and the Madera Subbasin as a whole. Because of this GFWD works hard to be transparent and proactive in their management practices.

Beneficial Users

Beneficial users in the District are mainly agricultural users with a minimal number of domestic users that are often tied to agricultural operations. Beneficial users within GFWD are unlikely to experience any direct effects resulting from SGMA implementation initially. However, as lawsuits progress and policies change GFWD may experience effects on operations, which would affect all members of the District, both residential and agricultural, as the District economy is almost entirely dependent on agriculture.

The largest impact on plan implementation and sustainability comes from environmental factors. As climate change impacts rainfall, snowpack, and temperatures these impacts will filter down to the District. The geological changes to the River may also affect the ability to divert surface water for irrigation and recharge.

Proposed Adaptive Management to Meet Goals

As stated previously, the District intends to construct projects that will increase their ability to recharge water during wet years. This is a direct response to the reductions in surface water allocations due to drought and climate change impacts. The District receives Class II surface water as a part of their USBR contract. The District is adapting by pivoting from a water district that focuses on diverting surface water for irrigation to a district that diverts surface water for recharge.

3.8 - Plan Amendments

This periodic evaluation is being developed concurrently with the GFWD GSP Amended 2025 and the Madera Subbasin Joint GSP Amended 2025. The 2025 amendments to the GSPs for all Plan Areas are dependent on the decisions that come out of the Technical Committee discussions as they relate to the DWR corrective actions. Likely changes resulting from the Technical Committee decisions include changes to the groundwater model, most of which have been outlined in Section 2.1, updated SMCs for subsidence and groundwater quality, and updated projects resulting from those changes.

The GFWD GSP Amended 2025 will also address specific changes in the GSA, such as changes to the monitoring network and numerical changes to SMCs for water levels as they pertain to the new monitoring stations. It will also outline the status and progress of proposed projects and future plans for funding and implementation.

SECTION 4 - STATUS OF PROJECTS AND MANAGEMENT ACTIONS

The District has worked to implement projects and management actions by raising funds. The District increased revenue through multiple successful Proposition 218 landowner assessments and is currently seeking grant funding for additional capital project design and, eventually, construction. In 2019, the District passed an assessment that funds GSP implementation and monitoring programs. This assessment was created in perpetuity to provide continued funding for existing programs. In 2023, the District determined that the existing assessment was insufficient to implement new projects and management actions, so a new Engineer's Report was drafted, and ballots were sent out to landowners on May 30, 2024. The election was held on July 15, 2024. The election passed, and the 2019 assessment was replaced with the new 2023 assessment.

The 2023 assessment will fund water purchases for irrigation and recharge, operation and maintenance (including deferred maintenance to increase irrigation efficiency), and capital projects. The Engineer's Report evaluated the total revenue need, assuming that a large portion of capital projects are covered by grants, to be approximately $90/acre. Proposition 218 election approved the $90/acre maximum with the understanding that for the first five years, the board would only assess landowners approximately $40/year (subject to a 2.8% annual increase in costs due to inflation). The $90/acre maximum tax was approved in perpetuity.

In addition to increased revenue for project implementation, the District has applied for several grants. These grants include funding from the Madera Regional Water Management Group, and the Department of Water Resources SGMA Implementation Program for the second round of grant funding. Neither of these grant opportunities resulted in funding. The District is currently applying for funding from the USBR WaterSMART Program and encouraging landowners to apply for NRCS grants. The District applied for the USBR WaterSMART Planning and Design Program and the WaterSMART Small Scale Water Efficiency Program. Awards for these grants are estimated to be determined in April 2025.

A complete summary of projects and management actions, including anticipated completion date, status, and anticipated benefits can be found in Appendix C - Projects and Management Action Implementation Plan and Benefits.

4.1 - Recharge Program

4.1.1 - STATUS UPDATE

The District is actively incorporating their recharge program into their conjunctive use program. Since the initial 2020 GSP submittal, the District received surface water in 2023 and 2024. Surface water deliveries for 2024 have not yet been quantified. In 2023, surface water was received between the months of April and August. Water was delivered to growers for irrigation and any surplus was left to recharge in the Gravelly Ford Canal or diverted into the Gravelly Ford Recharge Basin. See Table 4-1 for a summary of surface water delivered to the District. GFWD recharged approximately 10,000 af of water in 2023. This estimate is based on consumptive use of crops, precipitation, and surface water deliveries. The District has also received surface water in 2024 during the development of this Periodic Evaluation. The total surface water deliveries and recharge will be reflected in the 2024 Annual Report. The District recharge program has been successful in offsetting groundwater consumption by the District. See Figure 3-8 for changes in groundwater storage as they relate to water levels.

Table 4-1
Surface Water Deliveries

Surface Water Deliveries (Acre-Feet)						
Year	Diversion from San Joaquin River (Bureau Class 2)	Diversions from MID Conveyance System	Diversions from Cottonwood Creek via MID *	Diversions from Cottonwood Creek (Natural Flow)	Other	Totals (AF)
1999	7,174	1,850	3,197	5,287		17,508
2000	8,864	2,102	3,189	3,635		17,790
2001	3,707	872	1,308	841		6,728
2002	5,732	1,338	1,000	721		8,791
2003	7,509	1,367	1,386	1,374		11,636
2004	11,472	1,517	2,340	89		15,418
2005	9,562	1,281	2,736	1,611		15,190
2006	9,730	1,921	3,560	1,211		16,422
2007	7,940	1,183	1,202	291		10,616
2008	7,854	949	545	0		9,348
2009	2,556	373	0	0		2,929
2010	5,965	31	53	1,117		7,166
2011	6,302	2,876	3,604	3,475		16,257
2012	823	442	126	82		1,473
2013	0	0	0	0		0
2014	0	0	0	0		0
2015	0	0	0	0		0
2016	1,540	317	0	0		1,857
2017	12,400	940	0	800		14,140
2018	625	0	0	0		625
2019	12,187	0	0	1,019		13,206
2020		0	0	0		0
2021		0	0	0		0
2022		0	0	0		0
2023	19,332	0	0	2,099	194	21,625

* The District no longer receives water from MID

4.1.2 - Realized Benefits/Expected Benefits

The District had an estimated net recharge of 10,000 for the 2023 water year reporting period. Total deliveries for 2024 will be reported in the 2024 Annual Report. The recharge program will differ in subsequent years depending on precipitation and water availability. Based on historic values, it can be assumed that the District will receive surface water approximately three years out of the 5-year Periodic Evaluation horizon for an estimated average of 5,000 af of recharged water per year.

4.1.3 - Benefits and Impacts to Beneficial Uses and Users

The GFWD Recharge Program is a net benefit to all water users. The water used comes from both Unreleased Restoration Flows (URF) in the SJR and storm waters down Cottonwood Creek. URF water is water that exceeds the channel capacity of the SJRRP. The District taking this water benefits the SJRRP by providing relief to the channel being restored. It also benefits the SJRRP by maintaining and improving groundwater conditions.

The Gravelly Ford Canal and irrigation channels in the District also act as a flood control network, diverting excess flows that would otherwise affect flood-prone areas such as Firebaugh, CA. Severe flooding occurred in February 2017. Fears of flooding arose again in the spring of 2023, prompting diversions of water into the District.

4.2 - Agricultural Well Metering

4.2.1 - Status Update

The Agricultural Well Metering Program is a priority for implementation. Currently, the District monitors groundwater levels and ground surface elevations and will add water quality. The District also requests agricultural groundwater pumping data from growers if wells are metered. However, monthly groundwater pumping is reported on a voluntary basis as many of the agricultural wells do not have meters. Because of the lack of metered wells and the uncertainty of existing data, the District has applied for grant money from the United States Bureau of Reclamation, WaterSMART Small Scale Water Efficiency Project Program, to develop an Agricultural Well Metering Program. If awarded, the program will outline requirements for participation, eligible costs, contractor qualifications, and maximum rebates for meter installation on agricultural wells in the District.

4.2.2 - Realized Benefits/Expected Benefits

If awarded, the Agricultural Well Metering Program will provide funds for the installation of agricultural meters and allow the District to monitor groundwater production and fill data gaps in the Groundwater Sustainability Plan. Because groundwater production is not metered, system leaks or other inefficiencies cannot be quantified. Currently, groundwater production is estimated. Estimates use California Irrigation Management Information System (CIMIS) data which gives monthly evapotranspiration (ET_0) rates that can be converted to consumptive use based on crop type and precipitation data and surface water diversion data. The difference between crop consumptive use and effective precipitation and applied surface water is estimated to be agricultural groundwater pumping. While groundwater use can be estimated, it is unknown how efficient the existing groundwater systems are, and actual extraction amounts could vary greatly from estimated consumptive use. Irrigation efficiency is estimated to be 80%.

A requirement of SGMA is to develop a monitoring network and to continue to close data gaps. This project will work to close data gaps and allow the District to see trends as they relate to real-time groundwater production, including pumping effects on groundwater levels, groundwater storage, groundwater quality, and subsidence. The District is also working with the Madera Subbasin to coordinate an MOU that investigates the effects of groundwater production on interconnected surface waters.

4.2.3 - Benefits and Impacts to Beneficial Uses and Users

Groundwater production monitoring will allow the District and growers to determine inefficiencies in irrigation systems and implement repairs and management practices that conserve both surface and groundwater. Conservation of groundwater will prevent negative impacts on agricultural and domestic water supplies by stabilizing groundwater levels and water quality, which benefits crops and soil health. This benefits agricultural users by reducing production costs and maintaining groundwater quality. It benefits environmental and ecological users by protecting groundwater-dependent ecosystems, preventing invasive species, and promoting natural flow between surface water and groundwater if present.

4.3 - Increased Measurement, Sampling and Monitoring

4.3.1 - Status Update

A number of agricultural wells are monitored semi-annually in April and October for water levels and every other year for subsidence. The District is proposing to monitor wells for water quality annually and a full suite as determined by Ken Schmidt once every 3 years (see water quality in Section 3). The monitoring network also includes measurements of surface water deliveries and climate data. Surface water delivery data comes from estimates at Cottonwood Creek diversion points and the pump station at the San Joaquin River. The District also collects climate data from several CIMIS stations, with Firebaugh/Telles Station #7 being the closest. This station gives monthly ET and precipitation data. The District will begin collecting precipitation data at Yosemite International Airport in Fresno in the future as the data is considered to be more thorough and accurate. The District also collects flow data from the California Data Exchange Center (CDEC) at the San Joaquin River at Gravelly Ford (GRF) station. As stated above, the District is currently applying for grant funding from USBR for several projects to monitor and manage groundwater. One grant would provide funding to design radial gates to better monitor and manage flow through Cottonwood Creek, see Section 4.9 - Automation and SCADA for additional project details.

4.3.2 - Realized Benefits/Expected Benefits

Increased measurement, sampling and monitoring will provide the District, growers, and stakeholders with more precise data at well sites to close data gaps in the monitoring network, comply with the requirements of SGMA, and more efficiently manage both surface water and groundwater resources. Additional and increased monitoring will also allow the District to analyze impacts on sustainability indicators as they relate to each other as suggested by DWR.

4.3.3 - Benefits and Impacts to Beneficial Uses and Users

This data will benefit the Gravelly Ford Water District and the Madera Subbasin as a whole by providing more accurate, measured quantities of groundwater sustainability indicators. More accurate groundwater monitoring will benefit all the District's neighboring agencies and beneficial users in and out of the District by providing data to more efficiently manage water resources. The District continues to close data gaps and analyze trends in groundwater levels, groundwater storage, groundwater quality, and subsidence as they relate to the District. The District will also work to determine the effects of water management practices on interconnected surface waters.

4.4 - San Joaquin River Restoration Program

4.4.1 - Status Update

The San Joaquin River Restoration Project (SJRRP) is an ongoing project that aims to restore flows to the San Joaquin River (SJR) from the Friant Dam to the Merced River with the goal of reintroducing Chinook salmon. The first releases from the Friant Dam to the SJRRP began in October of 2009. The SJRRP was the result of the Restoration Settlement which was reached in September of 2006. The Settlement also addresses water management for the water contractors, such as GFWD, that have contracts with USBR.

4.4.2 - Realized Benefits/Expected Benefits

There are real benefits to the SJRRP for the District. Prior to the SJRRP, the segment of the SJR that is adjacent to the District would only see five cubic feet per second at the GFWD turnout. Often the bed of the SJR beyond the District would be dry. With the addition of the restoration flows, the river is now wet along the SJR, which is adjacent to the District. This provides seepage into the District, which has yet to be quantified. It also provides benefits to fish populations.

However, there are potential negative impacts to beneficial agricultural users. These include seepage that impacts the root zone of crops, and changes to the geology of the riverbed, among others. Changes to the riverbed have had significant impacts on the District as it is now more difficult to divert surface water at the GFWD pump station. The District is working on addressing these concerns.

4.4.3 - Benefits and Impacts to Beneficial Uses and Users

As discussed above, the SJRRP has benefits and impacts, which are described above. No anticipated changes to the SJRRP are anticipated; however, the District plans to work with neighboring GSAs to quantify seepage from the SJR and how this impacts or benefits interconnected surface water.

4.5 - Commitment to Subbasin GSP's Coordination & Implementation

4.5.1 - Status Update

The original GFWD GSP and the larger Joint Madera Subbasin GSP, which compliments the GFWD GSP and acts as a basin-wide document, were submitted to DWR in January 2020 and updated based on comments received in September 2022. The Madera Subbasin Technical Committee drafted a coordination agreement to complement the various Subbasin GSPs. This coordination agreement was deemed satisfactory in the final December 2023 determination by DWR that approved the Revised GSP. The coordination agreement expired on December 31, 2024. The Agreement is being negotiated as this periodic evaluation is being conducted. A coordination agreement signed by all Subbasin parties is required prior to the submission of this document on the SGMA portal. Details of the approved coordination agreement will be available on the DWR SGMA portal.

The Madera Subbasin GSAs and their technical consultants are currently working on their 2025 GSP Periodic Evaluations and Plan Amendments for submittal in January 2025. GFWD plays an active role in the Technical Committee and subbasin coordination. They are active members of the Madera Subbasin Technical Committee who analyze hydrology and groundwater conditions and make decisions regarding sustainability goals, water budget, sustainable yield, and undesirable results. They participate in the development and drafting of coordinated documents including the Madera Subbasin coordination agreement, the Domestic Well Mitigation Program, and the Interconnected Surface Water MOU.

4.5.2 - Realized Benefits/Expected Benefits

The benefits of coordination and implementation are maintaining local control of groundwater resources within the District and Subbasin as a whole. Additional benefits include increased efficiency and conservation of groundwater resources. The coordinated effort also provides an accountability tool so there is a clear understanding of expectations and accounting of implantation and progress.

4.5.3 - Benefits and Impacts to Beneficial Uses and Users

Benefits of this project are realized by all District members, Subbasin GSAs, and beneficial users of water in the Subbasin. The benefits include maintaining local control of groundwater and increased efficiency and conservation of groundwater resources. They also include a method of accounting for Plan expectations and implementation progress.

4.6 - San Joaquin River Flood Water Recharge

4.6.1 - Status Update

This project proposes to increase capacity at road crossings and in open canal channel areas along the Gravelly Ford Canal to convey San Joaquin River flood waters into the District distribution system and to the existing recharge areas for groundwater recharge. The project proposes the installation of additional pumping capacity at the District diversion point on the SJR and to enlarge road crossing culverts and open channels to increase the capacity of the distribution system. This project was identified in the Engineer's Report for the GFWD 2023 Proposition 218 assessment. Funding from the assessment will be used for these projects as decided by the board. This project, when implemented, is the infrastructure portion of the GFWD Recharge Program. See Section 4.1 for additional information on the GFWD Recharge Program.

4.6.2 - Realized Benefits/Expected Benefits

This project benefit will provide a quantifiable additional volume of water that the District can divert during wet years when water is available. The project proposes to install an additional pump at the San Joaquin River to increase the volume of water diverted into the Gravelly Ford Canal. It also includes expanding several road crossings to increase capacity flowing through the Gravelly Ford Canal. This project will be complimented by the Conveyance Pipeline from the San Joaquin River Pumps Project, which will install a 48" pipeline parallel to the existing conveyance pipeline from the San Joaquin River pumping station to the Gravelly Ford Canal. This project also protects nearby communities when the SJR reaches flood capacity and will increase the District's ability to assist in diverting additional flood waters.

4.6.3 - Benefits and Impacts to Beneficial Uses and Users

This project benefits the groundwater users in the District as it diverts additional surplus surface water for recharge in the Gravelly Ford Canal and GFWD recharge basin. Full implementation has the potential to double the diversion capacity of GFWD at the SJR, which could potentially triple the groundwater recharge capacity in the District. For reference, the estimated consumptive use is 22,000 af on average. In 2023 the District diverted 19,500 af of surface water from the SJR. When accounting for precipitation and deep percolation of irrigation water, it was estimated that a net 10,000 af of surface water was recharged. Therefore, by doubling surface water diversion capacity all 20,000 af would go directly to recharge for a total of approximately 30,000 af of water recharged during wet years.

Increased capacity also prevents negative impacts to domestic water supplies by stabilizing groundwater levels and water quality. It benefits agricultural users by reducing production costs and maintaining groundwater quality. It benefits environmental and ecological users by protecting groundwater-dependent ecosystems and promoting natural flow between surface water and groundwater if present.

4.7 - District System Water Metering Project

4.7.1 - Status Update

This project proposes installing meters at Cottonwood Creek coming into the District boundary, Cottonwood Creek, and the diversion to the Gravelly Ford Canal and Cottonwood Creek exiting the District. This will allow the District to monitor losses at Cottonwood Creek due to groundwater recharge and irrigation. This project will complement the Automated SCADA Water Control Gate Design Project (formerly Automation & SCADA) that plans to put radial gates at Cottonwood Creek coming into the District boundary and at the Cottonwood Creek and Gravelly Ford Canal. This District will likely apply for grant funding to install meters to monitor water flowing through the District from Cottonwood Creek.

4.7.2 - Realized Benefits/Expected Benefits

This project will allow the District to quantify surface water used for irrigation and groundwater recharge throughout the Gravelly Ford Canal within the District. This will allow the District to close data gaps. It will also allow the District to determine the effects of groundwater recharge on groundwater levels and other sustainability indicators.

4.7.3 - Benefits and Impacts to Beneficial Uses and Users

All users of groundwater will benefit from this project, and it will improve the existing monitoring network.

4.8 - Conveyance Pipeline from San Joaquin River Pumps

4.8.1 - Status Update

The District will continue to seek funding for capital projects to provide infrastructure that will aid in increasing groundwater recharge. The District has a Class II contract for surface water from the Central Valley Project's Friant Dam. The District diverts surface water from the pump station in the San Joaquin River. The District has two pumps that divert a maximum of 50 cfs from the SJR into a 48-inch pipeline that connects to the Gravelly Ford Canal. The District plans to seek funding to add an additional 48-inch pipeline from the San Joaquin River to the Gravelly Ford Canal in order to double its capacity to divert water during wet years. This project complements the San Joaquin River Flood Water Recharge Project described in Section 4.6.

4.8.2 - Realized Benefits/Expected Benefits

This project has the capability to increase the surface water available for recharge along the Gravelly Ford Canal and in the Gravelly Ford recharge basins by up to 20,000 acre-feet or more. In 2023, the District diverted 19,500 af of surface water. The District recharged approximately 10,000 af of surface water in both the Gravelly Ford recharge basin and the

Gravelly Ford Canal. As stated in Section 4.6, full implementation could result in approximately 30,000 af of recharge in a single wet year.

4.8.3 - Benefits and Impacts to Beneficial Uses and Users

All users of groundwater will benefit from this project as stated in the Recharge Project Sections 4.1 and 4.6, the San Joaquin River Flood Water Recharge.

4.9 - Automated SCADA Water Control Gate Project

4.9.1 - Status Update

GFWD submitted a grant for the design of the Automated SCADA Water Control Gate Project (formerly the Automation & SCADA Project). The grant application was submitted for the USBR WaterSMART Planning and Project Design grant program. USBR anticipates grant awards in March of 2025.

If awarded, the Automated SCADA Water Control Gate Design Project will produce a full set of construction documents for six radial, Rubicon-style gates with SCADA controls at six existing water control structures (weirs). The installation of the automated gates will allow more efficient management of surface water flows through the District conveyance system. A major benefit of this project will be targeted groundwater recharge. This will allow the District to combat the effects of climate change and drought by protecting groundwater within the District and the Madera Groundwater Subbasin as a whole.

4.9.2 - Realized Benefits/Expected Benefits

This project will enhance surface water management for irrigation. However, a large benefit will also be the management of flood flows during wet years with higher rainfall. The District intends to use the radial gates to impound flood water during wet years to target groundwater recharge in the northwestern areas of the District. These areas have been identified because they are more susceptible to climactic changes and are adjacent to the "areas of concern" identified in the Madera Subbasin Joint GSP Amended 2023. The groundwater gradient slopes in the northwest direction. The estimated rate of groundwater outflow is 11,500 af in years when surface water is present and 4,700 af when surface water is not available. This is a general estimate. The District has quantified annual net inflow/outflow in the water budget shown in Table 5-2. The net inflow/outflow is estimated by comparing change storage using groundwater elevation vs change in storage using recharge (precipitation, deep percolation, groundwater inflow, etc.) vs discharge (pumping, groundwater outflow). The difference was assumed to be net groundwater inflow/outflow. These estimates will be refined as data is gathered; however, all of these estimates should be assumed preliminary.

4.9.3 - Benefits and Impacts to Beneficial Uses and Users

Flood flow diversions from the San Joaquin River or Cottonwood Creek will be routed to address irrigation needs for growers or to provide recharge in specific areas of the District. This project will also assist in mitigating impacts to domestic wells within the area as required by the Madera Subbasin Domestic Well Program as part of the adopted GSP for the Madera Subbasin, which aims to prevent or provide corrective actions for domestic wells in the event that they become damaged or inoperable due critical lowering of groundwater levels from drought caused by climate change.

SECTION 5 - BASIN SETTING BASED ON NEW INFORMATION OR CHANGES IN WATER USE

Section 3, which reviews sustainable management criteria for all sustainability indicators, shows changes in current groundwater conditions. The District has not changed its water usage, except for changes in cropping patterns.

DWR provided the following recommended corrective action as it relates to groundwater conditions generally, "Describing data gaps in the hydrogeologic conceptual model."

5.1 - Hydrogeologic Conceptual Model

No updates have been made to the hydrogeologic conceptual model. KDSA addressed data gaps in the hydrologic conceptual model. Generally, the data gaps include adding meters to wells to quantify groundwater pumping, pump tests to determine transmissivity and subsequent groundwater inflow/outflow, locating and sampling all domestic wells, and additional surface water monitoring to determine seepage losses. The full document from KDSA is attached as Appendix E.

5.2 - Groundwater Conditions

As stated above, groundwater conditions have remained consistent. There have been variations in water year type and the amount of surface water available for irrigation and recharge. However, over the period from 2015 to the present, it is apparent that groundwater levels are recovering, and subsidence has remained within sustainable parameters as determined in the Madera Subbasin Joint GSP Amended 2023. See Section 3 for a detailed discussion of groundwater conditions as they relate to sustainable management criteria.

5.3 - Water Use Changes and Associated Water Budget

Unlike the Joint Subbasin, the District calculates the water budget as it relates to groundwater rather than surface water. Historic subsurface groundwater inflows and outflows into and out of the District were not estimated in the 2020 Joint Groundwater Subbasin GSP. Therefore, net groundwater inflow and outflow were calculated as a function of the change in groundwater storage as it equates to a change in water level. See Section 3.3 – Changes in Groundwater Storage for more information on changes in storage calculations. All other numbers were calculated using crop types and acreage, evapotranspiration, precipitation, surface water deliveries, and groundwater levels.

The water budget does not explicitly calculate precipitation evaporation or surface water evaporation in canals and waterways. It also does not specifically calculate groundwater inflow and outflow.

Table 5-1
All Water Sources

Component	Historic Condition Water Budget				
Hydrologic Period Inflows	WY 1989 - 2014	WY2020	WY2021	WY2022	WY2023
Surface Water	12,200	0	0	0	21,801
Other	1,900	0	0	0	194
Contract Water Class 2	6,600	0	0	0	19,508
MID Diversions	1,600	0	0	0	0
CVP supply by Cottonwood Cr.	2,100	0	0	0	2,099
Precipitation *	7,200	4,597	4,597	4,406	9,006
Groundwater Extraction - Ag	15,800	20,674	26,608	25,986	6,569
Subsurface Inflow	500	500	500	500	500
Groundwater Extraction - Residential	100	100	100	100	100
Outside Water Purchases					
San Joaquin River Seepage					
Total Inflows	**35,800**	**25,871**	**31,805**	**30,992**	**37,976**

Table 5-2
GFWD Groundwater Budget

Component	Historic Condition Budget AF/yr.	.	.	.	
Hydrologic Period	WY 1989 - 2014	WY2020	WY2021	WY2022	WY2023
RECHARGE					
Deep Percolation of Precipitation	500	1,417	3,212	2,826	4,645
Canal Seepage	6,200	0	0	0	10,840
Deep Percolation of Irrigation Water	6,400	3,446	4,435	4,331	1,095
Groundwater Inflow	5,200				
Total	**18,300**	**4,862**	**7,647**	**7,157**	**16,580**
DISCHARGE					
Pumpage	15,900	20,674	26,608	25,986	6,569
Groundwater Outflow	4100				
Total:	**20000**	**20674**	**26608**	**25986.3**	**6569**
Subtotal	**-1700**	**-15812**	**-18961**	**-18829.6**	**10011**
Change in Water Level (ft)	NA	NA	-4.8	-4.4	4.25
Change in Water Storage (Upper)	-900	NA	-4781	-4382	4233
Change in Water Storage (Lower)	-700	-141	-141	-141	-141
Net Groundwater Flow to District	NA	NA	14180	14448	-5778

Table 5-3
Surface Water Budget for GFWD From LSCE Model

Hydrologic Period	WY 1989 - 2014	WY 2014	WY 2020 - 2040
Inflows			
Surface Water	12,200	-	13,800
Native Flows	1,900	-	6,000
Contract Water Class 2	6,600	-	6,000
MID Diversions	1,600	-	-
CVP supply by Cottonwood Cr.	2,100	-	1,800
Precipitation *	7,200	2,500	7,200
Groundwater Extraction - Ag	15,800	21,800	14,000
Subsurface Inflow	500	-	-
Groundwater Extraction - Residential	100	100	100
Outside Water Purchases			1,200
San Joaquin River Seepage			1,200
Total Inflows	**35,800**	**24,400**	**37,500**
Outflows			
Evapotranspiration **	18,100	18,000	18,000
Infiltration of Precipitation Loss *	2,700	700	2,700
Infiltration of Surface Water Loss *	6,200	200	6,200
Infiltration of Applied Water Loss *	6,400	5,300	6,400
Subsurface Outflow *	4,100	300	4,100
Total Outflows	**37,500**	**24,600**	**37,500**
Change in Storage	-1700	-200	0

* Values for Historic/Current From Appendix 2.F. Tables f the Report Titled "Ground Sustainability Plan Madera Subbasin".
**ET Value based on total GSA Area of 8,380 acres and 2.16 af/ac/yr

5.4 - Model Updates

Model updates are described in more detail in Section 2.1 and will also be outlined in the Madera Subbasin Joint GSP Amended 2025.

SECTION 6 - MONITORING NETWORKS

6.1 - Monitoring Network Goals

The District and the Madera Subbasin are in the process of updating their GSPs. Changes to the Madera Subbasin monitoring network can be seen in the Madera Subbasin Joint GSP Amended 2025. The District initiated a monitoring plan in 2018 to monitor sustainability indicators at the 24 agricultural wells within the District. GFWD plans to monitor all sustainability criteria, with the exception of interconnected surface water, to determine long-term and seasonal groundwater conditions within the confines of the District. See Table 6-1 for a list of Representative Monitoring Sites.

Table 6-1
Representative Monitoring Sites

Representative Monitoring Sites			
Well 201	36.87367	-120.22513	187.13
Well 202	36.86461	-120.21026	191.77
Well 203	36.86536	-120.18311	200.3
Well 206	36.85081	-120.22789	183.94
Well 213	36.83287	-120.22316	183.8
Well 224	36.81194	-120.16901	203.78

The District currently monitors surface water levels twice a year in April and October at all representative monitoring wells. The District also surveys agricultural wells to calculate subsidence. Water levels and subsidence were prioritized in the monitoring plan implementation. The District plans to measure subsidence in October and water quality during Summer. Results will be available in the 2024 Annual Report.

Table 6-2
Monitoring Location and Frequency for SMCs

Sustainability Indicator	Measurement	Location	Frequency
Water Levels	Depth to Water (ft)	All RMS Wells	April, October
Change in Storage	Depth to Water (ft)	All RMS Wells	April, October
Water Quality	Constituent Concentrations (vol/vol)	Domestic Wells	Annually, Summer
Subsidence	Ground Surface Elevation (amsl, ft)	All RMS Wells	Every Other Year
Interconnected Surface Water*	Depth to Water (ft)	Shallow Wells Only	April, October

* The District is not currently monitoring Interconnected Surface Water.

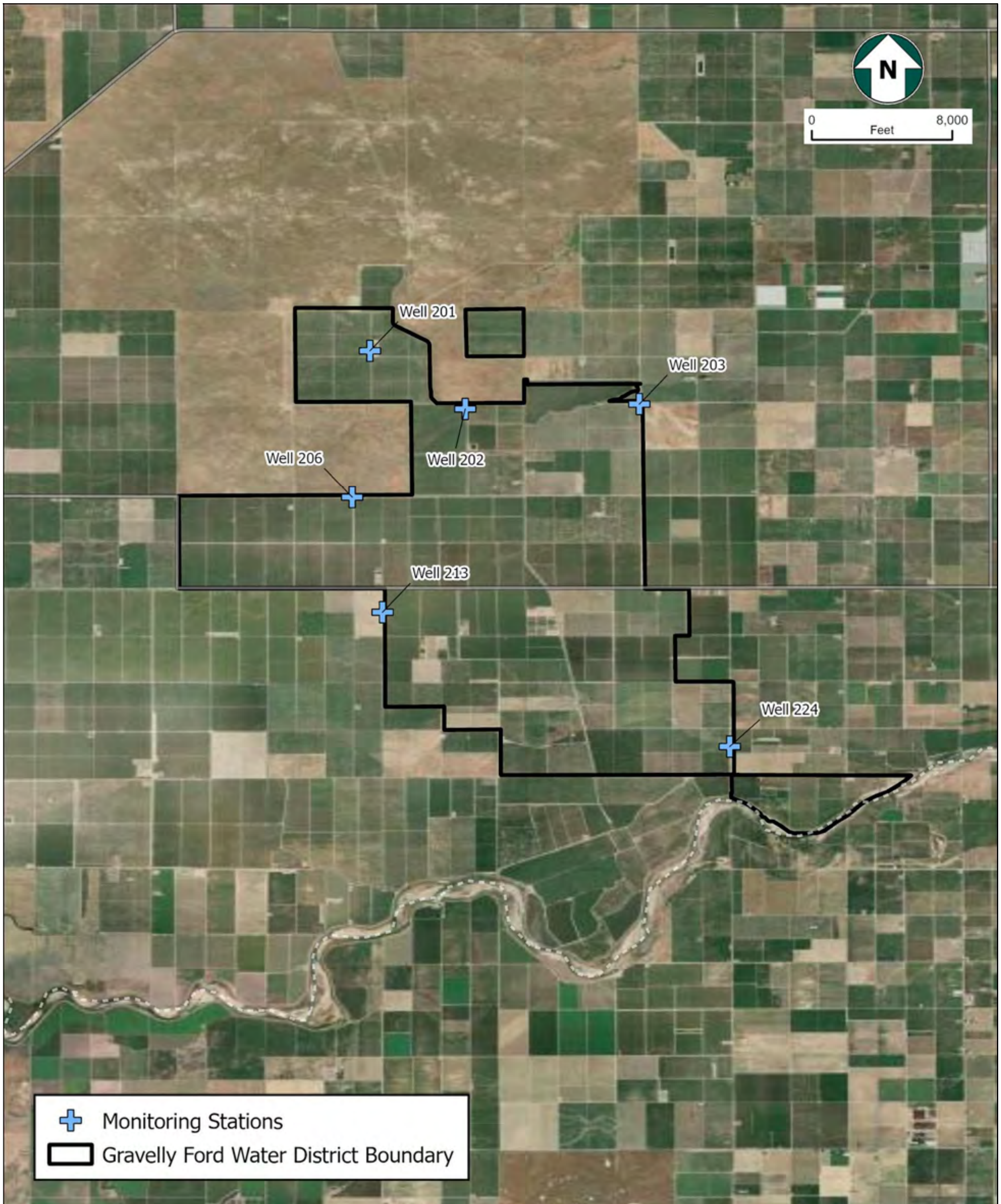

Figure 6-1
Groundwater Monitoring Network

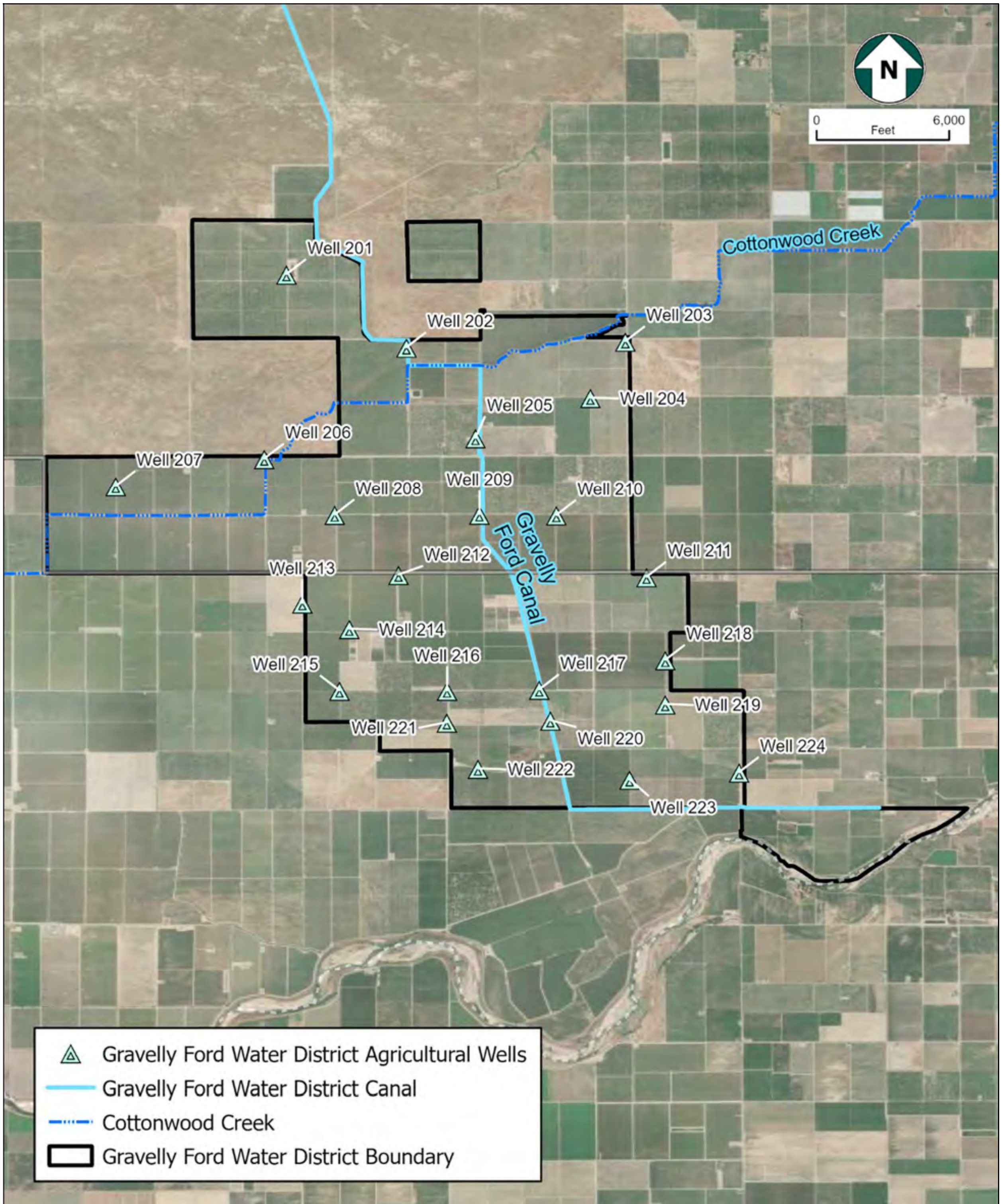

Figure 6-2
Agricultural Groundwater Wells Monitored

Previously, the District tracked water levels in two existing wells monitored by DWR to determine historic trends. In 2019, DWR stopped monitoring water levels at these wells. This has created a disconnect between the historic groundwater levels at the DWR wells, and the current representative monitoring network shown in Table 6-1.

The District had hoped to supplement the wells being monitored by DWR with the current representative monitoring network. However, considering the boundary of the GSA and Water District has changed, monitoring stations for groundwater levels, subsidence, and water quality may be added to the network. These changes will be reflected in future annual reports.

6.2 - Summary of Monitoring Network Changes

6.2.1 - Stations Added

GFWD has been measuring water levels semi-annually in 24 agricultural wells in the District since the fall of 2020. From the available data, a series of wells were selected, based on some simple criteria, to serve as the District's new representative monitoring wells (see Table 6-1). The wells that were selected met the following criteria: The wells were required to have spring 2015 groundwater level data for the basis of SMC development, construction information, and consistent data for the implementation period. These wells will be monitored for groundwater water levels and subsidence, groundwater quality will be sampled at domestic wells, to provide a complete snapshot of conditions at a specific location for all sustainability indicators, except for interconnected surface waters.

Additionally, the District tracks climate data from public sources to calculate crop consumptive use and effective precipitation. The District downloads and records CIMIS data for precipitation and evapotranspiration (ET) from the Firebaugh/Telles Station (#7) as it is the closest to GFWD. This data is used to calculate the consumptive use of agriculture for irrigation. The District also tracks climate at other nearby CIMIS stations and plans to start tracking precipitation at the Yosemite International Airport in Fresno. The District may also start tracking flow at the CDEC San Joaquin River at Gravelly Ford (GRF) station in cubic feet per second and surface water quality. This data is only for informational purposes and would not affect management practices in the District. They may also add shallow wells to the monitoring network to determine the extent and duration of interconnected surface waters, if any.

6.2.2 - Stations Removed

As stated above, DWR monitored historic groundwater levels at several locations in and near the District. Since the implementation of the original 2020 GSP, the wells used to establish historic groundwater trends are no longer been monitored. Because those wells are no longer monitored, they have essentially been removed from the monitoring network. The specifics of these wells can be seen in the original 2020 GFWD GSP in the Groundwater Conditions section.

No additional stations have been removed from the monitoring network. However, the precipitation data comes from the CIMIS station mentioned above rather than Weather Station 045233 as stated in the 2020 GSP.

6.2.3 - Monitoring Frequency/Density Changes

The District plans to schedule monitoring to reflect the schedule of representative sites monitored by the Madera Subbasin. Currently, the Madera Subbasin measures water levels in April and October. The Subbasin also tracks subsidence measured by others, which is typically measured annually in July and December. The District also measures water levels semi-annually in April and October. However, due to funding limitations and other resources, GFWD only measures subsidence every other year. The change to the six representative monitored sites has tripled the density of the monitoring network in the District. The District will implement a water quality monitoring program in the monitoring network. Currently, the plan is to monitor groundwater quality annually at domestic wells in the summer; however, if water quality remains good and within sustainable parameters, the District reserves the right to reduce monitoring frequency.

6.3 - Monitoring Network Data Gaps

6.3.1 - Data Gaps Addressed

Currently the largest data gap within the District is groundwater quality. The District plans to begin monitoring groundwater quality at domestic wells upon gaining access from land owners. The District plans to monitor for TDS, arsenic, and EC during the summers when wells are pumping, and water levels are assumed to be at their lowest. The District plans decide to measure an additional suite of constituents, to establish additional drinking water quality parameters and gradients or patterns. Once a baseline for water quality has been established, the District may change the representative monitoring sites for groundwater quality.

It is also important to note that due to the District boundary change additional monitoring sites may be added for all sustainability indicators to track groundwater conditions in the annexed area.

The District is also working with GSA partners in the Madera Subbasin to explore methods for identifying and monitoring interconnected surface waters.

6.3.2 - New Data Gaps

The District is currently working to get some historic water levels and other data for the updated monitoring network. At that time, the District was in contact with the pump company in charge of monitoring many of the District's wells. The District plans to compare this data to historical trends of nearby wells and the Joint Subbasin water model.

6.4 - Network Functionality Assessment

Currently, the monitoring network in the District functions as expected. There are no plans to change the existing monitoring frequency or locations except as described in the previous sections. The proposed changes will enhance the monitoring network and increase understanding of groundwater conditions and allow the District to track the effects of groundwater management practices on sustainability indicators.

6.5 - Additional Improvements Needed

The District also plans to add additional monitoring efforts as they relate to surface water. The District has outlined several projects and management actions that propose to add surface water monitoring stations to Cottonwood Creek and groundwater production meters on agricultural wells. These projects will allow the District to monitor surface water flowing through the District and groundwater pumping. This will allow GFWD to compare localized groundwater pumping to sustainability indicators. Monitoring Cottonwood Creek will allow the District to estimate percolation into the upper aquifer.

Implementation of these projects and monitoring sites is dependent on funding. Recently the District approved a per parcel assessment for implementation of the GSP. A portion of these funds will be used to address deferred maintenance and capital projects. The District has applied for grant funds from the USBR Water SMART program to offset the cost of the Automated SCADA Water Control Gate Project design and the Agricultural Well Metering Program. Both will assist the District in creating a more complete understanding of groundwater conditions.

SECTION 7 - GSA AUTHORITIES AND ENFORCEMENT ACTIONS

The District (GSA) has taken several actions to increase its ability to act regarding sustainability. One such action was to require all future well construction to include meters to quantify water production for integration into the well metering program. The District has also been authorized via popular vote to levy a per-acre tax on landowners for implementation of SGMA.

The District is working with their GSA partners to develop a Domestic Well Mitigation Program. The GSAs are also considering the development of a Demand Management Program that would establish triggers for implementation of demand management measures intended to maintain groundwater sustainability.

The District has not put in place any demand management plans or policies. Unlike other GSAs, the District intends to increase surface water use and increase irrigation efficiency rather than implement a reduction in groundwater pumping to achieve sustainability.

SECTION 8 - OUTREACH, ENGAGEMENT, AND COORDINATION WITH OTHER AGENCIES

8.1 - Outreach and Engagement

The GFWD District Engineer attends the Technical Committee regularly. Most recently the Technical Committee has been meeting every other Thursday, but as the deadline for the submission of the 2025 GSP looms nearer, the Technical Committee plans to meet weekly. The decisions made at these technical meetings inform the GSA boards and, ultimately, the drafting of the 2025 GSP. The GSAs have agreed to allow a 45-day public comment period despite the requirement for GSAs to only inform the public. GFWD publicly announced the development of the 2025 GSP on October 21, 2024, at their regularly scheduled board meeting. The District has also emailed all interested parties and uploaded notice of amendments to the GSP on their website.

The district has a standing agenda item in their monthly board meetings, during which the District Engineer updates the board members on project implementation decisions made by the technical committee and GSP matters. The public is welcome to attend all board meetings and agendas are sent out monthly to board members and other interested parties. The District also posts board meeting information on their website.

The District conducted a large outreach campaign for their Proposition 218 assessment. The District was clear when describing how assessment money would be spent. A large portion would be set aside for the purchase of surface water when available. The remainder will be used for deferred maintenance and to increase efficiency. A small amount is set aside to pay for consultants to develop plans and construction documents for projects.

8.2 - Responsibilities of GSA Boards

The board is responsible for approving plans and funds. They are responsible for hiring companies and consultants to draft plans and monitor groundwater conditions. Lastly, the board is responsible for informing the public and answering questions.

8.3 - Coordination with Other Agencies

The District is coordinating with other GSAs, subbasins, and DWR to develop the 2025 GSP.

SECTION 9 - OTHER INFORMATION

The Madera Subbasin is adjacent to the Chowchilla Subbasin, the Delta Mendota Subbasin, and the Kings Subbasin. Several factors affect the Madera Subbasin as a result of Plan implementation or lack thereof. It should be noted that neither the Delta Mendota nor Chowchilla Subbasins' GSPs were approved by DWR. This resulted in the SWRCB taking over the authority as the agency in charge.

It is important to consider the actions of the Madera Subbasin and more specifically GFWD on other subbasins as well. The Subbasin is adjacent to the SJR and diverts water directly from the River. This water can be used to offset groundwater use and for recharge. This is a net benefit to the Subbasin and prevents the District from causing effects to adjacent GSAs and subbasins.

To the northwest of the Subbasin is adjacent to the Chowchilla Subbasin where significant subsidence has occurred over the years. This subsidence can radiate outward and affect neighboring subbasins such as the Madera Groundwater Subbasin.

9.1 - Challenges Not Previously Discussed

There are no additional challenges not already addressed in this periodic evaluation.

9.2 - Legal Challenges

There are no legal challenges directly impacting the District. Legal challenges that could affect SGMA as a whole or the greater Madera Subbasin are explained in more detail in Section 2.6.

SECTION 10 - SUMMARY OF PROPOSED OR COMPLETED REVISIONS TO PLAN ELEMENTS

10.1 - Proposed Revisions to Plan Elements

The District will revise the monitoring network and sampling as part of its GFWD GSP Amended 2025 and add monitoring for groundwater quality. The District will update SMCs in accordance with the guidance of the Technical Committee and the Madra Subbasin Joint GSP Amended 2025. Other changes and information may be reflected in the Madra Subbasin Joint GSP Amended 2025. These changes include changes to the groundwater model and water budgets.

SECTION 11 - REFERENCES

2020 Gravelly Ford Water District Groundwater Sustainability Plan, January 2020, QK Inc.

Gravelly Ford Water District Annual Reports, 2020-2024, QK Inc

Madera Subbasin Joint GSP, 2020-Amended 2023, David's Engineering & Ludorff Scalmanini Consulting Engineer

A Guide to Annual Reports, Periodic Evaluations, and Plan Amendments, October 2023, DWR

Groundwater Sustainability Plan Annotated Outline, December 2016, DWR

San Joaquin River Restoration Settlement, March 2009, Public Law

Farmers Surprised: Judge blocks groundwater restrictions, July 2024, western-water.com

Depletions of Interconnected Surface Water, An Introduction, February 2024, DWR

Techniques for Estimating Interconnected Surface Water Depletion Caused by Groundwater Use, September 2024, DWR

Stream Depletions and Groundwater Pumping, June 2010, Nebraska Department of Natural Resources, Water Matters

Land Repurposing Program, Merced Subbasin GSA, mercedsubbasingas.org

A Guide to Water Quality Requirements Under SGMA, Spring 2009, Moran & Belin

DWR Electromagnetic Survey Project, February 2024, DWR

APPENDIX A
COORDINATION AGREEMENT

Add Final Coordination Agreement Here

Appendix B
DWR Approval Letter

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CALIFORNIA DEPARTMENT OF WATER RESOURCES

SUSTAINABLE GROUNDWATER MANAGEMENT OFFICE

715 P Street, 8th Floor | Sacramento, CA 95814 | P.O. Box 942836 | Sacramento, CA 94236-0001

December 21, 2023

John Davids
Madera Point of Contact
1772 Picasso Avenue, Suite A
Davis, CA 95618
john@davidsengineering.com

RE: Approved Determination of the Revised Groundwater Sustainability Plans Submitted for the San Joaquin Valley – Madera Subbasin

Dear John Davids,

The Department of Water Resources (Department) has evaluated the four groundwater sustainability plans (GSPs) submitted for the San Joaquin Valley – Madera Subbasin (Subbasin), as well as the materials considered to be part of the required coordination agreement. Collectively, the four GSPs and the coordination agreement are referred to as the Plan for the Subbasin. The Department has evaluated the resubmitted Plan for the Madera Subbasin in response to the Department's incomplete determination on September 22, 2022, and has determined the Plan is approved. The approval is based on recommendations from the Staff Report, included as an exhibit to the attached Statement of Findings, which describes that the Plan has taken sufficient action to correct deficiencies identified by the Department and satisfies the objectives of the Sustainable Groundwater Management Act (SGMA) and substantially complies with the GSP Regulations. The Staff Report also proposes recommended corrective actions that the Department believes will enhance the GSP and facilitate future evaluation by the Department. The Department strongly encourages the recommended corrective actions be given due consideration and suggests incorporating all resulting changes to the GSP in future updates.

Recognizing SGMA sets a long-term horizon for groundwater sustainability agencies (GSAs) to achieve their basin sustainability goals, monitoring progress is fundamental for successful implementation. GSAs are required to evaluate their GSPs at least every five years and whenever the Plan is amended, and to provide a written assessment to the Department. Accordingly, the Department will evaluate approved GSPs and issue an assessment at least every five years. The Department will initiate the first periodic review of the Plan no later than January 31, 2025.

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Please contact Sustainable Groundwater Management staff by emailing sgmps@water.ca.gov if you have any questions related to the Department's assessment or implementation of your GSP.

Thank You,

Paul Gosselin

Paul Gosselin
Deputy Director
Sustainable Groundwater Management

Attachment:

1. Statement of Findings Regarding the Determination of Approval of the San Joaquin Valley – Madera Subbasin Groundwater Sustainability Plans (December 21, 2023)

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STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

STATEMENT OF FINDINGS REGARDING THE APPROVAL OF THE SAN JOAQUIN VALLEY – MADERA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

The Department of Water Resources (Department) is required to evaluate whether a submitted groundwater sustainability plan (GSP or Plan) conforms to specific requirements of the Sustainable Groundwater Management Act (SGMA or Act), is likely to achieve the sustainability goal for the basin covered by the Plan, and whether the Plan adversely affects the ability of an adjacent basin to implement its GSP or impedes achievement of sustainability goals in an adjacent basin. (Water Code § 10733.) The Department is directed to issue an assessment of the Plan within two years of its submission. (Water Code § 10733.4.) If a Plan is determined to be Incomplete, the Department identifies deficiencies that preclude approval of the Plan and identifies corrective actions required to make the Plan compliant with SGMA and the GSP Regulations. The groundwater sustainability agency (GSA) has up to 180 days from the date the Department issues its assessment to make the necessary corrections and submit a revised Plan. (23 CCR § 355.2(e)(2)). This Statement of Findings explains the Department's decision regarding the revised Plan submitted by the City of Madera GSA, Madera County GSA, Madera Irrigation District GSA, Madera Water District GSA, Gravelly Ford Water District GSA, New Stone Water District GSA, and Root Creek Water District GSA (GSAs or Agencies) for the San Joaquin Valley – Madera Subbasin (No. 5-022.06) (Subbasin) on March 21, 2023 (2023 Plan).

Department management has discussed the 2023 Plan with staff and has reviewed the Department Staff Report, entitled Sustainable Groundwater Management Program Groundwater Sustainability Plan Assessment Staff Report, attached as Exhibit A, recommending approval of the 2023 Plan. Department management is satisfied that staff have conducted a thorough evaluation and assessment of the 2023 Plan and concurs with staff's recommendation and all the recommended corrective actions. The Department therefore **APPROVES** the 2023 Plan and makes the following findings:

A. The initial Plan for the basin submitted by the GSAs for the Department's evaluation on January 31, 2020 (2020 GSP or 2020 Plan) was determined by Department staff to satisfy the preliminary requirements for Plan review as outlined in § 355.4(a) of the GSP Regulations (23 CCR § 350 et seq.), and Department Staff therefore evaluated the initial Plan.

B. On September 22, 2022, the Department issued a Staff Report and Findings determining the initial 2020 GSP submitted by the Agencies for the basin to be incomplete because the 2020 Plan did not satisfy the requirements of

SGMA, nor did it substantially comply with the GSP Regulations. At that time, the Department provided corrective actions in the Staff Report that were intended to address the deficiencies that precluded approval. Consistent with the GSP Regulations, the Department provided the Agencies with up to 180 days to address the deficiencies detailed in the Staff Report. On March 21, 2023, within the 180 days provided to remedy the deficiencies identified in the Staff Report related to the Department's initial incomplete determination, the Agencies resubmitted a revised Plan to the Department for evaluation.

When evaluating a revised Plan that was initially determined to be incomplete, the Department reviews the materials (e.g., revised or amended Plan) that were submitted within the 180-day deadline and does not review or rely on materials that were submitted to the Department by the GSAs after the resubmission deadline. Part of the Department's review focuses on how the Agencies have addressed the previously identified deficiencies that precluded approval of the initially submitted Plan. The Department shall find a Plan previously determined to be incomplete to be inadequate if, after consultation with the State Water Resources Control Board, the Agencies have not taken sufficient actions to correct the deficiencies previously identified by the Department. (23 CCR § 355.2(e)(3)(C).) If the Department determines the Agencies have sufficiently addressed those deficiencies, the Department may evaluate other components of the Plan, particularly to assess whether and, if so, how revisions to address deficiencies may have affected other components of a Plan or its likelihood of achieving sustainable groundwater management.

C. The Department's initial Staff Report identified the deficiencies that precluded approval of the initially submitted 2020 Plan. After staff's thorough evaluation of the revised 2023 Plan, the Department makes the following findings regarding the sufficiency of the actions taken by the Agencies to address those deficiencies:

1. Deficiency 1: The corrective action advised the Agencies to modify several aspects of their respective GSPs to substantially comply with the GSP Regulations in a coordinated manner. The Department found that the initial GSPs did not sufficiently coordinate on data and methodologies, including coordination of the sustainability goal, water budget and sustainable yield, and undesirable results as required by SGMA and the GSP Regulations. The Department also determined that the 2020 Plan's definition of an undesirable result for the chronic lowering of groundwater levels was not consistent with the requirements of SGMA.

The 2023 Staff Report indicates that the Agencies have taken sufficient actions to correct this deficiency, and it should no longer materially affect the ability of the Agencies to achieve sustainability and the ability of the Department to evaluate the likelihood of the 2023 Plan to achieve sustainability.

2. Deficiency 2: The corrective action advised the Agencies to address several aspects of the 2020 Plan's disclosure, discussion, and analyses of groundwater level sustainable management criteria and potential impacts to groundwater users and uses. The initial 2020 Plan did not establish undesirable results and minimum thresholds for chronic lowering of groundwater levels in a manner substantially compliant with the GSP Regulations. Additionally, the Department found that the Plan did not present sufficient analysis of the effects of minimum thresholds on beneficial uses and users of groundwater in the Subbasin.

   The 2023 Staff Report indicates that the Agencies have taken sufficient actions to correct this deficiency, and it should no longer materially affect the ability of the Agencies to achieve sustainability and the ability of the Department to evaluate the likelihood of the 2023 Plan to achieve sustainability.

3. Deficiency 3: The corrective action advised the Agencies to address several aspects of the 2020 Plan's disclosure, discussion, and analyses of land subsidence sustainable management criteria and potential impacts to groundwater users and uses. The initial Plan did not establish sustainable management criteria for subsidence. The Department determined that the GSAs did not sufficiently demonstrate that undesirable results related to land subsidence are not present and are not likely to occur in the Subbasin.

   The 2023 Staff Report indicates that the Agencies have taken sufficient actions to correct this deficiency, and it should no longer materially affect the ability of the Agencies to achieve sustainability and the ability of the Department to evaluate the likelihood of the 2023 Plan to achieve sustainability.

4. Deficiency 4: The corrective action advised the Agencies to address several aspects of the 2020 Plan's disclosure, discussion, and analyses of interconnected surface water sustainable management criteria and potential impacts to groundwater users and uses. The initial 2020 Plan did not establish sustainable management criteria for interconnected surface water. The Department determined that the GSAs do not sufficiently demonstrate that interconnected surface

water or undesirable results related to depletions of interconnected surface water are not present and are not likely to occur in the Subbasin.

The 2023 Staff Report indicates that the Agencies have taken sufficient actions to correct this deficiency, and it should no longer materially affect the ability of the Agencies to achieve sustainability and the ability of the Department to evaluate the likelihood of the 2023 Plan to achieve sustainability.

D. The 2023 Plan satisfies the required conditions as outlined in § 355.4(a) of the GSP Regulations (23 CCR § 350 et seq.):

1. The 2020 Plan was submitted within the statutory deadline of January 31, 2022 (Water Code § 10720.7(a); 23 CCR § 355.4(a)(1)), and the 2023 Plan was submitted within 180 days of the Department's Incomplete determination (23 CCR § 355.2(e)(2)).

2. The 2023 Plan is complete, meaning it generally appeared to include the information required by the Act and the GSP Regulations sufficient to warrant a thorough evaluation and issuance of an assessment by the Department. (23 CCR § 355.4(a)(2).)

3. The 2023 Plan, either on its own or in coordination with other Plans, covers the entire Subbasin. (23 CCR § 355.4(a)(3).)

E. The general standards the Department applied in its evaluation and assessment of the Plan are: (1) "conformance" with the specified statutory requirements, (2) "substantial compliance" with the GSP Regulations, (3) whether the Plan is likely to achieve the sustainability goal for the Subbasin within 20 years of the implementation of the Plan, and (4) whether the Plan adversely affects the ability of an adjacent basin to implement its GSP or impedes achievement of sustainability goals in an adjacent basin. (Water Code § 10733.) Application of these standards requires exercise of the Department's expertise, judgment, and discretion when making its determination of whether a Plan should be deemed "approved," "incomplete," or "inadequate."

The statutes and GSP Regulations require Plans to include and address a multitude and wide range of informational and technical components. The Department has observed a diverse array of approaches to addressing these technical and informational components being used by GSAs in different basins throughout the state. The Department does not apply a set formula or criterion that would require a particular outcome based on how a Plan addresses any one of SGMA's numerous informational and technical components. The Department finds that affording flexibility and discretion to

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local GSAs is consistent with the standards identified above; the state policy that sustainable groundwater management is best achieved locally through the development, implementation, and updating of local plans and programs (Water Code § 113); and the Legislature's express intent under SGMA that groundwater basins be managed through the actions of local governmental agencies to the greatest extent feasible, while minimizing state intervention to only when necessary to ensure that local agencies manage groundwater in a sustainable manner. (Water Code § 10720.1(h)). The Department's final determination of a Plan is made based on the entirety of the Plan's contents on a case-by-case basis, considering and weighing factors relevant to the particular Plan and Subbasin under review.

F. In making these findings and Plan determination, the Department also recognized that: (1) it maintains continuing oversight and jurisdiction to ensure the Plan is adequately implemented; (2) the Legislature intended SGMA to be implemented over many years; (3) SGMA provides Plans with 20 years of implementation to achieve the sustainability goal in a Subbasin (with the possibility that the Department may grant GSAs an additional five years upon request if the GSA has made satisfactory progress toward sustainability); and, (4) local agencies acting as GSAs are authorized, but not required, to address undesirable results that occurred prior to enactment of SGMA. (Water Code §§ 10721(r); 10727.2(b); 10733(a); 10733.8.)

G. The 2023 Plan conforms with Water Code §§ 10727.2 and 10727.4, substantially complies with 23 CCR § 355.4, and appears likely to achieve the sustainability goal for the Subbasin. It does not appear at this time that the 2023 Plan will adversely affect the ability of adjacent basins to implement their GSPs or impede achievement of sustainability goals.

1. The sustainable management criteria and the 2023 Plan's goal to implement a package of projects and management actions that will, by 2040, balance long-term groundwater system inflows and outflows based on a 50-year period representative of average historical hydrologic conditions are sufficiently justified and explained. The 2023 Plan relies on credible information and science to quantify the groundwater conditions that the Plan seeks to avoid and provides an objective way to determine whether the Subbasin is being managed sustainably in accordance with SGMA. (23 CCR § 355.4(b)(1).)

2. The 2023 Plan demonstrates an understanding of where data gaps exist and has identified areas for improvement of its Plan, including addressing data gaps related to land subsidence and interconnected surface water, refining water budgets, incorporating new information

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into the numerical model, and expanding monitoring networks. (23 CCR § 355.4(b)(2).)

3. The projects and management actions proposed are designed to meet interim milestones and bring groundwater levels back up to minimum thresholds, mitigate overdraft, and operate the Subbasin sustainably. The projects and management actions are reasonable and commensurate with the level of understanding of the Subbasin setting. The projects and management actions described in the Plan provide a feasible approach to achieving the Subbasin's sustainability goal and should provide the GSAs with greater versatility to adapt and respond to changing conditions and future challenges during GSP implementation. (23 CCR § 355.4(b)(3).)

4. The 2023 Plan provides a detailed explanation of how the varied interests of groundwater uses and users in the Subbasin were considered in developing the sustainable management criteria and how those interests, including domestic wells, would be impacted by the chosen minimum thresholds. (23 CCR § 355.4(b)(4).)

5. The 2023 Plan's projects and management actions appear feasible at this time and appear likely to prevent undesirable results and ensure that the Subbasin is operated within its sustainable yield within 20 years. The Department will continue to monitor Plan implementation and reserves the right to change its determination if projects and management actions are not implemented or appear unlikely to prevent undesirable results or achieve sustainability within SGMA timeframes. (23 CCR § 355.4(b)(5).)

6. The 2023 Plan includes a reasonable assessment of overdraft conditions and includes reasonable means to mitigate overdraft. (23 CCR § 355.4(b)(6).)

7. At this time, it does not appear that the 2023 Plan will adversely affect the ability of an adjacent basin to implement its GSP or impede achievement of sustainability goals in an adjacent basin. The Plan states that the Subbasin's GSAs have met with GSAs in adjacent basins to share data and information to ensure that the implementation of the GSPs will not interfere with neighboring basins. The Plan also qualitatively describes how minimum thresholds and measurable objectives may affect an adjacent basin, concluding that the Madera Subbasin Plan will not hinder the ability of an adjacent basin to be sustainable; however, the evaluation is provided without specifics. (23 CCR § 355.4(b)(7).)

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8. A satisfactory coordination agreement has been adopted by all relevant parties. (23 CCR § 355.4(b)(8).)

9. The City of Madera GSA, Madera County GSA, Madera Irrigation District GSA, Madera Water District GSA, Gravelly Ford Water District GSA, New Stone Water District GSA, and Root Creek Water District GSA have historically had a role in water planning and management in the Subbasin. The seven GSAs' history of groundwater management provide a reasonable level of confidence that the GSAs have the legal authority and financial resources necessary to implement the 2023 Plan. (23 CCR § 355.4(b)(9).)

10. Through review of the 2023 Plan and consideration of public comments, the Department determines that the GSAs adequately responded to comments that raised credible technical or policy issues with the Plan, sufficient to warrant approval of the Plan at this time. The Department also notes that the recommended corrective actions included in the Staff Report are important to addressing certain technical or policy issues that were raised and, if not addressed before future, subsequent plan evaluations, may preclude approval of the Plan in those future evaluations. (23 CCR § 355.4(b)(10).)

H. In addition to the grounds listed above, DWR also finds that:

1. The 2023 Plan provides an analysis that documents the expected location and quantity of domestic wells that will experience undesirable results during the GSP implementation period based on future modeled groundwater conditions. Additionally, the Plan describes a domestic well mitigation program that the GSAs will implement to provide assistance to domestic and municipal wells adversely impacted by declining groundwater levels that have occurred since 2015. The Plan describes that the cost of mitigating domestic wells due to lowering groundwater levels is shown to be economically preferable to the costs associated with immediately stabilizing groundwater levels and the resulting impact to the local economy. The Plan's compliance with the requirements of SGMA and substantial compliance with the GSP Regulations supports the state policy regarding the human right to water (Water Code § 106.3). The Department developed its GSP Regulations consistent with and intending to further the policy through implementation of SGMA and the Regulations, primarily by achieving sustainable groundwater management in a basin. By ensuring substantial compliance with the GSP Regulations, the Department has considered the state policy

regarding the human right to water in its evaluation of the Plan. (23 CCR § 350.4(g).)

2. The 2023 Plan acknowledges and identifies interconnected surface waters within the Subbasin. The GSAs propose interim sustainable management criteria to manage this sustainability indicator and measures to improve understanding and management of interconnected surface water. The GSAs acknowledge, and the Department agrees, many data gaps related to interconnected surface water exist. The GSAs should continue filling data gaps, collecting additional monitoring data, and coordinating with resources agencies and interested parties to understand beneficial uses and users that may be impacted by depletions of interconnected surface water caused by groundwater pumping. Future updates to the Plan should aim to improve the initial sustainable management criteria as more information and improved methodology becomes available.

3. The California Environmental Quality Act (Public Resources Code § 21000 *et seq*.) does not apply to the Department's evaluation and assessment of the Plan.

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Accordingly, the revised 2023 Plan submitted by the Agencies for the San Joaquin Valley – Madera Subbasin is hereby **APPROVED.** The recommended corrective actions identified in the Staff Report will assist the Department's future review of the Plan's implementation for consistency with SGMA and the Department therefore recommends the Agencies address them by the time of the Department's periodic review, which is set to begin on January 31, 2025, as required by Water Code § 10733.8. Failure to address the Department's Recommended Corrective Actions before future, subsequent plan evaluations, may lead to a Plan being determined incomplete or inadequate.

Signed:

Karla Nemeth

Karla Nemeth, Director
Date: December 21, 2023

Exhibit A: Groundwater Sustainability Plan Assessment Staff Report – San Joaquin Valley – Madera Subbasin (December 21, 2023)

State of California
Department of Water Resources
Sustainable Groundwater Management Program
Groundwater Sustainability Plan Assessment
Staff Report

Groundwater Basin Name:	San Joaquin Valley - Madera Subbasin (No. 5-022.06)
Number of GSPs:	4 (see list below)
Number of GSAs:	7 (see list below)
Submittal Type:	Revised Plan in response to Incomplete Determination
Submittal Date:	March 21, 2023
Recommendation:	Approve
Date:	December 21, 2023

On March 21, 2023, multiple groundwater sustainability agencies (GSAs) resubmitted multiple groundwater sustainability plans (GSPs) for the entire Madera Subbasin (Subbasin), which are coordinated pursuant to a required coordination agreement, to the Department of Water Resources (Department) in response to the Department's incomplete determination on September 22, 2022[1] for evaluation and assessment as required by the Sustainable Groundwater Management Act (SGMA)[2] and GSP Regulations.[3] In total, four GSPs have been revised and implemented by seven GSAs. Collectively, all GSPs and the Coordination Agreement are, for evaluation and assessment purposes, treated and referred to as the Plan for the Subbasin. Individually, the GSPs include the following:

- *Gravelly Ford Water District Groundwater Sustainability Plan (Gravelly Ford GSP)* – prepared by the Gravelly Ford Water District GSA.
- *Joint Groundwater Sustainability Plan (Joint GSP)* – prepared jointly by the City of Madera GSA, Madera County GSA, Madera Irrigation District GSA, and Madera Water District GSA.
- *New Stone Water District Groundwater Sustainability Agency Groundwater Sustainability Plan (New Stone GSP)* – prepared by the New Stone Water District GSA.

[1] Water Code § 10733.4(b); 23 CCR § 355.4(a)(4). https://sgma.water.ca.gov/portal/service/gspdocument/download/9363; Water Code § 10733.4(b); 23 CCR § 355.4(a)(4).
[2] Water Code § 10720 *et seq*.
[3] 23 CCR § 350 *et seq*.

- *Root Creek Water District Groundwater Sustainability Agency Groundwater Sustainability Plan (Root Creek GSP)* – prepared by the Root Creek Water District GSA.

After evaluation and assessment, Department staff conclude the GSAs have taken sufficient actions to correct deficiencies identified by the Department; however, Department staff have provided recommended corrective actions which will be required to be addressed by the Plan's next periodic evaluation.

Overall, Department staff believe the Plan contains the required components of a GSP, demonstrates a thorough understanding of the Subbasin based on what appears to be the best available science and information, sets well explained, supported, and reasonable sustainable management criteria to prevent undesirable results as defined in the Plan, and proposes a set of projects and management actions that, if successfully implemented, are likely achieve the sustainability goal defined for the Subbasin.[4] Department staff will continue to monitor and evaluate the Subbasin's progress toward achieving the sustainability goal through Annual Reports and future Periodic Evaluations of the GSP and its implementation.

Based on the reevaluation of the Plan, Department staff recommend the Plan be approved.

This assessment includes six sections:

- **Section 1 – Summary:** Provides an overview of the Department Staff's assessment and recommendations.
- **Section 2 – Evaluation Criteria:** Describes the legislative requirements and the Department's evaluation criteria.
- **Section 3 – Required Conditions:** Describes the submission requirements of a response to an incomplete determination to be evaluated by the Department.
- **Section 4 – Deficiency Evaluation:** Provides an assessment of whether and how the contents included in the GSP submittal addressed the deficiencies identified by the Department in the initial incomplete determination.
- **Section 5 – Plan Evaluation:** Provides a detailed assessment of the contents included in the GSP organized by each Subarticle outlined in the GSP Regulations.
- **Section 6 – Staff Recommendation:** Includes the staff recommendation for the Plan and any recommended corrective actions.

[4] 23 CCR § 354.24.

1 Summary

Department staff recommend approval of the Plan for the Madera Subbasin and have recommended corrective actions designed to address shortcomings of the Plan described in this Staff Report. In the evaluation of the Plan, Department staff concluded that sufficient action was taken to correct the deficiencies; however, Department staff have provided recommended corrective actions which will be required to be address by the Plan's next periodic evaluation.

The GSA has identified areas for improvement of its Plan (e.g., addressing data gaps related to land subsidence and interconnected surface water, refining water budgets, incorporating new information into the numerical model, and expanding monitoring networks). Department staff concur that those items are important and recommend the GSA address them as soon as possible. As mentioned, Department staff have also identified additional recommended corrective actions that the GSA should consider for the next periodic evaluation of the Plan or sooner (see Section 6). Addressing these recommended corrective actions will be important to demonstrate, on an ongoing basis, that implementation of the Plan is likely to achieve the sustainability goal. The recommended corrective actions generally focus on the following:

1. Providing a detailed explanation specifically discussing and identifying Madera Irrigation District GSA's legal, contractual, or other authorities or arrangements to implement its obligations under the Joint GSP in the next periodic evaluation.
2. Continuing efforts to further coordinate the GSPs and groundwater management.
3. Sufficiently describing the effect of chronic lowering of groundwater level interim milestones on other sustainability indicators.
4. Reevaluating the quantitative metrics that constitute undesirable results due to land subsidence and sufficiently describing the effect and extent of land subsidence interim milestones that allow continued subsidence during the GSP implementation period.
5. Describing data gaps in the hydrogeologic conceptual model.
6. Sufficiently detailing the degraded water quality undesirable results and explaining the rationale to allow potential further degradation.

2 EVALUATION CRITERIA

The Department evaluates whether a Plan conforms to the statutory requirements of SGMA[5] and is likely to achieve the basin's sustainability goal,[6] whether evaluating a basin's first Plan,[7] a Plan previously determined incomplete,[8] an amended Plan,[9] or a GSA's periodic update to an approved Plan.[10] To achieve the sustainability goal, each version of the Plan must demonstrate that implementation will lead to sustainable groundwater management, which means the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.[11] The Department is also required to evaluate, on an ongoing basis, whether the Plan will adversely affect the ability of an adjacent basin to implement its groundwater sustainability program or achieve its sustainability goal.[12]

The Plan evaluated in this Staff Report is a revision of the 2020 Plan, which was evaluated by the Department and found to be incomplete. An incomplete Plan is one which Department staff identify as containing one or more deficiencies that preclude its initial approval. Deficiencies may result from supporting information that is insufficiently detailed or analyses that are insufficiently thorough or unreasonable, or where Department staff determine it is unlikely the GSAs in the basin could achieve the sustainability goal under the proposed Plan. After a GSA has been afforded up to 180 days to address the deficiencies and based on the GSA's efforts, the Department can either approve[13] the Plan or determine the Plan inadequate.[14]

The Department's evaluation and assessment of a revised or amended Plan, subsequent to the initial Plan being found to be incomplete, as presented in this Staff Report, continues to follow Article 6 of the GSP Regulations[15] to determine whether the Plan, with revisions or additions prepared by the GSA, complies with SGMA and substantially complies with the GSP Regulations.[16] As stated in the GSP Regulations, "substantial compliance means that the supporting information is sufficiently detailed and the analyses sufficiently thorough and reasonable, in the judgment of the Department, to evaluate the Plan, and the Department determines that any discrepancy would not materially affect the

[5] Water Code §§ 10727.2, 10727.4, 10727.6.
[6] Water Code § 10733; 23 CCR § 354.24.
[7] Water Code § 10720.7.
[8] 23 CCR § 355.2(e)(2).
[9] 23 CCR § 355.10.
[10] 23 CCR § 355.6.
[11] Water Code § 10721(v).
[12] Water Code § 10733(c).
[13] 23 CCR §§ 355.2(e)(1).
[14] 23 CCR §§ 355.2(e)(3).
[15] 23 CCR § 355 *et seq*.
[16] 23 CCR § 350 *et seq*.

ability of the Agency to achieve the sustainability goal for the basin, or the ability of the Department to evaluate the likelihood of the Plan to attain that goal."[17]

The recommendation to approve a Plan previously determined to be incomplete is based on a determination that the GSAs have taken sufficient actions (e.g., amended or revised the Plan) to correct the deficiencies previously identified by the Department that precluded earlier approval.

3 REQUIRED CONDITIONS

For a Plan that the Department determines to be incomplete, the Department identifies corrective actions to address those deficiencies that preclude approval of the Plan as initially submitted. The GSAs in a basin, whether developing a single GSP covering the basin or multiple GSPs, must attempt to address those corrective actions within the time provided, not to exceed 180 days, for the Plan to be evaluated by the Department.

3.1 INCOMPLETE RESUBMITTAL

GSP Regulations specify that the Department shall evaluate a resubmitted GSP in which the GSAs have taken corrective actions within 180 days from the date the Department issued an incomplete determination to address deficiencies.[18]

The Department issued the incomplete determination on September 22, 2022. The GSAs resubmitted their individual GSPs and the Coordination Agreement on March 21, 2023 in compliance with the 180 day deadline. However, the Madera Irrigation District GSA (MID GSA) did not adopt a resolution approving and/or adopting the Revised Joint GSP, which was prepared jointly by MID GSA, the City of Madera GSA, Madera County GSA, and Madera Water District GSA. However, MID GSA did approve the related Coordination Agreement.

MID GSA's failure to adopt the Revised Joint GSP concerned Department staff. Accordingly, on April 6, 2023, the Sustainable Groundwater Management Office sent a letter seeking clarification from MID GSA regarding its failure to adopt the Revised Joint GSP. The MID GSA responded by letter dated April 21, 2023, confirming that "the MID GSA has not and does not intend to adopt the Revised Joint GSP," stating that "MID GSA has determined the Revised Joint GSP is inadequate," and explaining that "the MID GSA cannot adopt the Revised Joint GSP without substantial revision." At the same time, the letter indicated that "[t]he lack of action on the Revised Joint GSP was not due to any intention on the part of MID GSA to avoid its implementation of the Revised Joint GSP," and vowed that "MID GSA will continue to fully implement its own obligations under the Revised Joint GSP."

[17] 23 CCR § 355.4(b).
[18] 23 CCR § 355.4(a)(4).

MID GSA's refusal to adopt the Revised Joint GSP, but its apparent intent to implement its obligations under the Revised Joint GSP, creates a level of inconsistency and uncertainty regarding Plan implementation that continues to concern staff. SGMA provides that a GSA may exercise any of the powers granted by SGMA if the GSA adopts and submits a Plan to the Department. Because of MID GSA's failure to adopt the Revised Joint GSP, it is unclear whether MID GSA has the necessary powers and authorities to implement its obligations under the Revised Joint GSP. In its previous letter, MID GSA claimed it would implement the Plan, but did not provide specific references to existing, non-SGMA authorities granting it the powers to implement the Revised Joint GSP or otherwise explaining how it retained SGMA authorities to do so, or identifying other agreements or entities that had the power and would implement those aspects of the Revised Joint GSP. Without an understanding of these issues, Department staff remain concerned that overall SGMA implementation in the Subbasin may be infeasible or delayed as a result of MID GSA's failure to adopt the Revised Joint GSP. However, Department staff do not believe this issue precludes an approval recommendation at this time, because various components of the overall Subbasin Plan have been and continue to be implemented and staff is not aware of any existing impediment or delay in implementation caused by these circumstances.

Nevertheless, MID GSA is the only GSA of which Department staff are aware that has refused to adopt a GSP that it intends to implement. This novel circumstance continues to be a concern to Department staff. To alleviate those concerns, Department staff provide a recommended corrective action requiring identification and listing of the specific projects and management actions that MID GSA will or may be responsible for implementing under the Revised Joint GSP and a parallel listing and detailed identification and discussion of the legal, contractual, or other authorities or arrangements that MID GSA is relying or will rely upon in adequately implementing the Plan including those projects or management actions to clearly demonstrate the feasibility of all projects and management actions (see Recommended Corrective Action 1) Department staff will closely monitor Plan implementation and may change its recommendation if MID GSA does not provide a satisfactory response addressing these issues in the next periodic evaluation or if it appears that MID GSA's failure to adopt the Revised Joint GSP is preventing or delaying Plan implementation or otherwise impacting the likelihood of the Subbasin to achieve sustainability consistent with SGMA timelines.

4 DEFICIENCY EVALUATION

As stated in Section 355.4 of the GSP Regulations, a basin "shall be sustainably managed within 20 years of the applicable statutory deadline consistent with the objectives of the Act." The Department's assessment is based on a number of related factors including whether the elements of a GSP were developed in the manner required by the GSP Regulations, whether the GSP was developed using appropriate data and methodologies and whether its conclusions are scientifically reasonable, and whether the GSP, through the implementation of clearly defined and technically feasible projects and management actions, is likely to achieve a tenable sustainability goal for the basin.

In its initial incomplete determination, the Department identified deficiencies in the Plan which precluded the Plan's approval in September 2022.[19] In September 2022 the GSAs were given 180 days to take corrective actions to remedy the identified deficiencies. Consistent with the GSP Regulations, Department staff have evaluated the revised 2022 Plan to determine if the GSAs have taken sufficient actions to correct the deficiencies.

4.1 DEFICIENCY 1. THE GSPS HAVE NOT SUFFICIENTLY COORDINATED ON DATA AND METHODOLOGIES INCLUDING COORDINATION OF SUSTAINABILITY GOAL, WATER BUDGET AND SUSTAINABLE YIELD, AND UNDESIRABLE RESULTS AS REQUIRED BY SGMA AND THE GSP REGULATIONS.

4.1.1 Corrective Action 1

As described in the Department's GSP Assessment Staff Report released on September 22, 2022, Department staff determined that the Subbasin's definition of an undesirable result for the chronic lowering of groundwater levels was not consistent with the requirements of SGMA. The Department provided the following corrective actions for the Subbasin to consider and address:

> *The Plan does not provide sufficient explanation to confirm that the GSPs have been developed using the same data and methodologies and that elements of the GSPs have been based upon consistent interpretations of the Subbasin's setting. The GSAs in the Subbasin should modify each of their respective GSPs, as well as any applicable coordination materials, to substantially comply with the GSP Regulations and define sustainable yield and undesirable results, and develop water budgets in a manner that addresses groundwater conditions occurring throughout the Subbasin, not for only the portion of the Subbasin represented by the respective GSPs.*

[19] *Incomplete Determination of the 2020 Groundwater Sustainability Plan for the San Joaquin Valley – Madera Subbasin*, Department of Water Resources, September 22, 2022. https://sgma.water.ca.gov/portal/service/gspdocument/download/9363

4.1.2 Evaluation

To address the identified deficiencies, the GSAs have supplemented portions of each Plan to use consistent data and methodologies. Specifically, the descriptions supporting the sustainability goal, water budgets, and undesirable results have been further detailed or revised. Most of the supplemented material is provided in the Joint GSP and Coordination Agreement and referenced by the other GSPs.

The Department's Incomplete Determination notified the GSAs that the Plan did not present a coordinated sustainability goal in the Coordination Agreement applicable to the entire Subbasin. Instead, each GSP described related, but varied sustainability goals. In response, the GSAs amended the Coordination Agreement to include a sustainability goal that all parties agree to as presented below:

> *The sustainability goal for the Madera Subbasin is to implement a package of projects and management actions that will, by 2040, balance long-term groundwater system inflows and outflows based on a 50-year period representative of average historical hydrologic conditions.*[20]

The Gravelly Ford GSP,[21] New Stone GSP,[22] and Root Creek GSP[23] still contain the varied language describing the sustainability goal that was present in the initial Plan submission; however, the language does not conflict with the overarching sustainability goal definition found in the Coordination Agreement. A detailed assessment of the sustainability goal is provided in Section 5.3.1.

The Department's Incomplete Determination also notified the GSAs that the water budgets presented in each GSP were unclear, used different data, and were difficult to assess. Additionally, the water budget along with an estimate of sustainable yield was not included in the Coordination Agreement as required. In response, the GSAs have amended the GSPs and the Coordination Agreement to include agreed upon water budgets and estimates of sustainable yield. Specifically, the GSPs now all reference historical, current, and projected water budgets[24] developed in February 2018 for the entire Madera Subbasin and developed for the seven subregions representing each GSA. This water budget information was part of the initial Joint GSP submission in 2020 but was not clearly recognized in the other GSPs at the time. A detailed assessment of the water budget is provided in Section 5.2.3.

The GSPs acknowledge that there are still refinements needed to remove discrepancies and further improve the accuracy of the water budgets. The New Stone and Root Creek resubmitted GSPs note that the availability of more specific information and knowledge on the regional scale (i.e., geography, geology, water management practices, familiarity,

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[20] Madera Subbasin Coordination Agreement, p. 34.
[21] Gravelly Ford GSP (Redlined), Section 3.1, p. 53.
[22] New Stone GSP (Redlined), Section 4.1, pp. 129-130.
[23] Root Creek GSP (Redlined), Section 4.1, pp. 184-185.
[24] Joint GSP (Resubmitted), Appendix 2.F, pp. 1322-1620; Appendix 6.D, pp. 2012-3335.

and understanding)[25] have been discussed amongst the GSAs and updates to the model will occur during the 2025 evaluation cycle.[26] Department staff encourage these efforts and also recommend the GSAs continue productive coordination and refinement of each GSP to be a cohesive Plan for sustainable groundwater management in the Subbasin (see Recommended Corrective Action 2).

4.1.3 Conclusion

Overall, Department staff believe the GSAs have taken sufficient action to address the identified deficiencies. Staff conclude that the enhanced coordination and addition of a coordinated sustainability goal and water budget with agreed upon estimates of sustainable yield for the Subbasin allows the GSAs to manage the Subbasin as intended by SGMA. However, as highlighted in the recommended corrective actions, the GSP should continue efforts to increase cooperative coordination and alignment of each GSP by the next periodic evaluation. The Plan also provides an agreed upon definition of undesirable results occurring in the Subbasin, which is discussed in Section 4.2.2.1.

4.2 Deficiency 2. The Plan does not establish minimum thresholds for chronic lowering of groundwater levels in a manner substantially compliant with the GSP Regulations.

4.2.1 Corrective Action 2

As described in the Department's GSP Assessment Staff Report released on September 22, 2022, Department staff determined that the GSAs must provide more detailed explanation and justification regarding the selection of the sustainable management criteria for groundwater levels, particularly the undesirable results, the minimum thresholds, and the effects of those criteria on the interests of beneficial uses and users of groundwater. The Department provided the following corrective actions for the Subbasin to consider and address:

1. The GSAs should describe the specific undesirable results they aim to avoid through implementing the Plan. If, for example, significant and unreasonable impacts to domestic wells are a primary management concern for the Subbasin, then the GSAs should sufficiently explain why that effect was selected and what level of impact(s) to those wells the GSAs consider to be significant and unreasonable. In support of its explanation, the GSPs should also clearly discuss and disclose the anticipated impact of operating the Subbasin at conditions protective against those effects on users of domestic wells and all other beneficial uses and users of groundwater in the Subbasin. The discussion should be supported using best available information, such as using State or county information on well completion reports and dry well reports, to analyze the

[25] New Stone GSP (Redlined), Section 3.3, p. 106; Root Creek GSP (Redlined), Section 3.3.3, p. 180.
[26] New Stone GSP (Redlined), Section 3.3.1, p. 107.

locations and quantities of domestic wells and other types of well infrastructure that could be impacted by groundwater management when implementing the Plan.

2. The GSAs should either explain how the existing minimum threshold groundwater levels are consistent with avoiding undesirable results or they should establish minimum thresholds at the representative monitoring wells that account for the specific undesirable results the GSAs aim to avoid. The Plan should include a detailed description of the factors and information considered and the analytic route and rationale the GSAs employed to reach conclusions regarding significant and unreasonable effects constituting undesirable results for groundwater levels and other applicable sustainability indicators.
3. The GSAs need to provide a description of the relationship between established minimum thresholds for all applicable sustainability indicators including how conditions at minimum thresholds avoid undesirable results for each applicable indicator.

4.2.2 Evaluation

To address the identified deficiencies, the GSAs have supplemented portions of the Plan related to the sustainable management criteria for chronic lowering of groundwater levels. Specifically, descriptions supporting the undesirable result, minimum thresholds, measurable objectives, interim milestones, and a domestic well mitigation program have been further detailed or revised. Most of the supplemented material is provided in the Joint GSP and referenced by the other GSPs.

4.2.2.1 Describing Undesirable Results and Potential Effects (1)

The Department's Incomplete Determination notified the GSAs that the Plan incorrectly established undesirable results which were applicable only within each GSP area—without agreement between GSPs—and some of the information provided in each GSP was insufficiently detailed.

In response to the corrective action, the GSAs coordinated to develop agreed-upon undesirable results applicable to the entire Subbasin. The GSPs reference information in the Joint GSP as a basis for developing undesirable results, particularly coordinating on defining when an undesirable result will occur (i.e., the quantitative description of minimum threshold exceedances that cause significant and unreasonable effects). In describing undesirable results, each GSP provides a different level of detail. For example, the Joint GSP describes an undesirable result as "those conditions that: 1) Cause significant financial burden to local agricultural interests or other beneficial uses and users who rely on the Subbasin's groundwater resources, 2) Cause groundwater level conditions at private domestic wells that cannot be mitigated, and 3) Interfere with other sustainability indicators." [27] The Gravelly Ford GSP refers to this information but also, alongside the New Stone GSP and the Root Creek GSP, provides additional description

[27] Joint GSP (Redlined), Section 3.4.1, p. 323.

such as: "Chronic lowering of groundwater levels in the Plan area cause significant and unreasonable declines if they are sufficient in magnitude to lower the rate of production of pre-existing groundwater wells below that necessary to meet the minimum required to support overlying beneficial use where alternative means of obtaining sufficient groundwater resources are not technically or financially feasible."[28] The varied descriptions presented in each GSP do not conflict and appear to be generally coordinated. All GSPs refer to a domestic well mitigation framework which provides more specific information describing effects on beneficial uses and users.[29]

The Plan states that an undesirable result would occur when "… more than 30 percent of RMS in the Subbasin (including RMS in all four GSP plan areas) [are] exceeding their [minimum thresholds] for the same two consecutive Fall readings."[30] The Plan further describes that "…implementation of the GSP is designed to avoid undesirable results during the sustainability period (i.e., the "planning and implementation horizon," per CWC §10721(v)), after 2040."[31]

As mentioned, the Plan describes details for a domestic well mitigation program,[32] which the GSAs will implement to provide assistance to domestic and municipal wells adversely impacted by declining groundwater levels that have occurred since 2015.[33] The Plan includes supporting information for the mitigation program which document the expected location and quantity of domestic wells that will experience undesirable results during the GSP implementation period. Staff believe the details provided for this framework effectively describe the specific undesirable results the GSAs are trying to avoid. Based on an analysis of 4,822 wells, the GSP documents that up to 1,294 wells,[34] located primarily in the central and eastern portion of the Subbasin,[35] would be impacted due to future modeled groundwater conditions. The total cost to assist impacted wells is estimated to be approximately $39,000,000; however, the Plan describes that the cost of mitigating domestic wells due to lowering groundwater levels is shown to be economically preferable to the costs associated with immediately stabilizing groundwater levels and the resulting impact to the local economy.[36] The GSAs have provided a commitment to this program including a schedule, timeline, and have reported progress in recent Annual Reports. The GSAs expect that the program would be implemented during the GSP

[28] Gravelly Ford GSP (Redlined), Section 3.4.1, p. 60; New Stone GSP (Redlined), Section 4.2.1.1, p. 131; Root Creek GSP (Redlined), Section 4.2.1, p. 186.
[29] Joint GSP (Redlined), Section 3.3.1.1, pp. 294-295; Gravelly Ford GSP (Redlined), Section 3.4.1, p. 60; New Stone GSP (Redlined), Section 4.2.1.2, pp. 132-133; Root Creek GSP (Redlined), Section 4.2.1.1, pp. 187-188.
[30] Joint GSP (Redlined), Section 3.4.1, p. 323.
[31] Joint GSP (Redlined), Section 3.4.1, p. 323.
[32] Joint GSP (Resubmitted), Appendix 3.E, pp. 1904-1918, Appendix 2.G, pp. 1733-1813.
[33] Joint GSP (Redlined), Section 3.3.1.1, p. 294.
[34] Joint GSP (Resubmitted), Appendix 2.G, p. 1762.
[35] Joint GSP (Resubmitted), Appendix 2.G, pp. 1783-1787.
[36] Joint GSP (Resubmitted), Appendix 3.D, p. 1902.

implementation period, no later than 2025; as of March 2023, the GSP states, the GSAs are continuing to develop the program's eligibility criteria and terms.[37]

In addition to the domestic well mitigation program, the Plan includes a suite of over 25 projects and management actions (e.g., demand management, increased recharge, increased surface water supply) which will be utilized to meet interim milestones and bring groundwater levels back up to minimum thresholds, mitigate overdraft, and operate the Subbasin sustainably. At full implementation, by 2040, the projects and actions will provide 215,840 acre-feet per year of annual gross benefit. The estimated capital cost of the projects is over $260,000,000, with an estimated annual operating cost of over $70,000,000; Department staff note that the GSAs have included an estimated economic cost from reduced crop production resulting from demand management in the estimated annual operating cost, which is approximately $54,000,000 per year or over 75% of the total annual cost provided.[38] The implementation schedule and expected benefit of each project was also considered in the modeling scenario used to develop interim milestones.[39] A review of the Annual Reports submitted to the Department shows progress on many of the projects.[40] For example, the GSAs report a cumulative total benefit of over 63,000 acre--feet from projects and management actions to date, with a benefit of 7,300 acre-feet for the latest reported water year.[41] With reporting of active progress toward project implementation, Department staff have increased confidence in the likelihood of the Plan to achieve the sustainability goal of the Subbasin.

Based on the information provided, Department staff think the Plan provides a reasonable description of the potential effects of undesirable results due to lowering of groundwater levels to domestic wells, generally the shallowest wells, and encourage the GSAs to continue development of the domestic well mitigation program and provide progress updates in Annual Reports. The GSAs should continue to progress projects and provide updates of observed benefits to the Department in Annual Reports. Department staff conclude that defining agreed upon undesirable results for the Subbasin and describing the potential effects of planned undesirable results that are likely to occur has sufficiently addressed component 1 of the corrective action.

4.2.2.2 Establishing Minimum Thresholds, Measurable Objectives, and Interim Milestones (2)

The Department's Incomplete Determination notified the GSAs that each Plan's varied descriptions and methods to establish minimum thresholds for chronic lowering of groundwater levels were not provided with sufficient supporting information to allow Department staff to evaluate whether the criteria were reasonable or whether operating

[37] Joint GSP (Redlined), Section 3.3.1.1, p. 295.
[38] Joint GSP (Redlined), Table 4-3, p. 366; Section 4.4.4.5, p. 409.
[39] Joint GSP (Redlined), Section 3.2.1.2, p. 270; Joint GSP, Appendix 6.D, pp. 2323-2326.
[40] Madera Subbasin Annual Reports, https://sgma.water.ca.gov/portal/gspar/submitted.
[41] Joint GSP Water Year 2022 Annual Report, pp. 57-58.

the Subbasin to avoid those thresholds is consistent with avoiding undesirable results—in part due to undesirable results being insufficiently defined in the Plan.

In response to the corrective action, the GSAs revised the chronic lowering of groundwater levels minimum thresholds to be set at the fall 2015 groundwater level measurement recorded at each representative monitoring site.[42] The Plan explains that the groundwater level minimum thresholds based on fall 2015 groundwater levels are consistent with the avoidance of significant and unreasonable impacts to other sustainability indicators.[43] The Plan states that the minimum thresholds will keep groundwater elevations generally above levels that have been experienced in the past, and that impacts to shallow well users and other beneficial users of groundwater will generally not exceed what has historically been experienced in the Subbasin.[44] Furthermore, the Plan explains that minimum thresholds established at fall 2015 groundwater levels are consistent with the avoidance of significant and unreasonable impacts for subsidence, water quality, and depletions of interconnected surface water.[45] The measurable objectives were revised to the fall 2010 groundwater levels which represents Subbasin conditions prior to the 2012 to 2015 drought period.[46]

Department staff believe that establishing minimum thresholds at the fall 2015 groundwater level is a reasonable approach. However, the GSAs intend to allow continued groundwater level declines during the 20-year implementation period based on the GSP's proposed interim milestones. The process to establish interim milestones is described as a "review and evaluation of measured groundwater level data and future projected fluctuations in groundwater levels during the GSP implementation period utilizing the numerical groundwater flow model, which simulated implementation of projects and management actions."[47] As a result, interim milestones were set to levels below minimum thresholds in years 2025, 2030, and 2035, prior to recovering by 2040 due to the implementation of projects and management actions.[48] Interim milestones for 2030 are the lowest groundwater elevations expected to occur during the GSP implementation period. When examining the hydrographs provided, Department staff note the 2030 milestones are frequently below historical lows.[49]

To successfully implement such a management program, GSAs are required to fully and thoroughly describe undesirable results that may occur prior to achieving sustainability, implement necessary projects and management actions to eliminate those undesirable results, and show measurable progress in annual reporting. The GSP provides information detailing how the proposed management of lowering groundwater levels

[42] Joint GSP (Redlined), Section 3.3.1, p. 293.
[43] Joint GSP (Redlined), Section 3.3.1.4, pp. 301-303.
[44] Joint GSP (Redlined), Section 3.3.1, pp. 293-294.
[45] Joint GSP (Redlined), Section 3.3.1.4, pp. 302-303.
[46] Joint GSP (Redlined), Section 3.2.1.1, pp. 269-270.
[47] Joint GSP (Redlined), Section 3.2.1.2, p. 270.
[48] Joint GSP (Redlined), Section 3.2.1.3, p. 271.
[49] Joint GSP (Resubmitted), Appendix 2.E.b, pp. 1243-1380; Gravelly Ford GSP (Redlined), Appendix G, pp. 218-224.

below minimum thresholds for an extended period will affect the interests of beneficial uses and users of groundwater in the Subbasin. As discussed above, during the period when interim milestones exceed minimum thresholds, the GSAs plan to implement a domestic well mitigation program to assist impacted users that effectively manages the effects of the undesirable results that are expected to occur; also, the Plan includes a suite of over 25 projects and management actions which the GSAs have reported progress on implementing in recent Annual Reports.

Based on a review of the information found in the resubmitted Plan and Annual Reports, Department staff conclude that at this time the GSAs have sufficiently addressed component 2 of the corrective action.

4.2.2.3 Describing How Minimum Thresholds Avoid Undesirable Results For Other Sustainability Indicators (3)

The Department's Incomplete Determination notified the GSAs that the GSPs require a description of how conditions at minimum thresholds avoid undesirable results for each applicable indicator.

In response to the corrective action, the GSAs revised the GSPs to include a discussion of the relationship between established minimum thresholds and undesirable results for other sustainability indicators. However, the GSP Regulations require the Department to evaluate whether the minimum thresholds and interim milestones are reasonable[50] and established in a manner to avoid undesirable results for each of the other sustainability indicators.[51] Department staff believe the lower interim milestones have the potential to cause undesirable results related to land subsidence, water quality, and interconnected surface water in the Subbasin. For example, the highest annual rate of subsidence was recorded between December 2012 and July 2014, when groundwater levels were declining to historical lows.[52] The GSAs should consider and disclose their understanding of the correlation between the declining groundwater levels and the maximum historical rate of subsidence while also describing the relationships between groundwater levels and the other applicable sustainability indicators. Department staff are concerned that impacts on other indicators (such as subsidence and water quality) may not recover in the same manner that groundwater levels may. Therefore, the GSAs should analyze how the groundwater levels at interim milestones will avoid causing undesirable results for other sustainability indicators (see Recommended Corrective Action 3).

Based on a review of the information found in the resubmitted Plan, Department staff conclude that the GSAs have taken sufficient action to address component 3 of the corrective action.

[50] 23 CCR § 355.4(b)(1).
[51] 23 CCR § 354.28(b)(2).
[52] New Stone GSP (Redlined), Section 3.2.6.1, p. 99.

4.2.3 Conclusion

At this time, Department staff believe the GSAs have taken sufficient action to address the deficiency identified. Department staff believe that having all the GSPs coordinated and establishing minimum thresholds at 2015 groundwater levels – in conjunction with the implementation of a well mitigation program and the projects and managements actions outlined in the Plan – to be a reasonable means of mitigating overdraft to achieve sustainability by 2040. However, Department staff note the GSAs intend to continue overdraft before 2040 based on the revised interim milestones, which after examining the hydrographs provided, are frequently below historical lows.[53] While SGMA and the GSP Regulations do not preclude undesirable results from occurring during Plan implementation, undesirable results cannot remain or continue after 20 years of Plan implementation. Department staff encourage the GSAs to continue with planning and implementation of the domestic well mitigation program to assist those users and uses of groundwater and other sustainability indicators (e.g., land subsidence, water quality, or interconnected surface water) that may be affected by lowering groundwater levels. The recommended corrective actions should also be considered by the next Periodic Evaluation for further advancement of the sustainable groundwater management in the Subbasin.

4.3 Deficiency 3. The Plan does not develop sustainable management criteria for land subsidence based on best available information and science.

4.3.1 Corrective Action 3

As described in the Department's GSP Assessment Staff Report released on September 22, 2022, Department staff determined that the GSAs do not sufficiently demonstrate that undesirable results related to land subsidence are not present and are not likely to occur in the Subbasin. The Department provided the following corrective actions for the Subbasin to consider and address the following:

1. Clarify and address the currently conflicting information in the Plan regarding what is known, qualified by the level of associated uncertainty, about the existence and impact of land subsidence.

2. The GSP should develop sustainable management criteria based on information in the basin setting and establish a monitoring network to adequately monitor conditions.[54] The basin setting should sufficiently detail the physical setting and characteristics of the Subbasin including descriptions of principal aquifers. the definable bottom of the Subbasin and identify data gaps and uncertainty within the

[53] Joint GSP (Resubmitted), Appendix 2.E.b, pp. 1243-1380; Gravelly Ford GSP (Redlined), Appendix G, pp. 218-224, New Stone GSP (Redlined), Figures 4-2 through 4-7, pp. 145-150; Root Creek GSP (Redlined), Figures 4-2 through 4-7, pp. 196-201.

[54] 23 CCR § 354.26.

hydrogeologic conceptual model. If applicable, data gaps monitoring and steps to fill data gaps before the next periodic assessment should be described.

4.3.2 Evaluation

To address the identified deficiency, the GSAs have supplemented portions of each Plan to develop sustainable management criteria and monitoring for land subsidence. Most of the supplemented material is provided in the Joint GSP and referenced by the other GSPs.

4.3.2.1 Clarifying Conflicting Information in the Plan (1)

The Department's Incomplete Determination notified the GSAs that the GSPs provided conflicting information related to whether significant and unreasonable land subsidence has occurred or will occur in the Subbasin.

In response to the corrective action, the GSPs acknowledge that significant and unreasonable land subsidence has historically occurred during periods with groundwater pumping in excess of the sustainable yield in areas where critical infrastructure exists and in the western areas that overlay the Lower Aquifer, where the Corcoran Clay exists.[55] Additionally, loss of groundwater storage and associated reduction in pore pressures in clay layers in the Lower Aquifer (indicated by lowering groundwater levels) is understood by all parties to lead to conditions that cause or exacerbate land subsidence.[56] Between 1926 and 1972, subsidence resulted in up to 4.0 feet of elevation change within the western portion of the Subbasin.[57] The highest rate of subsidence, also in western portion of the Subbasin, was 0.60 feet per year from December 2012 through July 2014.[58] The Plan also provides various maps documenting the location and extent of subsidence in the Subbasin.[59]

The Plan provides information about infrastructure that is susceptible to subsidence. Specifically, the Joint GSP provides an infrastructure sensitivity assessment of critical infrastructure including roads, railroads, highways, waterways, surface water conveyance structures, agricultural wells, domestic wells, public supply wells, and wastewater infrastructure. The assessment discusses impacts or interference with surface land uses and includes details such as proximity, orientation, and relative vulnerability to adverse effects of land subsidence.[60] Generally, the assessment states that the critical infrastructure were not anticipated to be impacted by future subsidence rates. For example, the GSP identifies the Chowchilla Bypass and the Eastside Bypass as critical infrastructure overlaying the Corcoran Clay, near an area of past documented subsidence; based on annual average subsidence rates from 2011 to 2017, the design profile and freeboard of the bypass will not be impacted by residual subsidence through

[55] Joint GSP (Redlined), Section 3.4.3, p. 325.
[56] Joint GSP (Redlined), Section 3.3.3.7, p. 313.
[57] Gravelly Ford GSP (Redlined), Section 2.2.2, p. 41.
[58] New Stone GSP (Redlined), Section 3.2.6.1, p. 99.
[59] New Stone GSP (Redlined), Figures 3-23 and 3-24, pp. 101-102.
[60] Joint GSP (Resubmitted), Appendix 3.G, pp. 1921-1953.

2026.[61] Additionally, for impacted wells, such as domestic wells, well owners are to be assisted by the domestic well mitigation program.[62] The GSP also states the GSAs are analyzing the potential to couple implementation efforts with the Subsidence Control Measures Agreement that is currently in effect in parts of the Chowchilla Subbasin near the Subbasin boundary.[63]

Based on a review of the information found in the resubmitted Plan, Department staff conclude that the GSAs have addressed component 1 of the corrective action.

4.3.2.2 Developing Sustainable Management Criteria and Monitoring Network (2)

The Department's Incomplete Determination notified the GSAs that the GSPs do not sufficiently demonstrate that undesirable results related to land subsidence are not present and are not likely to occur in the Subbasin.

In response to the corrective action, the GSPs establish revised, coordinated sustainable management criteria for the Subbasin to not allow subsidence once sustainability is achieved in 2040. With that the GSPs amended the minimum thresholds to 0 feet per year (ft/yr).[64] The Plan also identifies a total uncertainty of subsidence to be -0.16 ft/yr, meaning any amount of subsidence less than -0.16 ft/yr would be considered within the uncertainty of measurement and considered 0 ft/yr.[65] The Plan states that this minimum threshold is consistent with the sustainable management criteria for groundwater levels which seeks to keep levels above 2015 conditions by 2040.[66] The GSAs also revised the measurable objective rate to 0 ft/yr.[67] The Plan allows for minimum threshold exceedances throughout the duration of the implementation phase with the proposed interim milestones, which were revised based on two areas: areas of subsidence monitoring and areas of greater subsidence concern.[68] For areas of monitoring, interim milestones are established at -0.20 ft/yr by 2025, -0.13 ft/yr by 2030, -0.07 ft/yr by 2035, and 0 ft/yr by 2040 which are monitored by three survey benchmarks and one continuous GPS station. For areas of concern, interim milestones are established at -0.60 ft/yr by 2025, -0.40 ft/yr by 2030, -0.20 ft/yr by 2035, and 0 ft/yr by 2040 and monitored at three survey benchmarks. The established interim milestones are based on observed data with the highest rates (i.e., milestones to 2025) being slightly higher than actual subsidence rates experienced in the Subbasin between 2011 and 2016.[69] The Plan defines an undesirable result as occurring when "… the average subsidence across 75 percent or

[61] Joint GSP (Resubmitted), Appendix 3.G, p. 1932.
[62] Joint GSP (Resubmitted), Appendix 3.G, p. 1935.
[63] Joint GSP (Resubmitted), Appendix 3.G, p. 1933; Joint GSP (Redlined) Section 3.3.3.7, p. 312.
[64] Joint GSP (Redlined), Section 3.3.3, pp. 310-314.
[65] Joint GSP (Redlined), Section 3.3.3.1, p. 311.
[66] Joint GSP (Redlined), Section 3.3.1.4, p. 301.
[67] Joint GSP (Redlined), Section 3.2.3.1, p. 279.
[68] Joint GSP (Redlined), Section 3.2.3.2, pp. 279-280.
[69] Joint GSP (Redlined), Section 3.2.3.2, p. 280.

more RMS in the Subbasin (including RMS in all four GSP plan areas) exceeds the minimum threshold for two consecutive years."[70]

Department staff have identified areas for improvement in the GSAs' defined undesirable results. Specifically, the quantification of conditions that likely would cause undesirable results as when more than 75 percent of the representative monitoring sites in the Subbasin exceed threshold levels for two consecutive years is unsatisfactory, because the Plan does not explain how this threshold would avoid effects the GSAs have determined to be significant and unreasonable. On the contrary, the values and timing of exceedances appear to be arbitrary. Subsidence is prominent and likely to occur in western portions of the Subbasin in correlation with the presence of the Corcoran Clay. Two of the seven representative monitoring sites are located in that area of the Subbasin; using the current definition, localized subsidence could occur indefinitely without meeting the quantitative criteria for an undesirable result. Furthermore, when considering land subsidence, compacted sediments may not rebound alongside rising groundwater levels due to irreversible changes in the subsurface. Additionally, the Plan establishes two subsidence areas, as mentioned above, which the GSAs do not consider when establishing the quantitative metrics for an undesirable result (i.e., Department staff would expect more stringent metrics in the areas of greater subsidence concern as compared to the subsidence monitoring areas). These criteria should be considered when defining when and where undesirable results occur (see Recommended Corrective Action 4a)

While Department staff are encouraged by the updated sustainable management criteria, the Plan still does not identify a total (i.e., cumulative) amount of subsidence which would be considered significant and unreasonable. The interim milestones established using annual rates would allow for up to 6.5 feet of total subsidence by 2040. This appears inconsistent with the legislative intent of SGMA to avoid or minimize subsidence, and no adequate justification for allowing this amount of additional subsidence is provided in the GSP.[71] Considering the Subbasin has recently experienced subsidence and contains infrastructure that the GSP identifies as susceptible to subsidence, the GSAs should identify and disclose the cumulative amount of subsidence that can occur without causing significant and unreasonable impacts to the beneficial uses and users of groundwater, surface land uses, and property interests, all of which must be clearly defined. In establishing the cumulative amount of potential subsidence that could occur during GSP implementation, the GSAs should consider the conditions necessary to minimize or halt subsidence during GSP implementation and maintain those conditions once sustainability has been achieved on or before 2040. Based on the amount of subsidence anticipated between now and 2025, Department staff believe this does not preclude approval at this time. However, given that the Plan projects minimum threshold exceedances during implementation, which may likely result in undesirable results related to water levels, and the Plan intends for subsidence to be 0 ft/yr only by and after 2040, Department staff

[70] Joint GSP (Redlined), Section 3.4.3, p. 325.
[71] Water Code § 10720.1 (e).

recommend identifying and including a quantitative value for cumulative subsidence for minimum thresholds and other sustainability criteria related to subsidence by the first Periodic Evaluation (see Recommended Corrective Action 4b).

SGMA and the GSP Regulations indicate that for a basin to be sustainably managed, the basin must experience no undesirable results within 20 years of plan implementation and then throughout the planning and implementation horizon. Unlike other indicators, the legislature specifically indicated its intent that SGMA implementation avoid or minimize subsidence.[72] Unlike groundwater levels that may fall and then rise in a basin, subsidence can often be inelastic and permanent. This means that undesirable results from subsidence during plan implementation will likely still exist and persist to 2040 and beyond. For instance, subsidence that occurs during early Plan implementation that causes lasting impacts to infrastructure, like flood control structures, that substantially interferes with the infrastructure's operations and utility in 2040 and beyond, constitutes an undesirable result under SGMA. Department staff believe that the Plan's continued allowance of minimum threshold exceedances during the first 20 years of plan implementation (i.e., allowing further subsidence as a result of water level declines below historic lows at the interim milestones) and potential permanent impacts to surface infrastructure and uses is not consistent with the intent of SGMA to achieve sustainability and to avoid or minimize subsidence. The Plan should consider and provide details describing the current and potentially lasting impacts of subsidence on land uses and groundwater beneficial uses and users as described above in Recommended Corrective Action 4b.

The GSP Regulations require the Department to evaluate whether the minimum thresholds and interim milestones are reasonable[73] and established in a manner to avoid undesirable results for each of the other sustainability indicators.[74] Department staff believe the interim milestones below the minimum threshold have the potential to cause undesirable results related to other sustainability indicators which the GSAs also have a responsibility to avoid. For example, the Plan does not provide a discussion of how the subsidence milestones, that allow for continued subsidence and associated irreversible compaction of aquifer materials, relate to the reduction of groundwater storage or the degradation of water quality sustainability indicators. The GSAs should consider and disclose their understanding of this and other relationships between sustainability indicators. The GSAs should analyze whether or how the land subsidence rates at interim milestones will avoid causing undesirable results for other sustainability indicators (see Recommend Corrective Action 4c).

In the establishment of the minimum thresholds for land subsidence, the Plan describes the application of a level of uncertainty to measurements, claiming that the survey measurements have a vertical accuracy of plus or minus 2.5 centimeters. The Plan

[72] Water Code § 10720.1(e).
[73] 23 CCR § 355.4(b)(1).
[74] 23 CCR § 354.28(b)(2).

proposes adding these uncertainty values so that when two measurements are taken the Agencies consider the total uncertainty in subsidence to be 5 centimeters, which equals approximately -0.16 ft/yr. By this rationale, the Plan assumes that subsidence values less than 0.16 ft/yr are within the uncertainty of measurement and considered to be compliant with the minimum threshold of 0 ft/yr.[75] However, although there may be some uncertainty in subsidence measurements, the uncertainty does not necessarily mean that small measurements of subsidence within that range of uncertainty (or accuracy) should be ignored or mean that no subsidence is occurring. Department staff believe this approach of always rounding any annual subsidence measurements within the range of error to zero every year is inconsistent with standard practices. When multiple measurements are taken at the same location, they are compared to the same baseline measurement and, in turn, have the same single level of uncertainty. While it's understandable to build in an allowance for some level of uncertainty, it appears the Plan allows for the continued subsidence if the measured rate is equal to or less than 0.16 ft/yr. Department staff recommend the Plan revise its application of the level of uncertainty as it relates to subsidence measurements according to standard professional practices (see Recommended Corrective Action 4d).

The Plan acknowledges there are data gaps in assessing subsidence in the Subbasin and provides a workplan[76] which aims to provide sufficient data and analysis to fill data gaps, including enhancing monitoring and understanding relationships between land subsidence and groundwater levels at different depths within the western part of the Subbasin, improving quantification of groundwater pumping within Upper Aquifer and Lower Aquifer, and assessing the adequacy of the sustainable management criteria. Considering the Department provides quarterly updates for monthly InSAR subsidence data covering much of the Subbasin, the GSP should address or explain why the GSAs have decided to not utilize this reliable data source to assess whether management is causing significant and unreasonable effects to surface land uses. Department staff encourage these efforts and also recommend the GSAs take steps to address the recommended corrective actions by the next Periodic Evaluation of the Plan.

Based on a review of the information found in the resubmitted Plan, Department staff conclude that the GSAs have addressed component 2 of the corrective action.

4.3.3 Conclusion

Overall, Department staff believe the GSAs have taken sufficient action to address the deficiency identified. Staff conclude that the zero tolerance for land subsidence minimum thresholds and measurable objectives at the end of the implementation period in 2040 is commensurate with the understanding of SGMA. However, Department staff are concerned with the amount of subsidence that may occur during the implementation period and the potential undesirable results that may cause as a result of permanent impacts to infrastructure and surface land uses. The recommended corrective actions

[75] Joint GSP (Redlined), Section 3.3.3.1, p. 311.
[76] Joint GSP (Resubmitted), Appendix 3.H, pp. 1954-1968.

should be considered by the next Periodic Evaluation to more align with the intent of SGMA to avoid or minimize subsidence.

4.4 Deficiency 4. The Plan does not develop sustainable management criteria for the depletions of interconnected surface water based on best available information and science.

4.4.1 Corrective Action 4

As described in the Department's GSP Assessment Staff Report released on September 22, 2022, Department staff determined that the GSAs do not sufficiently demonstrate that interconnected surface water or undesirable results related to depletions of interconnected surface water are not present and are not likely to occur in the Subbasin. The Department provided the following corrective actions for the Subbasin to consider and address the following:

1. Clarify and address the currently conflicting information in the Plan regarding what is known, qualified by the level of associated uncertainty, about the presence and degree of interconnected surface water and, if applicable, the depletion of that interconnected surface water by groundwater use, including quantities, timing, and locations.[77]

2. If the GSAs cannot provide a sufficient, evidence-based justification for the absence of interconnected surface water, then they should develop sustainable management criteria, as required in the GSP Regulations[78] based on best available information and science. Evaluate and disclose, sufficiently and thoroughly, the potential effects of the Plan's sustainable management criteria for depletion of interconnected surface water on beneficial uses of the interconnected surface water and on groundwater uses and users. Additionally, development of sustainable management criteria must be supported by information in the basin setting and the GSAs must develop a monitoring network capable of collecting sufficient data to support analysis of the quantified spatial and temporal exchanges between surface water and groundwater that can be associated with groundwater pumping.

4.4.2 Evaluation

To address the identified deficiency, the GSAs have supplemented portions of the Plan to describe the basin setting, develop sustainable management criteria and monitoring for depletions of interconnected surface water.

4.4.2.1 Clarifying Conflicting Information in the Plan (1)

The Department's Incomplete Determination notified the GSAs that the GSPs provided conflicting information related to identifying the presence of interconnected surface water in the Subbasin.

[77] 23 CCR §§ 354.28(c)(6)(A-B).
[78] 23 CCR §§ 354.26, 354.28, 354.30.

In response to the corrective action, the GSPs revised the descriptions of groundwater—surface water interactions in the Subbasin, acknowledging that data indicates that the San Joaquin River appears to be in connection with groundwater during some periods and there is at least some potential for regional groundwater pumping to impact groundwater dependent ecosystems (GDEs) with roots extending down 20 to 30 feet along the San Joaquin River.[79]

The method the GSP used to determine the connectivity was to compare the historical regional aquifer groundwater elevations to stream thalweg (deepest portion of stream channel) elevations and assess stream seepage. The comparison of the groundwater levels and stream thalweg suggest the San Joaquin River was likely connected with groundwater from 1958 through 1984, but groundwater was about 10 to 50 feet below the thalweg from 1989 through 2016.[80] While this approach is sufficient to confirm the presence of a hydraulic connection, Department staff note groundwater levels dropping below the thalweg of the San Joaquin River would not be sufficient to prove surface water and groundwater are disconnected. This is because water from the river is still recharging the aquifer and may do so at a rate that would cause mounding in the local water table surrounding the river. The mounding in the water table may enable the river and aquifer to maintain a saturated hydraulic connection when groundwater levels drop well below the bottom of the river. Additionally, stream seepage indicates that during above normal and wet years, such as 2017 and 2019, groundwater is discharged to streams.[81] The GSP states that there are data gaps, and provides a workplan[82] which aims to provide sufficient data and analysis to fill data gaps, including making a more informed determination of whether or not interconnected surface water is present along the San Joaquin River, improving understanding of the relationship between streamflow and regional groundwater pumping, and providing an improved basis for setting sustainable management criteria if it is determined that interconnected surface water conditions exist.[83] At this time, Department staff conclude sufficient action has been taken on this deficiency and believe the GSAs can work with the Department to further efforts on interconnected surface water.

Based on a review of the information found in the resubmitted Plan, Department staff conclude that the GSAs have addressed component 1 of the corrective action.

4.4.2.2 Sustainable Management Criteria and Monitoring Network (2)

The Department's Incomplete Determination notified the GSAs that the GSPs do not sufficiently demonstrate that undesirable results related to depletions of interconnected surface water are not present and are not likely to occur in the Subbasin. Therefore, if the GSAs cannot provide a sufficient, evidence-based justification for the absence of

[79] Joint GSP (Redlined), Section 2.2.2.5, p. 120.
[80] Joint GSP (Redlined), Section 2.2.2.4, p. 118.
[81] Joint GSP (Resubmitted), Figure 2-76, p. 310.
[82] Joint GSP (Resubmitted), Appendix 3.I, pp. 1969-1981
[83] Joint GSP (Resubmitted), Appendix 3.I, p. 1971.

interconnected surface water, then they should develop sustainable management criteria, as required in the GSP Regulations.

In response to the corrective action, the GSPs established interim sustainable management criteria for depletions of interconnected surface water along the San Joaquin River. Specifically, the GSAs define an undesirable result occurring when greater than 30 percent of representative monitoring wells exceed their minimum thresholds for two consecutive five-year rolling averages.[84] Minimum thresholds are defined as the percent of time surface water and groundwater was connected over the historical period of 1989 to 2015. Measurable objectives and interim milestones are the same as minimum thresholds. Monitoring will be conducted annually using three monitoring sites.

The GSAs used a metric called "percent of time connected" to develop the interim sustainable management criteria for depletion of interconnected surface water.[85] In reviewing the information provided in the GSP, Department staff conclude that while developing sustainable management criteria for interconnected surface water is a substantial step forward in addressing the deficiency, the development of sustainable management criteria in the Plan is not consistent with the GSP Regulations. Reporting the percent of time connected does not provide adequate information to describe or evaluate the quantity and timing of depletions of interconnected surface water due to groundwater use, as required by the GSP Regulations.[86] As mentioned in Section 4.4.2.1, the GSAs prepared a work plan outlining an approach to fill these data gaps.[87] The work plan states the GSAs intend to compile and review pertinent existing data and reports, construct and install new monitoring facilities, collect additional field data, and conduct additional technical analysis. The purpose is to make a more informed determination of whether interconnected surface water is present along the San Joaquin River, to improve understanding of the relationships between streamflow, shallow groundwater levels, and regional groundwater pumping.[88] While the work plan states that the GSAs will potentially refine or modify the interim sustainable management criteria, it also indicates that the GSAs will continue using the metric of "percent of time connected" for sustainable management criteria[89] – a metric Department staff conclude is not appropriate in estimating timing and volume of interconnected surface water depletion and evaluating potential impacts to beneficial uses and users. The GSAs proposed to complete most of the tasks in the work plan by 2024 with the intent of including the early results in the first Periodic Evaluation.[90] Department staff are encouraged by the GSA's intent to increase data collection and fieldwork. At this time, Department staff conclude sufficient action has

[84] Joint GSP (Redlined), Section 3.4.5, p. 327.
[85] Joint GSP (Redlined), Section 3.2.5.1, p. 291, Section 3.3.5.1, p. 319.
[86] 23 CCR §§ 354.28(c)(6)(A), 354.28(c)(6)(B).
[87] Joint GSP (Resubmitted), Appendix 3.I, pp. 1969-1981.
[88] Joint GSP (Resubmitted), Appendix 3.I, pp. 1970-1971.
[89] Joint GSP (Resubmitted), Appendix 3.I, p. 1979.
[90] Joint GSP (Resubmitted), Appendix 3.I, p. 1980.

been taken on this deficiency and believe the GSAs can work with the Department to further efforts on interconnected surface water.

Based on a review of the information found in the resubmitted Plan, Department staff conclude that the GSAs have addressed component 2 of the corrective action.

4.4.3 Conclusion

Overall, Department staff believe the GSAs have taken sufficient action to address the deficiency identified.

Department staff understand that quantifying depletions of interconnected surface water from groundwater extractions is a complex task that likely requires developing new, specialized tools, models, and methods to understand local hydrogeologic conditions, interactions, and responses. During the initial review of GSPs, Department staff have observed that most GSAs have struggled with this requirement of SGMA. However, staff believe that most GSAs will more fully comply with regulatory requirements after several years of Plan implementation that includes projects and management actions to address the data gaps and other issues necessary to understand, quantify, and manage depletions of interconnected surface waters. Department staff further advise that at this stage in SGMA implementation GSAs address deficiencies related to interconnected surface water depletion where GSAs are still working to fill data gaps related to interconnected surface water and where these data will be used to inform and establish sustainable management criteria based on timing, volume, and depletion as required by the GSP Regulations.

The Department will continue to support GSAs in this regard by providing, as appropriate, financial and technical assistance to GSAs, including the development of guidance describing appropriate methods and approaches to evaluate the rate, timing, and volume of depletions of interconnected surface water caused by groundwater extractions. Once the Department's guidance related to depletions of interconnected surface water is publicly available, GSAs, where applicable, should consider incorporating appropriate guidance approaches into their future periodic updates to the GSP. GSAs should consider availing themselves of the Department's financial or technical assistance, but in any event must continue to fill data gaps, collect additional monitoring data, and implement strategies to better understand and manage depletions of interconnected surface water caused by groundwater extractions and define segments of interconnectivity and timing within their jurisdictional area. Furthermore, GSAs should coordinate with local, state, and federal resources agencies as well as interested parties to better understand the full suite of beneficial uses and users that may be impacted by pumping induced surface water depletion.

5 PLAN EVALUATION

As stated in Section 355.4 of the GSP Regulations, a basin "shall be sustainably managed within 20 years of the applicable statutory deadline consistent with the objectives of the Act." The Department's assessment is based on a number of related factors including whether the elements of a GSP were developed in the manner required by the GSP Regulations, whether the GSP was developed using appropriate data and methodologies and whether its conclusions are scientifically reasonable, and whether the GSP, through the implementation of clearly defined and technically feasible projects and management actions, is likely to achieve a tenable sustainability goal for the basin.

The Department staff's evaluation of the likelihood of the Plan to attain the sustainability goal for the Basin is provided below. Department staff consider the information presented in the Plan to satisfy the general requirements of the GSP Regulations.

5.1 ADMINISTRATIVE INFORMATION

The GSP Regulations require each Plan to include administrative information identifying the submitting Agency, describing the plan area, and demonstrating the legal authority and ability of the submitting Agency to develop and implement a Plan for that area.[91]

The Madera Subbasin is bound by the San Joaquin River and Kings Subbasin in the south, Delta-Mendota Subbasin in the west, Chowchilla Subbasin in the north, and the foothills of Sierra Nevada in the east.[92] No adjudicated areas are shown on the maps provided in the GSP.[93] The Subbasin does not have any considerable federal lands or state-owned lands.[94]

The Subbasin is managed by seven groundwater sustainability agencies. Four of those seven groundwater sustainability agencies have developed the Madera Joint Groundwater Sustainability Plan, and the other three groundwater sustainability agencies developed individual groundwater sustainability plans.[95] The four GSPs that cover the entire Madera Subbasin are:

- Madera Joint Groundwater Sustainability Plan (Joint GSP)
- Gravelly Ford Water District Groundwater Sustainability Plan (Gravelly Ford GSP)
- New Stone Water District Groundwater Sustainability Plan (New Stone GSP)

[91] 23 CCR § 354.2 *et seq*.
[92] Joint GSP, Section 2.1, p. 63.
[93] Joint GSP, Section 2.1.1, p. 63, Figure 2-1, p. 64.
[94] Joint GSP, Section 2.1.1, p. 63. Note: Federal land includes primarily rights of way along canals conveying USBR Central Valley Project water. State land includes primarily California Department of Parks and Recreation land along San Joaquin River near Friant, California.
[95] Joint GSP, Table 1-4, p. 56.

- Root Creek Water District Groundwater Sustainability Plan (Root Creek GSP)

The four groundwater sustainability agencies that developed the Joint GSP collectively are:

- Madera County Groundwater Sustainability Agency
- City of Madera Groundwater Sustainability Agency
- Madera Irrigation District Groundwater Sustainability Agency
- Madera Water District Groundwater Sustainability Agency

The Joint GSP plan area represents 94% of the Madera Subbasin.[96] The Joint GSP provides information that is encompassing-of, relevant-to, and reiterated-in the other three groundwater sustainability plans and is often cited by Department staff when referencing information relevant to the entire Subbasin. Collectively, unless otherwise specified, the four GSPs are referred to as the Plan for the Subbasin.

The Gravelly Ford GSP boundaries are contiguous with the Gravelly Ford Water District and contain approximately 8,500 acres comprised of grape vineyards, tree groves, and rural residences.[97] The New Stone GSP boundaries are coterminous with the New Stone Water District boundaries, encompassing approximately 4,200 acres in the northwestern area of the Madera Subbasin. The New Stone Water District consists primarily of agriculture and two landowners.[98] The Root Creek GSP boundaries are the same as the Root Creek Water District boundaries and is located in the southeastern portion of the Madera subbasin—bounded on the south by San Joaquin River—with the majority of the land being used as agriculture.[99]

A map showing the Subbasin and adjacent subbasins is shown in Figure 1 below.

[96] Joint GSP, Table 1-2, p. 42.
[97] Gravelly Ford GSP, Section 1.1.1, p. 6.
[98] New Stone GSP, Executive Summary, p. 12.
[99] Root Creek GSP, Executive Summary, p. 13, Figure 2-5, p. 43.

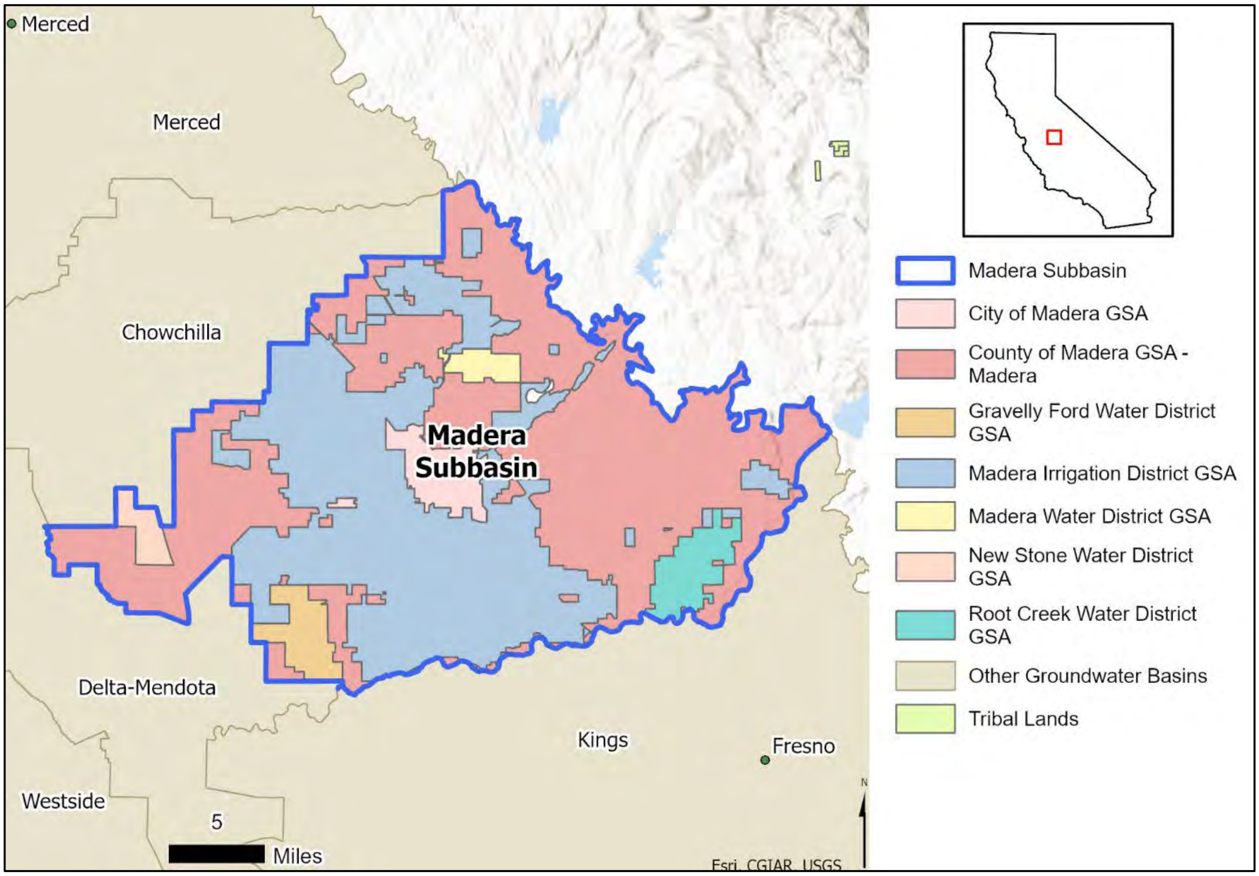

Figure 1. Madera Subbasin Location Map[100]

The land use areas in the Subbasin are broadly classified across three sectors: agricultural (including dairies), urban, and native vegetation.[101] The Plan includes a summary of land use stating irrigated agriculture is the most prominent land use in the Subbasin, covering approximately 213,000 acres.[102] For example, the New Stone GSP states that 100% of land use in the GSP is agricultural.[103] Native vegetation and water surfaces collectively were reported to cover the second highest acreage approximately 100,000 acres.[104] Urban area that includes cities, residential, and semi-agricultural cover approximately 36,000 acres.[105]

The water use source type was not independently presented for the entire Subbasin. For example, the Gravelly Ford GSP states an unquantified, small amount of groundwater pumping occurs for domestic use.[106] Instead, it is reported that the water source type is

[100] Joint GSP, Figure 2-1, p. 64.
[101] Joint GSP, Section 2.1.1, p. 65, Figure 2-2, p. 66.
[102] Joint GSP, Table 2-1, p. 68.
[103] New Stone GSP, Section 2.5.1, p. 38.
[104] Joint GSP, Table 2-1, p. 68.
[105] Joint GSP, Table 2-1, p. 68.
[106] Gravelly Ford GSP, Section 2.1.5, p. 21.

both groundwater and local surface water supplies, but groundwater appears to be the primary water source in the Subbasin.[107]

The Plan includes maps that depict the density of wells (domestic, agricultural, and public supply) by township range and section in Figure 2-5, Figure 2-6, and Figure 2-7 of the Joint GSP prepared from the Department's Well Completion Report Map Application.[108] The highest concentrations of reported domestic wells are centered primarily around the City of Madera and Bonadelle Ranchos-Madera Ranchos in the eastern portion of the Subbasin.[109] Reported irrigation wells are generally less concentrated and more evenly distributed across the Subbasin, though slightly higher concentrations are found in some areas within rural Madera County, Madera Irrigation District, and Root Creek Water District.[110]

The Plan describes existing water resource management programs operating in the Subbasin. The Joint GSP states the local agencies that have formed each of the Subbasin's groundwater sustainability agencies have prepared and adopted several water planning documents in the past, including Madera Integrated Regional Water Management Plan and Madera Regional Groundwater Management Plan. The Subbasin's other local water management plans, federal, state, and regional groundwater and surface water programs were discussed.[111] The Joint GSP states the existing water resource monitoring and management programs constitute a well-developed and broadly distributed system that provides representative data throughout the Subbasin that have been, and will be, incorporated into the Plan as appropriate.[112]

The Plan provides a list of public meetings where the Plan was discussed, including GSA board meetings, Coordination Committee meetings, stakeholder advisory committee meetings, and public workshops.[113] The GSPs include stakeholder communication and engagement plans to assist Subbasin groundwater sustainability agencies in their efforts to develop general and strategic communications to engage stakeholders in groundwater management activities.[114]

The Plan identifies beneficial uses and users of groundwater in the Subbasin. The various stakeholders identified are the general public, private water users, urban and agricultural water users, industrial water users, environmental and ecosystem water uses, tribes, federal lands and integrated regional water management groups.[115] The Plan describes the beneficial uses of groundwater in the Subbasin, which includes irrigation and drinking

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[107] Joint GSP, Figure 2-2, p. 66.
[108] Joint GSP, Figures 2-5 through 2-7, pp. 171-173.
[109] Joint GSP, Section 2.1.1, p. 70.
[110] Joint GSP, Section 2.1.1, p. 70.
[111] Joint GSP, Section 2.1.2, pp. 70-77.
[112] Joint GSP, Section 2.1.2, pp. 70-77.
[113] Joint GSP, Section 2.1.5, pp. 83-90, Table A6.C-2, pp. 1768-1779.
[114] Joint GSP, Appendix 2.C.a, pp. 586-638; Gravely Ford GSP, Section 2.1.5, p. 22, New Stone GSP, Section 2.5.3 and 2.5.4, pp.39-40, Root Creek GSP, Section 2.5.3 to 2.5.4, pp. 73-75.
[115] Joint GSP, Table 2-5, pp. 85-86, Table A2.C.a-1, pp. 592-593.

water supply (i.e., municipal, urban, and rural).[116] According to the Joint GSP, each of the seven groundwater sustainable agencies in the Subbasin held regular public meetings, coordination committee meetings, and subbasin wide technical meetings.[117] For example, according to the Root Creek GSP,[118] engagement with the groundwater users occurred at the time of formation of GSAs, development of the draft GSP, finalization of the GSP and engagement will continue for the implementation of the GSP.[119]

Overall, Department staff believe the GSAs have thoroughly described Agency information, plan area, and notice and communication process, in substantial compliance with the GSP Regulations.

5.2 Basin Setting

GSP Regulations require information about the physical setting and characteristics of the basin and current conditions of the basin, including a hydrogeologic conceptual model; a description of historical and current groundwater conditions; and a water budget accounting for total annual volume of groundwater and surface water entering and leaving the basin, including historical, current, and projected water budget conditions.[120]

5.2.1 Hydrogeologic Conceptual Model

The GSP Regulations require a descriptive hydrogeologic conceptual model of the basin that includes a written description supported by cross sections and maps.[121] The hydrogeologic conceptual model is a non-numerical model of the physical setting, characteristics, and processes that govern groundwater occurrence within a basin, and represents a GSA's understanding of the geology and hydrology of the basin that support the geologic assumptions used in developing mathematical models, such as those that allow for quantification of the water budget.[122]

The Plan provides a description of the hydrogeologic conceptual model documented in a 2017 technical memoranda[123] and qualified maps.[124] The Gravelly Ford GSP provided additional descriptions to the hydrogeological conceptual model using a 2018 report titled *Hydrogeologic Conceptual Model and Groundwater Conditions for the Gravelly Ford Water District GSP*,[125] which describes the physical components in the Gravelly Ford

[116] Joint GSP, Section 1, p. 40.
[117] Joint GSP, Section 2.1.5.3, p. 86.
[118] Root Creek GSP, Appendix 2-C, pp. 245-246.
[119] Root Creek GSP, Section 2.5.1, pp. 72-73.
[120] 23 CCR § 354.12 *et seq*.
[121] 23 CCR § 354.12 *et seq*.
[122] DWR Best Management Practices for the Sustainable Management of Groundwater: Hydrogeologic Conceptual Model, December 2016: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-3-Hydrogeologic-Conceptual-Model_ay_19.pdf.
[123] Joint GSP, Section 2.2.1, pp. 90-96.
[124] Joint GSP, Figures 2-5 through Figure 2-46, pp. 171-211, Appendix 2.D, pp. 1078-1090.
[125] Gravelly Ford GSP, Appendix B, pp. 89-124.

GSP area, including, but not limited to, the principal aquifers,[126] surface water bodies,[127] and primary users of groundwater[128] in the Gravelly Ford GSP area.

The surface geology of the Subbasin is described predominantly as younger and older alluvium with subsurface deposits, from the surface to the bottom of the Subbasin, consisting of alluvium and unconsolidated continental deposits.[129] The Subbasin is depicted to be underlain by crystalline basement complex rocks of the Sierra Nevada.[130]

The lateral boundaries of the Subbasin are described as the hydrogeologic boundary created by the bedrock of the Sierra Nevada to the east; and the political boundaries of the Kings Subbasin to the south, Chowchilla Subbasin to the north, and Delta-Mendota Subbasin to the west.[131]

The Plan describes that the bottom of the Subbasin, throughout most of the Subbasin, is defined by the depth to the base of fresh water (groundwater with conductivity up to 3,000 micromhos per centimeter), except in the eastern portion where it is defined by the depth to basement rock.[132] However, the Plan states that there are wells screened below the defined base of fresh water while explaining these wells will likely have hydraulic connection with the overlying freshwater zone, so they are considered to be part of the Subbasin.[133] For example, cross-sections provided by the Joint GSP depict wells that extend below the bottom of the Subbasin.[134]

The Plan does not explicitly use the term principal aquifers to describe aquifers within the Subbasin, instead the Plan provides a description of aquifer systems present in the Subbasin. The Plan states that the Corcoran Clay underlies the western one-third of the Subbasin[135] and acts as a confining layer separating the upper unconfined aquifer from the lower confined aquifer.[136] The top of Corcoran Clay lies between 200 to 350 feet beneath the New Stone GSP area.[137] The Plan describes that the area outside of the Corcoran Clay, located in the central and eastern portions of the Subbasin, contains discontinuous clay layers interspersed with permeable coarse-grained units and is generally considered to be semi-confined. The semi-confined aquifer is further described as an upper semi-confined aquifer and a lower semi-confined aquifer (at an estimated depth ranging from 200 to 400 feet which generally correlates to the depth of the Corcoran Clay).[138] The Plan states the Subbasin contains areas of perched water. For example,

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[126] Gravelly Ford GSP, Appendix B, p. 102.
[127] Gravelly Ford GSP, Appendix B, pp. 96-99.
[128] Gravelly Ford GSP, Appendix B, p. 107.
[129] Joint GSP, Section 2.2.1.1, p. 91.
[130] Joint GSP, Section 2.2.1.1, p. 91, Figure 2-19, p. 184.
[131] Joint GSP, Section 2.2.1.2, p. 91, Figure 2-17, p. 182.
[132] Joint GSP. Section 2.2.1.2. pp. 91-92, Figures 2-24 through 2-34, pp. 189-199.
[133] Joint GSP, Section 2.2.1.2, p. 92.
[134] Joint GSP, Figures 2-24 to 2-34, pp. 189-199.
[135] Joint GSP, Section 2.2.1.3, p. 93.
[136] New Stone GSP, Section 3.1.8, p. 60.
[137] New Stone GSP, Section 3.1.8, p. 60.
[138] Joint GSP, Section 2.2.1.3, pp. 93-94.

the Joint GSP states that the approximate location of the perched aquifers are six miles southeast of the City of Madera and ten miles northwest of the City of Madera; depths range from 3 to 27 feet southeast of the City of Madera, 100 feet within the City of Madera, and 105 to 130 feet northeast of Madera. Other sites with perched groundwater are believed to exist, but locations and depths are uncertain due to limited data.[139]

Department staff find that the Plan introduces uncertainty in the hydrogeologic conceptual model by identifying several aquifers in the Subbasin, but not directly defining any of these aquifers as principal aquifer(s). Additional details are provided below.

- The Plan identifies formations (i.e., Modesto, Riverbank, and Turlock Lake Formation - which contains the Corcoran Clay)[140] of the Subbasin but does not associate them with principal aquifer(s).
- The Plan describes the lateral and vertical boundaries of the Subbasin[141] but does not provide details that describe the lateral and vertical boundaries by principal aquifer. Also, the GSP does not provide sufficient details to support that east of the Corcoran Clay, the upper regional aquifer is semi-confined, instead of unconfined.
- The Plan does not provide a map depicting the source and point of delivery for imported waters.
- The Plan provides a description of water quality for total dissolved solids, nitrate, and arsenic along with maps of concentrations within the Subbasin.[142] None of the water quality data is identified by principal aquifer, although some of the data is identified by different aquifer descriptions such as upper, lower, shallow wells and deep wells.[143]

The Plan provides cross-sections that provide sufficient information to depict the major stratigraphic and structural features in the Subbasin. Physical characteristics of the Subbasin are depicted on various maps and figures. The cross-sections depict the base of freshwater, top of crystalline basement complex of the Sierra Nevada along the eastern portion of the Subbasin. Also shown is the upper aquifer and lower aquifer separated by the Corcoran Clay. Additionally, the GSP describes that east of the Corcoran Clay extent, the aquifer system is considered to consist of an upper semi-confined aquifer and a lower semi-confined aquifer;[144] however, the cross-sections show unconfined groundwater levels in the areas identified in the GSP as semiconfined.

The Plan does not explicitly identify data gaps and uncertainty concerning the hydrogeologic conceptual model as required by the GSP Regulations.[145] Department staff believe that a discussion regarding data gaps and uncertainty in the hydrogeologic

[139] Joint GSP, Section 2.2.2.1, p. 98.
[140] Joint GSP, Section 2.2.1.1, p. 91; Root Creek GSP, Section 3.1.2, p. 76.
[141] Joint GSP, Section 2.2.1.2, p. 91.
[142] Joint GSP, Section 2.2.2.3, pp. 102-104.
[143] Joint GSP, Appendix 2.E., pp. 1267-1321.
[144] Joint GSP, Section 2.2.1.1, p. 95.
[145] 23 CCR § 354.14(b)(5).

conceptual model, and plans to address data gaps is necessary, as lack of data and understanding of the physical characteristics of the subbasin may limit sustainable groundwater management (see Recommended Corrective Action 5).

5.2.2 Groundwater Conditions

The GSP Regulations require a written description of historical and current groundwater conditions for each of the six sustainability indicators and groundwater dependent ecosystems.[146]

Groundwater levels are currently declining across much of the Subbasin in both the unconfined and lower aquifer zones.[147] The current conditions are a continuation of historical trends of declining groundwater levels across much of the Subbasin that have been observed for at least the past 30 years.[148] In total, more than 500 hydrographs are included in the Plan covering varying timelines over the last 100 years. Hydrographs included in the Plan show two measurements per year over the well's entire period of record with the timeline beginning in 1945 or 1920.[149]

The Subbasin is also losing groundwater storage and has been since at least 1988 based on information provided in the Plan.[150] The Joint GSP includes a summary of various studies which utilized different specific yield values to estimate the total volume of groundwater storage loss ranging between 1,891,308 acre-feet to 3,073,376 acre-feet for the period 1988 to 2014 and 2,809,149 acre-feet to 4,564,868 acre-feet for the period 1988 to 2016.[151] This equates to an annual storage loss of 73,000 to 163,000 acre-feet per year since 1988.[152] The range in change in groundwater storage conditions result from five different specific yield estimates that vary from 5% to 12% for the Subbasin. The Joint GSP includes a summary table (Table 2-8) showing the total change of storage over two time periods: 1988 to 2014 and 1988 to 2016 based on five different specific yield values.[153]

The Plan identifies nitrate, total dissolved solid (TDS), and arsenic as the current key water quality constituents in the Subbasin. These three constituents were highlighted because they “have greater potential for presenting broader regional groundwater quality concerns extending beyond localized or site-specific contamination cases and are likely to reflect a range of potential contamination sources.”[154] The New Stone GSP also states that salinity, chloride, specific conductance, and pesticides are constituents being detected in areas in the district; however, data available within and near the district indicates that levels of these constituents are generally below respective maximum

[146] 23 CCR § 354.16 (a-f).
[147] Joint GSP, Section 2.2.2.1, pp. 97-100.
[148] Joint GSP, Figures 2-56 and 2-57, pp. 221-222.
[149] Joint GSP, Appendix 2.E.b, pp. 1129-1266.
[150] Joint GSP, Section 2.2.2.2, p. 101.
[151] Joint GSP, Section 2.2.2.2, pp. 101-102, Table 2-8, p. 102.
[152] Joint GSP, Section 2.2.2.2, pp. 101-102, Table 2-8, p. 102.
[153] Joint GSP, Table 2-8, p. 102.
[154] Joint GSP, Section 2.2.2.3, p. 102.

contaminant limits (MCLs) for drinking water.[155] The Root Creek GSP also included an evaluation of other constituents historically present in the GSP area, and states that the evaluation of historical results indicate that the area generally has acceptable groundwater quality for agricultural use and drinking water.[156] The Plan includes more than 50 maps displaying chemical concentrations for the key water quality constituents and other chemicals.[157]

Land subsidence has occurred and continues to occur in the Subbasin. The Joint GSP includes a written description detailing land subsidence over three time periods: 1926 to 1970, 2007-2011, and 2015-2017.[158] The discussion in the GSP focuses on the northwestern portion of the Subbasin where 1 to 2 feet of land subsidence occurred between 1926 and 1970, 0.5 to 1.0 feet occurred between 2007 and 2011, and 1.0 to 1.5 feet between 2015 and 2017.[159] The New Stone GSP states the subsiding area near El Nido is approximately 25 miles in diameter and its outer reach extends to the Plan area and the western area of the Subbasin.[160] United States Bureau of Reclamation monitoring point 1007R located on the western boundary of Plan area has indicated an annual subsidence rate ranging from 0.09 to 0.60 feet per year since December 2011 with the highest annual rate occurring from December 2012 through July 2014.[161] The Plan includes maps displaying both historical and current land subsidence.[162] Department staff provide information relevant to this in Section 4.3.

Interconnected surface water potentially exists in localized areas along the San Joaquin River within the Subbasin based on an analysis of comparing groundwater levels to the stream thalweg.[163] Based on this analysis, there were also additional portions of the San Joaquin River that were connected with groundwater historically (from 1958 to 1984) but may no longer be connected due to declining groundwater levels.[164] The Joint GSP states characterization of hydrogeologic conditions related to the potential for interconnected surface water is currently based on very limited data and, therefore, additional data collection and analyses are needed to update and refine the understanding of how surface water and GDEs may (or may not) be connected to the regional aquifers where groundwater pumping occurs.[165] Department staff provide information relevant to this in Section 4.4.

[155] New Stone GSP, Section 3.2.5, pp. 77-79.
[156] Root Creek GSP, Section 3.2.6, pp. 120-125.
[157] Joint GSP, Appendix 2.E, pp. 1268-1321; Root Creek GSP, Figures 3-27 through 3-29, pp. 121-123.
[158] Joint GSP, Section 2.2.2.4, p. 105.
[159] Joint GSP, Section 2.2.2.4, p. 105, Figures 2-67 through 2-70, pp. 232-235.
[160] New Stone GSP, Section 3.2.6.1, p. 82.
[161] New Stone GSP, Section 3.2.6.1, p. 82.
[162] New Stone GSP, Figures 3-23 and 3-24, pp. 84-85.
[163] Joint GSP (Redline), Section 2.2.2.5, p. 118.
[164] Joint GSP, Section 2.2.2.5, p. 105.
[165] Joint GSP (Redline), Section 2.2.2.5, p. 121.

The Plan identifies four areas within the Subbasin as “Potential GDE Units”.[166] The Joint GSP includes a technical memorandum that provides additional information about each of the four Potential GDE Areas including a series of maps, identification of potential GDE species, and a description of GDE conditions in the Subbasin.[167]

Overall, the Plan sufficiently describes the historical and current groundwater conditions throughout the Subbasin and the information included in the Plan substantially complies with the requirements outlined in the GSP Regulations.

5.2.3 Water Budget

GSP Regulations require a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current, and projected water budget conditions, and the change in the volume of water stored, as applicable.

The seven GSAs in the Subbasin use the data and analysis provided in the Technical Memorandum: Data Collection and Analysis (Davids engineering and Luhdorff & Scalmanini Consulting Engineers, July 2017) and the Draft Preliminary Basin Boundary Water Budget (Davids engineering and Luhdorff & Scalmanini Consulting Engineers, February 2018).[168] These documents were used to develop the Subbasin’s water budget.[169] The water budget described in the Joint GSP presents a water budget for the entire Plan area, including annual water budget information for Gravelly Ford GSP, New Stone GSP, and Root Creek GSP; the Gravelly Ford GSP, New Stone GSP, and Root Creek GSP also reference the water budget information in the Joint GSP.[170] Detailed information is provided for all seven GSAs in Appendix 6.D of the Joint GSP.[171] An assessment of the information is provided below.

The water budgets contain a surface water system and a groundwater system (referred to as accounting centers) for the entire Subbasin. The Plan clearly lists the inflow, outflow, and change in storage components for each accounting center.[172] This framework is applied to the current, historical, and projected budgets.

The period 1989-2014 is used as the base period for both the historical and current water budget and represents average hydrologic conditions based on cumulative departure from mean precipitation.[173] The average annual change in storage is calculated as -34,200 acre-feet per year[174] for the historical budget. The overdraft estimate for the current water budget is -93,276 acre-feet, calculated using an average of historical

[166] Joint GSP, Section 2.2.2.6, p. 107.
[167] Joint GSP, Appendix 2.B, pp. 518-584.
[168] Madera Subbasin Coordination Agreement, p. 12.
[169] Joint GSP, Section 2.2.3.1, p. 114.
[170] Joint GSP, Appendix 2.F, pp. 1322-1620.
[171] Joint GSP, Appendix 6.D, pp. 2012-2175.
[172] Joint GSP, Table 2-10, p. 117.
[173] Joint GSP, Section 2.2.3.2, pp. 122-123, Figures 2-81 and 2-82, p. 124.
[174] Joint GSP, Table 2-26, p. 159.

hydrologic conditions from 1989-2014 with 2015 land use data.[175] The information presented indicates that change in storage is positive only during wet years at a volume of 122,900 acre-feet. All other years indicate decreases in storage ranging from -82,700 to -230,400 acre-feet.[176]

Sustainable yield is calculated for the historical and projected water budgets.[177] As reported in the Plan, the historical sustainable yield for the Subbasin is 437,300 acre-feet per year.[178] The projected sustainable yield for the Subbasin is 439,300 acre-feet per year with a lower bound of 329,500 acre-feet per year and upper bound of 549,100 acre-feet per year.[179] The projected sustainable yield was calculated only for the sustainability period 2040-2090 with the reasoning that ongoing projects and demand management during the implementation period (2020-2039) will continually shift sustainable yield as project efficacy is evaluated.[180] The similarity of historical and projected sustainable yields suggests the sustainable yield during the implementation period would not differ appreciably from these estimates.

Department staff conclude the historical, current, and projected water budgets included in the Plan substantially comply with the requirements outlined in the GSP Regulations. The GSP provides the required historical, current, and future accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the Subbasin including an estimate of the sustainable yield of the Subbasin and projected future water demands.

5.2.4 Management Areas

The GSP Regulations provide the option for one or more management areas to be defined within a basin if the GSA has determined that the creation of the management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives, provided that undesirable results are defined consistently throughout the basin.[181]

No management areas were designated per the information provided in the Plan.

5.3 Sustainable Management Criteria

The GSP Regulations require each Plan to include a sustainability goal for the basin and to characterize and establish undesirable results, minimum thresholds, and measurable objectives for each applicable sustainability indicator, as appropriate. The GSP Regulations require each Plan to define conditions that constitute sustainable groundwater management for the basin including the process by which the GSA

[175] Joint GSP, Table 2-30, p. 163.
[176] Joint GSP, Table 2-33, p. 165.
[177] Joint GSP, Section 2.2.3.4, pp. 166-167.
[178] Joint GSP, Table 2-34, p. 167.
[179] Joint GSP, Table 2-35, p. 168.
[180] Joint GSP, Section 2.2.3.4, p. 167.
[181] 23 CCR § 345.20.

characterizes undesirable results and establishes minimum thresholds and measurable objectives for each applicable sustainability indicator.[182]

5.3.1 Sustainability Goal

The GSAs establish a sustainability goal for the Subbasin in the Coordination Agreement which is to "…implement a package of projects and management actions that will, by 2040, balance long-term groundwater system inflows and outflows based on a 50-year period representative of average historical hydrologic conditions."[183] The Joint GSP explains that during the 20-year implementation period a combination of recharge projects, replacing groundwater use with surface water, and demand reduction management actions are planned. These efforts will "increase groundwater inflows and decrease groundwater outflows to bring the groundwater system into balance by 2040 and will allow its operation to remain sustainable over a 50-year period representing average hydrologic conditions."[184]

Each GSP also provides additional specific information describing the goal for each GSP area. For example, the Gravelly Ford GSP describes the sustainability goal for the Subbasin as "…to minimize the listed undesirable results throughout the Subbasin by providing a Gravelly Ford GSP water supply that supports current cultivated acreage in the Plan area by developing an expanded surface water irrigation and recharge program, and groundwater monitoring and land elevation measurement program."[185] The New Stone GSP states that "[t]he goal for the GSP is to provide a tool for managing groundwater, basin-wide, on a long-term basis and to meet measurable objectives for each indicator by maintaining a sustainable yield, thus avoiding undesirable results."[186] The Root Creek GSP explains that the sustainability goal is to work collectively with the other GSAs within the Subbasin to "sustainably manage the groundwater resources of the basin while maintaining openness to the public and stakeholders such that local citizenry has a voice in the outcome."[187] Additionally, the goal of the Root Creek GSP is to "immediately reduce and eventually eliminate systematic overdraft within the [GSP] area.[188] While, specifying how each GSP will support the Subbasin sustainability goal within its' GSP area is an appropriate level of detail for each GSP, Department staff recommend the GSAs continue to coordinate and align this portion of each GSP to provide a more cohesive definition between the specific GSP goal and the sustainability goal for the Subbasin (see Recommended Corrective Action 2).

[182] 23 CCR § 354.22 *et seq*.
[183] Madera Subbasin Coordination Agreement, p. 34.
[184] Joint GSP, Section 3.1.2, p. 244.
[185] Gravelly Ford GSP, Section 3.1, p. 48.
[186] New Stone GSP, Section 4.1, p. 110.
[187] Root Creek GSP, Section 4.1, p. 157.
[188] Root Creek GSP, Section 1.2, p. 17.

5.3.2 Sustainability Indicators

Sustainability indicators are defined as any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results.[189] Sustainability indicators thus correspond with the six undesirable results – chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon, significant and unreasonable reduction of groundwater storage, significant and unreasonable seawater intrusion, significant and unreasonable 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[190] – but refer to groundwater conditions that are not, in and of themselves, significant and unreasonable. Rather, sustainability indicators refer to the effects caused by changing groundwater conditions that are monitored, and for which criteria in the form of minimum thresholds are established by the agency to define when the effect becomes significant and unreasonable, producing an undesirable result.

The following subsections consolidate three facets of sustainable management criteria: undesirable results, minimum thresholds, and measurable objectives. Information, as presented in the Plan, pertaining to the processes and criteria relied upon to define undesirable results applicable to the basin, as quantified through the establishment of minimum thresholds, are addressed for each sustainability indicator. However, a GSA is not required to establish criteria for undesirable results that the GSA can demonstrate are not present and are not likely to occur in a basin.[191]

5.3.2.1 Chronic Lowering of Groundwater Levels

The GSP Regulations require the minimum threshold for chronic lowering of groundwater levels to be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results.[192]

In the September 2022 Incomplete Determination, the Department identified deficiencies related to the sustainable management criteria for the chronic lowering of groundwater levels. The GSAs revised this portion of the Plan, and Department staff evaluate this sustainability indicator in Section 4.2 of this Staff Report. As presented above, Department staff concluded that the GSAs took sufficient action to correct this deficiency to warrant approving the Plan, but staff also provided recommended corrective actions based on the changes the Agencies have made to the sustainable management criteria for this sustainability indicator to further improve management during Plan implementation.

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[189] 23 CCR § 351(ah).
[190] Water Code § 10721(x).
[191] 23 CCR § 354.26(d).
[192] 23 CCR § 354.28(c)(1).

5.3.2.2 Reduction of Groundwater Storage

The GSP Regulations require the minimum threshold for the reduction of groundwater storage to be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the basin's sustainable yield, calculated based on the basin's historical trends, water year type, and projected water use.[193]

The Plan states groundwater levels act as a proxy for the groundwater storage sustainability indicator and the sustainable management criteria for reduction in groundwater storage are the same as those established for chronic lowering of groundwater levels.[194] Department staff will evaluate and compare the groundwater level conditions and reduction of storage in Annual Reports submitted to the Department. Department staff expect the information will be reported on a per aquifer basis given the groundwater level monitoring network identifies which aquifer the representative monitoring site is monitoring.

5.3.2.3 Seawater Intrusion

The GSP Regulations require the minimum threshold for seawater intrusion to be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results.[195]

As stated in the Plan, seawater intrusion sustainability criteria are not applicable to the Subbasin, because it is located more than 70 miles inland and hydraulically disconnected from the ocean.[196]

5.3.2.4 Degraded Water Quality

The GSP Regulations require the minimum threshold for degraded water quality to be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum thresholds shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.[197]

The GSP states that "an undesirable result for degraded groundwater quality occurs when groundwater quality exceeds an established MCL and minimum threshold for arsenic, nitrate, or TDS [total dissolved solids] for a significant duration of time and at a significant number of representative monitoring sites and is the direct result of projects or management actions undertaken as part of the GSP implementation."[198] More

[193] 23 CCR § 354.28(c)(2).
[194] Joint GSP, Section 3.4.2, pp. 277-278.
[195] 23 CCR § 354.28(c)(3).
[196] Joint GSP, Section 3.2.6, p. 259.
[197] 23 CCR § 354.28(c)(4).
[198] Joint GSP, Section 3.4.4, p. 279.

specifically, a “significant duration of time” is defined as “a three-year monitoring period” and a “significant number of representative monitoring sites” is defined as “greater than 10 percent of representative groundwater quality monitoring wells exceeding a minimum threshold for a given constituent.”[199] This definition is overly narrow. SGMA specifies that the significant and unreasonable effects are those “caused by groundwater conditions occurring throughout the basin” not just from groundwater management activities. By solely focusing on water quality impacts caused directly by the GSAs implementing an action, the GSP does not define undesirable results for degraded water quality in accordance with the SGMA. SGMA’s definition of undesirable results includes “significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.”[200] As currently defined in the Plan, if, for instance, a minimum threshold exceedance occurs because of mobilization of naturally occurring constituents or migration of a contaminant plume to supply wells caused by groundwater pumping in the Subbasin, but the GSAs have not determined this to be a result of a project or management action, the GSAs would not identify this as an undesirable result. Staff consider this to be inconsistent with the intent of SGMA, which requires GSAs to ensure management of groundwater conditions in the Subbasin, including any action taken by the GSAs, will not significantly and unreasonably degrade water quality. Therefore, degraded water quality caused by groundwater pumping, changes in groundwater levels, changes in the direction of groundwater flow, or changes in horizontal or vertical movement of groundwater within the Subbasin should be considered in the assessment of undesirable results in the Subbasin. Department staff recommend the GSAs revise the definition of their overly-narrow definition of undesirable results such that groundwater pumping and other factors, whether due to action or inaction of the GSAs with respect to Subbasin management, is considered and not excluded in the undesirable result definition (see Recommended Corrective Action 6a).[201]

Significant and unreasonable degradation of water quality is defined as “when beneficial uses for groundwater are adversely impacted by constituent concentrations increasing to levels above the drinking water MCLs for one of the key constituents of interest …due to implementation of a GSP project or management action.”[202] Though the definition provided appears to consider specific effects of degradation of groundwater quality, the GSP does not provide details that explain how the GSAs determined what “adversely impacted by constituent concentrations” means. Additionally, the GSP does not provide descriptions, supported by analysis, of the potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results. The GSAs should update the definition of undesirable results to include specific scenarios the GSAs are trying to avoid (e.g., additional cost to domestic well users for well treatment, decrease in water available

[199] Joint GSP, Section 3.4.4, p. 279.
[200] Water Code § 10721(x).
[201] 23 CCR § 354.26 (b)(2).
[202] Joint GSP, Section 3.4.4, p. 279.

for certain beneficial uses, etc.). Department staff recommend that the GSAs refine the definition to better describe the specific significant and unreasonable effects related to degraded water quality the GSAs are managing to avoid (see Recommended Corrective Action 6b).

The GSP provides a description of potential causes of an undesirable result, limited to direct effects of GSP projects or management actions, such as localized pumping clusters (which would particularly affect areas prone to elevated arsenic concentrations occurring at greater pumping water level depths)[203] and groundwater recharge which particularly affect areas of actively or formerly cultivated lands where high residual concentrations of nutrients, especially nitrogen, may exist.[204]

The GSP establishes the minimum thresholds for degraded water quality at the "[maximum contaminant level (MCLs)] for drinking water for identified key constituents (10 mg/L for nitrate as nitrogen; 500 mg/L for TDS; 10 ug/L for arsenic) or when existing or historical concentrations for the key constituents already exceed the MCL, the minimum threshold is set at the recent concentration plus 20 percent."[205] Measurable objectives are set at current constituent concentrations.[206] However, the GSP does not identify which wells have had exceedances in the past or provide the current constituent concentrations in the Plan. The GSP also states "significant and unreasonable degradation of water quality occurs when beneficial uses for groundwater are adversely impacted by constituent concentrations increasing to levels above the drinking water MCLs,"[207] but the GSP does not explain or justify setting minimum thresholds at 20 percent above MCLs, or demonstrate that these increased levels would not adversely impact beneficial uses and users of water. Department staff are not aware of specific concerns regarding degraded water quality that warrant immediate action based on what is provided in the Plan; however, staff believe the GSAs should identify the exact minimum threshold values what will be used and justify how establishing minimum thresholds at the higher of either MCLs or existing concentrations plus 20 percent does not constitute significant and unreasonable effects as defined by the GSP (i.e., "when beneficial uses for groundwater are adversely impacted by constituent concentrations) (see Recommended Corrective Action 6c).

5.3.2.5 Land Subsidence

SGMA defines the undesirable result for subsidence to be significant and unreasonable land subsidence that substantially interferes with surface land uses, caused by groundwater conditions occurring throughout the basin.[208] The GSP Regulations require the minimum threshold for land subsidence to be the rate and extent of subsidence that

[203] Joint GSP, Section 3.4.4, pp. 279-280.
[204] Joint GSP, Section 3.4.4, p. 280.
[205] Joint GSP, Section 3.3.4, p. 271.
[206] Joint GSP, Section 3.4.2.1, p. 253.
[207] Joint GSP, Section 3.4.4, p. 271.
[208] Water Code § 10721(x)(5).

substantially interferes with surface land uses and may lead to undesirable results.[209] Minimum thresholds for subsidence shall be supported by the identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including an explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects and maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.[210]

In the September 2022 Incomplete Determination, the Department identified deficiencies related to the sustainable management criteria for land subsidence. The GSAs revised this portion of the Plan and Department staff provide evaluation for this sustainability indicator in Section 4.3 of this Staff Report. As presented above, Department staff concluded the GSAs had taken sufficient actions to correct the deficiencies and provided additional recommended corrective actions based on the changes the Agencies have made to the sustainable management criteria for this sustainability indicator to further improve basin management as the Plan is implemented.

5.3.2.6 Depletions of Interconnected Surface Water

SGMA defines undesirable results for the depletion of interconnected surface water as those that have significant and unreasonable adverse impacts on beneficial uses of surface water and are caused by groundwater conditions occurring throughout the basin.[211] The GSP Regulations require that a Plan identify the presence of interconnected surface water systems in the basin and estimate the quantity and timing of depletions of those systems.[212] The GSP Regulations further require that minimum thresholds be set based on the rate or volume of surface water depletions caused by groundwater use, supported by information including the location, quantity, and timing of depletions, that adversely impact beneficial uses of the surface water and may lead to undesirable results.[213]

In the September 2022 Incomplete Determination, the Department identified deficiencies related to the sustainable management criteria of depletions of interconnected surface water. The GSAs revised this portion of the Plan and Department staff provide evaluation for this sustainability indicator in Section 4.4 of this Staff Report. As presented above, Department staff concluded the GSAs had taken sufficient actions to correct the deficiencies and provided additional recommended corrective actions based on the changes the Agencies have made to the sustainable management criteria for this sustainability indicator.

[209] 23 CCR § 354.28(c)(5).
[210] 23 CCR §§ 354.28(c)(5)(A-B).
[211] Water Code § 10721(x)(6).
[212] 23 CCR § 354.16(f).
[213] 23 CCR § 354.28(c)(6).

5.4 Monitoring Network

The GSP Regulations describe the monitoring network that must be developed for each basin including monitoring objectives, monitoring protocols, and data reporting requirements. Collecting monitoring data of sufficient quality and quantity is necessary for the successful implementation of a groundwater sustainability plan. The GSP Regulations require a monitoring network of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.[214] Specifically, a monitoring network must be able to monitor impacts to beneficial uses and users,[215] monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds,[216] capture seasonal low and high conditions,[217] include required information such as location and well construction, and include maps and tables clearly showing the monitoring site type, location and frequency.[218] Department staff encourage GSAs to collect monitoring data as specified in the GSP, fill data gaps identified in the GSP prior to the first 5 year update,[219] update monitoring network information as needed, follow monitoring best management practices,[220] and submit all monitoring data to the Department's Monitoring Network Module immediately after collection including any additional groundwater monitoring data that is collected within the Plan area that is used for groundwater management decisions. Staff note that if GSAs do not fill their identified data gaps, the GSA's basin understanding may not represent the best available science for use to monitor basin conditions.

Each GSP identifies a distinct monitoring network that measures groundwater elevations for assessment of chronic lowering of groundwater levels. The Joint GSP identifies 37 monitoring wells with 11 wells in the Upper Aquifer, 22 wells in the Lower Aquifer, and four composite wells screened in both aquifers.[221] The Joint GSP acknowledges the spatial coverage of the monitoring network for the Upper Aquifer is limited to the southwestern portion of the GSP area.[222] The Gravelly Ford GSP states that two different groups of wells are currently being used for monitoring chronic lowering of groundwater levels; one with a network of 24 wells and another network of four wells from outside the GSP area to compare future measurements.[223] However, the Gravelly Ford GSP does not specify which aquifer the wells are monitoring. The New Stone GSP monitoring network includes six monitoring wells comprised of three California Groundwater Elevation Monitoring Program (CASGEM) monitoring sites and three district wells that will

214 23 CCR § 354.32.
215 23 CCR § 354.34(b)(2).
216 23 CCR § 354.34(b)(3).
217 23 CCR § 354.34(c)(1)(B).
218 23 CCR §§ 354.34(g)-(h).
219 23 CCR § 354.38(d).
220 Department of Water Resources, 2016, Best Management Practices and Guidance Documents.
221 Joint GSP, Section 3.5.1, p. 281.
222 Joint GSP, Section 3.5.1, p. 282.
223 Gravelly Ford GSP, Section 3.5.1, pp. 57-58.

be monitoring the unconfined aquifer and confined aquifer respectively.[224] The Root Creek GSP states that the GSA will use the five wells in the monitoring network within the single aquifer that underlies the GSP area.[225]

The Plan proposes to use groundwater levels and the groundwater level monitoring network as a proxy for the loss of groundwater in storage monitoring network because changes in groundwater storage are directly dependent on changes in groundwater levels.[226]

The groundwater quality monitoring network in the Joint GSP consists of 12 monitoring sites selected from the GSP groundwater level monitoring network.[227] Of these wells, two are screened in the Upper Aquifer, eight in the Lower Aquifer, and two are composite wells screened in both.[228] Additionally, two domestic wells from the Irrigated Lands Regulatory Program, and thirteen public supply wells with ongoing monitoring conducted by other entities are also part of the representative monitoring sites but the GSP does not identify which aquifers the wells are completed in.[229] The Gravelly Ford GSP states groundwater quality samples will be collected from 24 wells throughout the district and the samples will be collected once a year.[230] The New Stone GSP states the GSA will use the three district wells that monitor the confined aquifer.[231] The Root Creek GSP states that degraded water quality will be monitored from 17 sites throughout the GSA's area of the Subbasin which includes municipal wells, monitoring wells associated with the Riverstone wastewater treatment plant, agricultural wells used in the GSP, and wells associated with CASGEM.[232] The Plan states that several agencies monitor and regulate water quality in the Subbasin and the GSAs will collect and review the data published by these agencies, which include the Regional Water Quality Control Board, Environmental Protection Agency, Department of Toxic Substance Control, Madera County, United States Geological Survey, and State Water Resources Control Board.[233]

The land subsidence monitoring network in the Joint GSP is comprised of six benchmark survey points monitored by the United States Bureau of Reclamation as part of the San Joaquin River Restoration Program (SJRRP) and one continuous GPS station monitored by UNAVCO as part of the Plate Boundary Observatory Project.[234] Two of the benchmark survey points are underlaid by the Corcoran Clay, where subsidence is of most concern. Representative monitoring site 1007R, a benchmark survey point which is located on the

[224] New Stone GSP, Section 5.2.1, pp. 133-134.
[225] Root Creek GSP, Section 5.2.1, p. 191.
[226] Joint GSP, Section 3.5.1.2, p. 286; Gravelly Ford GSP, Section 3.5, p. 59; New Stone GSP, Section 5.3.1, p. 138; Root Creek GSP, p. 196.
[227] Joint GSP, Section 3.5.1.4, p. 287.
[228] Joint GSP, Figure 3-2, p. 300.
[229] Joint GSP, Section 3.5.1.4, p. 287.
[230] Gravelly Ford GSP, Section 3.5.1, p. 58.
[231] New Stone GSP, Section 5.5.1, p. 139, Figure 5-1, p. 137.
[232] Root Creek GSP, Section 5.4.1, pp. 199-201.
[233] Root Creek GSP, Section 5.4.1, p. 199.
[234] Joint GSP (Redlined), Section 3.2.3.2, p. 279, Figure 3-10, p. 360.

western edge of the New Stone GSP area, has reported the most severe rate of recent subsidence in the Subbasin.[235] The Plan states that all SJRRP and UNAVCO sites will be used to monitor for subsidence in the area and monitoring stations outside the Subbasin will be used to provide regional context. The Root Creek GSP also provides a list of subsidence monitoring done by other agencies such as USGS, DWR, USACE which will be used to verify the Plan's monitoring network.[236] The Gravelly Ford GSP subsidence monitoring program will be expanded by the district to include observations on all the 24 monitoring sites in the GSP area, at a period of three to five years, with some wells observing the Lower Aquifer.[237] See Section 4.3.2 for further evaluation of the Plans sustainable management criteria and monitoring network for land subsidence.

Interconnected surface water is evaluated by monitoring groundwater levels at three wells[238] screened in the Upper Aquifer near the San Joaquin River. The Joint GSP explains the representative monitoring sites include a combination of irrigation and monitoring wells with data representing surface water-groundwater interconnection trends from 1989.[239] Streamflow data from gaging stations is also collected and will be used in future studies and evaluations of interconnected surface water, including generating data to better estimate groundwater basin conditions related to interconnected surface water[240] (also see Section 4.4.2).

The description of the monitoring in the Plan substantially complies with the requirements outlined in the GSP Regulations. Overall, the Plan describes in sufficient detail a monitoring network that promotes the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the Subbasin and evaluate changing conditions that occur through Plan implementation. The GSP provides a good explanation for the conclusion that the monitoring network is supported by the best available information and data and is designed to ensure adequate coverage of sustainability indicators. The Plan also describes existing data gaps and the steps that will be taken to fill data gaps and improve the monitoring network. Department staff consider the information presented in the Plan as satisfying the general requirements of the GSP Regulations regarding monitoring networks, but also provide recommended corrective actions related to managing and monitoring land subsidence (see Recommended Corrective Action 4).

[235] New Stone GSP (Redlined), Section 3.2.6.1, p. 99, Figure 5-2, p. 185.
[236] Root Creek GSP (Redlined), Section 5.5.1, pp. 266-267, Section 5.5.3, p. 268.
[237] Gravelly Ford GSP (Redlined), Section 3.5.1, p. 76, Section 3.5.4.2, p. 77.
[238] Joint GSP (Redlined), Figure 3-4, p. 352, Section 3.5.1.5, p. 336.
[239] Joint GSP (Redlined), Section 3.5.1.5, p. 336, Section 3.2.5, p. 288.
[240] Joint GSP (Redlined), Section 3.5.1.5, p. 336.

5.5 Projects and Management Actions

The GSP Regulations require a description of the projects and management actions the GSAs have determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.[241]

The Plan lays out the projects which were selected by the GSAs to achieve the Subbasin sustainability goal by 2040.[242] Generally, the projects are supply augmentation (i.e., recharge or conveyance enhancement) projects which source water from flood releases, Section 215 water, bypass flows, or water purchases. While the total cost of project implementation is not provided, the estimated costs provided in each individual GSP total to over $270,000,000 in capital costs and over $70,000,000 in annual costs; Department staff note that the GSAs have also included an estimated economic cost from reduced crop production resulting from demand management in the estimated annual operating cost, which is approximately $54,000,000 per year or over 75% of the total.[243] Many of the projects are currently being implemented, having been initiated by past efforts, or will be implemented by 2040. The total expected benefit is 215,840 acre-feet per year[244] at full implementation with the majority of the benefit deriving from a demand management program led by the Madera County GSA which will conserve 90,000 acre-feet per year. Madera County determined that projects were unlikely to generate enough benefit to offset the estimated current and projected future overdraft conditions and decided to implement a management action to gradually reduce groundwater pumping over the GSP implementation period.[245] The demand management effort started in 2020 with 2% demand reduction per year until 2025. Starting in 2026, the demand reduction increases to a 6% reduction rate until 2040.[246]

Since the submission of the Plan in 2020, the GSAs have provided Annual Reports to the Department that provide updates on progress, a brief overview of these efforts from Water Year 2019 to Water Year 2022 is provided in each revised GSP. A review of the Annual Reports submitted shows progress on a majority of the projects and enhancements of monitoring networks, which now collect more land subsidence, water quality, and groundwater level data; the GSAs also report efforts being made to collect more interconnected surface water data.[247]

A review of the projects presented in each GSP is provided below.

[241] 23 CCR § 354.44 et seq.
[242] Joint GSP (Redlined), Section 4, pp. 361-431; Gravelly Ford GSP (Redlined), Section 4, pp. 83-37; Root Creek GSP (Redlined), Section 6, pp. 309-327; New Stone GSP (Redlined), Section 6, pp. 189-199.
[243] Joint GSP, Table 4-3, p. 312, Section 4.4.4.5, p. 352.
[244] Joint GSP, Tables 4-1 and 4-2, pp. 310-311.
[245] Joint GSP, Section 4.4.4, p. 347.
[246] Joint GSP, Section 4.4.4.2, p. 348.
[247] Joint GSP Water Year 2022 Annual Report, Table 7-1, pp. 56-57; Gravelly Ford GSP Water Year 2022 Annual Report, Section 2.4.3, pp. 18-19; New Stone GSP Water Year 2022 Annual Report, Section 3.1.2, p. 10; Root Creek GSP Water Year 2022 Annual Report, p. 26.

The Joint GSP describes each project and management action proposed by Madera Water District GSA, Madera Irrigation District GSA, City of Madera GSA, and Madera County GSA.[248] They are:

Madera Water District GSA

1. Surface Water Purchase Program

Madera Irrigation District GSA

1. Groundwater Recharge Basins
2. On-Farm Recharge (Flood-MAR)
3. Madera Irrigation District System Improvements and Programs
4. Madera Ranch Annexation

The City of Madera GSA

1. Berry Basin for groundwater recharge
2. The City of Madera Metering and Volumetric Billing program.

Madera County GSA

1. Water Purchase for Direct or In-Lieu Recharge (starts in 2025)
2. Import and Recharge of Millerton Flood Releases (Flood-MAR) (starts in 2025)
3. Chowchilla Bypass Flood Water Recharge Basins (starts in 2025)
4. Chowchilla Bypass Flood Water Recharge Basins (starts in 2040)
5. Management Action: Demand Management (starts in 2020)

The Joint GSP provides an estimate for implementing projects and management actions, which totals approximately $193,460,000 in capital costs and $69,550,000 in annual operating costs.[249] As noted above, the GSAs have included an estimated economic cost from reduced crop production resulting from demand management of approximately $54,000,000 per year in the total annual cost.[250] Based on information provided in the Joint GSP resubmittal and the 2022 Annual Report,[251] the GSA reports that a cumulative total benefit of over 63,000 acre-feet from projects and management actions to date, with a benefit of 7,300 acre-feet for the latest reported water year for the GSP area.[252] Demand management is described to potentially utilize a range of options including allocations, a water trading program, or easements to reduce groundwater demand. In 2022, Madera County took steps to develop a demand management study that was intended to result

[248] Joint GSP (Redlined), Section 4, pp. 361-341.
[249] Joint GSP (Redlined), Table 4-3, p. 366.
[250] Joint GSP (Redlined), Section 4.4.4.5, p. 409.
[251] Joint GSP Water Year 2022 Annual Report, Section 7.1, pp. 53-69.
[252] Joint GSP Water Year 2022 Annual Report, Table 7-2, p. 58.

in an acreage-based rate for extraction of groundwater within the GSA area. However, following an injunction issued by the Madera County Superior Court in December 2022, the Madera County GSA was ordered to refrain from imposing or collecting any new fees, rates, or GSP Project Fees enacted under Madera County Resolution 2022-086 against landowners in the Madera Subbasin.[253] Nonetheless, Department staff encourage the GSAs to continue efforts to develop and implement a successful management strategy to reduce groundwater pumping in the Subbasin, since the reduction of groundwater demand, as detailed in the Plan, is an essential part of achieving the sustainability goal for the basin. Department staff will closely monitor and track the implementation of the demand management program; delays in implementation due to litigation or funding are insufficient to justify delays in implementing demand reduction strategies that are needed to sustainably manage the basin.

The Gravelly Ford GSP[254] provides details for two projects which the GSA is currently implementing:

1. Recharge Program: this project is the continuation of the recharge program established by the Gravelly Ford Water District in 1961.
2. Increased Measurement, Sampling and Monitoring: this project is to continue data collection efforts.

The Gravely Ford GSP does not provide an estimate for projects and management actions; the cost of implementing the GSP is estimated to be $961,000.[255] Based on information in the 2022 Annual Report,[256] the GSA reports that a number of measurements (i.e., depth to groundwater) of private agricultural wells in the GSP area were made and the installation of measurement meters has started on those wells to increase data collection; but the GSAs were not able to discharge surface water into the existing recharge basins during the 2022 Water Year.

The New Stone GSP includes a brief description of one project that is “currently being considered by the [New Stone Water] District”[257] which is the:

1. Construct Chowchilla Bypass Turnout, New Canals, and Recharge Basins (Bypass Project)

The Bypass Project is in the “conceptual phase” and implementation will “depend on the availability of land for new recharge basins [which will also determine amount of recharge] and acquiring a source of funding”; the amount of recharge will depend on acres available for recharge facilities but the district has a 15,700 acre-feet appropriative water right.[258] The estimated cost over 20-years for implementing the project is $7,800,000 but no

[253] Joint GSP (Redlined), Section 4.10.5.4, p. 430.
[254] Gravelly Ford GSP, Section 4, pp. 64-66.
[255] Gravelly Ford GSP (Redlined), Section 5.3.1, p. 88.
[256] Gravelly Ford GSP Water Year 2022 Annual Report, Section 2.4.3, p. 18-19.
[257] New Stone GSP, Section 6.2, pp. 151-157.
[258] New Stone GSP, Section 6.2.1.2 through 6.2.1.6, pp. 152-153.

schedule is provided.[259] Management actions will be enacted "[i]f basin overdraft isn't mitigated"[260] and the GSP doesn't provide related cost of implementation or schedule estimates. Based on information in the 2022 Annual Report,[261] the GSA did not provide substantial updates on the project or management action progress for the 2022 Water Year—but the GSA did report three new wells were added to the monitoring network.

The Root Creek GSP[262] includes brief descriptions of three projects:

1. Expansion of the In-Lieu Pipeline (to fully utilize surface water allocations)
2. Intentional Recharge Projects
3. Agricultural Land Conversion (Development of Riverstone)
4. Monitoring Well Program – Interconnected Surface Water

The Root Creek GSP provides project cost estimates and projects 2 and 3 are currently being implemented. Additionally, though management actions are referenced,[263] no specific details are provided; the GSP references the continuation of programs that were enacted prior to SGMA related to the use and sustainable management of groundwater.[264] During 2022, the GSP states, a benefit of 4,500 acre-feet was realized from projects for the GSP area.[265]

The Plan adequately describes proposed projects and management actions in a manner that is generally consistent and substantially complies with the GSP Regulations.[266] The projects and management actions, which focus largely on recharge or conveyance projects and demand management, are directly related to the sustainable management criteria and present a generally feasible approach to achieving the sustainability goal of the Subbasin.

As projects and management actions are implemented, the Department expects that progress be included in Annual Reports and any addition or removal of project and management actions be documented in Periodic Evaluations.

5.6 Consideration of Adjacent Basins/Subbasins

SGMA requires the Department to "…evaluate whether a groundwater sustainability plan adversely affects the ability of an adjacent basin to implement their groundwater sustainability plan or impedes achievement of sustainability goals in an adjacent basin."[267] Furthermore, the GSP Regulations state that minimum thresholds defined in each GSP

[259] New Stone GSP, Table 7-3, p. 160.
[260] New Stone GSP, Section 6.3, p. 154.
[261] New Stone GSP Water Year 2022 Annual Report, Section 3.1, pp. 10-11.
[262] Root Creek GSP, Section 6.1 through 6.4, pp. 212-226.
[263] Root Creek GSP, Table 6-1, p. 213.
[264] Root Creek GSP, Section 6.5, p. 226.
[265] Root Creek GSP (Redlined), Section 6.7, pp. 326-327.
[266] 23 CCR §§ 354.44 (a), 354.44 (b), 354.44 (c), 354.44 (d).
[267] Water Code § 10733(c).

be designed to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.[268]

The Madera Subbasin has three adjacent basins; the Kings Subbasin, Delta-Mendota Subbasin, and the Chowchilla Subbasin, are all high-priority and required to be managed under a GSP. The Delta-Mendota Subbasin and Chowchilla Subbasins are critically overdrafted and currently have inadequate plans which the Department has referred to the State Water Resources Control Board under Chapter 11 of SGMA. The Kings Subbasin is to the south of the Madera Subbasin bordering the south bank of the San Joaquin River. The Kings Subbasin is designated critically overdrafted and the Kings Subbasin Plan has been approved by the Department.

The Plan states that the Madera Subbasin GSAs have met multiple times with GSAs in adjacent subbasins to ensure that implementation of the Madera Subbasin GSPs will not interfere with the ability of adjacent subbasins to also achieve sustainable groundwater management; however, further details are not provided in the Plan.[269] The Plan also qualitatively describes how minimum thresholds and measurable objectives may affect an adjacent basin, concluding that the Madera Subbasin Plan will not hinder the ability of an adjacent basin to be sustainable;[270] however, the evaluation is provided without specifics.

Based on information available at this time, Department staff have insufficient evidence to conclude that groundwater management in the Madera Subbasin will adversely affect the implementation of a plan or impede achievement of sustainability goals in an adjacent basin. Department staff encourage the GSAs to evaluate whether their Plan adversely affects the ability of an adjacent basin to implement their groundwater sustainability plan or impedes achievement of sustainability goals in an adjacent basin. Department staff will continue to review periodic evaluations to the Plan and Annual Reports to assess whether implementation of the Madera Subbasin GSP is likely to impact adjacent basins.

5.7 Consideration of Climate Change And Future Conditions

The GSP Regulations require a GSA to consider future conditions and project how future water use may change due to multiple factors including climate change.[271]

Since the GSP was adopted and submitted, climate change conditions have advanced faster and more dramatically. It is anticipated that the hotter, dryer conditions will result in a loss of 10% of California’s water supply. As California adapts to a hotter, drier climate, GSAs should be preparing for these changing conditions as they work to sustainably manage groundwater within their jurisdictional areas. Specifically, the Department

[268] 23 CCR § 354.28(b)(3).
[269] Joint GSP (Redlined), Executive Summary, p. 25.
[270] Joint GSP (Redlined), Section 3.2.1.4, p. 277, Section 3.2.2.4, p. 278, Section 3.2.4.4, p. 285, Section 3.2.5.4, p. 291, Section 3.3.1.5, p. 304, Section 3.3.2.3, p. 309, Section 3.3.3.3, p. 312, Section 3.3.4.3, p. 318, Section 3.3.5.3, p. 319.
[271] 23 CCR § 354.18.

encourages the GSAs to explore how the proposed groundwater level thresholds have been established in consideration of groundwater level conditions in the Subbasin based on current and future drought conditions. The Department encourages the GSAs to also explore how groundwater level data from the existing monitoring network will be used to make progress towards sustainable management of the Subbasin given increasing aridification and effects of climate change, such as prolonged drought. Lastly, the Department encourages the GSAs to continually coordinate with the appropriate groundwater users, including but not limited to domestic well owners and state small water systems, and the appropriate overlying county jurisdictions developing drought plans and establishing local drought task forces[272] to evaluate how the GSAs' groundwater management strategy aligns with drought planning, response, and mitigation efforts within the Subbasin.

[272] Water Code § 10609.50.

6 STAFF RECOMMENDATION

Department staff believe sufficient action has been taken by the GSAs to the deficiencies identified. Department staff recommend approval of the Plan with the required and recommended corrective actions listed below. The Plan conforms with Water Code Sections 10727.2 and 10727.4 of SGMA and substantially complies with the GSP Regulations. Implementation of the Plan will likely achieve the sustainability goal for the Madera Subbasin. The GSAs have identified several areas for improvement of its Plan and Department staff concur that those items are important and should be addressed as soon as possible. Department staff have also identified additional recommended corrective actions that should be considered by the GSAs for the first periodic assessment of its GSP. Addressing these recommended corrective actions will be important to demonstrate that implementation of the Plan is likely to achieve the sustainability goal. The recommended corrective actions include:

RECOMMENDED CORRECTIVE ACTION 1

Considering MID GSA has yet to adopt the Plan, by the first periodic evaluation, MID GSA should identify and list the specific projects and management actions that MID GSA will or may be responsible for implementing under the Revised Joint GSP and provide a parallel listing and detailed identification and discussion of the legal, contractual, or other authorities or arrangements that MID GSA is relying or will rely upon in adequately implementing the Plan including those projects or management actions to clearly demonstrate the feasibility of MID GSA implementing all projects and management actions.

RECOMMENDED CORRECTIVE ACTION 2

While the GSAs have established a framework for coordination of multiple GSPs that could serve as a basis to achieve Subbasin sustainability, it is vital that the GSAs continue their efforts to improve coordination and eliminate any remaining areas of disagreement that could delay Plan implementation or affect the likelihood of achieving sustainability. For example, the GSA should come to a consensus regarding the data and methods utilized to develop refined future water budgets for the entire Subbasin, and agreement regarding the availability and use of more detailed data as it becomes available from each GSP area. These efforts should be done with the ultimate goal that the contents of each GSP should represent a component of a cohesive, unified Plan that will achieve the sustainability goal in the Subbasin consistent with SGMA timelines and not be an isolated document only for a specific GSP area.

RECOMMENDED CORRECTIVE ACTION 3

The GSAs should revise the GSPs to include a discussion of the relationship between the management criteria for chronic lowering of groundwater levels and the other sustainability indicators, including an explanation of how the criteria, including interim milestones, were established to avoid undesirable results for each of the other sustainability indicators.

RECOMMENDED CORRECTIVE ACTION 4

Department staff recommend the following as it relates to land subsidence:

a. The GSAs should refine the description of undesirable results to clearly describe the significant and unreasonable conditions the GSAs are managing the Subbasin to avoid, as it relates to land subsidence. More specifically, the GSAs should reevaluate the quantitative metrics that define an undesirable result for subsidence. The reevaluation should consider localized subsidence conditions and the irreversibility of continued inelastic subsidence, especially in the area deemed of “greater subsidence concern.” This is to say that the current quantitative metrics (i.e., 75 percent of the representative monitoring sites in the Subbasin exceed threshold levels for two consecutive years across the entire Subbasin) would not minimize or avoid inelastic subsidence in the most susceptible areas of the Subbasin – predominantly in the north-northwestern portion of the Subbasin which are describe as the areas of greater subsidence concern.

b. The GSAs should identify the cumulative amount of subsidence that, if exceeded, would substantially interfere with groundwater and land surface beneficial uses and users in the Subbasin. The Plan should explain how the rate and extent of any future subsidence permitted in the Subbasin may interfere with surface land uses. The Plan should also include additional details describing measures that consider and disclose the current and potentially lasting impacts of subsidence on land uses and groundwater beneficial uses and users.

   Additionally, the GSAs should provide specific details and schedule for projects or management actions that will be implemented to minimize or eliminate subsidence. The projects or management actions must be supported by best available information and science[273] and consider the level of uncertainty associated with the Subbasin.[274]

c. The GSAs should revise the GSPs to include a discussion of the relationship between the management criteria for land subsidence and the other sustainability indicators, including an explanation of how criteria, including interim milestones, were established to avoid undesirable results for each of the other sustainability indicators.

d. The GSAs should reevaluate or eliminate the application of the level of uncertainty as it relates to subsidence measurements according to standard professional practices. Establishment of sustainable management criteria should not allow for

[273] 23 CCR § 354.44 (c).
[274] 23 CCR § 354.44 (d).

subsidence in perpetuity based on the error of measurement. The GSAs should also consider incorporation of remotely sensed subsidence data (i.e., InSAR data) made available by the Department on an ongoing basis to monitor for subsidence in conjunction with the representative monitoring sites. For reference, the statewide vertical displacement measurements provided via the InSAR data present an error of 0.1 foot.

Recommended Corrective Action 5

The GSA should provide a discussion of the uncertainty concerning the hydrogeologic conceptual model and a description of hydrogeologic conceptual model data gaps.[275] For example, the GSP should include revisions to identify how many wells are completed below the bottom of the Subbasin, the amount of water that is extracted from these wells, and a description of changes to groundwater storage calculations for the Subbasin based on best available information.

Recommended Corrective Action 6

The GSAs must provide more detailed explanation and justification regarding the selection of the sustainable management criteria for degradation of water quality. Department staff recommend the GSAs consider and address the following:

a. The GSAs should revise the definition of undesirable results so that exceedances of minimum thresholds caused by groundwater extraction are considered in the assessment of undesirable results in the Subbasin.

b. The GSAs should provide a clear definition of what the Plan considers an undesirable result for degraded water quality by describing conditions that it would consider to be significant or unreasonable. For example, the Plan should—in addition to qualitative descriptions—quantify the specific potential effects to beneficial users and uses from undesirable results using best available data and science. This definition should be supported by information described in the basin setting, and other data or models as appropriate, as required by the GSP Regulations.[276]

c. The GSAs should identify which minimum threshold values—either the MCL or existing concentration plus 20 percent—will be used at which representative monitoring sites. Also, the GSAs should justify how establishing minimum thresholds at the higher of either MCLs or existing concentrations plus 20 percent does not constitute significant and unreasonable effects as defined by the GSP (i.e., “when beneficial uses for groundwater are adversely impacted by constituent concentrations).

[275] 23 CCR § 354.14(b)(5).
[276] 23 CCR § 354.26 (b)(1).

APPENDIX C
PROJECTS AND MANAGEMENT ACTION IMPLEMENTATION PLAN AND BENEFITS

Project or Management Action Name	Project or Management Action Description	Targeted Sustainability Indicator	Project Status	Expected Schedule	Benefits Observed to Date or Anticipated Benefits	Estimated Accrued Benefits per Interim Period (acre-feet)	Notes
Recharge Program	Increase percolation in the District's recharge basin and make improvements to canal controls to increase recharge capabilities and metering.	Groundwater levels	Active	Ongoing	Increase in percolation and groundwater storage volume in the GFWD GSA area	20000	This project currently increases groundwater recharge by about 10,000 af twice per interim period (5-years)
Agriculture Well Metering	Metering program is a future option of District Board to consider as a requirement for new well to be registered in the District	Groundwater levels, land subsidence and groundwater storage	Waiting on Funding	4/1/26	Provide more accurate data for water budgeting and SMC analysis in future years	5000	This project will likely decrease pumping by approximately 1000 af per year
Increased Measurement, Sampling, and Monitoring	Program has been initiated and will be continued. Wells will be surveyed and base line elevation will be recorded	Water quality, groundwater levels, and subsidence	Active and Expanding	Ongoing	Increase water level measurements, groundwater sampling, and testing	0	This project will likely not increase net groundwater recharge. It is for informational and management purposes
San Joaquin River Restoration Program	Settlement goal would benefit the restoration area to maintain fish populations and increase groundwater inflow due to seepage	Groundwater storage, Interconnected surface water	Active	Ongoing	To protect fish population and interconnected surface water, increase groundwater inflow into the District	Unknown	This ongoing project increases groundwater inflow
Coordination Agreement	GFWD GSA is committed to implementing sustainability goals and working with their GSA partners	All SMCs	In Process	Ongoing	Communication with Madera Subbasin partner GSAs and the community at large	0	This project will likely not increase net groundwater recharge. It is for management purposes
San Joaquin River (SJR) Flood Water Recharge	Focused on conveyance of SJR Flood Water Flows and increasing capacity to allow increased volume	Groundwater storage and groundwater levels	Waiting on Funding	4/1/30	Increase diversion of surface water which will offset to groundwater use, increase surface water for recharge, and reduce pumping for agriculture crops	40000	This project currently increases groundwater recharge by about 10,000 af twice per interim period (5-years)
District System Water Metering Project	Installing metering stations and controls at three locations to monitor and record flows	Groundwater levels, groundwater storage	Waiting on Funding	4/1/30	Increase metering and monitoring and reduce data gaps	0	This project will likely not increase net groundwater recharge. It is for informational and management purposes
Conveyance Pipeline from San Joaquin River Pumps	Installing additional pipeline to convey water from existing SJR pumps to Gravelly Ford Main Canal	Groundwater levels, groundwater storage	Waiting on Funding	4/1/30	Increase diversions of surface water to the GSA	Project combined with SJR Flood	This project currently increases groundwater recharge by about 10,000 af twice per interim period (5-years)
Automation & SCADA	Provide water management through installation of structures and gates, which allows improved water management of flood flows to be routed for irrigation needs or recharge	Groundwater levels, groundwater storage	Waiting on Funding	4/1/26	Improve monitoring and management of surface water in the District	6000	This project currently increases groundwater recharge by about 3,000 af twice per interim period (5-years)
					Minimum estimated net recharge per 5-year interim	**71000**	
					Annual minimum estimated net recharge per year	**14200**	

APPENDIX D
DATA GAPS FOR 2018 HCM REPORT FOR GRAVELLY FORD WATER DISTRICT

DATA GAPS FOR 2018 HCM REPORT
FOR GRAVELLY FORD WATER DISTRICT

Both water levels and subsidence have been addressed through the semi-annual water-level measurement program for 24 wells and the biennial subsidence (ground surface elevation) measurements for six RMS wells. Following are additional data gaps to be addressed.

Pumpage

Totalizing flowmeters should be installed for all large capacity wells (greater than 200 gpm) in the District. If grant funds can't be obtained, then well owners should pay for this. The total pumpage should be measured twice a year and reported to the GSA.

Aquifer Characteristics

In order to determine groundwater inflows and outflows, Darcy's Law is used, where Q = TIL.

Q = groundwater flow (gpd)

T = aquifer transmissivity (gpd/ft)

I = water-level slope (feet per mile)

L = width of flow (miles).

The semi-annual water-level elevation and direction of groundwater flow maps can be used to determine the water-level slopes and widths of flow. Aquifer tests are needed to determine the transmissivity. The aquifer tests would be done by Madera Pump under the direction of KDSA. A constant rate test of about 9 hours would be necessary, plus several hours of recovery measurements. The well selected would have verifiable construction data (preferably drillers logs) and a totalizing flowmeter. Approximately six wells would be tested. Three of these would be along the southeast District boundary (inflow). The other three would be along the northwest District boundary (outflow). Possible inflow area wells would be 201, 202, 206, and 213. Possible outflow area wells would be 203, 223, and 224. KDSA would prepare graphical plots of the drawdown and recovery measurements and determine transmissivity. They would also prepare estimates on a semi-annual basis of groundwater inflows and outflows.

Private Domestic Wells

All active private domestic wells in the District need to be field located, mapped, and information collected on their construction (ie drillers logs, etc).

Domestic Well Sampling

Each domestic well would be sampled in the summer, after about 20 minutes of pumping. KDSA would conduct the sampling and arrange and pay for the analyses. Major constituents of concern are nitrate, DBCP, 1,2,3-TCP, and gross alpha activity. Once the initial sampling and analyses are completed, a select number of these wells would be selected for sampling every three years.

Surface Water Monitoring

Flowmeters would be installed at the following locations:

Cottonwood Creek inflow and outflow at District boundaries

Diversion to Gravelly Ford Canal

This information is needed to better determine seepage losses.

APPENDIX E
HYDROGEOLOGIC CONCEPTUAL MODEL KDSA

HYDROGEOLOGIC CONCEPTUAL MODEL AND GROUNDWATER CONDITIONS FOR THE GRAVELLY FORD WATER DISTRICT GSP

Draft Report

prepared for
Gravelly Ford Water District
Madera, California

by
Kenneth D. Schmidt & Associates
Groundwater Quality Consultants
Fresno, California

October 2018

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HYDROGEOLOGIC CONCEPTUAL MODEL AND GROUNDWATER CONDITIONS FOR THE GRAVELLY FORD WATER DISTRICT GSP

INTRODUCTION

This report is intended to satisfy Sections 354.14 (Hydrologic Conceptual Model) and Section 354.16 (Groundwater Conditions) of a Groundwater Sustainability Plan (GSP) for the Gravelly Ford Water District (GFWD). The GFWD (the GSA) is located north of the San Joaquin River and southwest of the City of Madera.

SURFICIAL CHARACTERISTICS OF BASIN

Topography

Figure 1 shows topographic conditions in the basin. The land surface generally slopes to the west. Land surface elevations range from about 200 feet above mean sea level near the northeast corner of the GSA to about 175 feet above mean sea level near the southwest corner of the GSA. The southeast corner of the GSA is near the San Joaquin River and Road 21. The Chowchilla Canal Bypass is several miles west of the west edge of the GSA. Cottonwood Creek flows into the District from the northeast.

Surficial Geology

Wagner (2002) mapped the surficial geology of the Madera area,

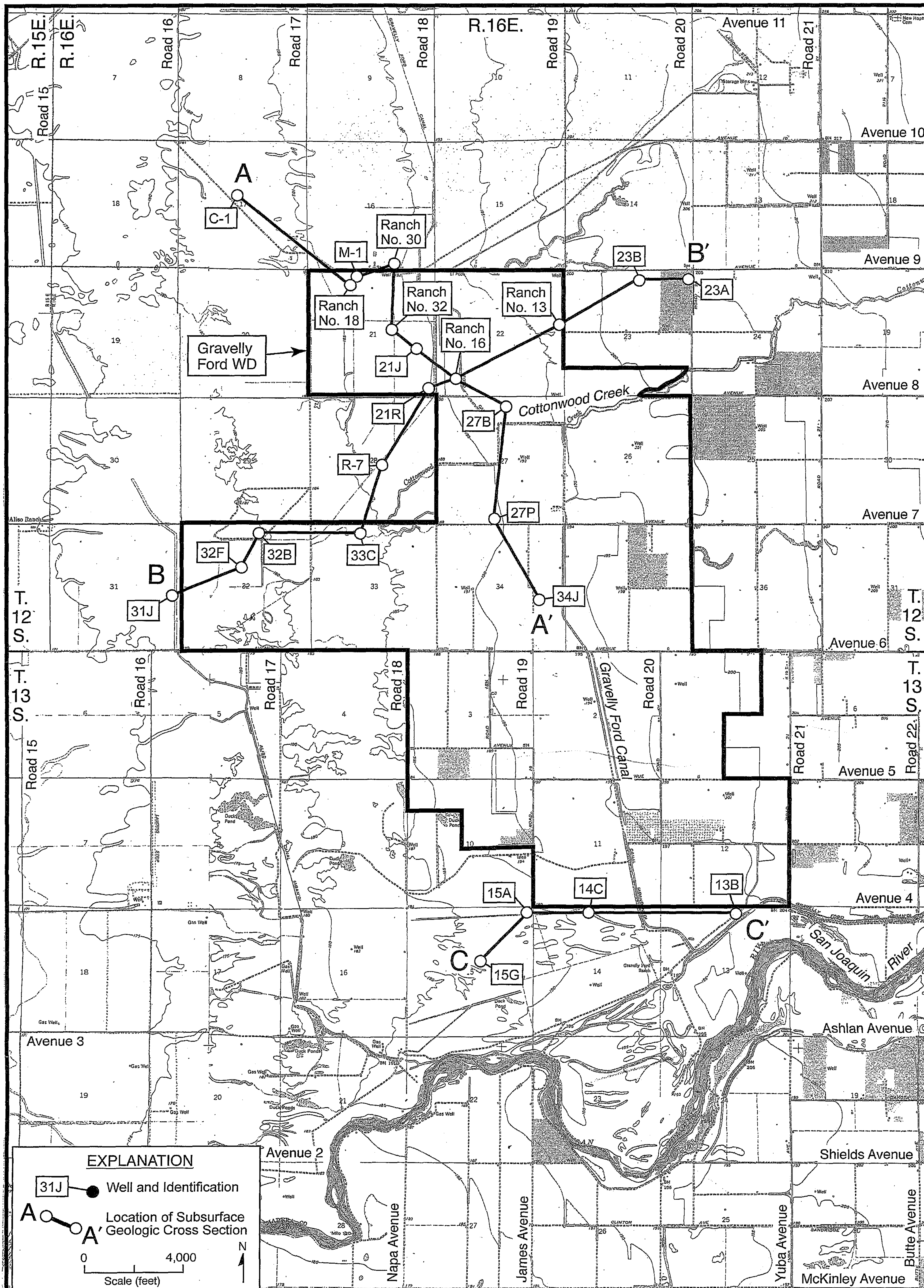


FIGURE 1 - TOPOGRAPHIC MAP OF GSA AND LOCATIONS OF SUBSURFACE GEOLOGIC CROSS SECTIONS

which include the GFWD GSA. Figure 2 shows the part of his map that covers the GSA. The southern part of the GSA was mapped as Quaternary fan deposits. The northern part of the District was mapped as Quaternary basin deposits.

Topsoils

Figure 3 shows the major types of topsoils in the GSA from the U.S. Soil Conservation Service report on soils in the Madera area (Ulrich and Stromberg, 1962). Four soil associations were shown in the GSA. Topsoils in most of the GSA were mapped as the Dinuba-El Peco association. North of Avenue 6, some topsoils are of the Fresno-El Peco association. Both of these soils have hardpan development. Traver-Chino association soils are present in only a small area, south of Avenue 7 and east of Road 16. These soils don't have a hardpan, but have more clay in the subsoil. Between Avenues 4 and 5, soils of the Hanford-Tujunga association are present. These soils are coarse-grained and the most permeable of the topsoils in the GSA.

Surface Water Bodies

Figure 1 shows the location of surface water bodies in and near the GSA. The San Joaquin River is the mayor stream in the area and is near the southeast corner of the GSA. Cottonwood Creek drains a considerable area in the foothills and enters the

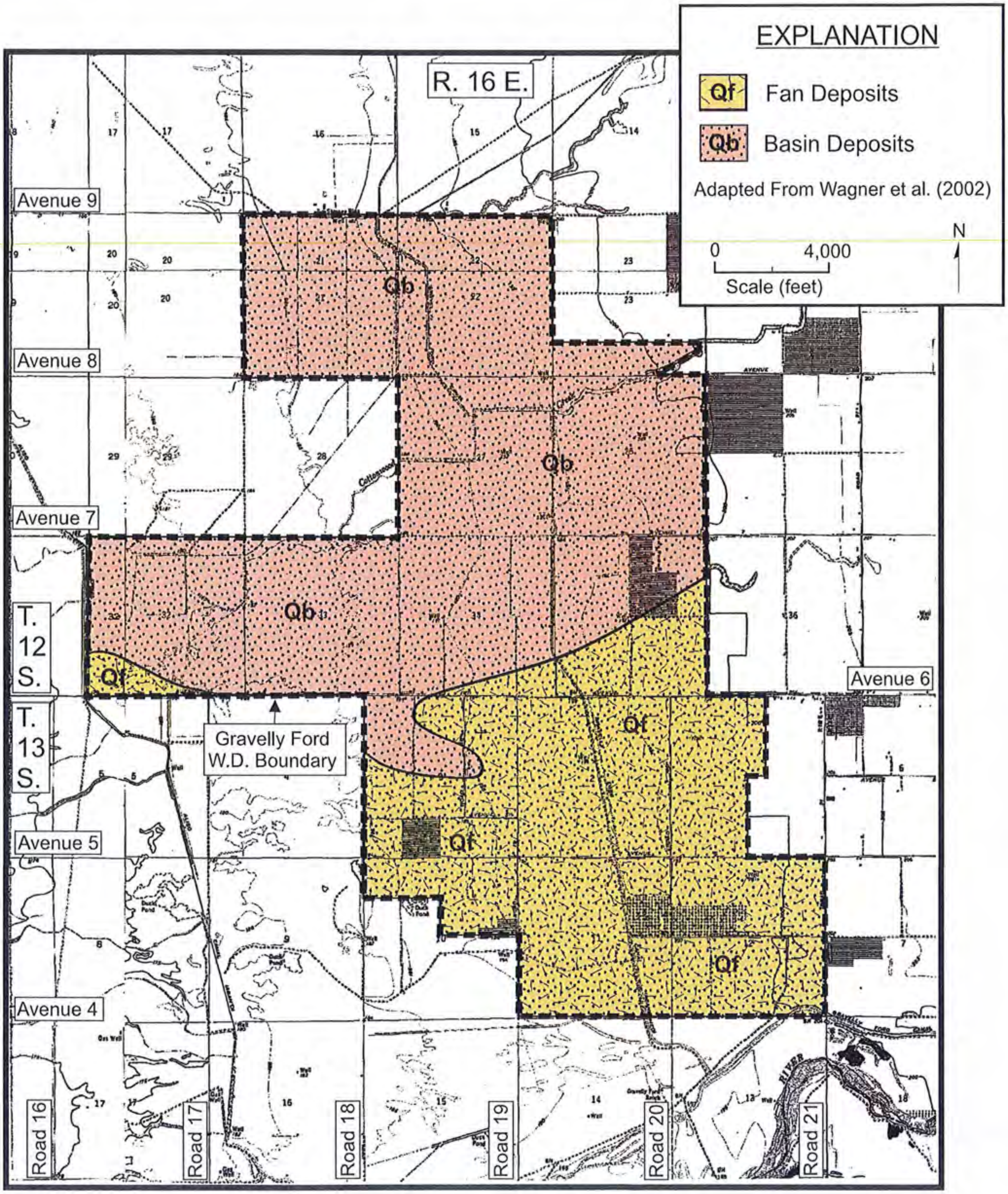


FIGURE 2 - SURFICIAL GEOLOGIC MAP

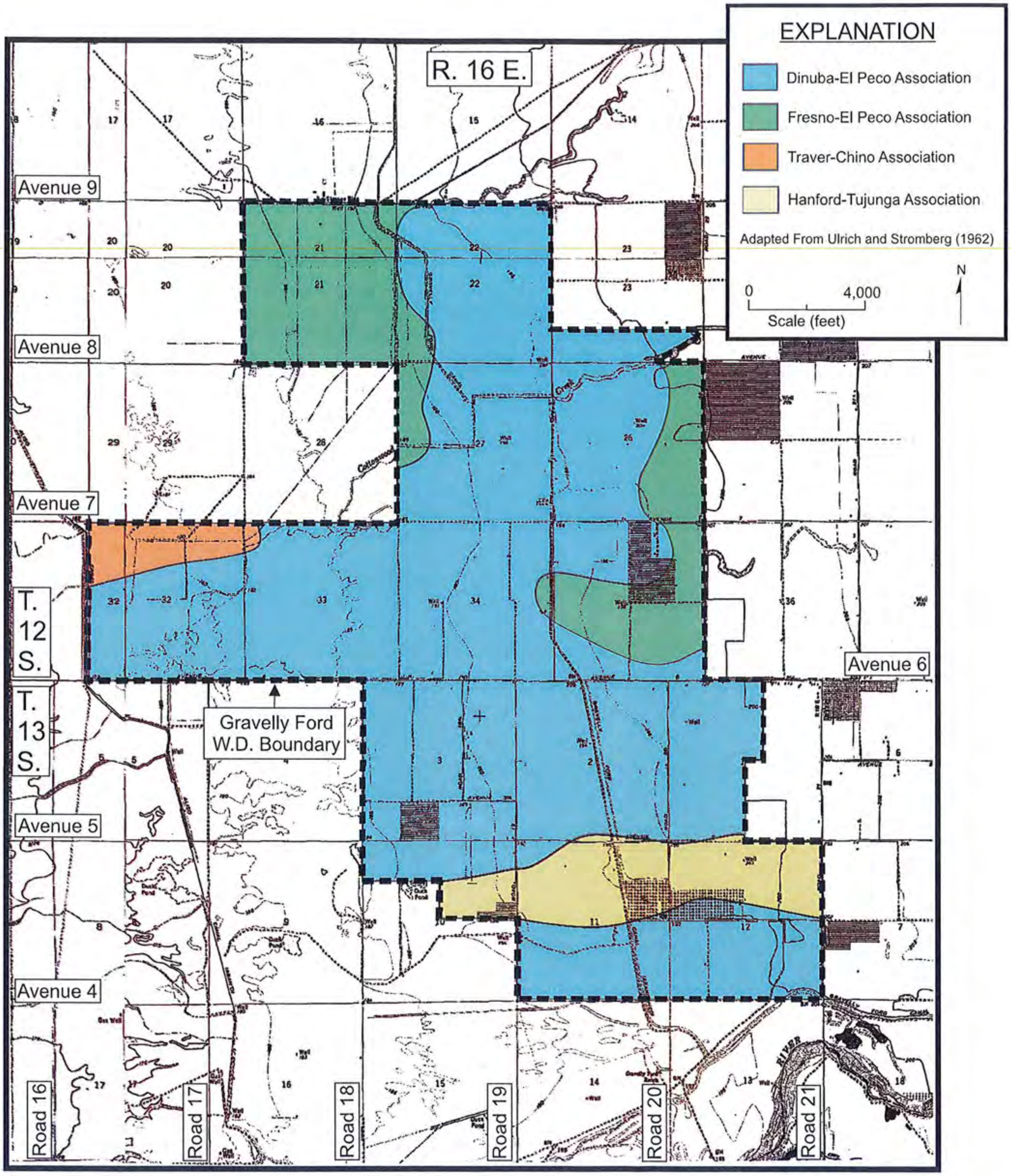


FIGURE 3 - TOPSOILS

GSA from the northeast. The Chowchilla Canal Bypass is a major flood control channel that passes from the south to north several miles west of the east edge of the District.

SUBSURFACE GEOLOGIC CONDITIONS

Mitten, LeBlanc, and Bertoldi (1970) described the geology, hydrology, and water quality of the Madera Area, which includes the GSA.

Regional Geologic and Structural Setting

The GSA is within the San Joaquin Valley, which is a topographic and structural through, bounded on the east by the Sierra Nevada fault block and on the west by the folded and faulted Coast Ranges. Both mountains blocks have contributed to marine and continental deposits in the Valley. In the west-central part of the valley, more than 12,000 feet of sediments are present. Alluvial deposits comprise the aquifer in the area. These interlayered deposits dip slightly to the south-southwest in the area.

Lateral Basin Boundaries

Figure 1 shows the boundaries of the basin. The basin boundaries include the San Joaquin River on the south end. The remaining boundaries are political boundaries, including the Aliso W.D. service area on the west and the Madera Irrigation District service area to the north and east. All of the basin is in Madera County.

Definable Bottom of the Basin

Figure 4 shows the definable bottom of the basin. Historically, the U.S. Geological Survey (Page, 1973) used an electrical conductivity of about 3,000 micromhos per centimeter at 25°C to delineate the regional base of the fresh groundwater in the San Joaquin Valley. The base of the fresh groundwater could be called the "bottom of the basin". However, another factor to consider is where the deposit predominantly become fine-grained at depth. As part of this evaluation, electric logs for deep holes were obtained from the California Division of Oil & Gas, and Geothermal Resources. A review of these logs indicated depths to the bottom of the basin ranging from about 800 to 1,100 feet. The bottom of the basin is generally the shallowest beneath the southwest part of GSA and deepest beneath the northeast and east parts of the GSA.

Formation Names

Mitten, LeBlanc, and Bertoldi (1970) divided the unconsolidated deposits in the Madera area into the younger alluvium (normally less than about 50 feet thick), the Quaternary older alluvium (less than 1,000 feet thick), and the Tertiary-Quarternary continental deposits (about 1,000 to 2,200 feet thick). The Corcoran Clay is a regional confining bed. This clay divides the groundwater into an upper aquifer and lower aquifer. Depos-

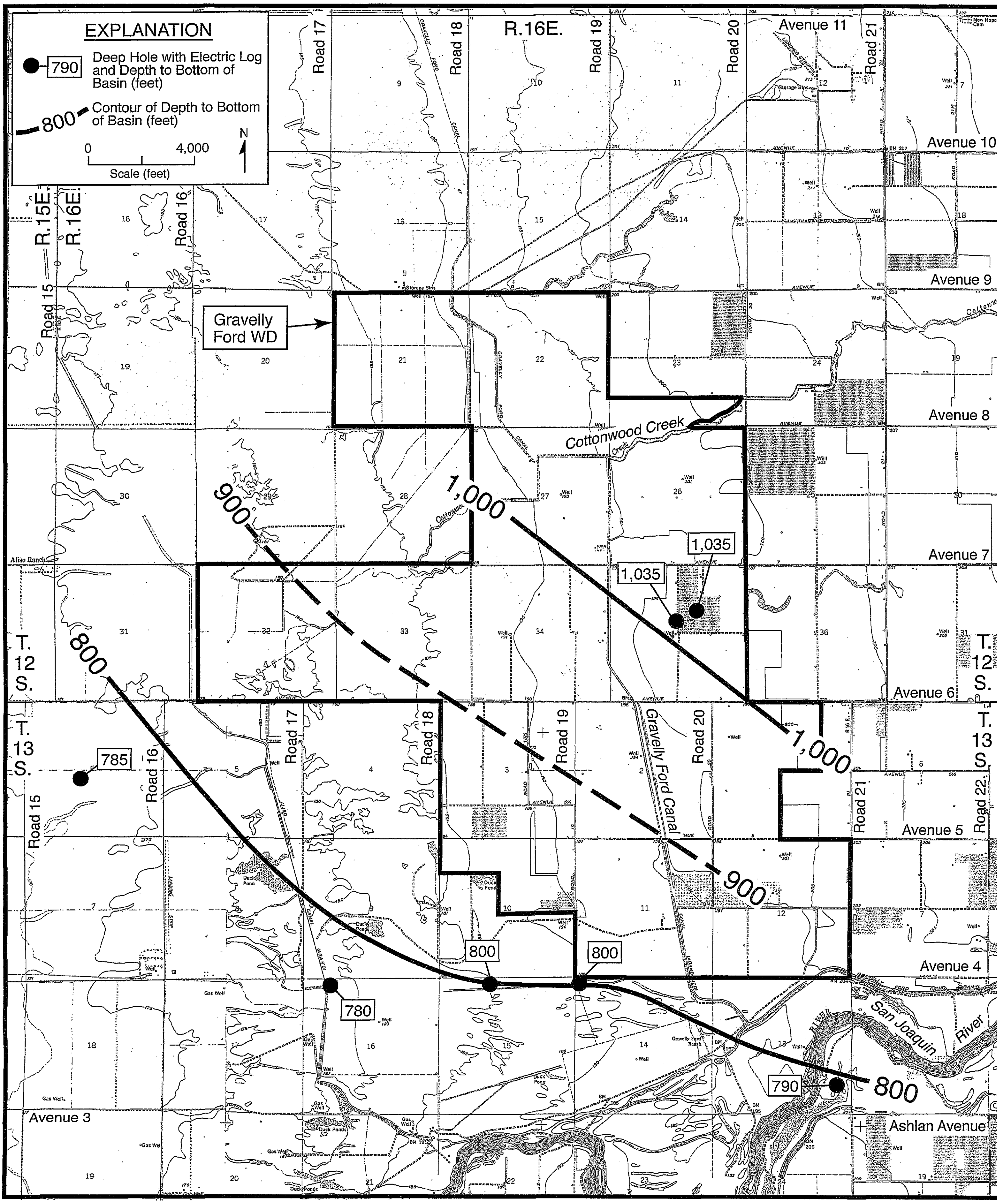


FIGURE 4 - DEFINABLE BOTTOM OF BASIN

aquifer. Deposits in the GSA are generally termed the Sierra deposits, as they were derived from the Sierra Nevada.

Confining Beds

The confining bed that is important beneath the GSA is the E-Clay or Corcoran Clay. Figure 5 shows the depth to the top of the Corcoran Clay. The top of this clay is shallowest (about 300 feet deep) in the north part of the GSA and is deepest (about 380 feet deep) near the south edge of the GSA. The depth to the top of the Corcoran Clay essentially defines the base of the upper aquifer. The Corcoran Clay generally thickens to the southwest beneath the GSA.

Principal Aquifers

Based on subsurface geologic cross sections (presented in the next section) and water well drillers logs and completion reports, the lower part of the upper aquifer and the upper part of the lower aquifer comprise the principal strata tapped by irrigation wells in most of the District. Because of relatively shallow water levels, near the San Joaquin River some wells in this part of the GSA tap only the upper aquifer.

Subsurface Geologic Cross Sections

KDSA have developed three subsurface geologic cross sections in and near the GSA. Locations of these cross sections are pro-

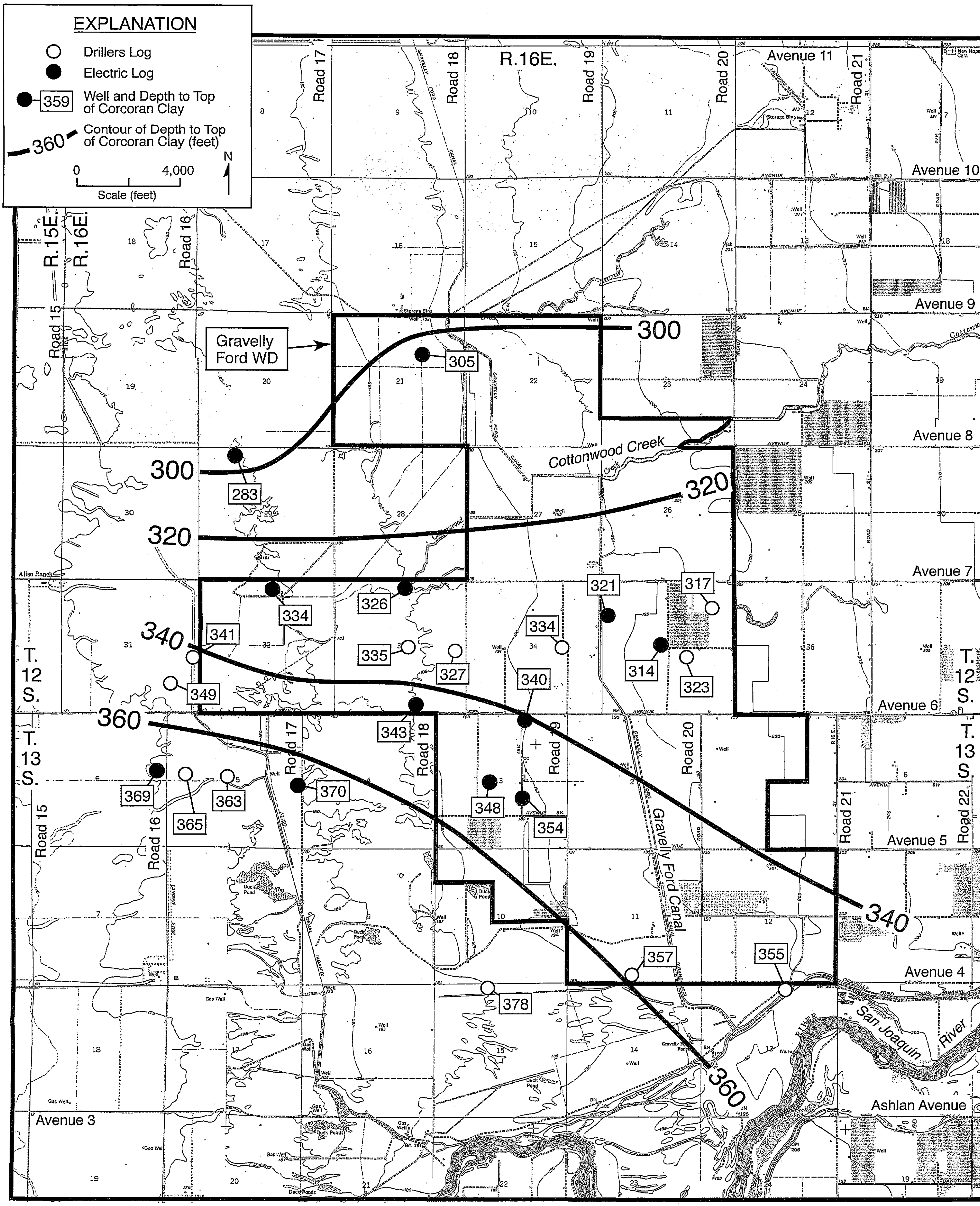


FIGURE 5 - DEPTH TO TOP OF CORCORAN CLAY

vided on Figure 1. The important confining beds (clay layers) and major water producing strata (sand and gravel) are shown on these sections. Cross Section A-A′ generally extends from the northwest to the southeast, perpendicular to the inferred dip of the alluvial deposits. In contrast, Cross Sections B-B′ and C-C′ extend from the southwest to the northeast, generally perpendicular to Cross Section A-A′, and along the inferred dip of the deposits.

Cross Section A-A′ (Figure 6) extends from near Avenue 9-1/2 and Road 16-1/2 on the northwest, to near Avenue 6-1/2 and Road 19 on the southeast. The Corcoran Clay thickens to the northwest along the section, from about 10 feet near the southeast edge to about 30 feet beneath the northwest part. Sand or gravel layers are common above the Corcoran Clay and below the water level along this section. Interbedded sand and clay layers are present below the Corcoran Clay along the section. In general, clays are thicker and more predominant below the Corcoran Clay than above. More sand is indicated below the Corcoran Clay along the northwest point of the section than elsewhere.

Cross Section B-B′ (Figure 7) extends from near Avenue 6-1/2 and Road 16 in the southwest to the northeast, to near Avenue 9 and Road 20. The Corcoran Clay generally thickens to the southwest along this section, from about 15 feet near the northeast edge to about 40 feet near the southwest end. Sand layers are

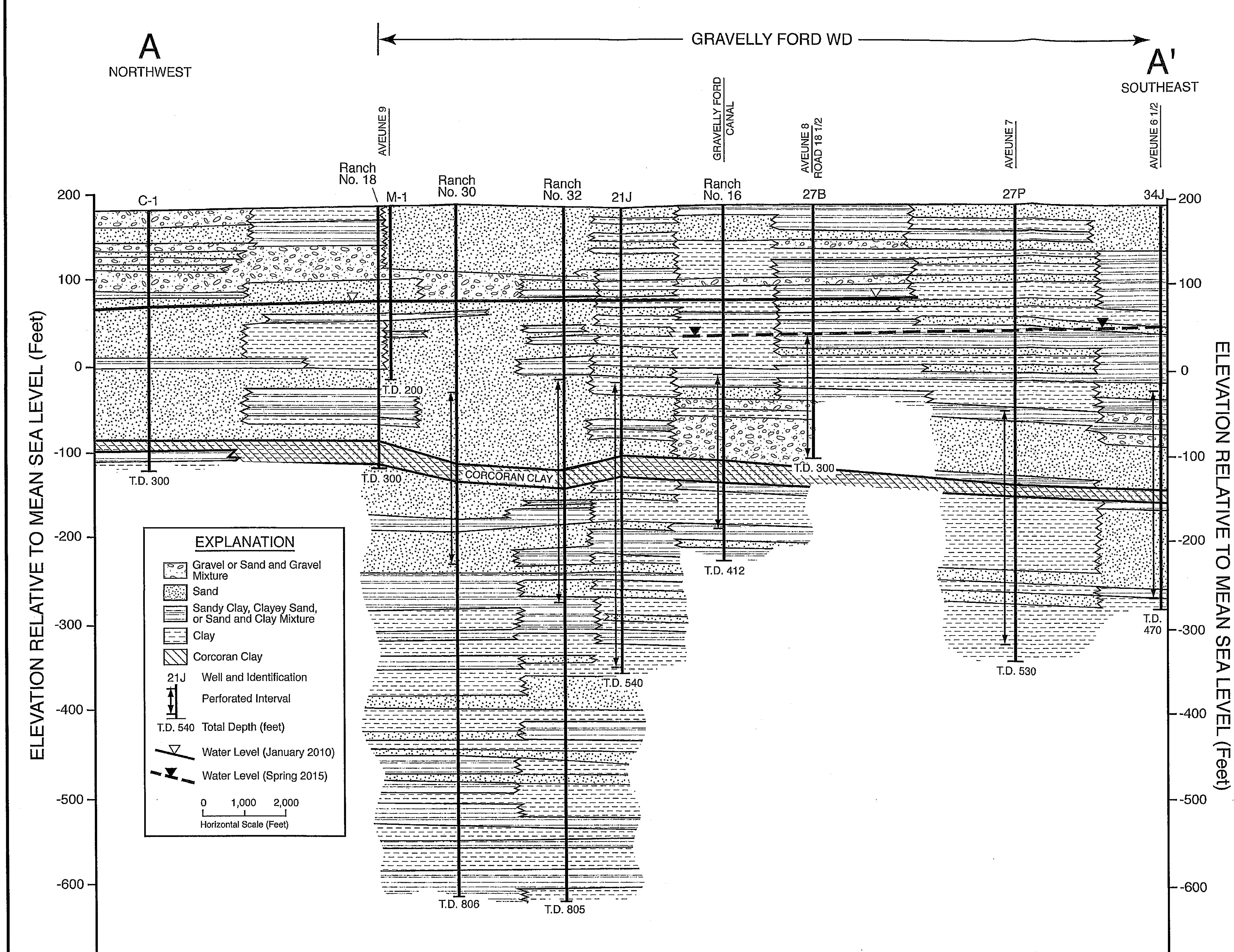


FIGURE 6 - SUBSURFACE GEOLOGIC CROSS SECTION A - A'

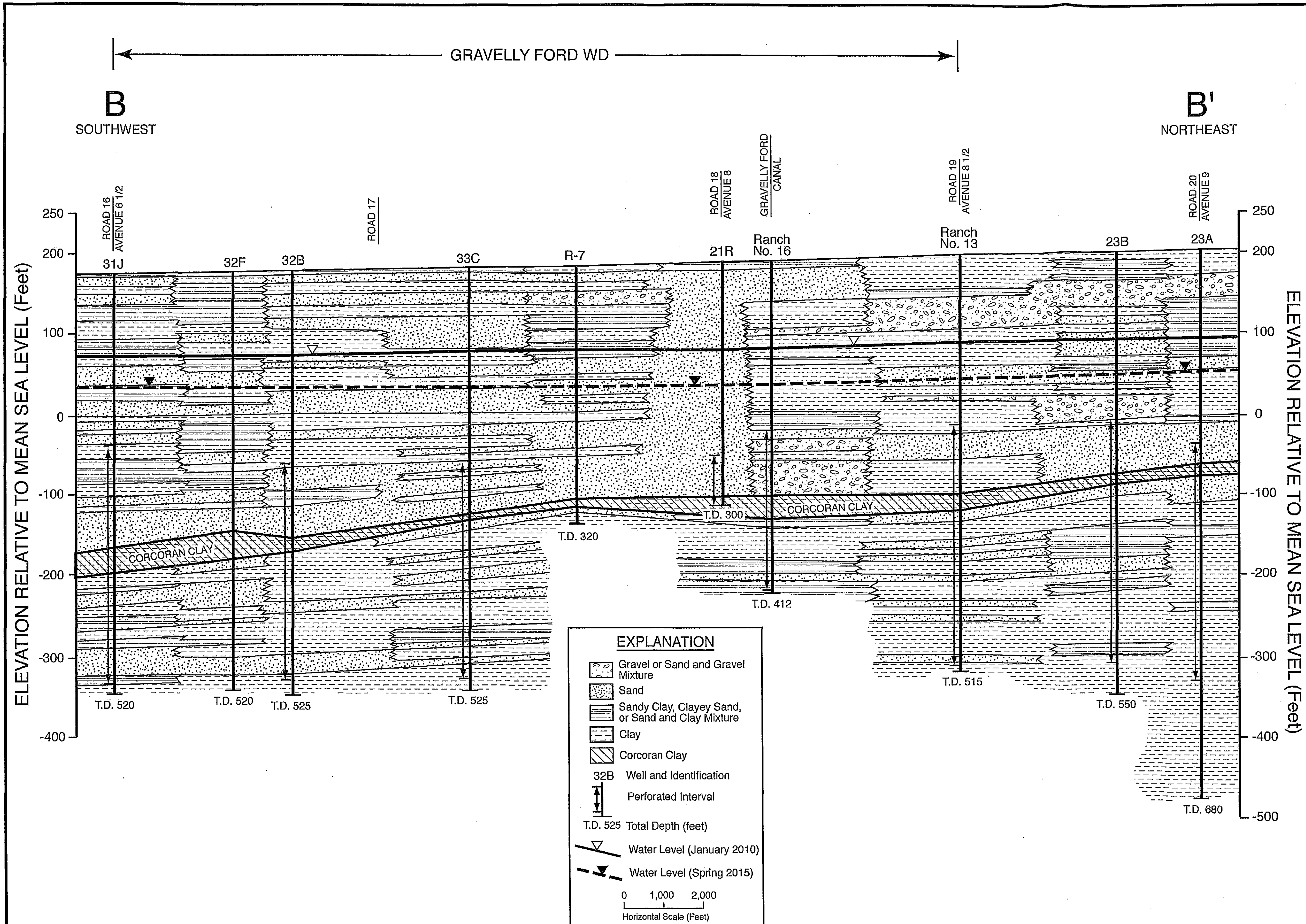


FIGURE 7 - SUBSURFACE GEOLOGIC CROSS SECTION B - B'

common above the Corcoran Clay and below the water level at most locations. Based on the available data, sands below the Corcoran Clay are thickest beneath the southwest part of the section. Clay strata are thick and fairly extensive below the Corcoran Clay along much of this section.

Cross Section C-C′ (Figure 8) extends from near Avenue 3 and Road 17-1/2 on the southwest to the northeast and east to near Avenue 4 and Road 20-1/2. The Corcoran Clay ranges from about 15 to 30 feet thick along the section. There are a number of laterally extensive sand layers above the Corcoran Clay and below the water level along much of the section. Interbedded sand and clay layers are present below the Corcoran Clay along most of the section. Sands below the Corcoran Clay are more common beneath the northeast part of the section.

GROUNDWATER USE AND WELL DATA

Primary Uses of Each Aquifer

Within the GSA, the primary use of the upper and lower aquifer is for irrigation. Some water is also used for private domestic use.

Depths of Supply Wells

Driller′s logs and well completion reports indicate that depths of the majority of active irrigation wells in the GSA

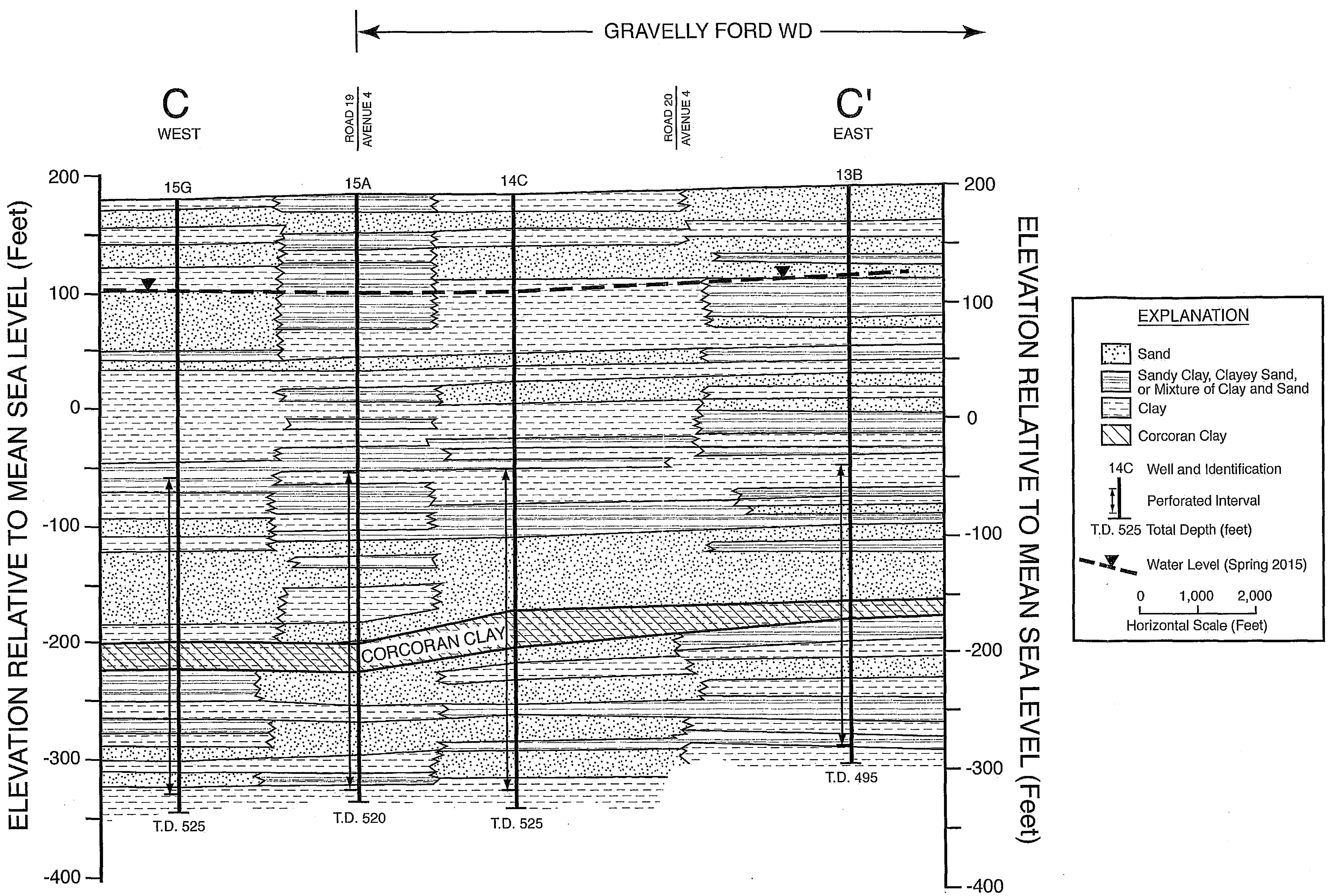


FIGURE 8 - SUBSURFACE GEOLOGIC CROSS SECTION C - C'

with records range from about 350 to 600 feet. Only a small percent of these wells tap only the upper aquifer. Almost all of the remaining irrigation wells are indicated to be composite wells, tapping strata both above and below the Corcoran Clay.

WATER LEVELS

This water-level discussion focuses on measurements primarily for irrigation wells, many of which are composite wells, tapping both the upper and lower aquifers. Because of the lack of wells that solely tap the lower aquifer in and near the GSA, it is not possible to prepare a water-level map for the lower aquifer. However, limited data based on a few wells in nearby areas indicate a southwesterly direction of groundwater flow in the lower aquifer.

Water-Level Elevations and Direction Of Groundwater Flow

Figure 9 shows water-level elevations in Spring 2015, based largely on measurements for composite wells. Water-level elevations ranged from more than 110 feet above mean sea level near the southeast corner of the GSA to about 30 feet near the north part of the GSA. The direction of groundwater flow was away from the San Joaquin River to the northwest or north. This map indicates the importance of recharge from streamflow in the river to groundwater tapped by irrigation wells in the GSA.

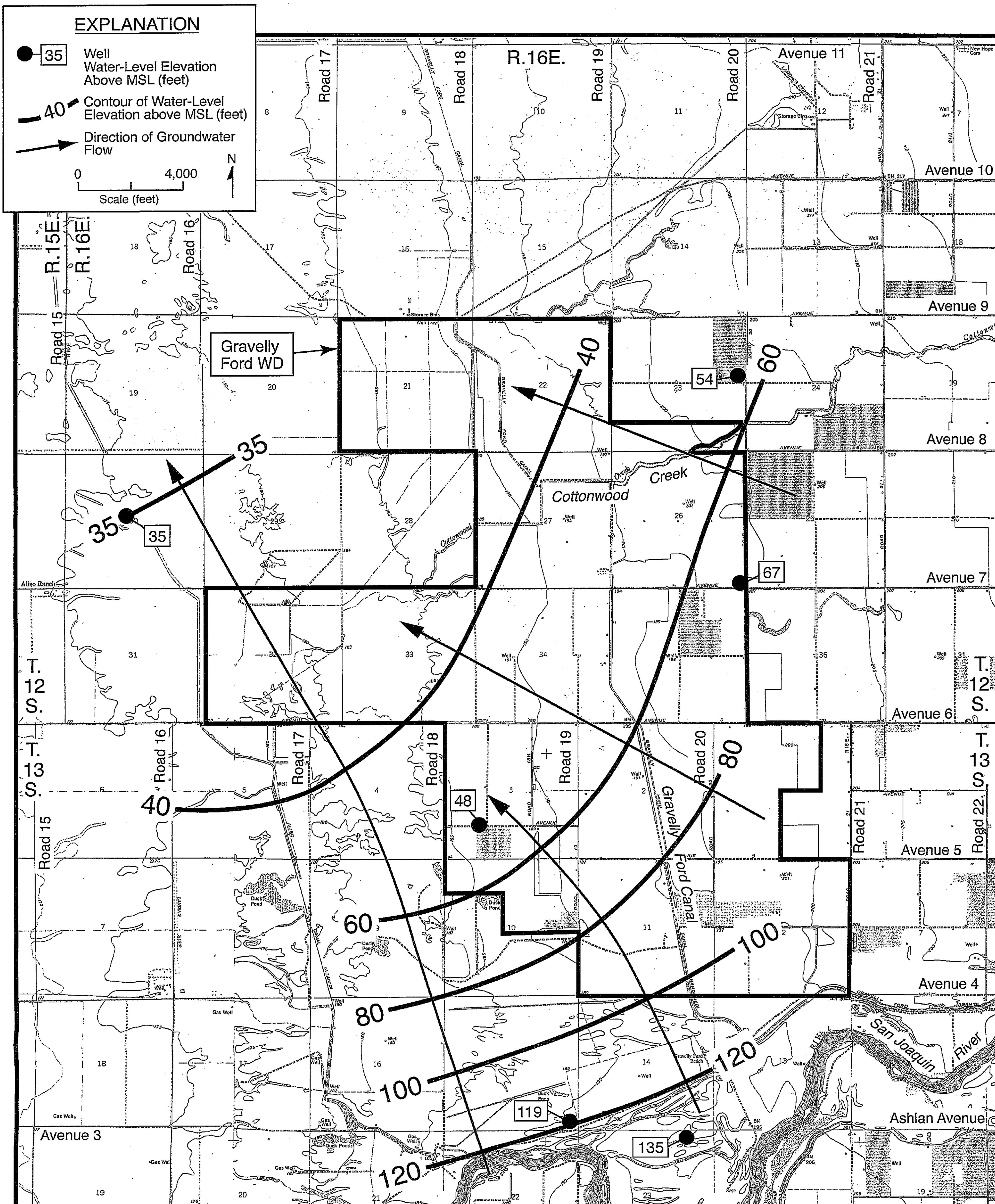


FIGURE 9 - WATER-LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW FOR IRRIGATION WELLS (SPRING 2015)

Groundwater was flowing from the river toward a pumping depression located primarily north of Avenue 6.

Water-Level Fluctuations

Long-term water-level hydrographs from the DWR website were accessed for five wells in or near the GFWD. Figure 10 shows representative water-level hydrographs for two of these wells.

Well T12S/R16E-23H1 is located near Avenue 8-1/2 and Road 20, about half a mile north of Cottonwood Creek. The water level in this well fell from about 20 feet deep in 1938 to about 60 feet deep in 1954 or an average of about 2.5 feet per year. Spring water levels fell an average of about 0.8 foot per year since 1960 (Figure 10).

Well T12S/R16E-26H1 is located near Avenue 7 and Road 20, about three-fourths of south of Cottonwood Creek. Spring water levels fell an average of 1.0 foot per year between 1950 and 1980. The average water-level decline after 1980 has been about 1.2 feet per year. Both wells 23H1 and 26H1 are indicated to be composite wells, tapping both aquifers.

Well T12S/R16E-26R1 is indicated to be a shallow well and is located near Avenue 7 and Road 20, about a mile and a quarter south of Cottonwood Creek. Water-level records for this well are available since 1949. Spring water levels in this well have fallen at an average rate of 0.4 foot per year since 1960.

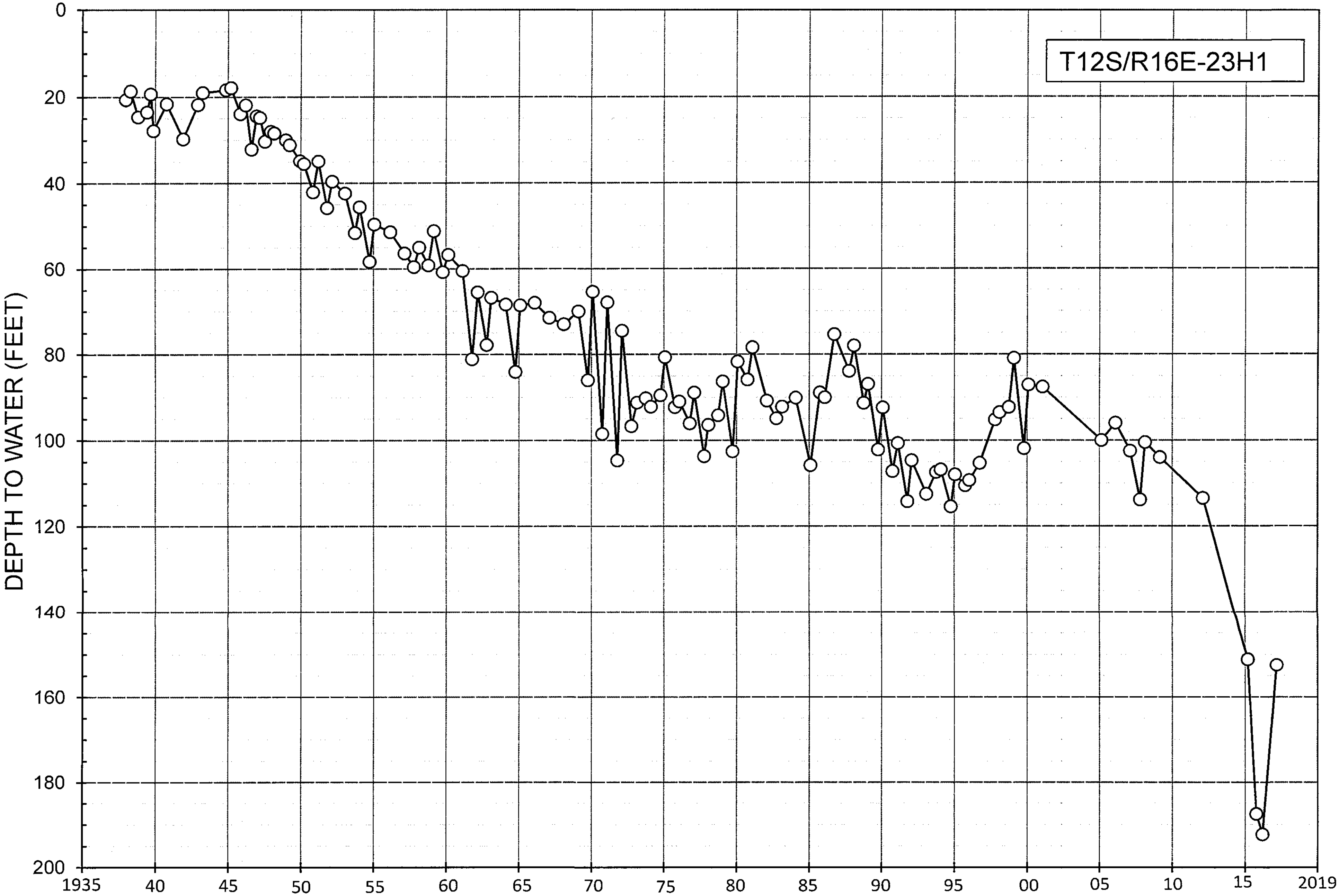


FIGURE 10 - REPRESENTATIVE WATER-LEVEL HYDROGRAPHS FOR IRRIGATION WELLS

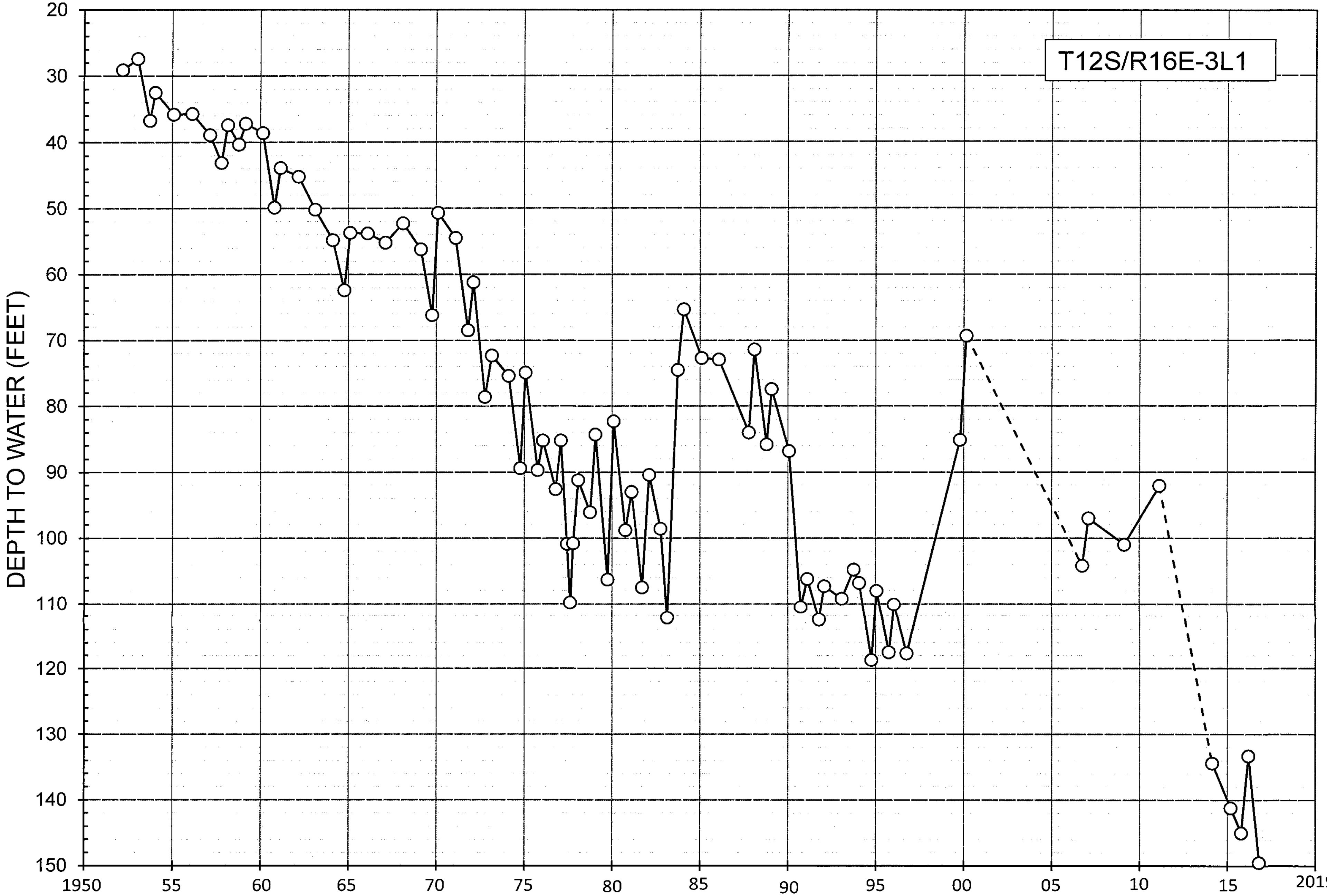


FIGURE 10 - REPRESENTATIVE WATER-LEVEL HYDROGRAPHS FOR IRRIGATION WELLS (continued)

Well T12S/R16E-31G is located near Avenue 6-1/2 and Road 15-1/2, about two miles northeast of the Chowchilla Bypass. Spring water levels fell from 50 feet deep in 1987 to about 105 feet deep in 2009, or an average of about 2.5 feet per year. Water levels fell significantly during 2013-16 during the drought. Water levels for this well appear to be more indicative of the lower confined aquifer.

Well T13S/R16E-3L1 is located near Avenue 5-1/2 and Road 18-1/2. Spring levels fell from about 35 feet in 1960 to 92 feet in 2011, or an average of about 1.1 feet per year (Figure 10).

Overall, the average water-level decline for these wells in recent decades has been about 0.9 foot per year.

Groundwater Overdraft

The best method to calculate groundwater overdraft is to use the specific yield for the unconfined groundwater and the long-term average water-level change over a hydrologic base period. Using an area of 8,500 acres, specific yield of 0.12, and average water-decline of 0.9 foot per year, the overdraft in the GSA is about 900 acre-feet per year. David's Engineering, as part of studies of the Madera Sub-basin, has made water budget estimates for the Gravelly Ford GSA. They estimated recharge to average about 15,000 acre-feet per year for 1989-2014. They estimated the average groundwater pumpage to be about 16,700 acre-feet per year. This leaves a residual of 1,700 acre-feet per year. Because the GSA is in a subsiding area, an additional source of water is compaction from the Corcoran Clay and underlying clay layers. Assuming that the average compaction during 1989-2014 was about 0.08 foot per year (half of the subsidence between 2011 and 2016), the amount of water expelled from the clays would be about 2.2 feet times 8,500 acres, or about 700 acre-feet per year. This would reduce the net imbalance to about 1,000 acre-feet per year, in good agreement with the value determined from the water-level change-specific yield estimate.

SOURCES OF RECHARGE

Figure 11 shows potential groundwater recharge areas in the GSA. Water-level maps indicate that seepage from the San Joaquin River streamflow has been an important source of recharge to the groundwater in the GSA. Historically, there has been also been recharge from flows in Cottonwood Creek. Seepage from conveyance facilities has also been important.

SOURCE OF DISCHARGE

Groundwater discharge in the GSA is primarily from pumping wells and secondarily from groundwater outflow to the northwest. Figure 12 shows potential groundwater discharge areas.

AQUIFER CHARACTERISTICS

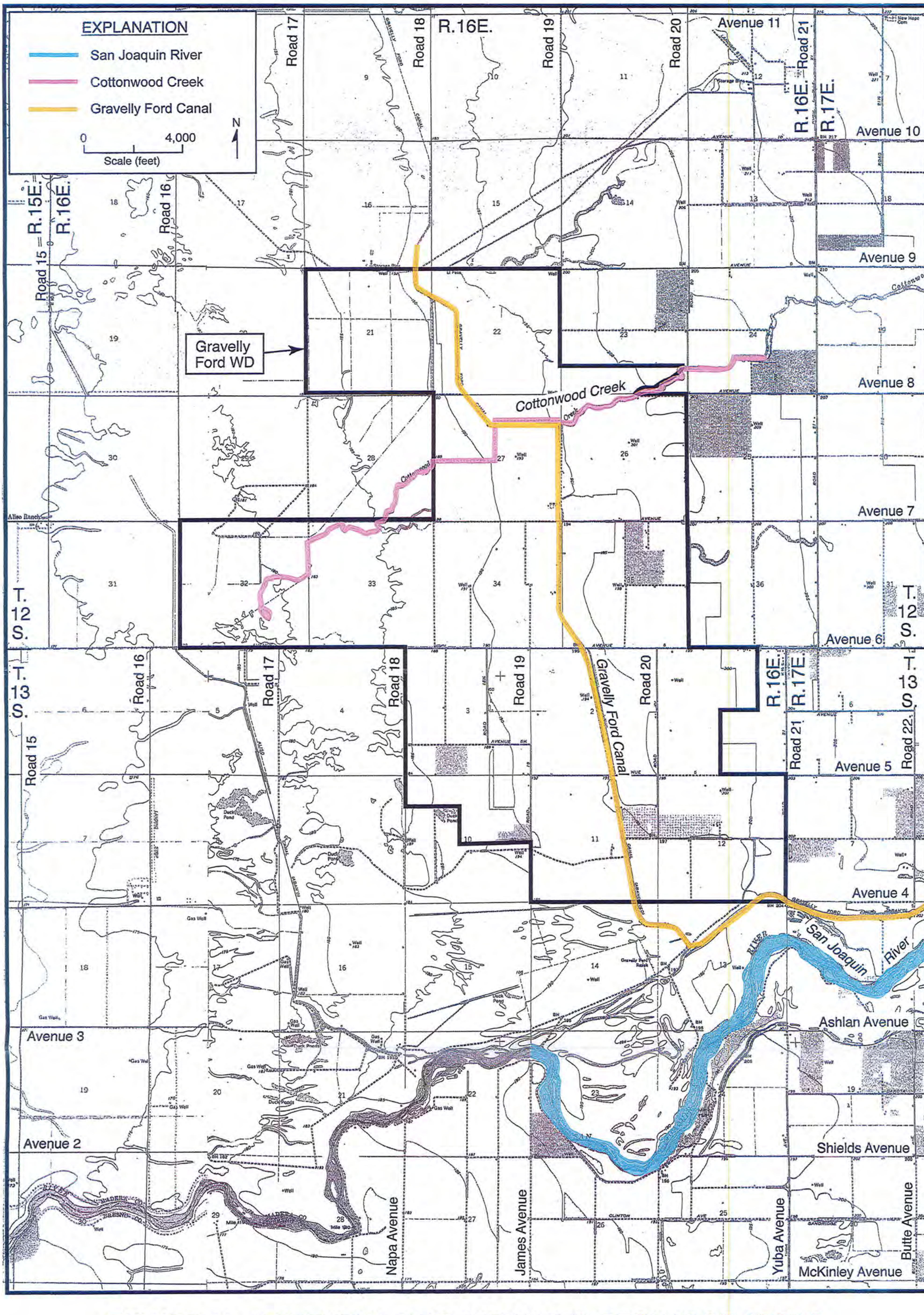


FIGURE 11 - POTENTIAL GROUNDWATER RECHARGE AREAS

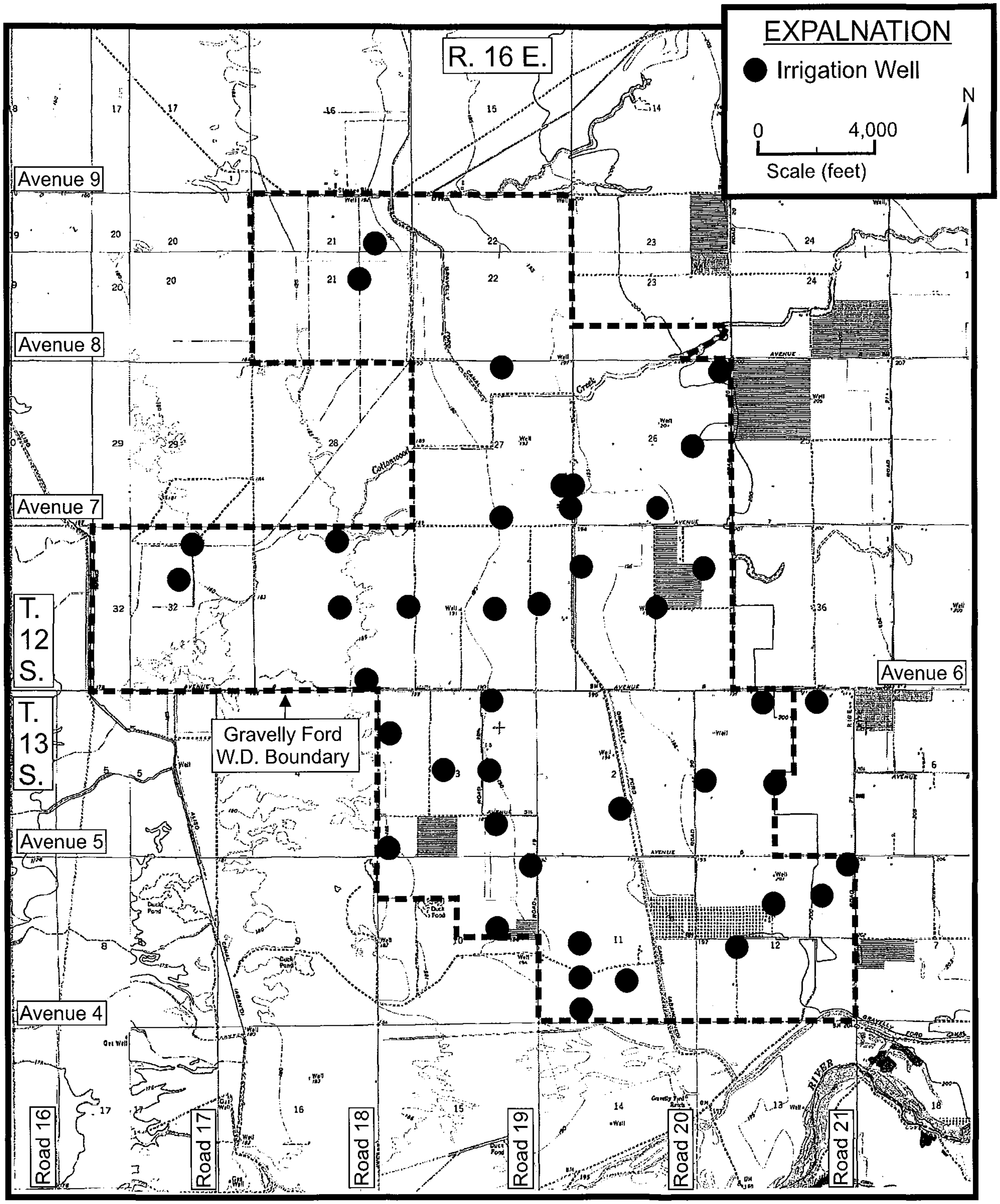


FIGURE 12 - POTENTIAL GROUNDWATER DISCHARGE AREAS

Pump tests area available for dozens of irrigation wells in the GSA. Pumping rates for many irrigation wells range from about 800 to 2,300 gpm. Specific capacities of most wells range from about 25 to 70 gpm per foot. For wells tapping both aquifers, specific capacities can be multiplied by a factor of 1,750 to estimate aquifer transmissivity. Based on the range of specific capacities, transmissivities would be expected to range from about 45,000 to 120,000 gpd per foot. Transmissivity has been determined at some wells, and values range from about 60,000 to 120,000 gpd per foot. The best values of specific yield for the upper aquifer are derived from textural descriptions and specific yield estimates commonly used by the U.S. Geological Survey. For the GSA, a specific yield of 12 percent is reasonable, based on a review of the subsurface geologic cross sections presented in this report. For the groundwater confined below the Corcoran Clay, a storage coefficient of 0.001 to 0.0001 is considered reasonable.

CHANGE IN STORAGE

Based on the average water-level decline of 0.9 foot per year in recent decades in the GSA, and using an average specific yield of 0.12, the groundwater overdraft beneath the 8,500-acre GSA has averaged about 900 acre-feet per year.

Figure 13 shows annual changes in groundwater storage for strata tapped by irrigation wells in the District.

LAND SUBSIDENCE

Land subsidence has become a large issue in the Red Top area in the last several years, due to increased pumping from numerous new wells tapping the lower aquifer. This subsidence has affected conveyance facilities, including the Eastside Bypass. Water-level declines have been much greater in that area than in the GSA. In addition, a number of wells in that area tap only the lower aquifer. Measures are being undertaken to reduce future subsidence in the Red Top area by decreasing lower aquifer pumping. Included are in-lieu recharge (delivering surface water to lands where irrigation water has been pumped from the lower aquifer), and intentional recharge through percolation basins and development of more upper aquifer wells to tap this water.

Land subsidence in and near the GSA has been measured as part of the San Joaquin River restoration project between December 2011 and June 2016 (Figure 14). One station is located north of the San Joaquin River about a mile and a half upstream of the east boundary of the GSA. The land subsidence at this station averaged 0.15 foot per year between December 2011 and June 2016. Another station was located near the west edge of the GSA and Avenue 7. The land subsidence at this station averaged 0.18 foot

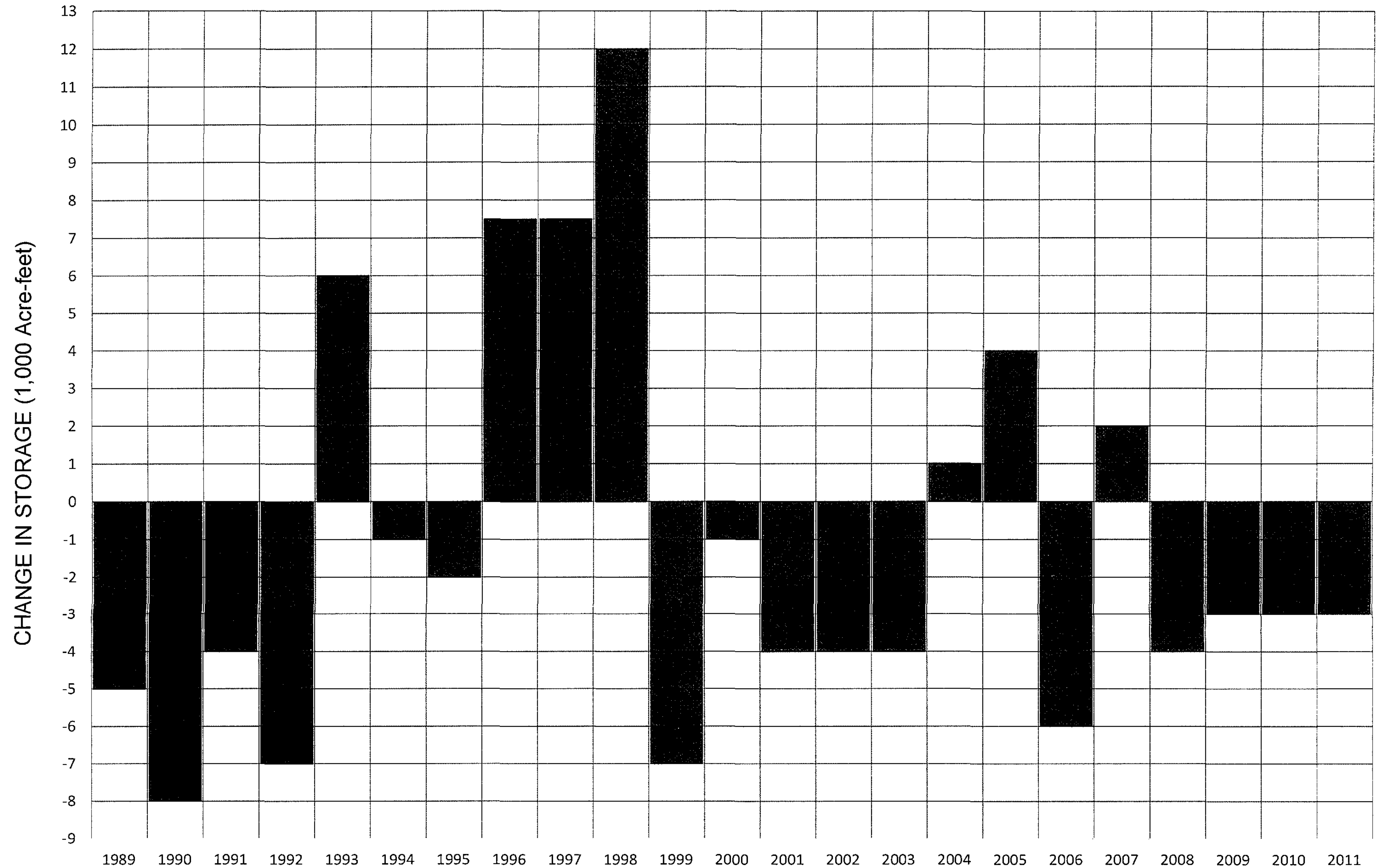
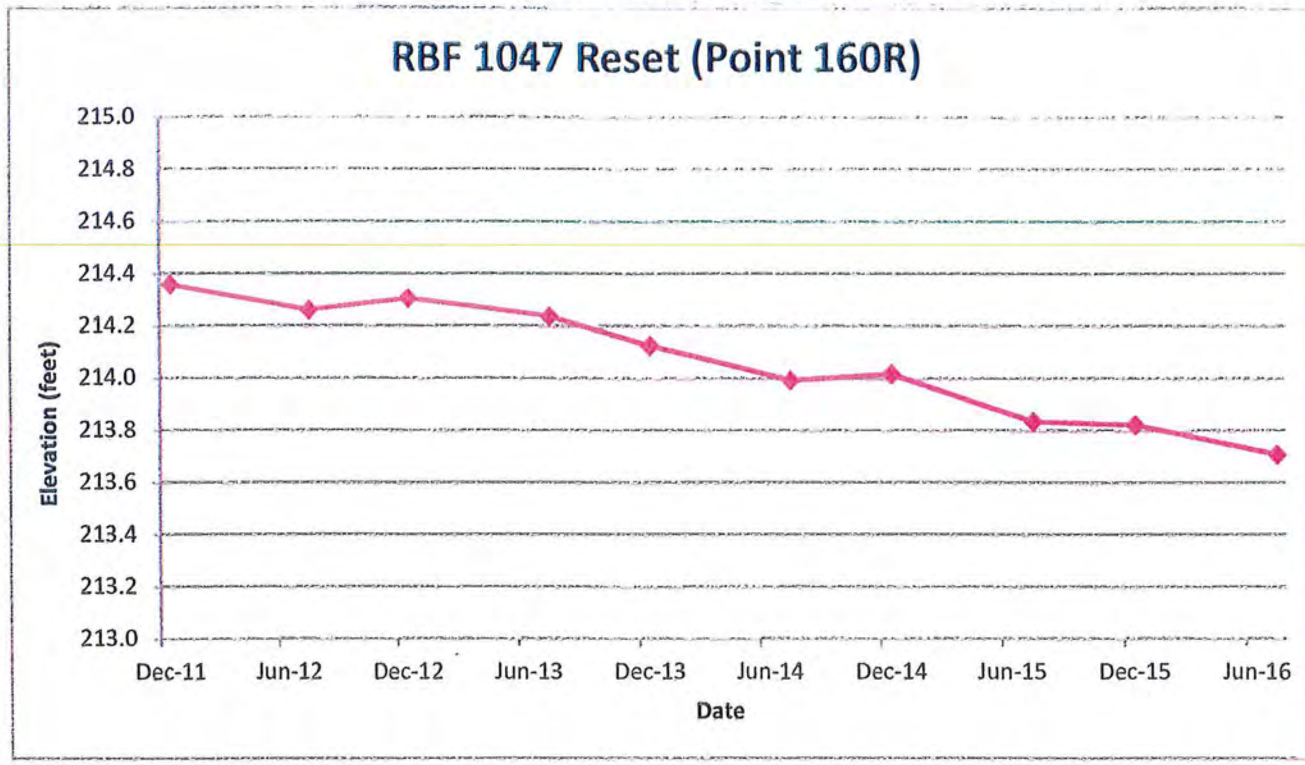
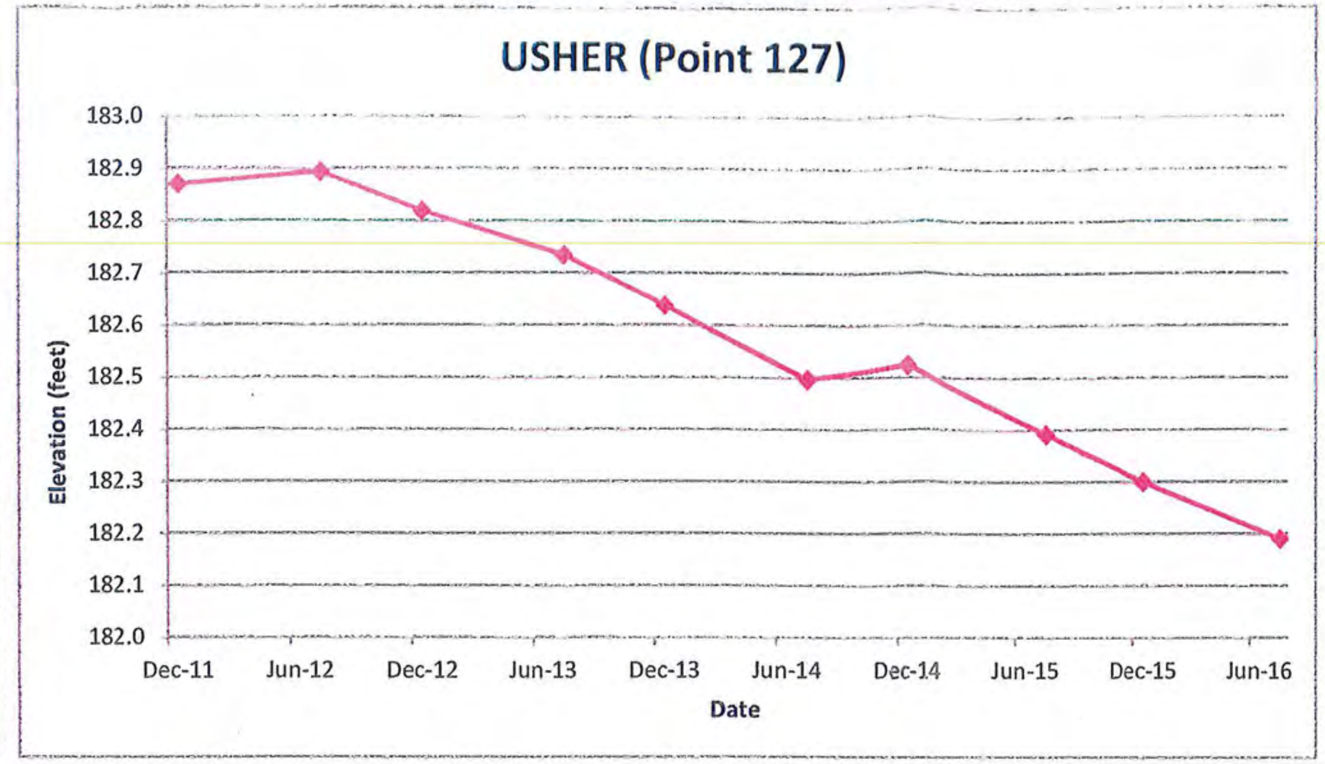


FIGURE 13 - CHANGES IN GROUNDWATER STORAGE

SAN JOAQUIN RIVER NEAR GRAVELY FORD



EASTSIDE BYPASS NEAR AVENUE 7



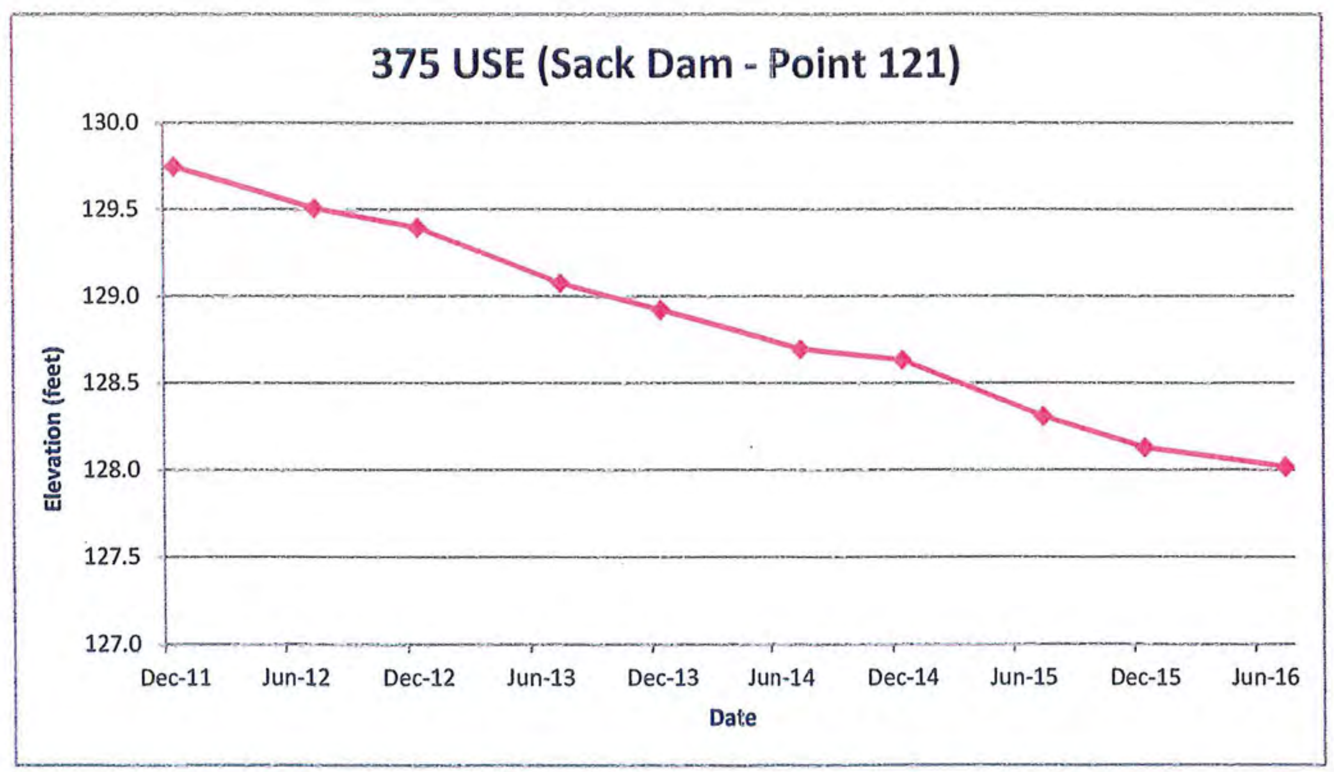


FIGURE 14 - LAND SUBSIDENCE (2011-16)

per year between June 2012 and June 2016. This land subsidence is attributed primarily to pumping from the lower aquifer, primarily east of the Chowchilla Bypass in Madera County and south of the San Joaquin River in Fresno County.

GROUNDWATER QUALITY

Total dissolved solids (TDS) concentrations range from about 160 mg/l to 500 mg/l. The lowest TDS concentrations are generally in shallow groundwater near the San Joaquin River. Some of the higher TDS concentrations are in shallow groundwater beneath irrigated areas more than several miles from the river. The shallow groundwater tends to have higher hardness concentrations. Overall, the chemical quality of the groundwater is suitable for irrigation of most crops. Some of the groundwater requires treatment to lower the pH and/or sodium adsorption ratio (SAR).

INTERCONECTED SURFACE AND GROUNDWATER SYSTEMS

A source of information that can be used to address the interconnection of surface water and groundwater are water-level measurements for a number of shallow monitor wells that were installed for Reclamation along the San Joaquin River as part of the river restoration program. In general, river flows have been always been present in the area east of Gravelly Ford (about a mile and a half east of the southeast corner of the GSA). A review of these measurements for the area farther west indicates that during periods of no flow in the river, the shallow groundwater levels have been below the river channel along the river west of Gravelly Ford. When the river is flowing, there has been a direct connection between the surface water and groundwater. Figure 15 shows the locations of interconnected surface and groundwater bodies in or near the GSA.

KNOWN GROUNDWATER CONTAMINATION SITES

Information on known contamination sites in and near the GSA was obtained from the Central Valley Regional WLB Geotracker website. No such sites are present in or near the GSA.

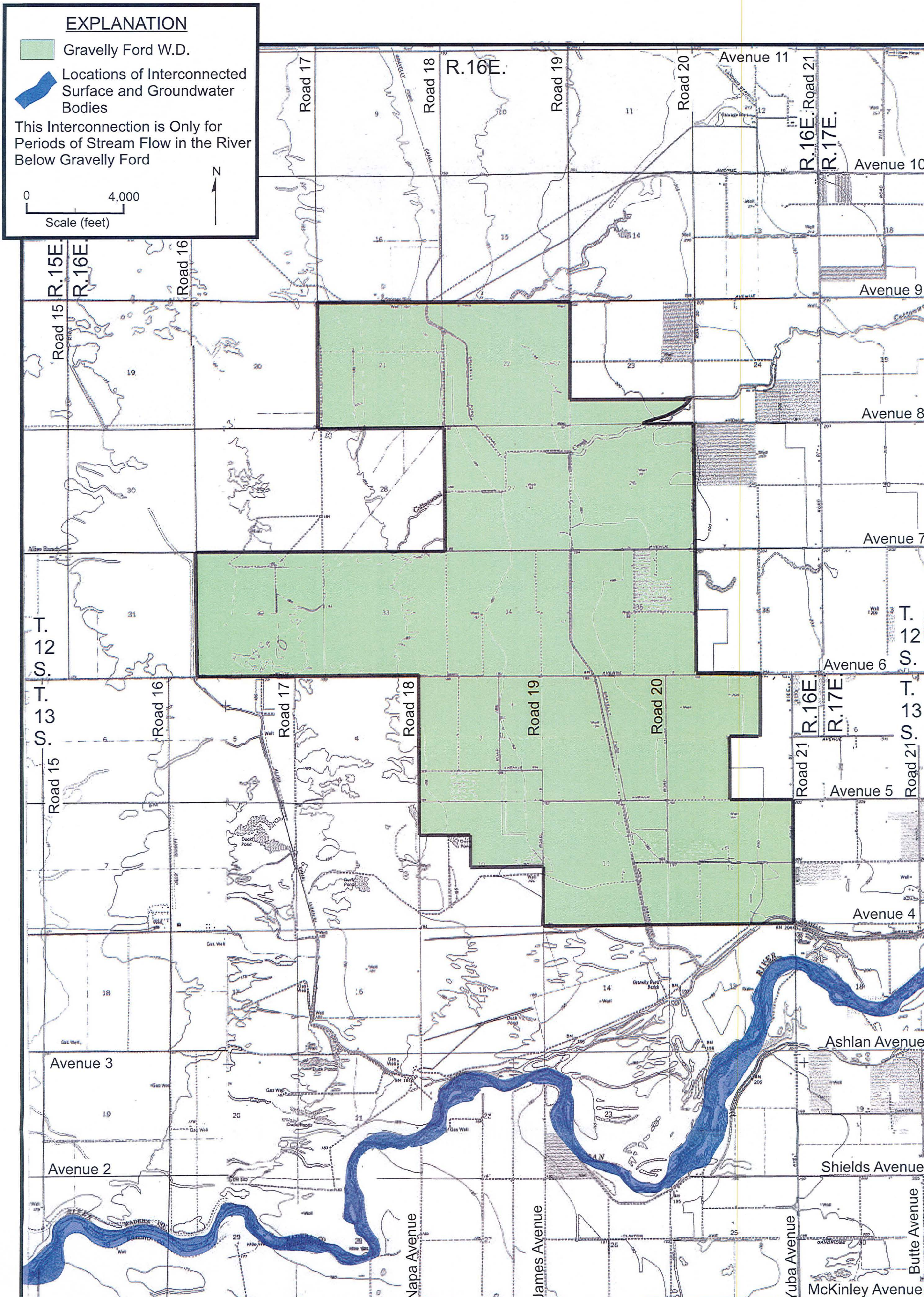


FIGURE 15 - LOCATIONS OF INTERCONNECTED SURFACE AND GROUNDWATER BODIES

APPENDIX F
WATER LEVEL ELEVATION AND DIRECTION OF GROUNDWATER FLOW

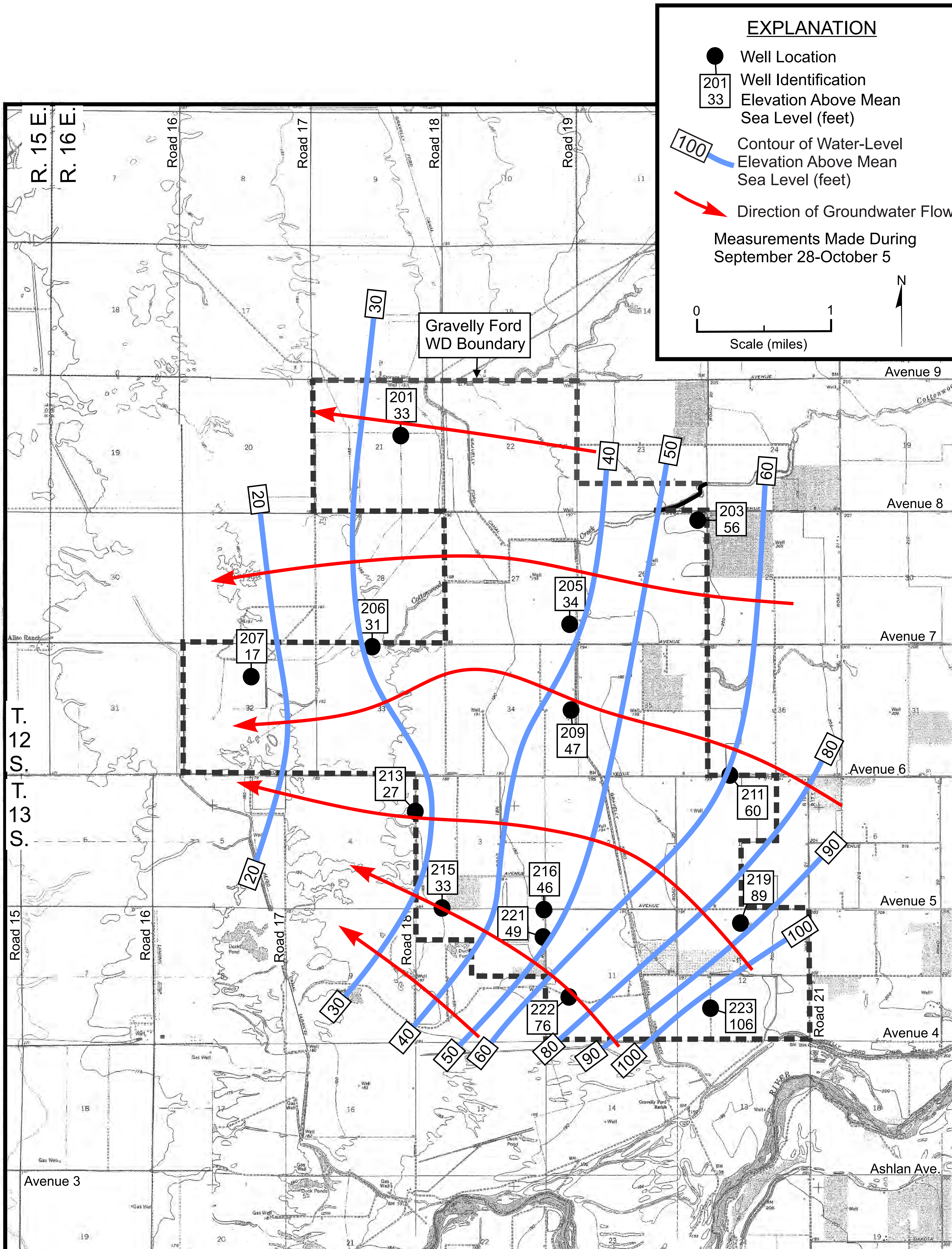
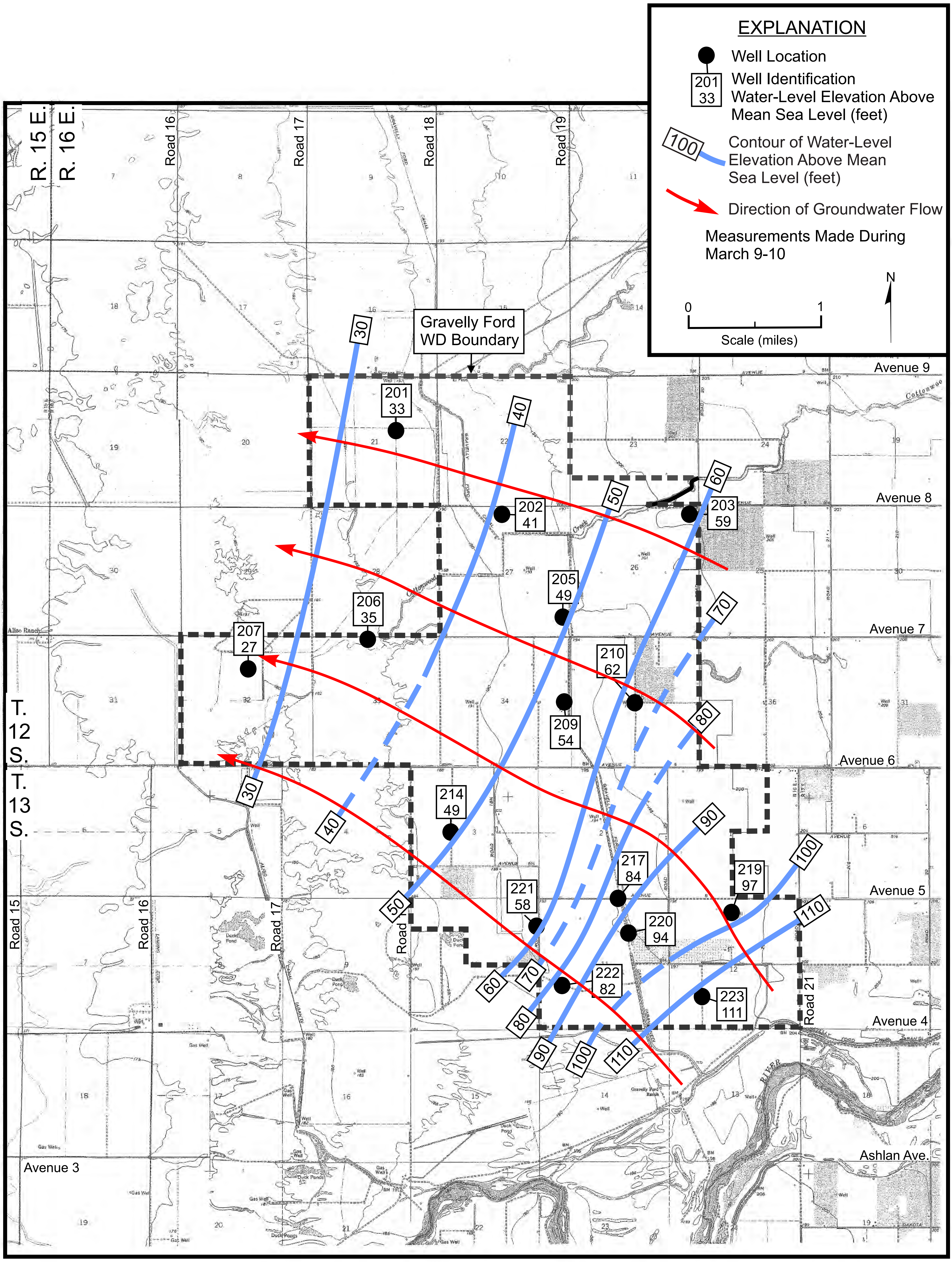
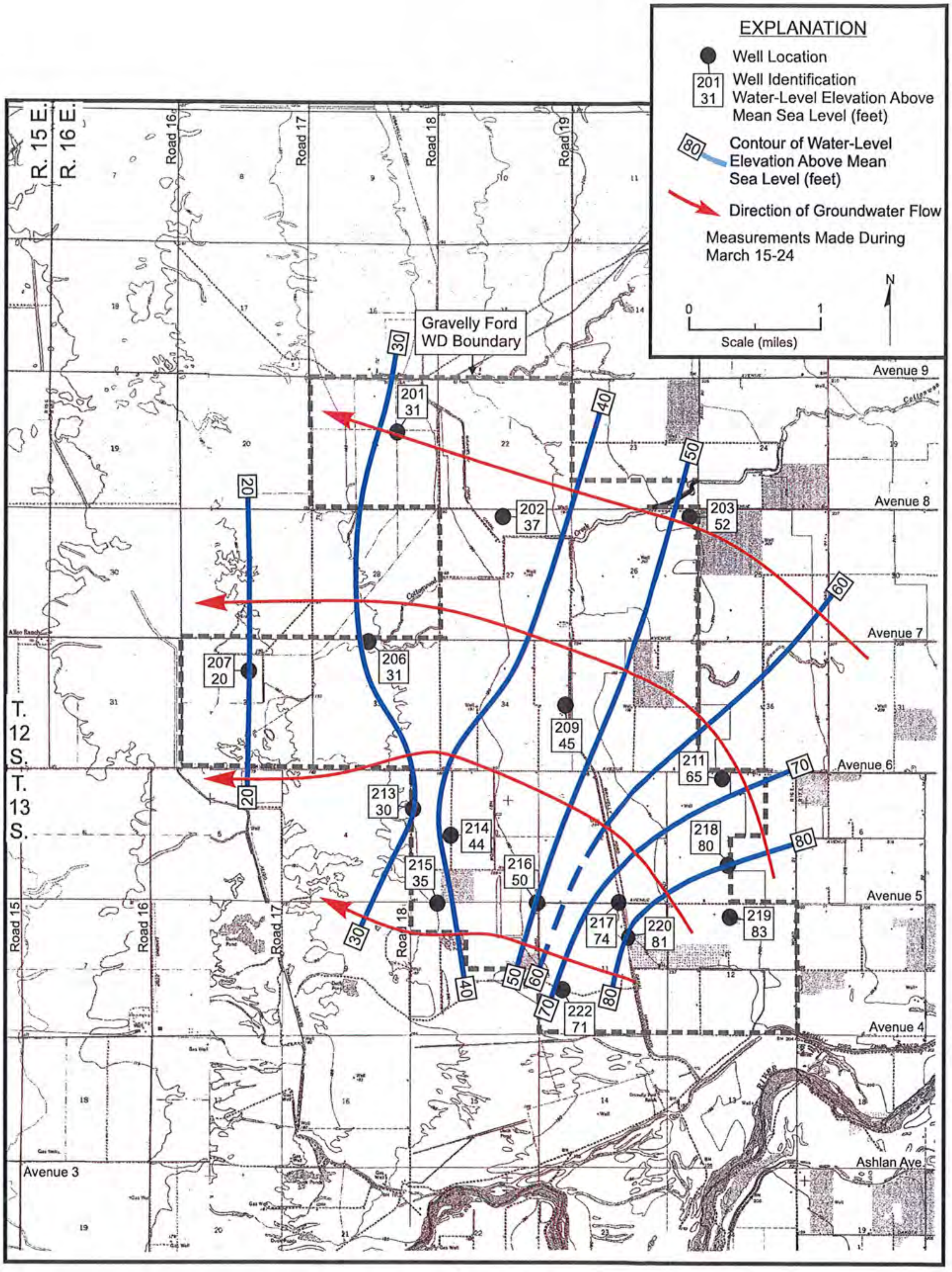


Figure 2-1

Water-Level Elevations & Directions of Groundwater Flow (Fall 2020)



WATER-LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW (SPRING 2021)



WATER-LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW (SPRING 2022)

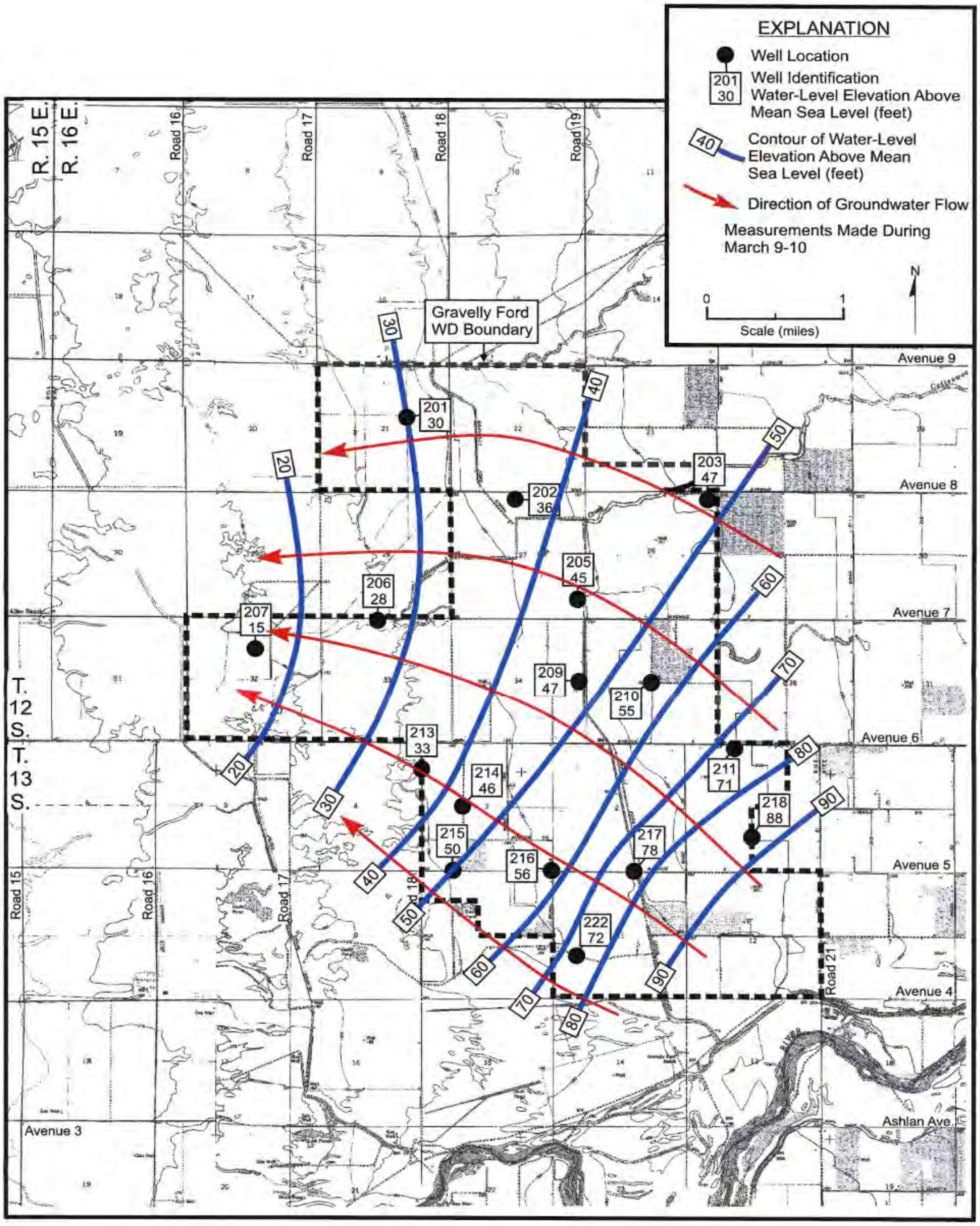
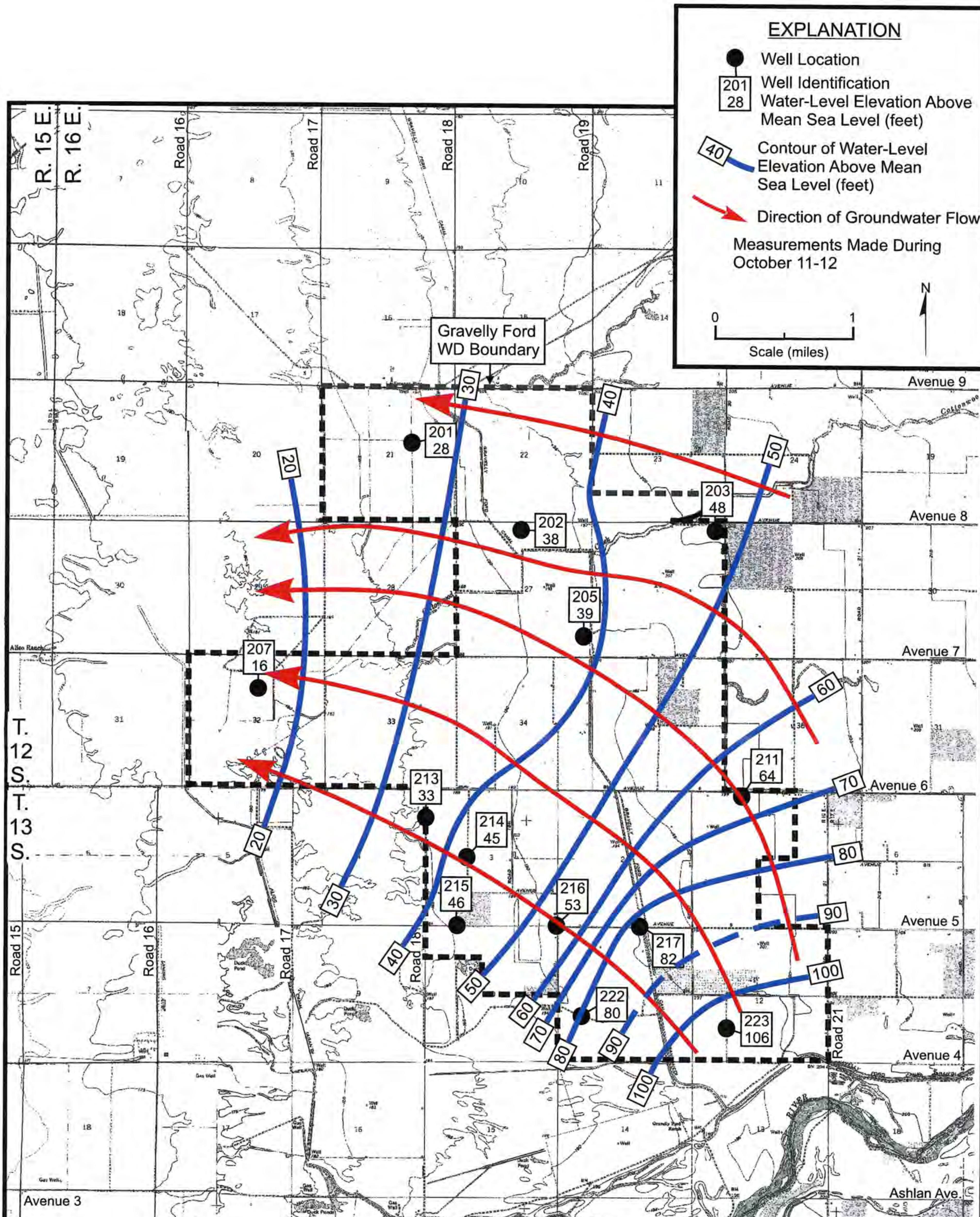
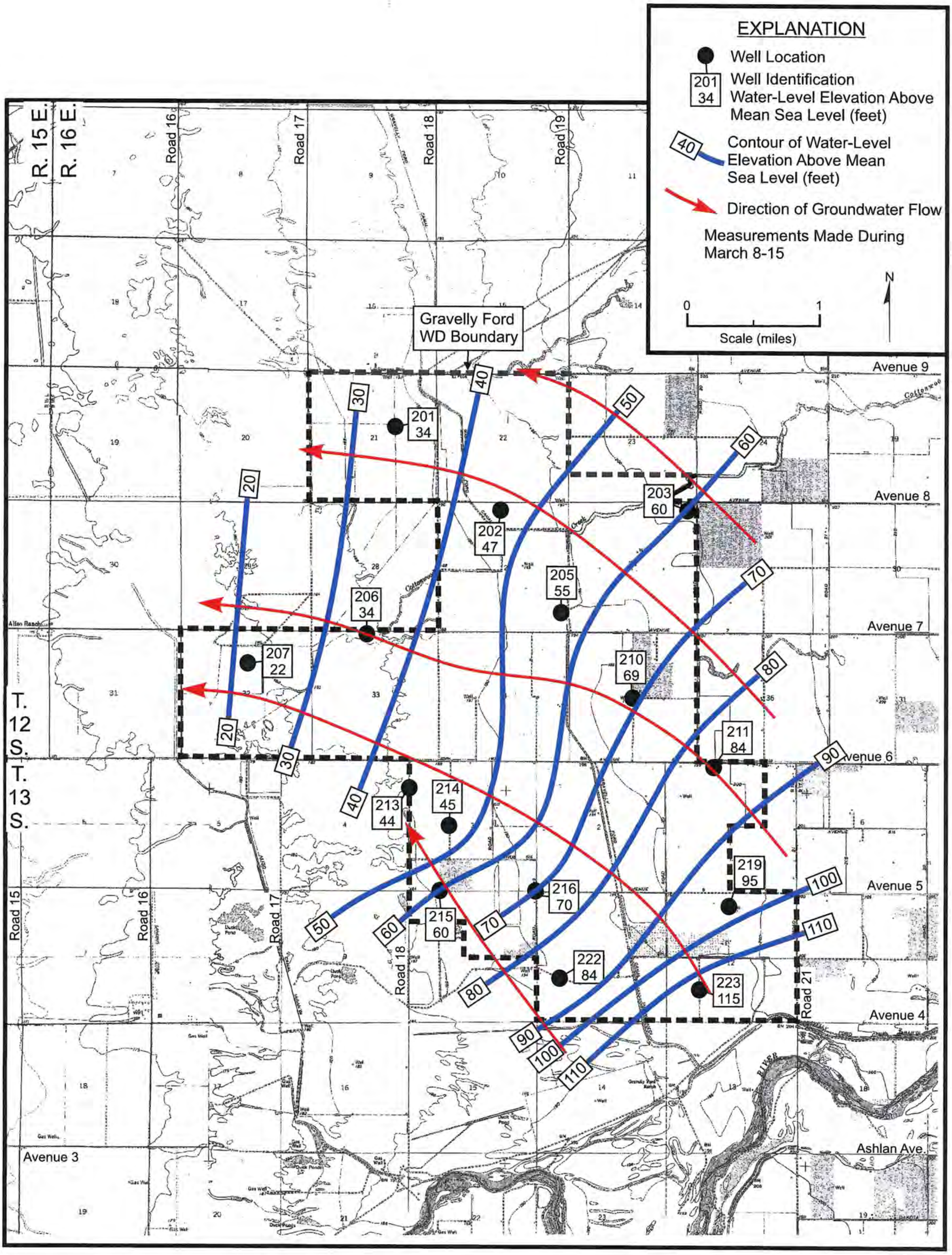


Figure 2-2
Water-Level Elevations & Directions of Groundwater Flow (Spring 2023)



WATER-LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW (FALL 2023)



WATER-LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW (SPRING 2024)

Appendix 1.B. 2025 Periodic Evaluation GSP Attachments

Appendix 1.B.3. NSWD GSA GSP 2025 Periodic Evaluation Elements

NEW STONE WATER DISTRICT GROUNDWATER SUSTAINABILITY AGENCY

MADERA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

2025 Periodic Evaluation

MADERA COUNTY, CALIFORNIA
JANUARY 2025

PREPARED FOR:
New Stone Water District Groundwater Sustainability Agency
Madera County, CA

PREPARED BY:
PROVOST & PRITCHARD CONSULTING GROUP
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PRITCHARD

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ABBREVIATIONS

CEQA .... California Environmental Quality Act
cfs .... Cubic Feet per Second
FWA .... Friant Water Authority
GSA .... Groundwater Sustainability Agency
GSP .... Groundwater Sustainability Plan
IM .... Interim Milestones
ISW .... Interconnected Surface Water
MCSim .... Madera-Chowchilla Model Simulation
Mos .... Measurable Objectives
MOU .... Memorandum
MTs .... Minimum Thresholds
MW .... Monitoring Well
NSWD .... New Stone Water District
NSWD GSA .... New Stone Water District Groundwater Sustainability Agency
RMN .... Representative Monitoring Network
RMS .... Representative Monitoring Site
SJRRP .... San Joaquin River Restoration Project
URs .... Undesirable Results
USBR .... United States Bureau of Reclamation

EXECUTIVE SUMMARY

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation for a high-level overview of Subbasin implementation activities and progress towards implementation.

This periodic evaluation covers the period from January 2020 through December 2024. This periodic evaluation is accompanied by an amended plan that was modified to respond to the corrective actions contained in a letter from the Department of Water Resources dated December 21, 2023. The plan was amended with plans to be adopted by the New Stone Water District GSA on January 24, 2025.

OVERVIEW OF PERIODIC EVALUATION

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation.

An overview consists of:

1. *No changes to governance*
2. *No modification to member agencies*
3. *Corrective action modifications to plan*
4. *Public meetings monthly to discuss activities*
5. *Achievement of implementing projects and management actions and maintaining water levels for sustainability.*

1 NEW INFORMATION COLLECTED

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation.

2 GROUNDWATER CONDITIONS RELATIVE TO SUSTAINABLE MANAGEMENT CRITERIA

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation for a discussion on the overall groundwater conditions in the Madera Subbasin as a whole.

This section of the Periodic Evaluation was prepared for the New Stone Water District Groundwater Sustainability Agency (NSWD GSA) to review and evaluate current groundwater conditions for each applicable sustainability indicator relative to the sustainable management criteria established in the GSP (amended 2025). A summary of the Minimum Thresholds (MTs), Measurable Objectives (MOs) and Undesirable Results (URs) is provided in **Table 1**. Locally defined undesirable results were based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives.

Table 1 Summary of MTs, MOs and Undesirable Results

Sustainability Indicator	Minimum Threshold	Measurable Objective	Undesirable Result (After 2040)
Chronic Lowering of Groundwater Levels	Set equal to the Fall 2015 measurement, if that observed data point is available at the RMS. Otherwise, set equal to the expected Fall 2015 groundwater level determined from MCSim results, with adjustment, if necessary, to account for the offset between historical observed and modeled data.	Set equal to the Fall 2010 measurement, if that observed data point is available at the RMS. Otherwise, set equal to the expected Fall 2010 groundwater level determined from MCSim results, with adjustment, if necessary, to account for the offset between historical observed and modeled data.	Same 30 percent of RMS wells within the subbasin below minimum threshold for two consecutive fall measurements.
Reduction of Groundwater Storage	Same as MTs for chronic lowering of groundwater levels. (Groundwater levels used as proxy.)	Same as MOs for chronic lowering of groundwater levels. (Groundwater levels used as proxy.)	Same 30 percent of RMS wells within the subbasin below minimum threshold for two consecutive fall measurements (Groundwater levels used as proxy)
Degraded Water Quality	Nitrate as N = 10 mg/L or existing level plus 20% (whichever is greater) Arsenic = 10 µg/L or existing level plus 20% (whichever is greater) TDS = 500 mg/L or existing level plus 20% (whichever is greater)	Baseline constituent concentrations	10 percent of RMS wells within the subbasin above the minimum threshold for the same constituent due to projects and/or management actions, or overall groundwater extraction based on average of most recent three year period

Sustainability Indicator	Minimum Threshold	Measurable Objective	Undesirable Result (After 2040)
Land Subsidence	0 feet/year, subject to uncertainty of +/- 0.16 feet/year	0 feet/year, subject to uncertainty of +/- 0.16 feet/year	Average subsidence across greater than 25 percent of RMS exceeding the minimum threshold for two consecutive years.
Depletion of Interconnected Surface Water[1]	A percent of time surface water is connected to shallow groundwater that is equal to historical conditions for a similar climatic/hydrologic period.	A percent of time surface water is connected to shallow groundwater that is equal to historical conditions for a similar climatic/hydrologic period.	Greater than 30 percent of RMS wells below minimum threshold for two consecutive annual five-year rolling average annual evaluations.
Seawater Intrusion	Not Applicable	Not Applicable	Not Applicable
[1] Interim SMCs will be replaced as a result of the Subbasin data gap analysis and findings from the ISW MOU.			

The NSWD GSA covers 4,200 acres in the northwestern area of the Madera Groundwater Subbasin (Subbasin) that is adjacent to the Chowchilla Bypass flood control channel. The NSWD GSA is coterminous with the New Stone Water District (NSWD or District) boundary. The District is predominantly agriculture and consists of two landowners. **Figure 1** shows the proximity of the NSWD GSA within the Madera Subbasin. It is adjacent to the Chowchilla and Eastside Bypass to the east, bordering the Chowchilla Subbasin to the north, and the Delta-Mendota Subbasin to the west. The area just north of the NSWD GSA, within the Chowchilla Subbasin, appears to have either more limited surface supplies or increased lower aquifer pumping. This is indicated by subsidence data showing increased subsidence occurring in this area and groundwater contouring showing flows are directed toward this area.

The NSWD GSP encompasses the southwestern one-fifth to one-quarter of the Subbasin. As the NSWD GSA continues to implement its plan, it is crucial that the NSWD GSA and neighboring Madera-Chowchilla Subbasin GSAs actively engage in project implementation and demand management activities. It is the responsibility of all agencies within the Subbasin to coordinate and ensure sustainable management practices of surface and groundwater use in order to reach the sustainability goal.

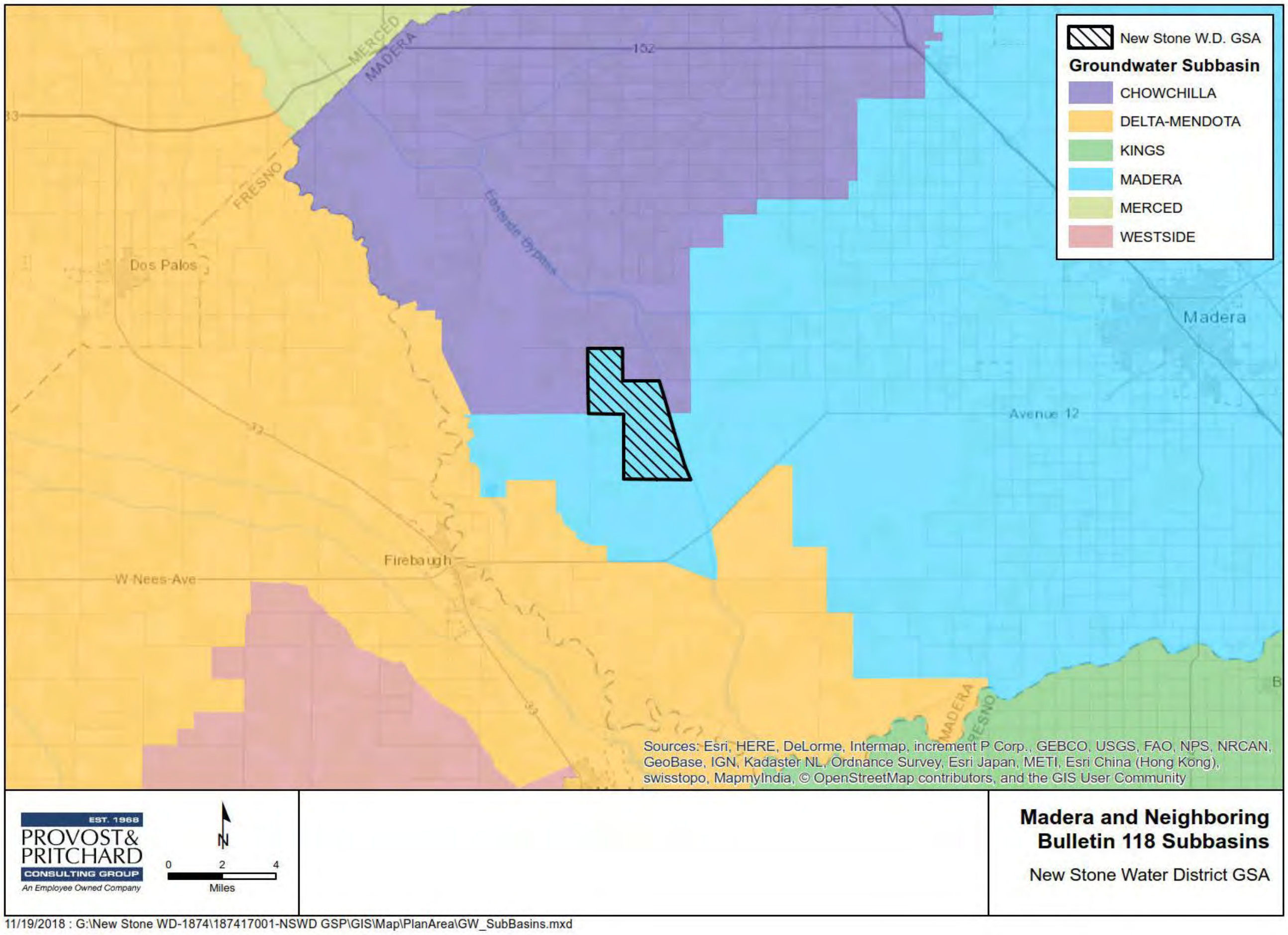

Figure 1 Plan Area Location Map

2.1 GROUNDWATER LEVELS

An undesirable result is defined to occur after 2040 if the same 30 percent of RMS wells within the subbasin fall below minimum thresholds for two consecutive fall measurements, or below the interim milestones during implementation. **Table 2** presents previous fall groundwater elevation measurements for the representative monitoring wells over the past two years, along with the minimum thresholds and measurable objectives. **Figure 2** shows a location map of NSWD GSA's representative monitoring sites for water levels and water quality. Three of the four sites are sub-Corcoran Clay, lower aquifer wells, as the lower aquifer is the principal aquifer source for the District's water supply. In Fall 2024, each measured RMS well was above the 2025 Interim Milestone, indicating that NSWD GSA is on track to meet interim milestones and sustainability goals. Due to access agreement negotiations and a miscommunication with the California Statewide Groundwater Elevation Monitoring Program (CASGEM), well 11S15E30A001M has not been measured since 2020, which is why data for that well is not represented in **Table 2** or have a hydrograph. The Madera Subbasin is critically over-drafted and is expected to experience undesirable results during the implementation period. Therefore, water levels are anticipated to drop below the MT during implementation with the goal to be above the MT after 2040.

Table 2 Progress Towards Water Level Sustainable Management Criteria

Well	Fall 2023	Fall 2024	2025 Interim Milestone	Minimum Threshold	Measurable Objective
10	5.0	7.0	-4	8	17
34	-7.0	-1.0	-22	-14	1
37	-6.0	-4.0	-16	-4	7
11S1530A001M	NM	NM	-4	-5	19
Water Surface Elevation (WSE) measured in feet above mean sea level					

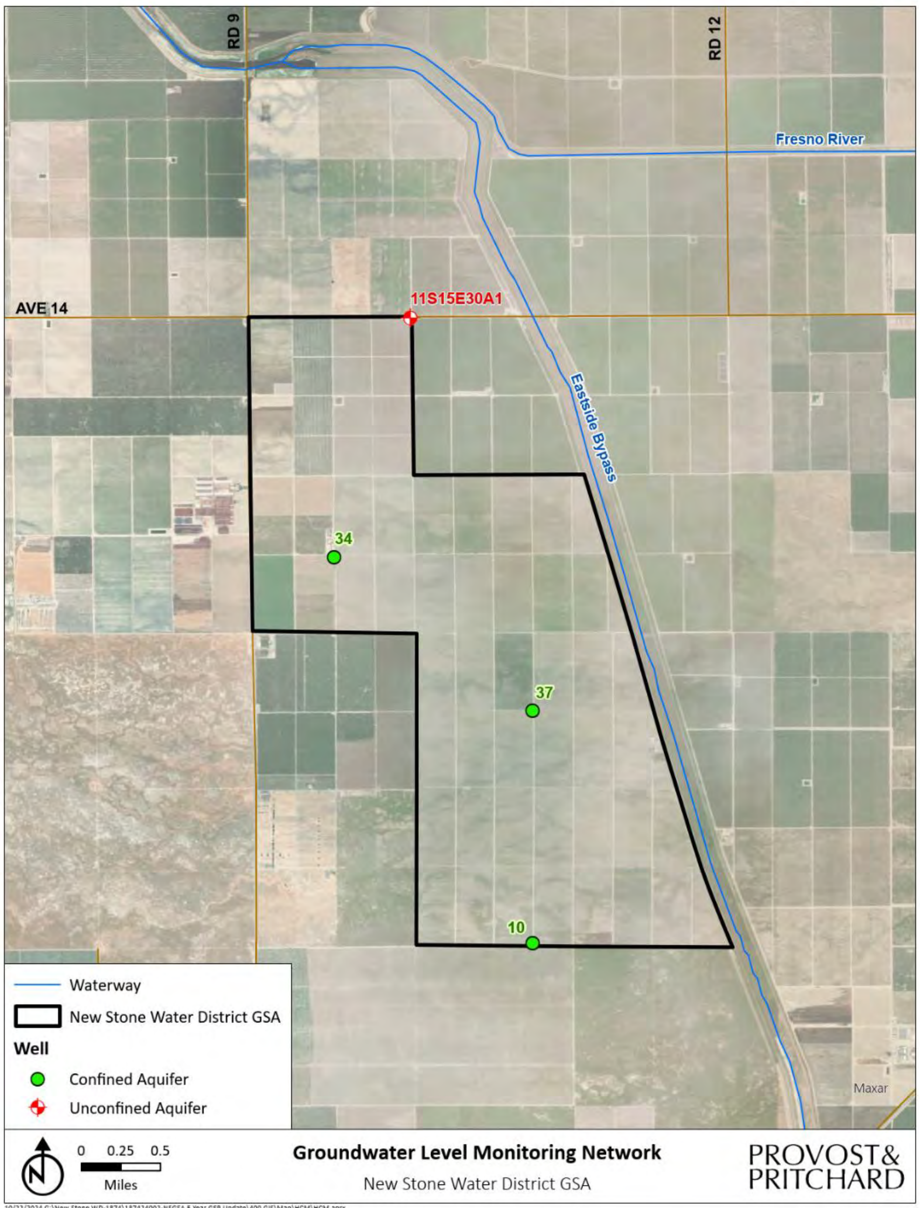

Figure 2 NSWD Representative Monitoring Network

Water levels have generally stabilized since 2020.Historical groundwater potentiometric surface contour maps from fall 2019 through fall 2024 are provided in **Appendix A**. Groundwater in this region typically flows from the District in a northerly direction with a slight easterly component, except for fall 2022, when water levels shifted to a northeasterly flow direction.

Figure 3, Figure 4, and **Figure 5** present hydrographs for the District's RMS wells, comparing recent data to interim milestones, measurable objectives, and minimum thresholds set by the NSWD GSA in coordination with Madera Subbasin methodologies. All wells are used to supply water for agricultural irrigation.

The representative monitoring wells for lower aquifer water levels remain consistent with the NSWD GSA GSP. However, two wells from the approved 2023 GSP were removed from the network: well 11S14E36R001M (upper) was destroyed and well 12S15E16A001M (lower, previously identified as upper) was removed per Joint GSP direction, as it is a well in the Madera County GSA and is already being accounted for in the Joint GSP. Currently, there are four wells in use for monitoring across the area, as shown in **Figure 2**.

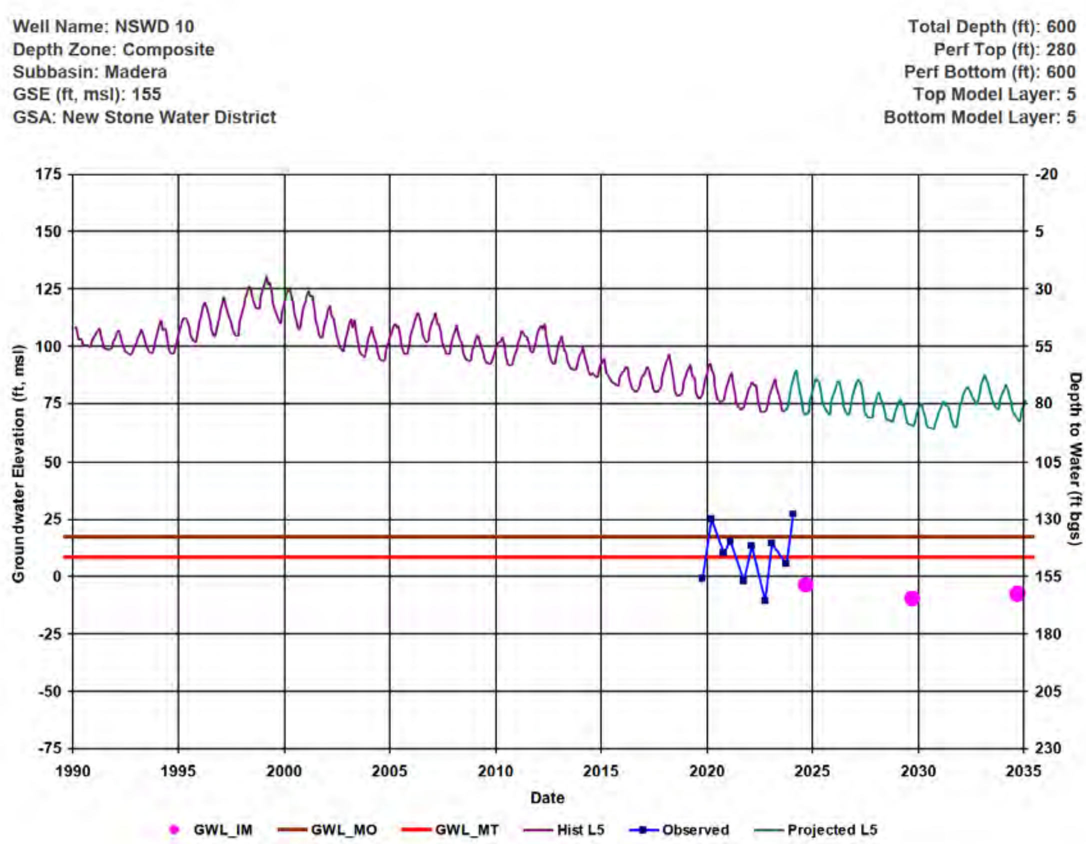

Figure 3 Well 10 Hydrograph

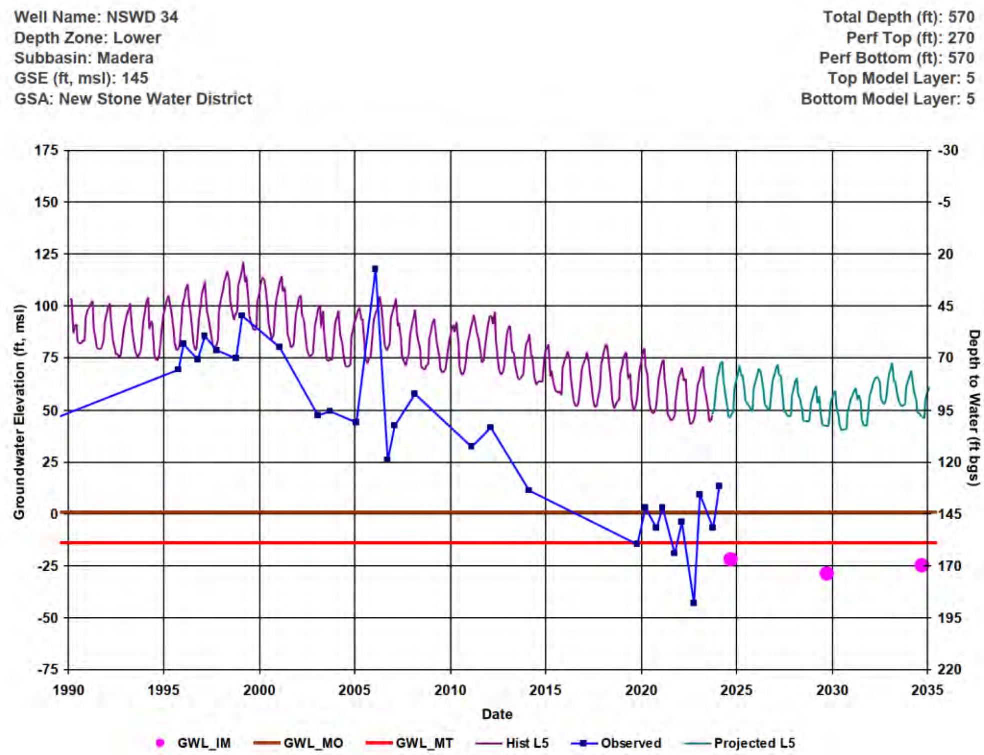

Figure 4 Well 34 Hydrograph

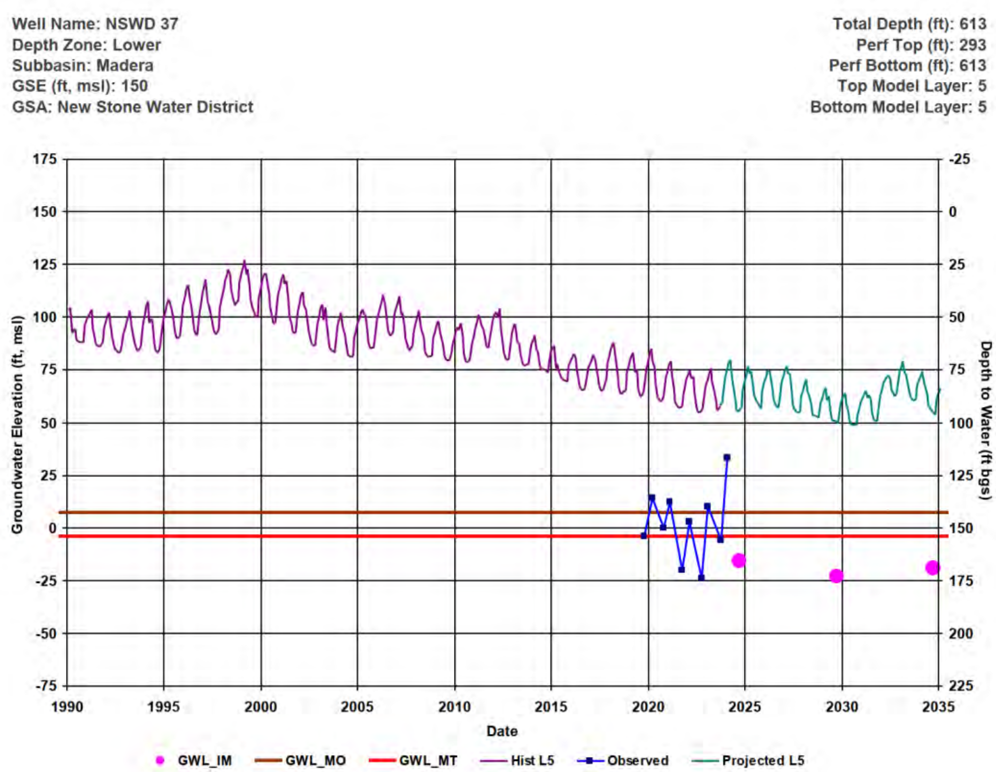

Figure 5 Well 37 Hydrograph

2.2 GROUNDWATER STORAGE CHANGE

The Sustainable Management Criteria (SMC) for groundwater storage reduction are based on the groundwater levels MT methodology. For the groundwater storage change sustainability indicator, the groundwater level MTs are used as a proxy for avoidance of reduction in groundwater storage. In Fall 2024, each measured RMS was above the 2025 Interim Milestone, indicating that NSWD GSA is on track to meet interim milestones and sustainability goals.

Changes in groundwater storage are calculated using the weighted average method applied to a GIS-generated surface, supported by hydrogeological interpretation. This analysis incorporates the representative monitor sites for groundwater levels, as well as water levels from additional wells both within and outside the District that are publicly available. Changes in groundwater storage occur when groundwater extraction exceeds recharge, or vice versa. NSWD GSA extracts groundwater exclusively for agricultural irrigation. Although the District primarily pumps from below the Corcoran Clay, the District holds an appropriative water for 15,700 acre-feet per year (permit number 19615) along the Chowchilla Bypass (also referred to as Eastside Bypass/Chowchilla Canal in permit), which can be used for intentional recharge of the upper aquifer to offset potential upper aquifer losses from vertical groundwater flow. Additional recharge occurs through seepage from the Chowchilla Bypass when floodwaters are available. Groundwater storage changes since Water Year 2015 is shown in **Table 3**.

Table 3 Groundwater Storage Change from 2015-2023

Time Period	Average Change (ft)	Surface Area of Analysis (ac)	Assumed Specific Yield	Storage Change (AF)	Cumulative Change (AF)
Spring 2015 – Spring 2016	-15.0	4,011	0.13	-7,801	-7,801
Spring 2016 – Spring 2017	34.3	4,011	0.13	17,864	10,064
Spring 2017 – Spring 2018	-12.0	4,011	0.13	-6,257	3,806
Spring 2018 – Spring 2019	-10.2	4,011	0.13	-5,319	-1,512
Spring 2019 – Spring 2020	-5.8	4,011	0.13	-3,003	-4,516
Spring 2020 – Spring 2021	-4.0	3,993	0.13	-2,076	-6,592
Spring 2021 – Spring 2022	-6.0	3,993	0.13	-3,115	-9,706
Spring 2022 – Spring 2023	7.0	3,993	0.13	3,634	-6,073
Average	-1.5			-759	
Fall 2014 - Fall 2015	1.2	4,011	0.13	647	647
Fall 2015 - Fall 2016	12.2	4,011	0.13	6,382	7,029
Fall 2016 - Fall 2017	-15.6	4,011	0.13	-8,134	-1,105
Fall 2017 - Fall 2018	-10.5	4,011	0.13	-5,465	-6,570
Fall 2018 - Fall 2019	-6.7	4,011	0.13	-3,476	-10,046
Fall 2019 - Fall 2020	7.7	4,011	0.13	3,998	-6,049
Fall 2020 - Fall 2021	-14.7	3,993	0.13	-7,631	-13,679
Fall 2021 - Fall 2022	-12.3	3,993	0.13	-6,385	-20,064
Fall 2022 - Fall 2023	25.3	3,993	0.13	13,133	-6,931
Average	-1.5			-770	

Those data presented in **Table 3** shows that the average change in groundwater storage over the period of record from 2014 to 2023 is less than negative 800 AF/year. The average change was a negative 1.5-foot per year using spring and fall data. As shown in **Table 3**, the positive values of storage change correlate to wet water years in WY17, WY19, and WY23, stressing the importance of capturing flood water when available.

2.3 GROUNDWATER QUALITY

In an effort to establish consistent constituents of concern monitored throughout the Madera Subbasin, technical representatives from each GSA set SMCs for degraded groundwater quality for nitrate, total dissolved solids, and arsenic. These constituents were selected with consideration of existing and historical groundwater quality conditions in the Subbasin, despite whether there was a historical record for each constituent. The MTs for Degraded Water Quality across the Subbasin are set at the following MCLs for drinking water for the identified key constituents of nitrate as nitrogen, TDS, and arsenic.

- *Nitrate as nitrogen = 10 mg/L, or baseline concentration plus 20%*
- *TDS = 500 mg/L, or baseline concentration plus 20%*
- *Arsenic = 10 µg/L, or baseline concentration plus 20%*

When existing or historical concentrations for the key constituents already exceed the MCL, the MT is set at the baseline concentration plus 20 percent. When current or historical water quality for the key constituents have not been measured, the MT will be set as the MCL and will be adjusted if needed. Since arsenic and TDS have not been historically sampled within the GSA, MTs will likely be revised following the development of baseline concentrations. **Table 4** lists the estimated thresholds for water quality for the NSWD GSP.

Table 4 Summary of Groundwater Quality Minimum Thresholds for Representative Monitoring Sites

Well ID	Well Type	MT Arsenic Concentration (µg/L)	MT Nitrate Concentration (mg/L)	MT TDS Concentration (mg/L)
NSWD 10	Production	10†	10†	500†
NSWD 34	Production	10†	10†	500†
NSWD 37	Production	10†	10†	500†
11S15E30A001	Production	10†	10†	500†

†Values will be confirmed and/or adjusted as needed once enough data are collected to establish meaningful baselines. If initial sampling exceeds the MCL, then the MT is set at the baseline concentration plus 20%.

Existing and historical concentrations for nitrate (as N) from NSWD GSA's representative monitoring sites are shown in **Table 5**. Since TDS and arsenic were added to the list of constituents to monitor in 2024, the District has added them to their sampling schedule and will be included in future reporting periods. Similar to why 11S15E30A001M is not represented in the water level section, water quality samples have not been collected from this well due to access agreement negotiations. Among the wells sampled consistently for nitrate (as N) over the most recent three-year period (2022-2024), no wells exceeded the initial MT for nitrate (as N) on average. Once a baseline concentration is set for TDS and arsenic for each well, the NSWD GSA, in coordination with the Subbasin methodology, may decide to adjust the MTs to baseline concentrations plus 20%.

Table 5 Summary of Nitrate (as N) Results from NSWD GSA Representative Sites

Nitrate as N (NO3-N) (mg/L)						
Well	**2020**	**2021**	**2022**	**2023**	**2024**	**Average (2022-2024)**
Well 10	3.3	1.2	1.6	1.0	1.9	1.5
Well 34	4.3	5.5	4.4	4.9	3.8	4.4
Well 37	6.2	8.1	6.5	7.3	5.9	6.6

2.4 LAND SUBSIDENCE

Inelastic land subsidence occurs when average annual groundwater pumping and other outflows from the Subbasin, primarily from the Lower Aquifer, exceed average annual inflows. Significant and unreasonable conditions were identified through discussions with GSAs and individual stakeholder outreach via subsidence interviews. These subsidence interviews resulted in a coordinated MT of no additional inelastic land subsidence, or 0 feet/year, after 2040 (subject to subsidence station uncertainty of +/- 0.16 feet/year), consistent across the Subbasin. **Table 6** shows the MT for land subsidence across the Subbasin displayed as both a rate and cumulative subsidence. Land subsidence is monitored at several stations close to the GSA. The Madera Subbasin monitoring network for subsidence consists of nine (9) subsidence stations. Since 2020, the two representative subsidence stations closest to the NSWD GSA (Station 1007R and 201R) have seen an average annual rate of subsidence of -0.22 to -0.24 feet/year (**Table 7**). Stations 1007R and 201R show a cumulative subsidence of -0.88 feet and -0.95 feet, respectively, indicating that stations near NSWD GSA are on track to meet the 2025 interim milestone goal of no more than 1.5 feet of cumulative subsidence from 2020 to 2025. Potentiometric surface contour maps show that groundwater is flowing north towards the Chowchilla Subbasin, due to an apparent groundwater cone of depression potentially caused by extraction activities in the neighboring Subbasin. It is the intent of the Madera Subbasin to establish "a subsidence working group committee" of technical GSA representatives to assist with identifying the cause of the subsidence and eliminating future subsidence beyond 2040. However, the absence of lower aquifer monitoring wells outside of NSWD GSA to the north and south, makes it challenging to monitor these activities in the neighboring GSAs and Subbasins.

Table 6 Summary of Subsidence Sustainable Management Criteria

5-Year Interval	Maximum Average Annual Rate of Subsidence (feet/year)	Maximum 5-Year Cumulative Subsidence (feet)[1]
2020-2025		1.5
2025-2030	0.2	1.0
2030-2035	0.1	0.5
2035-2040	0.05	0.25
Note: Due to the uncertainty in land subsidence measurement accuracy of +/- 0.16 feet/year, there may be instances where measurement error will indicate a rate of subsidence greater than the IMs. Undesirable results will trigger further management actions within the Subbasin.		

[1] A cumulative total of up to 1.0 feet of subsidence has already occurred in some portions of the subbasin between December 2019 and December 2023. Therefore, the maximum allowable cumulative subsidence of 1.5 feet as of December 2024 requires annual subsidence in 2024 to be less than 0.5 feet. Subsequent years after 2024 have significantly lower allowable annual rates of subsidence.

Table 7 Summary of Inelastic Subsidence Rates

Annual Inelastic Subsidence		
Monitoring Points		
Years	**1007R**	**201R**
Dec-16 – Dec-17	-0.30	NA
Dec-17 – Dec-18	-0.27	-0.18
Dec-18 – Dec-19	-0.26	-0.24
Dec-19 – Dec-20*	-0.20	-0.18
Dec-20 – Dec-21	-0.26	-0.19
Dec-21 – Dec-22	-0.28	-0.34
Dec-22 – Dec-23	-0.14	-0.24
Average Dec-20 – Dec-23	-0.22	-0.24
Cumulative Dec 20 – Dec 23	-0.88	-.95

*Dec 2019 to Dec 2020 is considered this first year of GSP Implementation

It should be noted that while groundwater level MTs and MOs are a separate sustainability indicator and are not specifically tied to subsidence thresholds, they are consistent with the objective to limit the potential for future subsidence. The MT may require modification in the future if subsidence continues to be seen approaching the end of the 20-year GSP implementation period.

2.5 INTERCONNECTED SURFACE WATER AND GROUNDWATER

Major surface water systems in the Madera Subbasin are the San Joaquin and Fresno Rivers. The nearest NSWDGSA boundaries are approximately 4 miles from Reach 3 of the San Joaquin River and 1 ½ miles from the confluence of the Eastside Bypass and the Fresno River. Therefore, NSDW GSA does not contain interconnected surface water and groundwater systems (ISW). Water flows in the adjacent Chowchilla Bypass only during wet years when flood flows are released from Friant, thus it is frequently dry. Due to the lack of ISW within the GSA, these Sustainability Indicator will not be monitored or considered when making management decisions.

SGMA Regulations are concerned with the volume or rate of surface water depletion caused by groundwater pumping in basins where surface water and groundwater are interconnected. Interconnected surface water systems are defined as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted (Modeling Best Management Practices, DWR, 2016). The purpose of this section is to identify any known areas within the NSWDGSA where groundwater pumping has caused surface water depletion. Currently, there is no evidence that active wells within the GSA are causing increased seepage loss or impacts to downstream beneficial uses.

3 STATUS OF PROJECTS AND MANAGEMENT ACTIONS

The NSWD GSA GSP that was adopted and approved contained a list of project and management actions summarized into the following project categories: groundwater recharge, surface water acquisition, water conservation, and management programs. A status of these projects is summarized in Table 8 below.

Table 8 Status of Projects and Management Actions from NSWD GSA GSP (as of 2024)

Type	Activity	Status
Groundwater Recharge Projects	Intentional Recharge	Implemented
	In-Lieu Recharge	Further evaluation required
	Groundwater Injection Wells	Currently not financially feasible*
	Banking Water Outside of District	Currently not financially feasible*
Surface Water Acquisition Projects	Acquisition of Chowchilla Bypass Flood Water	Implemented/ further expansion being considered
	Acquisition of USBR 215 Flood Water	Currently not financially feasible*
	Water Exchanges/Transfers/Purchases	Currently not financially feasible*
Water Conservation Projects	Irrigation Efficiency Improvements	Further evaluation required
	Installing Well Meters	Currently not needed
Management Programs	Prop 218	In progress
	Subsidies for Surface Water Use, Groundwater Conservation Improvements, and Crop Conversion	Further evaluation required
	Fallowing Rotation	Currently not needed
	Agency Reporting	Implemented
	Groundwater Allocation	Currently not needed

* Should there be Undesirable Results or continued exceedances within the NSWD GSA, “Currently not financially feasible” projects may be further evaluated.

3.1 INTENTIONAL RECHARGE AND ACQUISITION OF CHOWCHILLA BYPASS FLOOD WATER

When excess surface water is available during wet years when the San Joaquin River reaches capacity, water is diverted to the Chowchilla Bypass flood control structure for flood relief. These flood waters can be put to direct use (i.e., applied water for irrigation) or diverted for recharge basins, allowing water to percolate to the groundwater table and replenish the upper aquifer. The volume of water recharged is limited by the availability of and access to surface water.

The NSWD has an appropriate water right along the Chowchilla Bypass of 15,700 AF/year, which presents the District with a unique opportunity to recharge the upper aquifer and acquire floodwater from the Chowchilla Bypass for direct beneficial use on their property. Due to the location of the current turnout, NSWD is not able to exercise this right to its full potential. The District currently recharges water in a canal adjacent to the Chowchilla Bypass shown in **Figure 6**. Since 2015, the District has diverted approximately 745 AF into their canal as a result of the water right.

The GSA continues to investigate potential projects to apply water directly to crops and on-farm recharge opportunities. Though current investigations are in the conceptual phase, if the GSA moves forward with the opportunity, they will seek funding for the program through a Prop 218 assessment and through grants. The GSA plans to proceed as soon as funding is secured.

Table 9 Surface Water for Recharge

Year	Agricultural Use *(AF)*	Recharge (AF)	Total *(AF)*
2015	-		
2016	-		
2017	-	278	278
2018	-		
2019	-	72	72

2020	-		
2021	-		
2022	-		
2023	-	395	395
Total	-	745	745

3.2 IN-LIEU RECHARGE

Due to the location of the District's current turnout, NSWD is not able to exercise their appropriative water right to its full potential. Constructing a connection with the current turnout would allow the District to implement in-lieu recharge project

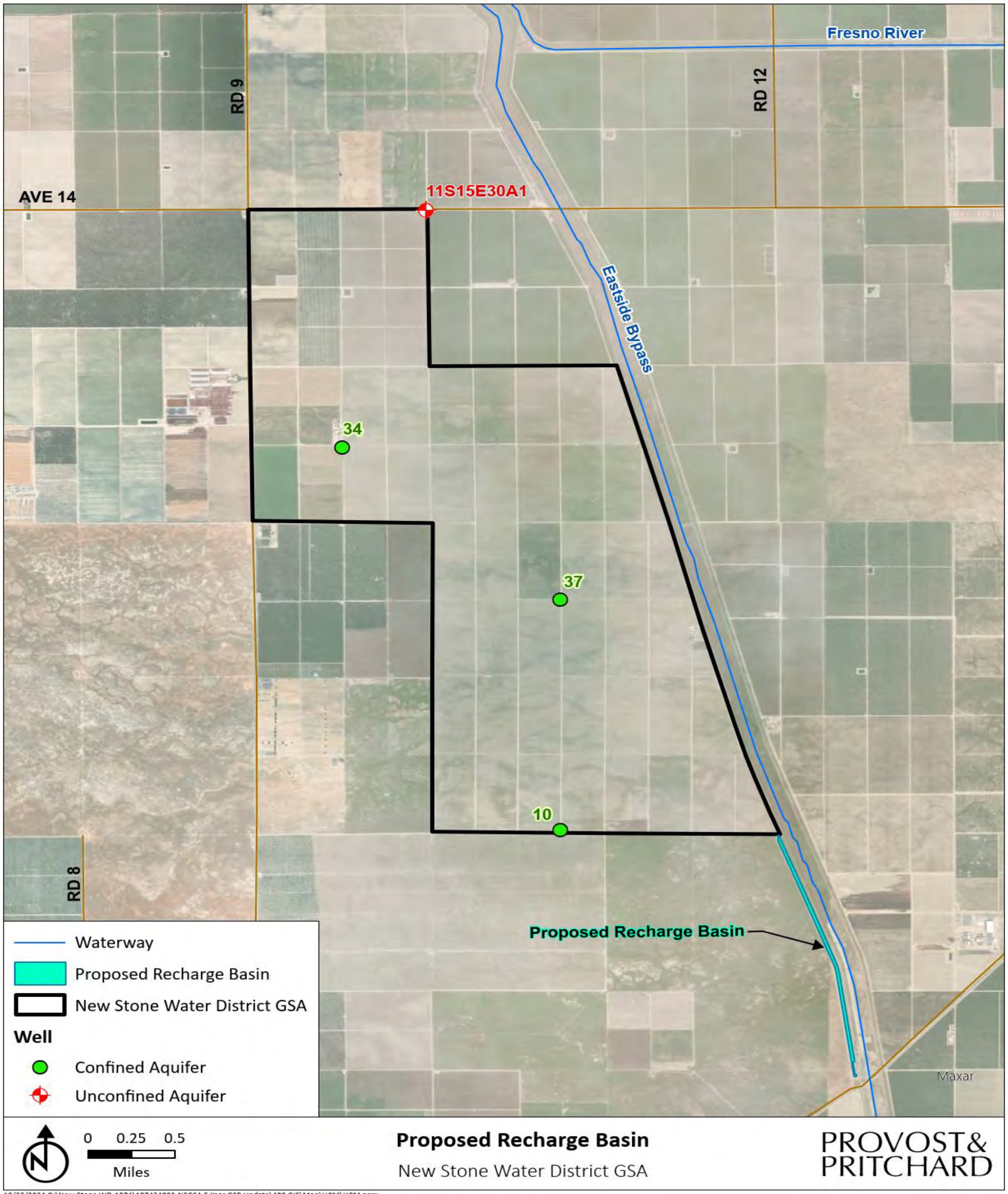

Figure 6 Proposed Recharge Basin

4 BASIN SETTING BASED ON NEW INFORMATION OR CHANGES IN WATER USE

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation.

5 MONITORING NETWORKS

Regulation Requirements:

GSP Regulations §354.38

a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.

c) If the monitoring network contains data gaps, the Plan shall include a description of the following:

1. **The location and reason for data gaps in the monitoring network.**
2. **Local issues and circumstances that limit or prevent monitoring.**

d) Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:

1. **Minimum threshold exceedances**
2. **Highly variable spatial or temporal conditions**
3. **Adverse impacts to beneficial uses and users of groundwater**
4. **The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin**

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation. Two upper aquifer wells represented in the approved 2023 NSWD GSA GSP were removed from the representative monitoring network as one well (11S14E36R001M) was destroyed and another well (12S15E16A001M) was removed due to direction from the Joint GSP, as the well is already being represented in the Joint GSP. The revised monitoring network for the NSWD GSA is included as **Figure 2**.

6 GSA AUTHORITIES AND ENFORCEMENT ACTIONS

The Periodic Evaluation should describe any new authorities the basin's GSAs have gained, established, or exercised since the last GSP submittal and summarize what has been implemented to advance groundwater sustainability. Authorities could pertain to relevant actions related to regulations and ordinances applicable to the Plan. In addition, GSAs should provide information describing any enforcement or legal actions taken in the basin to further the sustainability goal. This could include any new significant information such as funding and fee actions, installing volumetric measuring devices on wells (i.e., flow meters), or collecting other data related to allocation programs and pumping reductions. Demonstrating how these components of GSP implementation will help GSAs reach sustainability is important.

- Provide a summary of GSA regulations or ordinances related to the Plan [Water Code 10725, 10726, 10730, and 10731].
- Describe GSA enforcement or legal actions [Water Code 10725.4, 10730, and 10732].
- Describe activities advancing other regulations and orders outside of SGMA that are related to SGMA implementation, if applicable (e.g., legislation such as Senate Bill 55226 [Drought Planning

for Small Water Suppliers and Rural Communities], well moratoriums, and land use zoning). 26 https://water.ca.gov/Programs/Water-Use-And-Efficiency/SB-552

- Describe how Plan implementation has been affected by external regulatory requirements or executive orders issued by the Governor, if applicable.

7 OUTREACH, ENGAGEMENT, AND COORDINATION WITH OTHER AGENCIES

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation.

8 OTHER INFORMATION

8.1 CONSIDERATION OF ADJACENT BASINS

As discussed in the 2025 New Stone Water District Groundwater Sustainability Plan Amendment, the Madera Subbasin and Kings Subbasin are working to establish an MOU for Interconnected Surface Water, with Friant Water Authority and the Bureau of Reclamation.

9 SUMMARY OF PROPOSED OR COMPLETED REVISIONS TO PLAN ELEMENTS

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation.
The NSWD GSA has made great progress towards meeting its sustainability goals. From review of the sustainability indicators of levels and storage change it is apparent that subsidence occurring in the vicinity of the GSA within and outside of the Subbasin, along with groundwater outflow to the adjacent GSA within the Subbasin is of keen importance. Coordination and communication with the Subbasin GSAs, as demonstrated with weekly technical working group meetings over the past six months, will continue to play a key role in making progress towards sustainability.

Appendix 1.B. 2025 Periodic Evaluation GSP Attachments

Appendix 1.B.4. RCWD GSA GSP 2025 Periodic Evaluation Elements

ROOT CREEK WATER DISTRICT GROUNDWATER SUSTAINABILITY AGENCY

MADERA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

2025 Periodic Evaluation

MADERA COUNTY, CALIFORNIA
DECEMBER 2024

PREPARED FOR:
Root Creek Water District Groundwater Sustainability Agency
Madera County, CA

PREPARED BY:
PROVOST & PRITCHARD CONSULTING GROUP
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ABBREVIATIONS

CEQA .... California Environmental Quality Act
cfs .... Cubic Feet per Second
FWA .... Friant Water Authority
GSA .... Groundwater Sustainability Agency
GSP .... Groundwater Sustainability Plan
IM .... Interim Milestones
ISW .... Interconnected Surface Water
MCSim .... Madera-Chowchilla Model Simulation
Mos .... Measurable Objectives
MOU .... Memorandum
MTs .... Minimum Thresholds
MW .... Monitoring Well
RCWD .... Root Creek Water District
RCWDGSA .... Root Creek Water District Groundwater Sustainability Agency
RMN .... Representative Monitoring Network
RMS .... Representative Monitoring Site
SJRRP .... San Joaquin River Restoration Project
URs .... Undesirable Results
USBR .... United States Bureau of Reclamation

EXECUTIVE SUMMARY

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation for a high-level overview of Subbasin implementation activities and progress towards implementation.
This periodic evaluation covers the period from January 2020 through December 2024. This periodic evaluation is accompanied by an amended plan that was modified to respond to the corrective actions contained in a letter from the Department of Water Resources dated December 21, 2023. The plan was amended and adopted by the Root Creek Water District GSA on December 9, 2024.

OVERVIEW OF PERIODIC EVALUATION

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation.
An overview consists of:

1. *No changes to governance*
2. *No modification to member agencies*
3. *Corrective action modifications to plan*
4. *Public meetings monthly to discuss activities*
5. *Achievement of implementing projects and management actions and maintaining water levels for sustainability.*

1 NEW INFORMATION COLLECTED

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation.

2 GROUNDWATER CONDITIONS RELATIVE TO SUSTAINABLE MANAGEMENT CRITERIA

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation for a discussion on the overall groundwater conditions in the Madera Subbasin as a whole.

This section of the Periodic Evaluation was prepared for the Root Creek Water District Groundwater Sustainability Agency (RCWDGSA) to review and evaluate current groundwater conditions for each applicable sustainability indicator relative to the sustainable management criteria established in the GSP (amended 2025). A summary of the Minimum Thresholds (MTs), Measurable Objectives (MOs) and Undesirable Results (URs) is provided in **Table 1**. Locally defined undesirable results were based on discussion with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives.

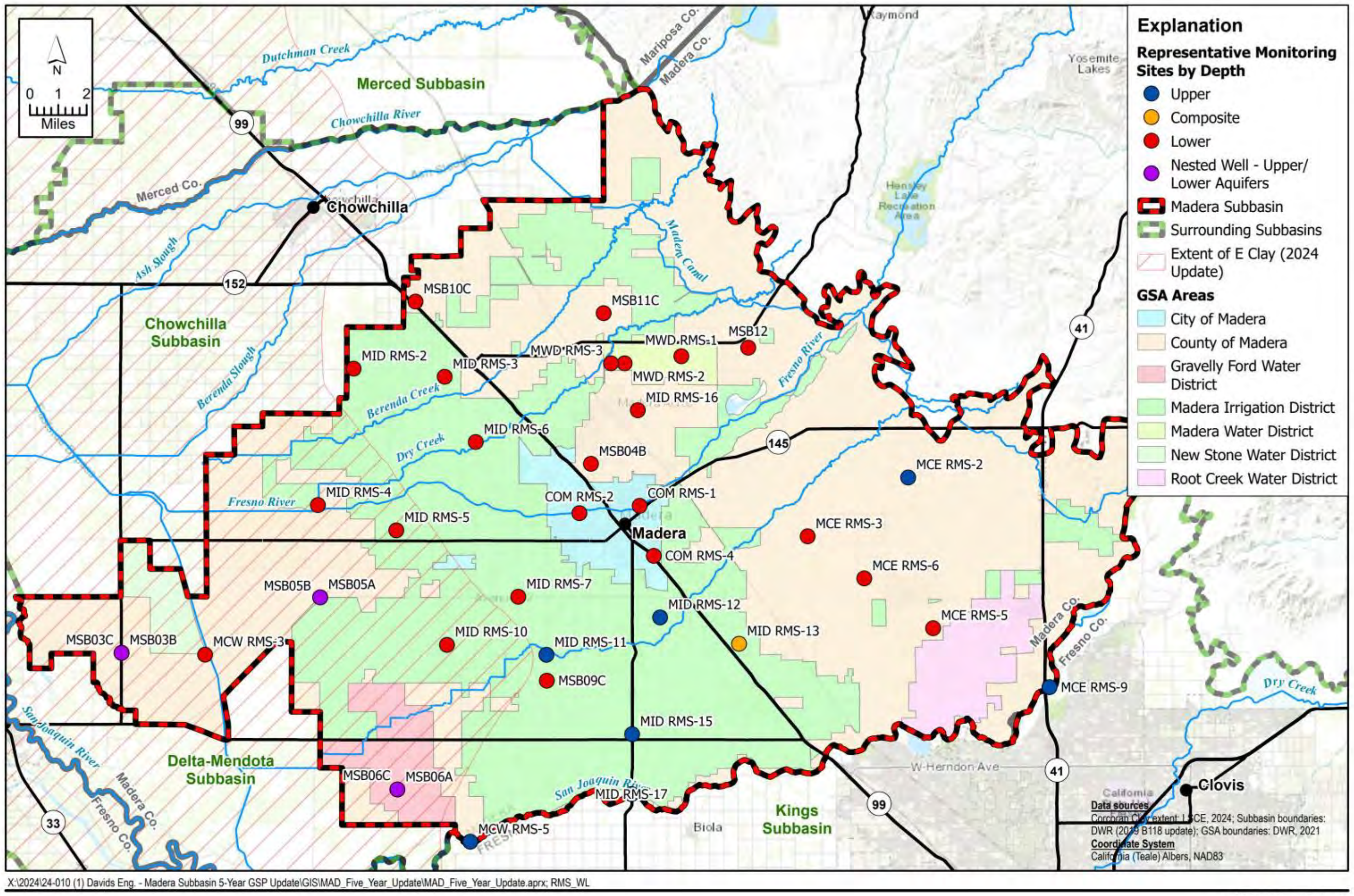
Table 1 Summary of MTs, MOs and Undesirable Results

Sustainability Indicator	Minimum Threshold	Measurable Objective	Undesirable Result (After 2040)
Chronic Lowering of Groundwater Levels	Set equal to the Fall 2015 measurement, if that observed data point is available at the RMS. Otherwise, set equal to the expected Fall 2015 groundwater level determined from MCSim results, with adjustment, if necessary, to account for the offset between historical observed and modeled data.	Set equal to the Fall 2010 measurement, if that observed data point is available at the RMS. Otherwise, set equal to the expected Fall 2010 groundwater level determined from MCSim results, with adjustment, if necessary, to account for the offset between historical observed and modeled data.	Same 30 percent of RMS wells within the subbasin below minimum threshold for two consecutive fall measurements.
Reduction of Groundwater Storage	Same as MTs for chronic lowering of groundwater levels. (Groundwater levels used as proxy.)	Same as MOs for chronic lowering of groundwater levels. (Groundwater levels used as proxy.)	Same 30 percent of RMS wells within the subbasin below minimum threshold for two consecutive fall measurements (Groundwater levels used as proxy)
Degraded Water Quality	Nitrate as N = 10 mg/L or existing level plus 20% (whichever is greater) Arsenic = 10 µg/L or existing level plus 20% (whichever is greater) TDS = 500 mg/L or existing level plus 20% (whichever is greater)	Baseline constituent concentrations	10 percent of RMS wells within the subbasin above the minimum threshold for the same constituent due to projects and/or management actions, or overall groundwater extraction based on average of most recent three year period

Sustainability Indicator	Minimum Threshold	Measurable Objective	Undesirable Result (After 2040)
Land Subsidence	0 feet/year, subject to uncertainty of +/- 0.16 feet/year	0 feet/year, subject to uncertainty of +/- 0.16 feet/year	Average subsidence across greater than 25 percent of RMS exceeding the minimum threshold for two consecutive years.
Depletion of Interconnected Surface Water[1]	Interim condition: Water levels in select SJRRP monitor wells will be compared to the invert of the San Joaquin River.		Water levels dropping below the invert of the San Joaquin River more frequently than historical.
Seawater Intrusion	Not Applicable	Not Applicable	Not Applicable
[1] Interim SMCs will be replaced as a result of the Subbasin data gap analysis and findings from the ISW MOU.			

While the Madera Subbasin is required to be sustainable as a whole, it should be noted that some areas within the Subbasin, especially the southeast portion, can and should be evaluated separately. **Figure 1** shows the proximity of the RCWDGSA within the Madera Subbasin, just north of the San Joaquin River. The Sierra Nevada foothills and three groundwater subbasins border the Madera Subbasin north of the San Joaquin River, including the Merced, Chowchilla, and the Delta-Mendota Subbasins. The Kings Subbasin adjoins the Madera Subbasin south of the San Joaquin River.

It is evident from coordination with the Joint GSP that this area of the basin has more limited surface supplies and groundwater flows are directed toward the center of this developed area. This RCWD GSP covers the southeastern one-quarter to one-third of the area. While RCWDGSA continues to implement its plan, it will be imperative that the neighboring Madera County GSA be active in this local region in project implementation and demand management activities. It is the responsibility of all agencies within the Subbasin to coordinate and ensure sustainable management practices of surface and groundwater use in order to reach the sustainability goal.



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DAVIDS ENGINEERING, INC
Luhdorff & Scalmanini Consulting Engineers

Proposed Groundwater Level Representative Monitoring Sites

Madera Subbasin
Groundwater Sustainability Plan - First Plan Amendment

Figure 1 Plan Area Location Map

2.1 GROUNDWATER LEVELS

The most recent groundwater elevation data for the representative monitoring wells is presented in **Table 2** along with the minimum thresholds and measurable objectives. A location map of RCWDGSA's representative monitoring sites for water levels, water quality, and subsidence is shown in **Figure 2**. A general downward trend has persisted over the last 40 years. However, within the RCWDGSA water levels have generally stabilized or improved over the past seven years. In Fall 2024, five of the six RMS wells were at or above the 2025 Interim Milestone, indicating that RCWDGSA is on track to meet interim milestones and sustainability goals. During this period, and due to implementation of projects and management actions, two wells are above their respective measurable objectives. Three wells (or half) were above the 2040 minimum threshold line. Well 130 is near the northern district boundary and is likely impacted by extractions within the neighboring GSA. However, the absence of monitoring wells outside of RCWDGSA to the north, as shown in **Figure 1**, makes it challenging to monitor these activities in the neighboring GSA.

Table 2 Progress Towards Water Level Sustainable Management Criteria

	Well	Fall 2023	Fall 2024	2025 Interim Milestone	Minimum Threshold	Measurable Objective
Southern	83	185	181	162	164	179
	22	219	216	216	218	221
Central	85	59	32	28	66	95
Northern	113	54	62	42	56	68
	65	96	99	74	71	79
	130	31.3	-13.6	1	38	64
Water Surface Elevation (WSE) measured in feet above mean sea level						

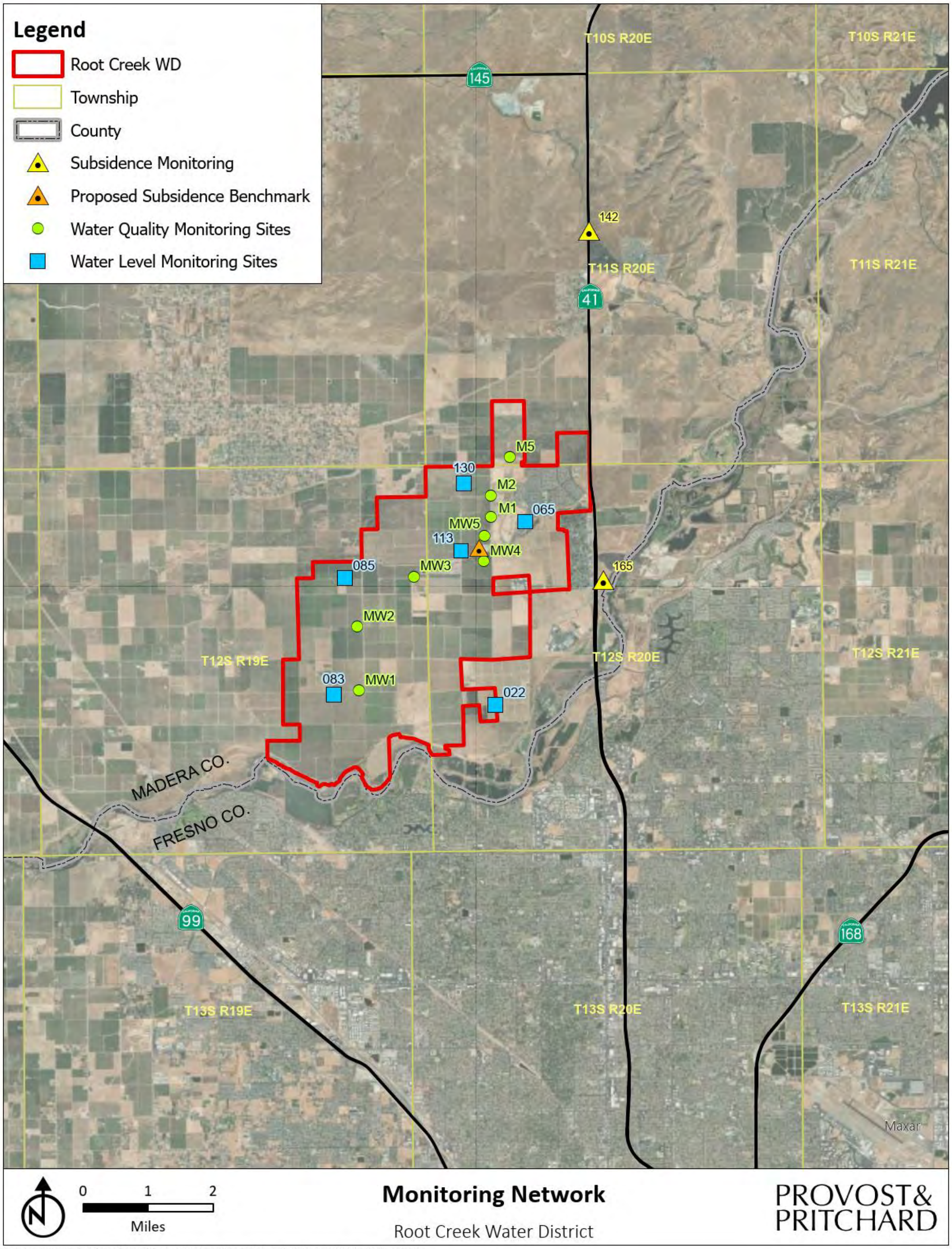


Figure 2 RCWD Representative Monitoring Network

In general, water levels fall during the summer as expected and rebound to recover or exceed previous fall groundwater elevations. This is in part due to RCWDGSA's efforts to increase conjunctive use of surface water and groundwater and the availability of surface water. Water year type, presented in **Table 3**, can be related to groundwater elevation trends seen in the hydrographs.

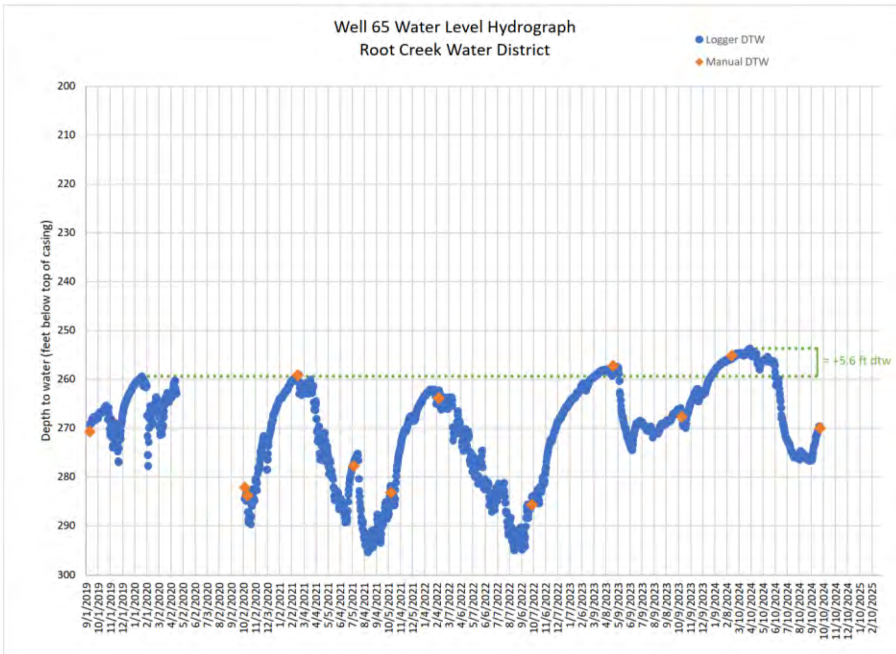
Table 3 DWR Water Year Type Classifications for the San Joaquin Valley

Year	WY Type	Year	WY Type	Year	WY Type
1975	W	1992	C	2009	BN
1976	C	1993	W	2010	AN
1977	C	1994	C	2011	W
1978	W	1995	W	2012	D
1979	AN	1996	W	2013	C
1980	W	1997	W	2014	C
1981	D	1998	W	2015	C
1982	W	1999	AN	2016	D
1983	W	2000	AN	2017	W
1984	AN	2001	D	2018	BN
1985	D	2002	D	2019	W
1986	W	2003	BN	2020	BN
1987	C	2004	D	2021	BN
1988	C	2005	W	2022	D
1989	C	2006	W	2023	W
1990	C	2007	C	2024	BN
1991	C	2008	C		

Historical groundwater surface elevation contour maps for spring 2015 – spring 2024 are shown in **Appendix A**. Generally, groundwater continues to flow away from the San Joaquin River, flowing in the northerly direction with a westerly component. The groundwater levels experience expected seasonable variability due to heightened groundwater pumping during the summer months to irrigate crops. Wells experience their lowest levels during the summer pumping events and the fall measurements in general are the measured low point, immediately following the irrigation season. Water levels rebound through the winter.

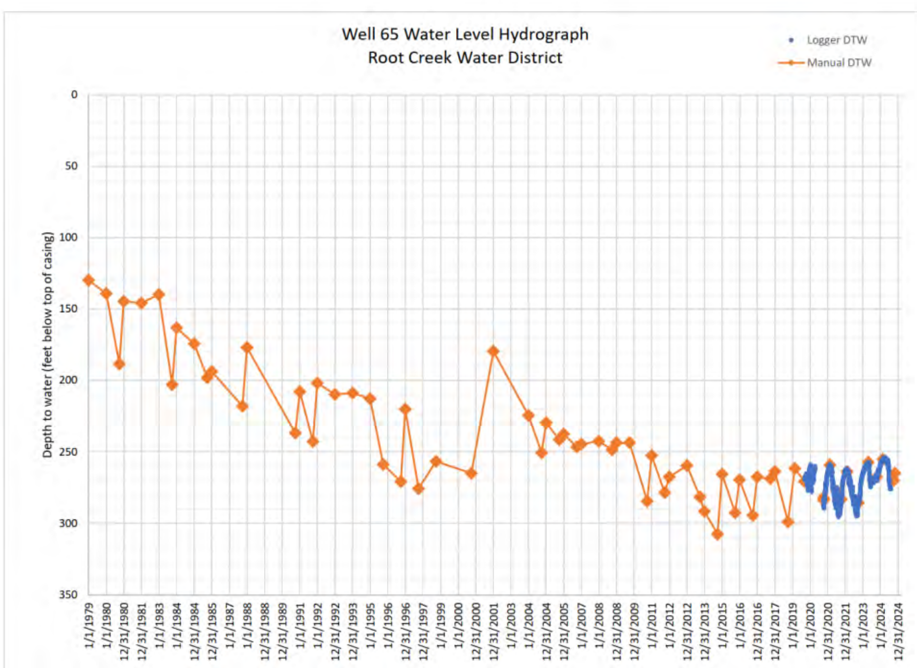
Figure 3 is a hydrograph for Well 65 that is developed from information gained from the use of a data logger. Well 65, located in the center of the Riverstone development, has a historic long-term record and was used to supply water for agricultural production. The well was discontinued due to urban development and has since been converted for use as a monitor well. A transducer was installed to collect daily water level data. Thus, it demonstrates how the conjunctive use management actions by the GSA have supported more stable long term groundwater level trends. As noted, from 2019 to the present, the spring level transducer readings have generally returned to the same levels over the period shown. Water levels dropped slightly in 2022, but water levels rose approximately 2 ft from 2019 to 2023 and 5.6 ft from 2019 to 2024. The water levels observed in this well have stabilized as a result of efforts made by the GSA. This well and the information generated give an excellent representation of the effectiveness of the District's and GSA's projects and management actions. Though Well 65 only has transducer data going back to 2019, the well has been manually measured since 1979, as shown in **Figure 4**. The figure demonstrates that efforts of the District and GSA contributed to stabilizing water levels in this well even before the adoption of the GSA's first GSP in 2020.

More recent information has been recorded at the municipal wells that serve the Riverstone development. Since these new wells have been constructed, water level readings from the wells take measurements frequently. **Figure 5** shows daily readings from these devices. At times the readings reflect the dynamic or pumping condition as indicated by the lower readings in the chart and the higher readings reflect a condition where the well is not operating. These charts show the dynamic nature of the change in levels of the groundwater and indicate that in general the highest levels are observed in the March and April months and the lowest levels correlate to July and August. While the levels fluctuate, the readings indicate that the levels, as of the end of Fall 2024, rebound to 290-310 feet depth to water for Well #2, and 200 feet depth to water for Well #1 since 2017. Well #4 was decommissioned in Fall 2021 and replaced with Well #5 in 2023. The representative monitoring wells being monitored for water levels have remained the same as in the RCWDGSA GSP. There are six wells total, located throughout the area as shown in **Figure 2**. The hydrographs associated with each of the representative monitor wells are presented as **Appendix B**. The hydrographs include historical groundwater elevation trends along with recent data compared to the interim milestones, measurable objectives, and minimum thresholds set by RCWDGSA.



https://us-partner-integrations.egnyte.com/msoffice/wopi/files/b095bdc0-62fb-42ad-ad6c-bd90993ca7dc/WOPIServiceId_TP_EGNYTE_PLUS/WOPIUserId_-/Well 65, 68, 169 Hydrographs.xlsx

Figure 3 Well 65 Transducer Data



https://us-partner-integrations.egnyte.com/msoffice/wopi/files/b095bdc0-62fb-42ad-ad6c-bd90993ca7dc/WOPIServiceId_TP_EGNYTE_PLUS/WOPIUserId_-/Well 65, 68, 169 Hydrographs.xlsx

Figure 4 Well 65 Transducer Data with Historic Data

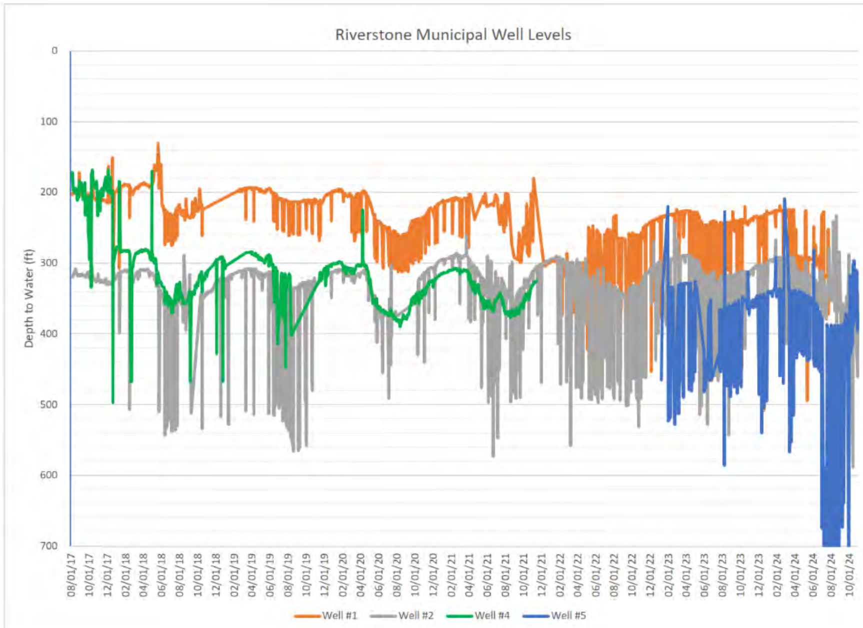


Figure 5 Transducer Data from Municipal Wells

2.2 GROUNDWATER STORAGE CHANGE

The SMCs for groundwater storage reduction are based on groundwater levels being measured for the groundwater level MT methodology. The representative wells use the groundwater level MTs as a proxy for avoidance of reduction in groundwater storage. To the extent that groundwater levels are collectively (on average) maintained above MTs, groundwater storage would be considered not to exceed its MT. In Fall 2024, five of the six RMS wells were at or above the 2025 Interim Milestone, indicating that RCWDGSA is on track to meet interim milestones and sustainability goals.

Change in groundwater storage is calculated by using the weighted average method on a GIS-generated surface with the assistance of hydrogeological interpretation. Included in this analysis are the six representative monitor sites for groundwater storage, in addition to water levels from other wells within the District. Change in groundwater storage is caused by extracting more groundwater than recharged or vice versa. RCWDGSA has two main sources of groundwater extraction: municipal water use and agricultural irrigation. More recently, practices such as intentional recharge, stormwater detention, and treated wastewater effluent percolation have been implemented which help to balance the volume of groundwater extracted. Additionally, recharge occurs through seepage from the San Joaquin River. Due to the listed water management strategies by RCWDGSA and others discussed in the preceding sections, groundwater storage change over the last 5 years has been relatively balanced as shown in **Table 4**.

Table 4 Groundwater Storage Change from 2015-2024

Time Period	Average Change (ft)	Surface Area of Analysis (ac)	Assumed Specific Yield	Annual Change (AF)	Cumulative Storage Change (AF)
Fall 2014-Fall 2015	10.5	7,569	0.12	9,500	9,500
Fall 2015-Fall 2016	-13.2	7,601	0.12	-12,000	-2,500
Fall 2016-Fall 2017	18.8	7,601	0.12	17,100	14,600
Fall 2017-Fall 2018	-25.0	7,598	0.12	-22,800	-8,200
Fall 2018-Fall 2019	10.9	7,598	0.12	10,000	1,700
Fall 2019-Fall 2020	0.7	7,728	0.12	600	2,300
Fall 2020-Fall 2021	-8.4	7,732	0.12	-7,800	-5,500
Fall 2021-Fall 2022	-8.4	8,145	0.12	-8,200	-13,700
Fall 2022- Fall 2023	15.9	8,111	0.12	15,500	**1,800**
Average	0.2			200	
Spring 2014-Spring 2015	7.8	7,596	0.12	7,100	7,100
Spring 2015-Spring 2016	-4.8	7,596	0.12	-4,300	2,700
Spring 2016-Spring 2017	-4.5	7,598	0.12	-4,100	-1,400
Spring 2017-Spring 2018	10.2	7,598	0.12	9,300	7,900
Spring 2018-Spring 2019	-10	7,598	0.12	-9,100	-1,200
Spring 2019-Spring 2020	-5.7	8,860	0.12	-6,000	-7,300
Spring 2020-Spring 2021	2.1	8,852	0.12	2,200	-5,100
Spring 2021-Spring 2022	-4.2	8,831	0.12	-4,500	-9,600
Spring 2022-Spring 2023	5.4	8,853	0.12	5,700	**-3,900**
	-0.4			-433	

The data presented in **Table 4** shows that the average change in groundwater storage over the period of record from 2014 to 2023 is close to zero. The average change was a positive 0.2-foot per year using fall data and a negative 0.4-foot per year using spring data. This approximately net zero change in groundwater storage over the period provides guidance on the District's overdraft correction. The District's efforts towards implementing projects has resulted in an average overdraft correction of 4,200 AF, which considers an average water supply augmentation of 2,200 AF (surface water for recharge and agricultural use and reclaimed water), an average water demand reduction of approximately 1,600 AF, and an average annual change in storage of 400 AF. It should be recognized that the RCWDGSA has maintained water levels and minimized storage change while the groundwater outflow to the adjacent GSA has increased by 9,300 AF in 2024 as calculated by hydrogeologist Kenneth D. Schmidt and Associates (KDSA).

The spring values are considered better to use to estimate storage change, as they are thought to indicate more static conditions. As noted on the hydrographs, there is a cyclic nature to the measurements at differing times of the year and that the Interim milestones, and thus the storage change, will reflect these changing measurements. Recognizing these variations, it could be suggested that these last four years indicate that the implementation of projects and management actions by the GSA have resulted in potentially sustainable conditions going forward. As the County GSA establishes policies on pumping and implements programs for recharge and reducing demand, the resulting change in storage is expected to provide positive results throughout the Subbasin. This data strongly indicates that RCWDGSA is on track to meet its interim milestones and overall sustainability goal set in the GSP.

2.3 GROUNDWATER QUALITY

In the Madera Subbasin, Sustainable Management Criteria for degraded groundwater quality were set for nitrate, total dissolved solids, and arsenic. These constituents were selected with consideration of existing and historical groundwater quality conditions in the Subbasin. The MTs for Degraded Water Quality across the Subbasin are set at the following MCLs for drinking water for the identified key constituents of nitrate as nitrogen, TDS, and arsenic.

- *Nitrate as nitrogen = 10 mg/L, or baseline concentration plus 20%*
- *TDS = 500 mg/L, or baseline concentration plus 20%*
- *Arsenic = 10 µg/L, or baseline concentration plus 20%*

When existing or historical concentrations for the key constituents already exceed the MCL, the MT is set at the baseline concentration plus 20 percent. When current or historical water quality for the key constituents has not been measured, the MT will be set as the MCL and will be adjusted if needed. **Table 5** lists the estimated thresholds for water quality for the RCWD GSP.

Table 5 Summary of Groundwater Quality Minimum Thresholds for Representative Monitoring Sites

Well ID	Well Type	MT Arsenic Concentration (µg/L)	MT Nitrate Concentration (mg/L)	MT TDS Concentration (mg/L)
Well M5	Municipal	10†	10†	500†
Well M2	Municipal	10†	10†	500†
Well M1	Municipal	10†	10†	500†
MW5	Monitoring	10†	~~10~~ 14.8	500†
MW4	Monitoring	10†	10.7†	500†
MW3	Monitoring	10†	~~10~~ 18.1	500†
MW2	Monitoring	10†	~~10~~ 13.3	500†
MW1	Monitoring	10†	10†	500†

†Values will be confirmed and/or adjusted as needed once enough data are collected to establish meaningful baselines. If initial sampling exceeds the MCL, then the MT is set at the baseline concentration plus 20%.

Existing and historical concentrations for the key constituents from RCWDGSA's representative monitoring sites are shown in **Table 6, Table 7,** and **Table 8**. Among the wells sampled consistently for each key constituent over the most recent three-year period (2022-2024), three wells exceeded the initial MT for nitrate (as N) on average (MW5, MW3, and MW2), while no wells exceeded the TDS MT during this period. Given that the baseline nitrate concentrations in three wells exceed initial MTs, the RCWDGSA, in coordination with the Subbasin methodology, has decided to adjust the MTs for MW5, MW3, and MW2 to baseline concentrations plus 20%. Adjusted MTs are shown in **Table 5**. Arsenic has not been consistently sampled within the RCWDGSA, as it was only recently added to the list of key constituents. Initial MTs will be confirmed and/or adjusted as needed once enough data is collected to establish meaningful baselines.

Table 6 Summary of Nitrate (as N) Results from RCWD GSA Representative Sites

	Nitrate as N (mg/L)								
Well	2017	2018	2019	2020	2021	2022	2023	2024	Average (2022-2024)
MW5	8.5	8.2	8.5	11	9.9	12	13	12	12.3
MW4	11	12	12	8.6	8.4	9.3	8.8	8.6	8.9
MW3	19	18	15	20	15	14	9.2	22	15.1
MW2	4.9	7.1	7	8.9	8.7	11	13	9.4	11.1
MW1	3.7	3.6	2.8	2.6	3.5	2.6	2.8	2.2	2.5
M5							1	-	
M2	2.8	-	-	5.3	ND	-	ND	-	
M1	3	-	-	2.9	3.8	-	3.7	-	

Table 7 Summary of TDS Results from RCWD GSA Representative Sites

	Total Dissolved Solids (TDS) (mg/L)								Average
Well	2017	2018	2019	2020	2021	2022	2023	2024	(2022-2024
MW5	210	180	190	230	230	200	280	320	267
MW4	280	290	330	200	200	200	220	280	234
MW3	330	290	330	360	310	350	290	550	397
MW2	210	260	280	250	260	290	440	360	364
MW1	220	210	200	200	220	180	180	250	203
M5	-	-	-	-	-	-	370	-	-
M2	370	-	-	260	790	-	840	-	-
M1	260	-	-	330	227	-	180	-	-

Table 8 Summary of Arsenic Results from RCWD GSA Representative Sites

	Arsenic (µg/L)								Average
Well	2017	2018	2019	2020	2021	2022	2023	2024	
MW5									-
MW4									-
MW3	Not historically measured. Constituent added to the RMN for 2025 update.								-
MW2									-
MW1									
M5	-	-	-	-	-	5.5	-	-	-
M2	-	-	4.5	-	-	5.1	-	-	-
M1	-	-	3.4	-	-	5.8	-	-	-

2.4 LAND SUBSIDENCE

Conditions that may lead to inelastic land subsidence are excessive overall average annual groundwater pumping and other outflows from the Subbasin, primarily from the Lower Aquifer, that exceed average annual inflows. Significant and unreasonable conditions were determined based on discussions with GSAs and through individual stakeholder outreach. These subsidence interviews resulted in a coordinated MT of no additional inelastic land subsidence, or 0 feet/year, after 2040 (subject to subsidence station uncertainty of +/- 0.16 feet/year), consistent across the Subbasin. **Table 9** shows the MT for land subsidence across the Subbasin, displayed as both a rate and cumulative subsidence. Land subsidence is monitored at several stations close to and several miles outside of the border of the GSA. Though subsidence is not a major concern within the GSA, the GSA plans to install a subsidence benchmark on the District's Wastewater Treatment Plan infrastructure. The subsidence near the RCWDGSA and the proposed subsidence benchmark within RCWDGSA is shown in **Figure 2.** Since 2020, the two representative subsidence stations outside of the RCWDGSA boundary along Highway 41 (Station 142 and 165) have been generally stable or improved, with an average annual rate of subsidence of 0.00 feet/year and -0.02 feet/year, respectively (**Table 10**), indicating that RCWDGSA is on track to meet interim milestones and sustainability goals for subsidence.

Table 9 Summary of Subsidence Sustainable Management Criteria

5-Year Interval	Maximum Average Annual Rate of Subsidence (feet/year)	Maximum 5-Year Cumulative Subsidence (feet)[1]
2020-2025		1.5
2025-2030	0.2	1.0
2030-2035	0.1	0.5
2035-2040	0.05	0.25
Note: Due to the uncertainty in land subsidence measurement accuracy of +/- 0.16 feet/year, there may be instances where measurement error will indicate a rate of subsidence greater than the IMs. Undesirable results will trigger further management actions within the Subbasin.		

Table 10 Summary of Inelastic Subsidence Rates

Annual Inelastic Subsidence		
Monitoring Points		
Years	**142**	**165**
Dec-16 – Dec-17	-0.02	NA
Dec-17 – Dec-18	-0.05	-0.09
Dec-18 – Dec-19	-0.01	-0.02
Dec-19 – Dec-20	+0.03	-0.05
Dec-20 – Dec-21	0.00	-0.03
Dec-21 – Dec-22	-0.14	-0.13
Dec-22 – Dec-23	+0.15	+0.09
Average Dec-20 – Dec-23	0.00	-0.02
Cumulative Dec 20 – Dec 23	+0.01	-0.07

It should be noted that while groundwater level MTs and MOs are a separate sustainability indicator and are not specifically tied to subsidence thresholds, they are consistent with the objective to limit the potential for future subsidence. The MT may require modification in the future if subsidence continues to be seen approaching the end of the 20-year GSP implementation period.

[1] A cumulative total of up to 1.0 feet of subsidence has already occurred in some portions of the subbasin between December 2019 and December 2023. Therefore, the maximum allowable cumulative subsidence of 1.5 feet as of December 2024 requires annual subsidence in 2024 to be less than 0.5 feet. Subsequent years after 2024 have significantly lower allowable annual rates of subsidence.

2.5 INTERCONNECTED SURFACE WATER AND GROUNDWATER

In RCWD, the primary area of potential interconnected surface water exists along the San Joaquin River. Available information to evaluate the presence of interconnected systems in RCWDGSA is minimal but will continue to be gathered by the USGS and the San Joaquin River Restoration (SJRRP). The Madera Subbasin GSAs, along with neighboring Kings Subbasin GSAs along the San Joaquin River, have established the framework of an Interconnected Surface Water Working Group outlined in a Memorandum of Understanding (MOU) included in the GSP. The MOU will establish a collaborative scope of work for further investigation of possible ISW along the San Joaquin River from Reach 1a to Mendota Pool. This investigation will help the GSAs better understand the timing and magnitude of potential surface water depletions from the San Joaquin River from groundwater pumping. This MOU and associated Working Group also includes the involvement from the USBR and Friant Water Authority (FWA).

With the construction of Friant Dam in 1940's, the USBR offered the landowners adjacent to the river Holding Contracts recognizing both the landowners right to divert surface water supplies as well as the possible impact to these rights from the construction of the dam, which could result in a curtailment of supplies to these landowners due to the storage and collection of surface waters behind the proposed dam. To this end the Holding Contracts require the USBR to release to the river surface water supplies to meet the demands of the landowners by maintaining a flow of at least 5 cfs past the point known as Gravelly Ford approximately 26 miles downstream of the dam. Additionally, these same contracts allow for the surface supplies delivered by the USBR to be diverted directly from the river adjacent to the property or to be pumped from wells located on the property. The Holding Contracts recognized the supply developed from wells to be considered delivery of surface water from the USBR. Hence these contracts represent conditions that the federal government will need to meet with the local landowners.

3 STATUS OF PROJECTS AND MANAGEMENT ACTIONS

The RCWDGSA GSP that was adopted and approved contained a list of project and management actions and their status, summarized in **Table 11** below.

Table 11 Status of Projects and Management Actions from RCWDGSA GSP (as of 2024)

Type	Activity	Status
Conjunctive Use	Intentional Recharge	Planning
	On Farm Field Flooding	Implemented
Surface Water	Import surface water supplies	Implemented
	Increase Conveyance Capacity	Implemented
	Fully Utilize surface water allocations	Being evaluated
	Surface water pricing	Implemented
Agricultural Land Conversion	Development of Riverstone	Implemented
Groundwater Use	Groundwater Metering	Implemented
	Groundwater Pumping Fees	Implemented
Water Conservation	Use of Recycled water	Further evaluation
Public Education	Outreach to stakeholders	In progress

The 2023 GSP outlined five (5) specific projects and management actions: (1) Expansion of the In-Lieu Pipeline, (2) Intentional Recharge Projects, (3) Agricultural Land Conservation, (4) Well Mitigation Program, and (5) Monitoring Well Program – Interconnected Surface Water. The "Intentional Recharge Projects" included a "Stormwater Basin Modification Project" and a proposed 80-acre recharge project outside of the District. The RCWDGSA has provided updates on Projects and Management Actions through the preceding Annual Reports submitted to the Department. These projects include those described in **Table 12**.

Table 12 Project and Management Actions from Previous Annual Reports

Project or Management Action Name	Project or Management Action Description	Project Status
In-Lieu Pipeline	Increase ability for conjunctive use in wet years	Operational – Completed 2014
Agricultural System Expansion/In-Lieu Recharge Project	2-mile pipeline to increase in-lieu recharge and direct groundwater recharge	Operational - Completed 2023
Storm Basin Modification Project	Reshaped and dredged basins to increase percolation	Operational – Completed 2022
Tiered Pricing	Incentivize use of surface water through pricing model	Implemented
Domestic Well Mitigation Program	A subbasin wide program to fund replacement of domestic wells impacted by lowering groundwater levels	In Development with other GSAs in the Subbasin
Monitoring Well Program – Interconnected Surface Water	Construction of nested monitoring wells to monitor the interconnectivity of surface water and groundwater	In Development with GSAs in multiple Subbasins

The 2025 Revised RCWDGSA GSP includes revisions to the Project and Management Actions chapter, for clarity, not because existing PMAs are insufficient or need revision. Completed projects have been removed from the 2025 Revised RCWDGSA GSP but are still included in summary tables. The ongoing implementation will continue to be reported, and project benefits will be communicated through Annual Reports and Periodic Evaluations. The 2025 Revised RCWDGSA GSP also includes a list of additional PMAs that could be implemented as part of an adaptive management strategy, should there be Undesirable Results or exceedances within the RCWDGSA.

The 2025 Revised RCWDGSA GSP also separates the table of PMAs into "Projects" and "Management Actions" as summarized in **Table 13** and **Table 14** below.

Table 13 Status of Projects from the 2025 Revised RCWDGSA GSP

Type	Activity	Status	Description
Conjunctive Use	Intentional Recharge	Complete	Dedicates land to allow for the intentional recharge of surface water Future recharge projects are being considered
	On Farm Field Flooding	Ongoing	Allows for the temporary use of field for intentional recharge while not dedicating the land to this purpose
Surface Water	Expansion of In-Lieu Pipeline	Complete	Expands agricultural service area that will be able to receive surface water deliveries
	Import surface water supplies	Ongoing	Importation of surface water supplies reduces the amount of groundwater pumping
	Increase Conveyance Capacity	Being Considered	Importation of surface water supplies reduces the amount of groundwater pumping
	Fully Utilize surface water allocations	Being Considered	Importation of surface water supplies reduces the amount of groundwater pumping

Type	Activity	Status	Description
	Surface water pricing	Complete	Importation of surface water supplies reduces the amount of groundwater pumping

Table 14 Status of Management Actions from the 2025 Revised RCWDGSA GSP

Type	Activity	Status	Description
Agricultural Land Conversion	Development of Riverstone	Complete	Changes land use and reduces groundwater pumping
Mitigation	Domestic Well Mitigation Program	Being Developed	Program is intended to get established so as to mitigate wells going dry due to the GSA actions on water levels.
Data Collection	Monitoring Well Program – Interconnected Surface Water	Being Developed	Establishes a program to work with others to identify and define the extent of interconnected surface water.

The projects proposed and implemented by the RCWDGSA include groundwater recharge activities and the importation of surface water. To date, the infrastructure anticipated to date has been constructed, with the exception of the 80-acre recharge basin project described in the 2023 Revised GSP. The PMAs being implemented are summarized in **Table 15**. Additional discussion for each PMA is included below.

Table 15 Project and Management Actions Summary Table

Project or Management Action Name	Project or Management Action Description	Targeted Sustainability Indicator	Project Status	Benefits Observed to Date
In-Lieu Pipeline	Increase ability for conjunctive use in wet years	Chronic lowering of groundwater levels	Operational – completed 2014	Average about 2,700 AF per year of surface water delivered
Agricultural System Expansion/In-Lieu Recharge Project	2-mile pipeline to increase in-lieu recharge and direct groundwater recharge	Chronic lowering of groundwater levels	Operational – Completed 2023	Included in Benefits for In-Lieu pipeline
Storm Basin Modification Project	Reshaped and dredged basins to increase percolation	Chronic lowering of groundwater levels	Operational – Completed 2022	Not Measured
80-Acre Recharge			Not Implemented	
Tiered Pricing	Incentivize use of surface water through pricing model	Chronic lowering of groundwater levels	Implemented	Not quantified
Agricultural Land Conversion	The expansion of the Riverstone community reduces the amount of land in irrigated agricultural production	Chronic lowering of groundwater levels	Ongoing	Irrigated agricultural acreage has reduced by about 21% from 2015 to 2023. From 2014 to 2023 an average of about 1,500 AF per year less water was used.
Domestic Well Mitigation Program	A subbasin wide program to fund replacement of domestic wells impacted by lowering groundwater levels	Chronic lowering of groundwater levels	In Development	N/A
Monitoring Well Program –	Construction of nested monitoring wells to monitor the interconnectivity of	Interconnected Surface Water Depletions	In Development	N/A

Project or Management Action Name	Project or Management Action Description	Targeted Sustainability Indicator	Project Status	Benefits Observed to Date
Interconnected Surface Water	surface water and groundwater			

3.1 IN-LIEU PIPELINE

The In-Lieu Pipeline project was built in 2014 to increase the ability of RCWD to implement conjunctive use of surface water in wet years. Benefits of the pipeline were seen in 2014, 2017, 2018, and 2019, prior to plan adoption. Water was also able to be delivered through the pipeline in 2021, 2022, 2023, and 2024. Water delivered through the pipeline is diverted from Madera Irrigation District (MID) Lateral 6.2, from the Madera Canal. RCWD has surface water contracts with MID, Wonderful Co., and the USBR. The MID contract allows RCWD to buy excess surface water at a contracted price, while the contract with the Wonderful Co. provides a readily available supply of surface water at a higher price. The contract with the USBR only allows for the purchase of Section 215 water, when available during flood conditions.

Summary of RCWD Surface Water Supply (AF)										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	Average
Agriculture										
Lateral 6.2	0	0	6,636	1,361	7,607	0	1,250	900	3,874	2,403
San Joaquin River – Holding Contracts	5,802	5,802	5,802	5,802	5,802	5,802	6,072	6,072	6,044	5,889
Total Surface Water for Agricultural Use	**5,802**	**5,802**	**12,438**	**7,163**	**13,409**	**5,802**	**7,322**	**6,972**	**9,918**	**8,292**
Recharge										
Reclaimed Water	0	0	1	22	46	85	119	176	232	97
Lateral 6.2	0	0	178	0	601	0	0	0	1,190	281
Total Surface Water for Recharge	**0**	**0**	**179**	**22**	**647**	**85**	**119**	**176**	**1,422**	**379**
Total Surface Water Supply for RCWD	**5,802**	**5,802**	**12,617**	**7,185**	**14,056**	**5,887**	**7,441**	**7,148**	**11,339**	**8,586**

3.2 AGRICULTURAL SYSTEM EXPANSION/IN-LIEU RECHARGE PROJECT

This project includes incorporating a 2-mile pipeline to increase in-lieu recharge area within the District and diversions to direct groundwater recharge. The project was anticipated to increase in-lieu recharge by approximately 1,800 AF/year and provide additional diversions of 275 AF/year for groundwater recharge. The project connects to the In-Lieu Pipeline described above. Construction of the Agricultural System Expansion project began in 2023 and became operational in 2024.

The capital and water purchase costs required to achieve the In-Lieu Pipeline and Agricultural System Expansion projects are summarized in Table 16.

Table 16 Costs Associated with Surface Water Deliveries

Year	Capital Cost	Water Purchase	Note
2002-2013	$650,000.00	-	MID Contract
2006-2017	$1,122,822.00	-	Wonderful Company
2014	$ 5,376,008.00	-	In-Lieu Pipeline
2015	-	-	-
2016	-		
2017	-	$923,060.00	Water Purchases
2018	-	$793,360.00	Water Purchases
2019	-	$2,544,750.00	Water Purchases
2020	-	$1,118,393.00	Water Purchases
2021	-	$1,380,247.00	Water Purchases
2022	-	$1,865,442.00	Water Purchases
2023	$2,719,548.53	$943,459.00	Agriculture System Expansion, Water Purchases
Total	$9,868,378.53	$9,568,711.00	

3.3 STORM BASIN MODIFICATION PROJECT

Three existing storm drain basins were reshaped and dredged in 2022 to increase their percolation potential. The three basins are sourced by surface runoff from the Riverstone urban development and are not currently measured.

3.4 80-ACRE RECHARGE PROJECT

This project was envisioned during the planning and permitting process with the Gateway Village community, which has since been renamed to Riverstone. In cooperation with the County of Madera, and funding from the State of California, project plans were developed. During permitting, another GSA in the Subbasin negatively commented on CEQA and the project has been put on hold and might be developed independently by the RCWD.

3.5 TIERED PRICING

The RCWD Board of Directors adopted a tiered pricing structure in December of 2020 which established groundwater rates at $95 per acre-foot, in addition to estimated energy costs for a total of $235 per acre-foot for pumping groundwater. Comparatively, surface water rates for imported water were $138 per acre-foot. These rates have been raised and will be $114.68 for groundwater pumping and $162.23 for surface water. This pricing structure is intended to incentivize growers to use surface water when it is available.

3.6 DOMESTIC WELL MITIGATION PROGRAM

The Madera Subbasin Domestic Well Mitigation Program is under development. RCWDGSA is cooperating in the development of the subbasin-wide domestic well mitigation program and plans to implement the provisions within the RCWDGSA boundary. The program will be modelled after the draft domestic well mitigation program for the Madera Subbasin. The program objectives are based on results of the Madera Subbasin groundwater model for the 2020-2040 implementation period and subsequent 50-year sustainability period.

3.7 MONITORING WELL PROGRAM – INTERCONNECTED SURFACE WATER

The Kings and Madera subbasins have developed a Memorandum of Understanding (MOU) with USBR and FWA that includes a cooperative scope of work for further investigation of possible ISW from along the SJR from Reach 1a to Mendota Pool. RCWDGSA will support the need for additional monitoring along the San Joaquin River, if USBR and FWA's work leads to that determination. The current GSP groundwater monitoring network was developed using existing wells in the Subbasin. It is expected that this network will be supplemented (and/or some initial wells replaced) by new nested monitoring wells.

4 BASIN SETTING BASED ON NEW INFORMATION OR CHANGES IN WATER USE

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation.

5 MONITORING NETWORKS

Regulation Requirements:

GSP Regulations §354.38 **a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.** **b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.** **c) If the monitoring network contains data gaps, the Plan shall include a description of the following:** **1. The location and reason for data gaps in the monitoring network.** **2. Local issues and circumstances that limit or prevent monitoring.** **d) Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.** **e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:** **1. Minimum threshold exceedances** **2. Highly variable spatial or temporal conditions** **3. Adverse impacts to beneficial uses and users of groundwater** **4. The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin**

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation.
The revised monitoring network for the RCWDGSA is included as Figure 2.

6 GSA AUTHORITIES AND ENFORCEMENT ACTIONS

The Periodic Evaluation should describe any new authorities the basin's GSAs have gained, established, or exercised since the last GSP submittal and summarize what has been implemented to advance groundwater sustainability. Authorities could pertain to relevant actions related to regulations and ordinances applicable to the Plan. In addition, GSAs should provide information describing any enforcement or legal actions taken in the basin to further the sustainability goal. This could include any new significant information such as funding and fee actions, installing volumetric measuring devices on wells (i.e., flow meters), or collecting other data related to allocation programs and pumping reductions. Demonstrating how these components of GSP implementation will help GSAs reach sustainability is important.

- Provide a summary of GSA regulations or ordinances related to the Plan [Water Code 10725, 10726, 10730, and 10731].
- Describe GSA enforcement or legal actions [Water Code 10725.4, 10730, and 10732].
- Describe activities advancing other regulations and orders outside of SGMA that are related to SGMA implementation, if applicable (e.g., legislation such as Senate Bill 55226 [Drought Planning for Small Water Suppliers and Rural Communities], well moratoriums, and land use zoning). 26 https://water.ca.gov/Programs/Water-Use-And-Efficiency/SB-552
- Describe how Plan implementation has been affected by external regulatory requirements or executive orders issued by the Governor, if applicable.

Additionally, in order to continue monitoring groundwater pumping throughout the District, the Board adopted the Agricultural Water Flow Meter and Water Level Measurement Policy in January of 2018. Those data will assist in filling known data gaps and will enhance groundwater contouring efforts, thus strengthening their annual reporting.

7 OUTREACH, ENGAGEMENT, AND COORDINATION WITH OTHER AGENCIES

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation.
The RCWDGSA has had monthly meetings where the public has been invited to discuss the progress made in implementing projects and striving to meet sustainability goals. These meetings are generally held the second Monday of the month at 11:00 am.

8 OTHER INFORMATION

8.1 CONSIDERATION OF ADJACENT BASINS

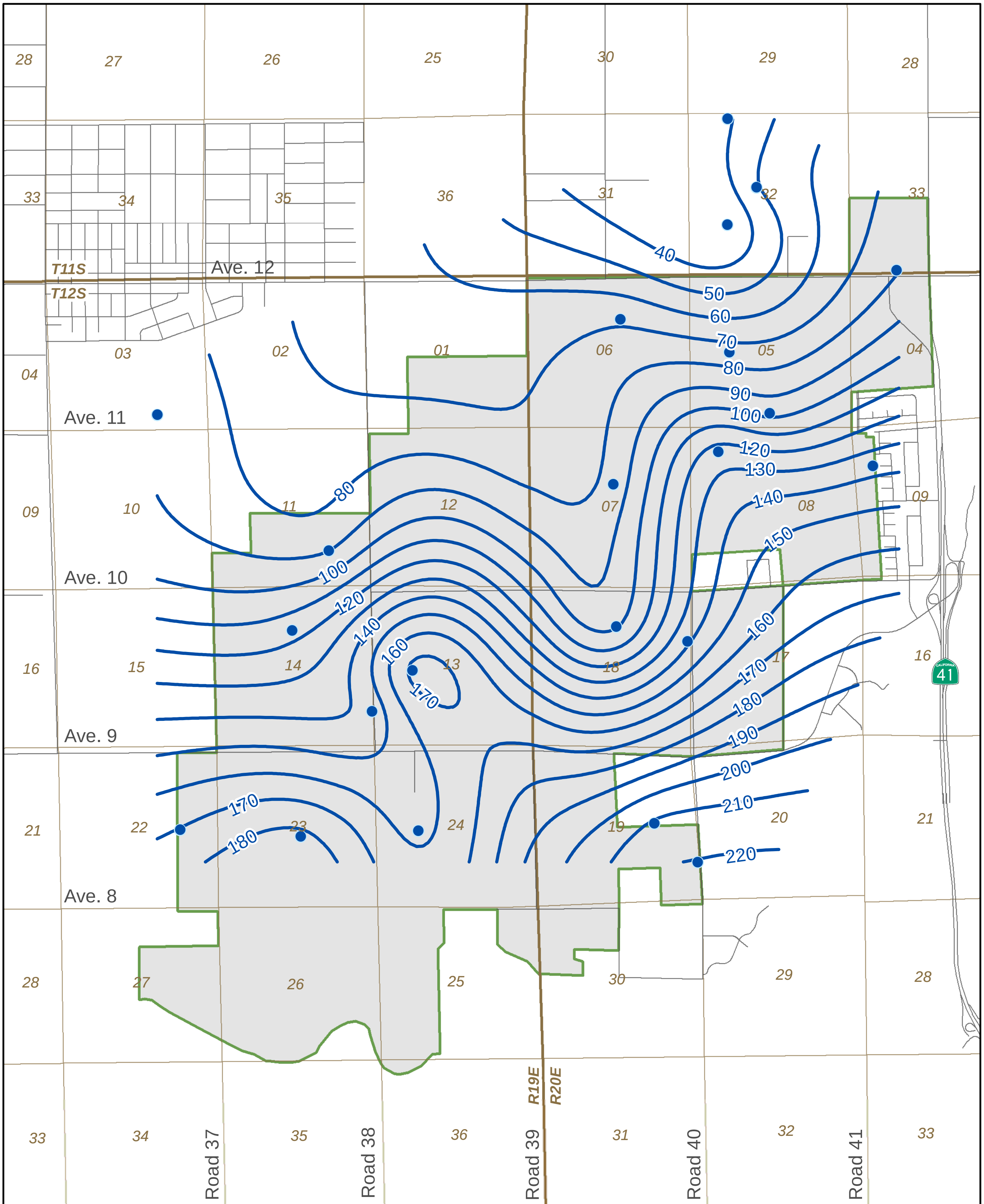
As discussed in the 2025 Root Creek Water District Groundwater Sustainability Plan Amendment, the Madera Subbasin and Kings Subbasin are working to establish an MOU for Interconnected Surface Water, with Friant Water Authority and the Bureau of Reclamation.

9 SUMMARY OF PROPOSED OR COMPLETED REVISIONS TO PLAN ELEMENTS

Please refer to the Madera Subbasin Groundwater Sustainability Plan Period Evaluation.
The RCWDGSA has made great progress towards meeting its sustainability goals. From review of the sustainability indicators of levels and storage change it is apparent that groundwater outflow to the adjacent GSA within the Subbasin is of keen importance. Coordination and communication with the Subbasin GSAs, as demonstrated over the past six months, will continue to play a key role in making progress towards sustainability.

APPENDIX

Appendix A - Historic WSE Contours



0 0.5 1 Miles

PROVOST & PRITCHARD CONSULTING GROUP

286 W. Cromwell Ave.
Fresno, CA 93711-6162
(559) 449-2700

Legend

Well Used In Analysis

Elevation of Water in Wells (feet above sea level)

Line of Equal Elevation (10 ft interval)

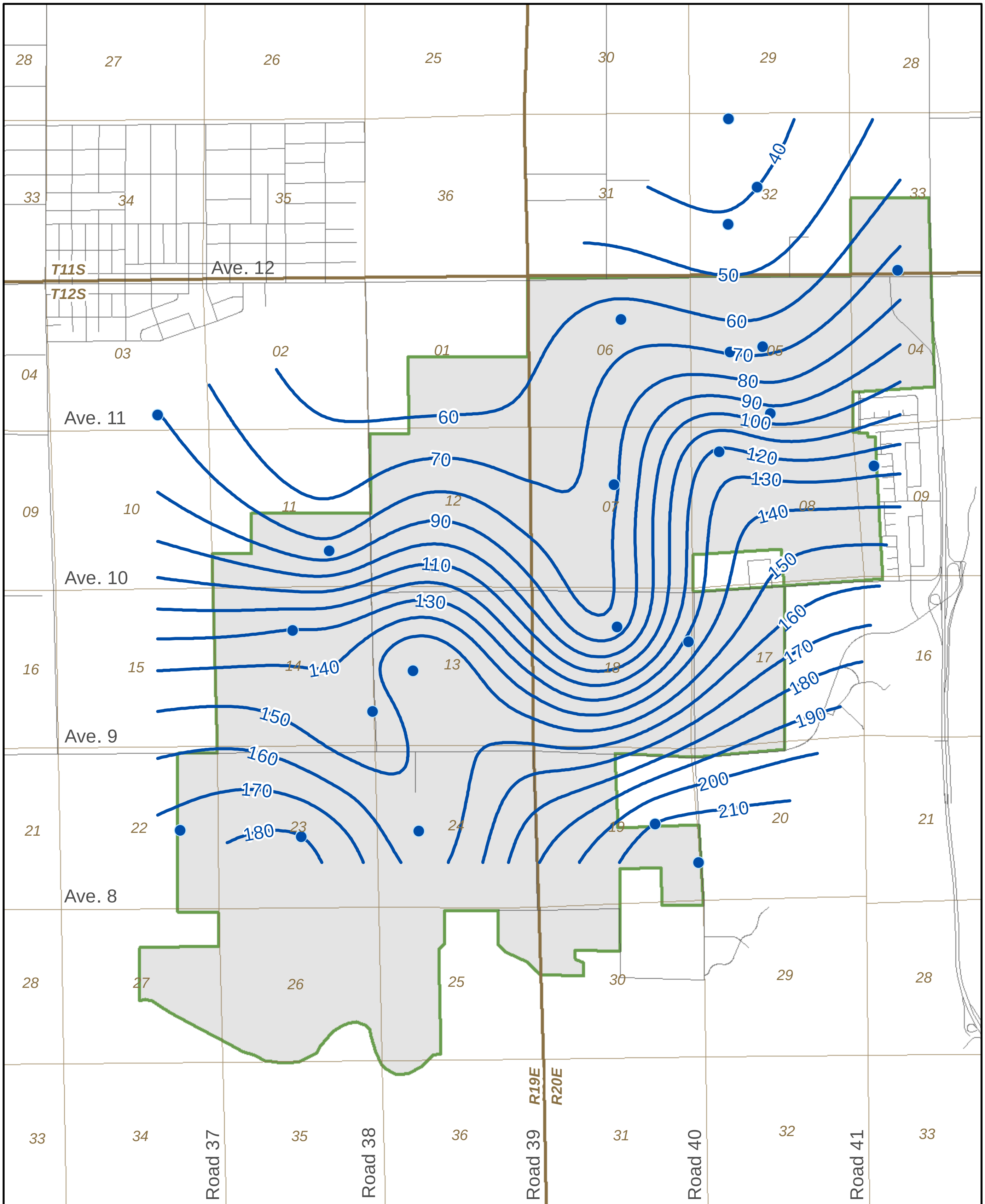
Root Creek WD

ROOT CREEK WATER DISTRICT

Elevation of Water in Wells

Spring 2015

9/9/2015: G:\Root Creek WD-1249\GIS\12491001-E\Groundwater Analysis\Map\Spring15_WSE.mxd



Legend

● Well Used In Analysis

Elevation of Water in Wells (feet above sea level)

Line of Equal Elevation (10 ft interval)

Root Creek WD

0 0.5 1
Miles

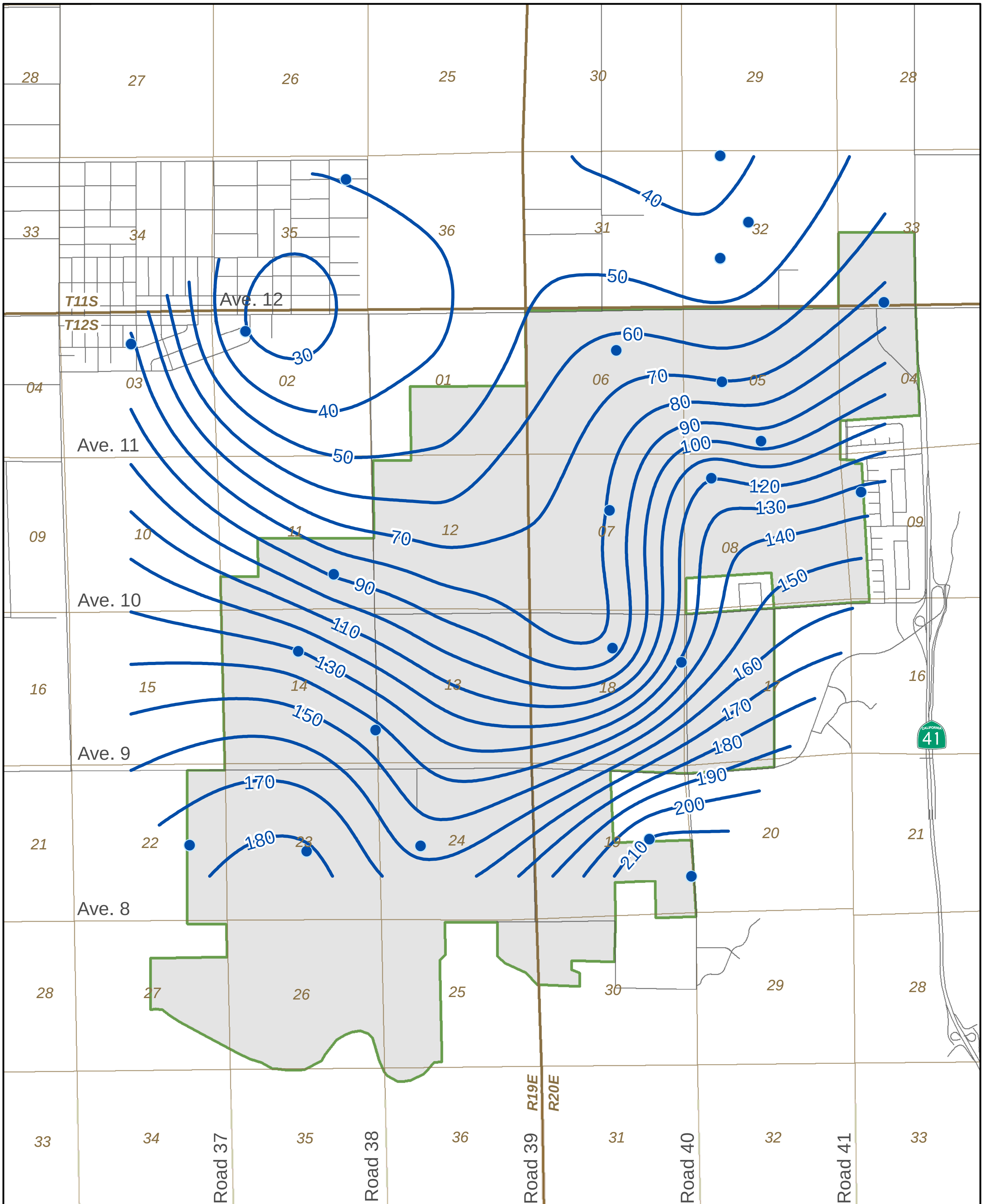
PROVOST & PRITCHARD CONSULTING GROUP
EST. 1968
An Employee Owned Company

ROOT CREEK WATER DISTRICT

Elevation of Water in Wells

Spring 2016

7/20/2016: G:\Root Creek WD-1249\GIS\12491001-E\Groundwater Analysis\Map\Spring16_WSE.mxd



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

0 0.5 1
Miles

Legend

● Well Used In Analysis

Elevation of Water in Wells (feet above sea level)

Line of Equal Elevation (10 ft interval)

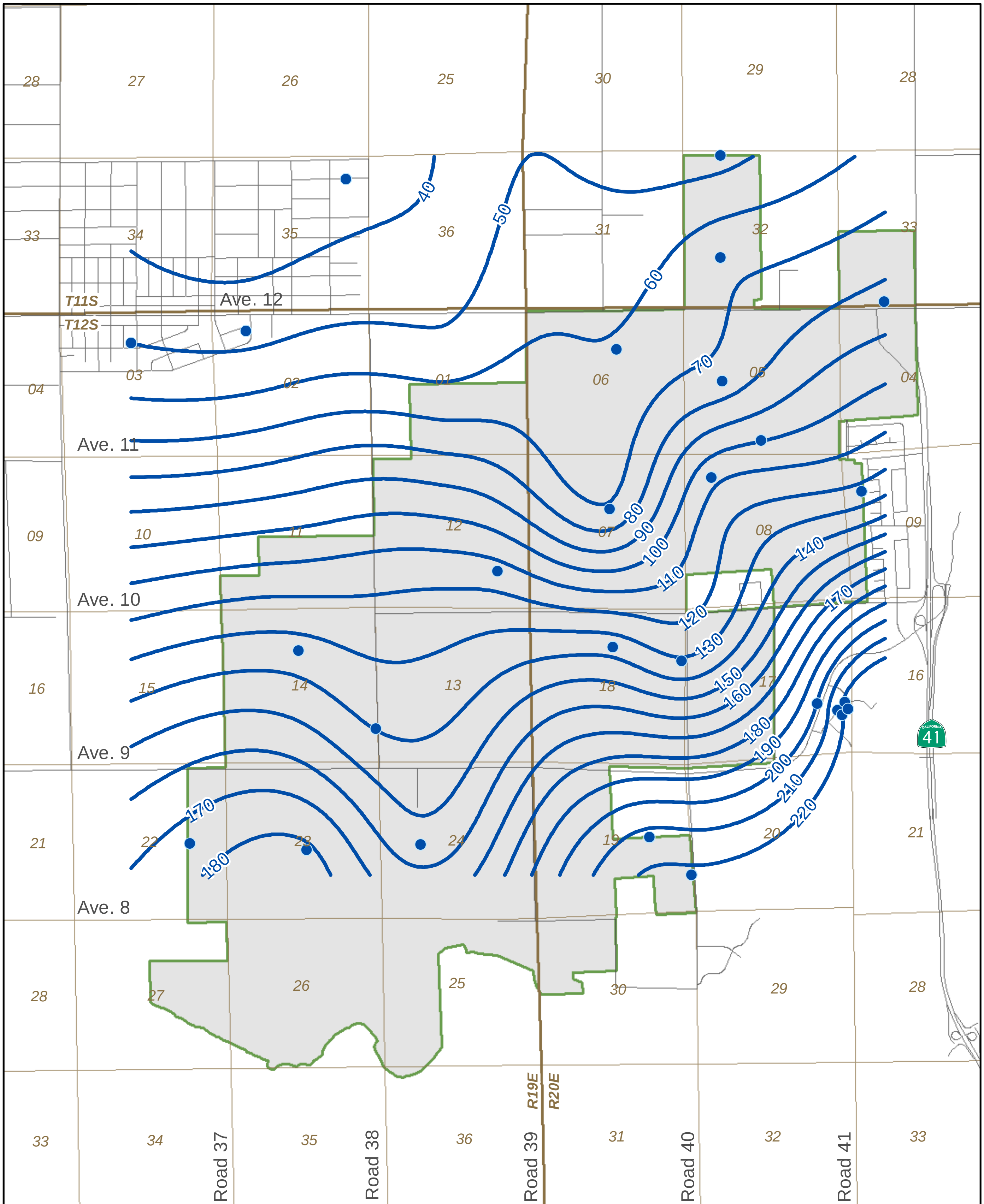
Root Creek WD

ROOT CREEK WATER DISTRICT

Elevation of Water in Wells

Spring 2017

6/28/2017: G:\Root Creek WD-1249\GIS\12491001-E\Groundwater Analysis\Map\Spring17_WSE.mxd



N

0 0.5 1

Miles

Legend

Root Creek WD

Well Used In Analysis

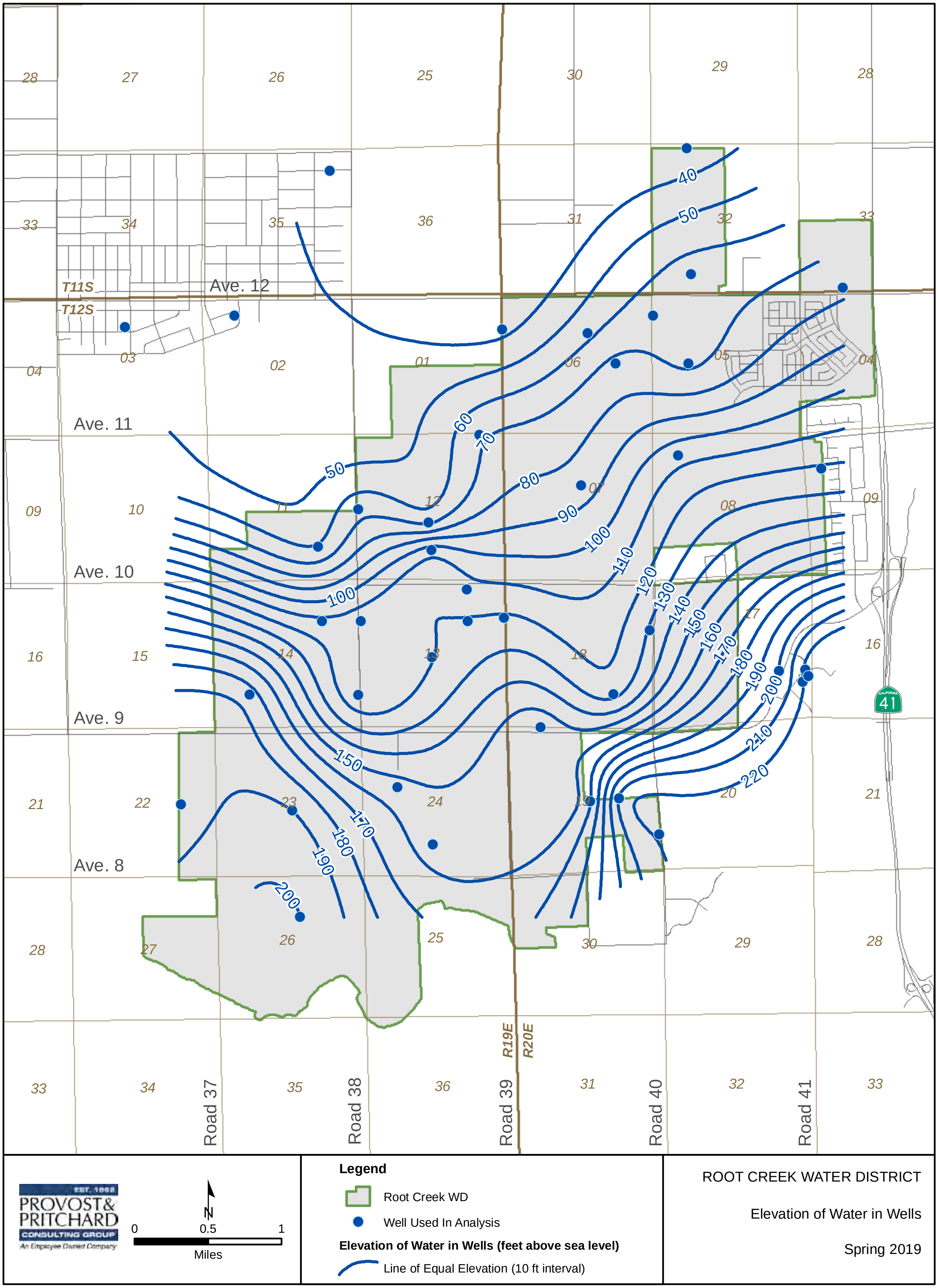
Elevation of Water in Wells (feet above sea level)

Line of Equal Elevation (10 ft interval)

ROOT CREEK WATER DISTRICT

Elevation of Water in Wells

Spring 2018

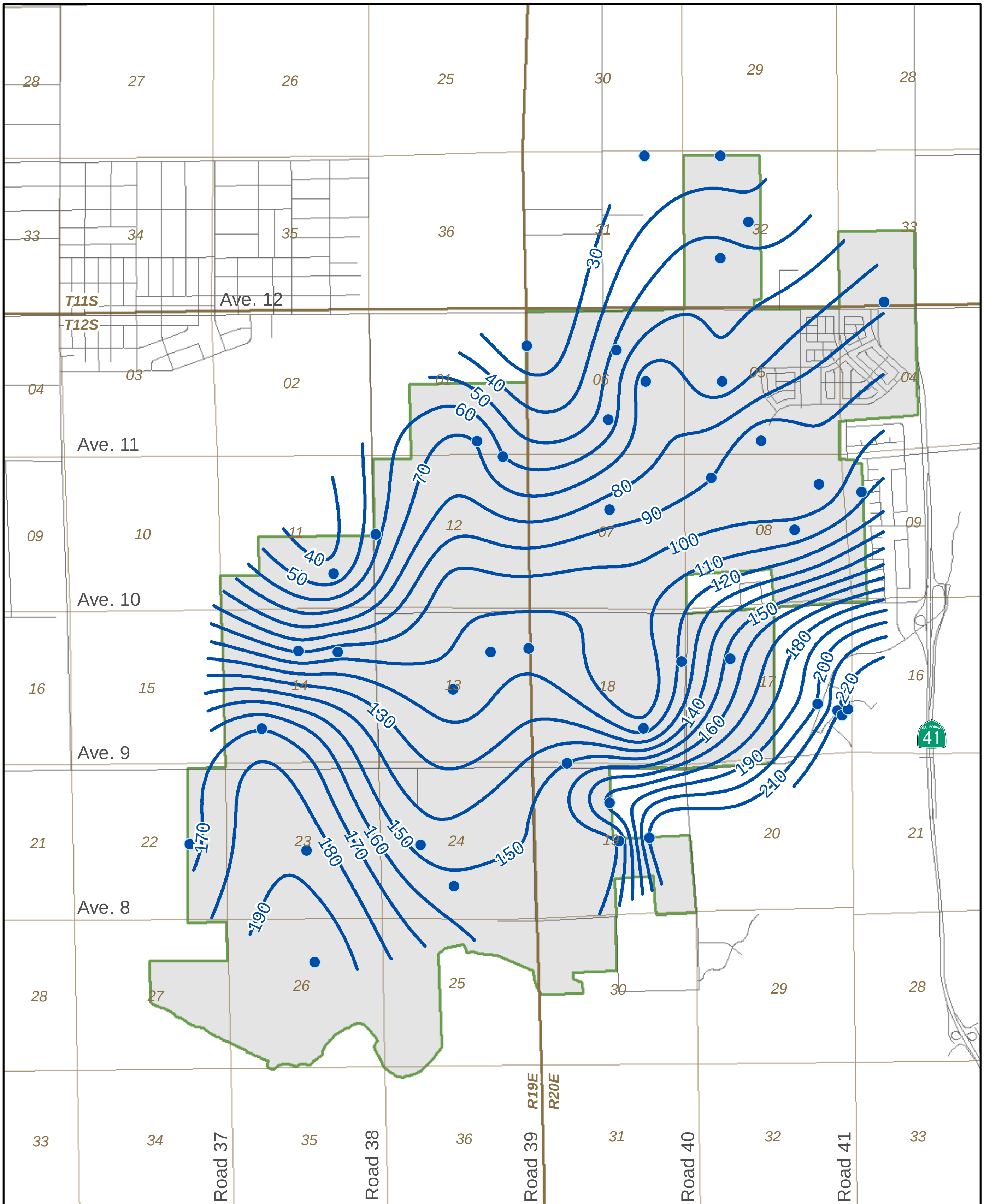


ROOT CREEK WATER DISTRICT

Elevation of Water in Wells

Spring 2019

2/12/2020: \\ppeng.com\pzdata\clients\Root Creek WD-1249\GIS\12491001-E\Groundwater Analysis\Map\Spring19_WSE.mxd



Legend

Root Creek WD

Well Used In Analysis

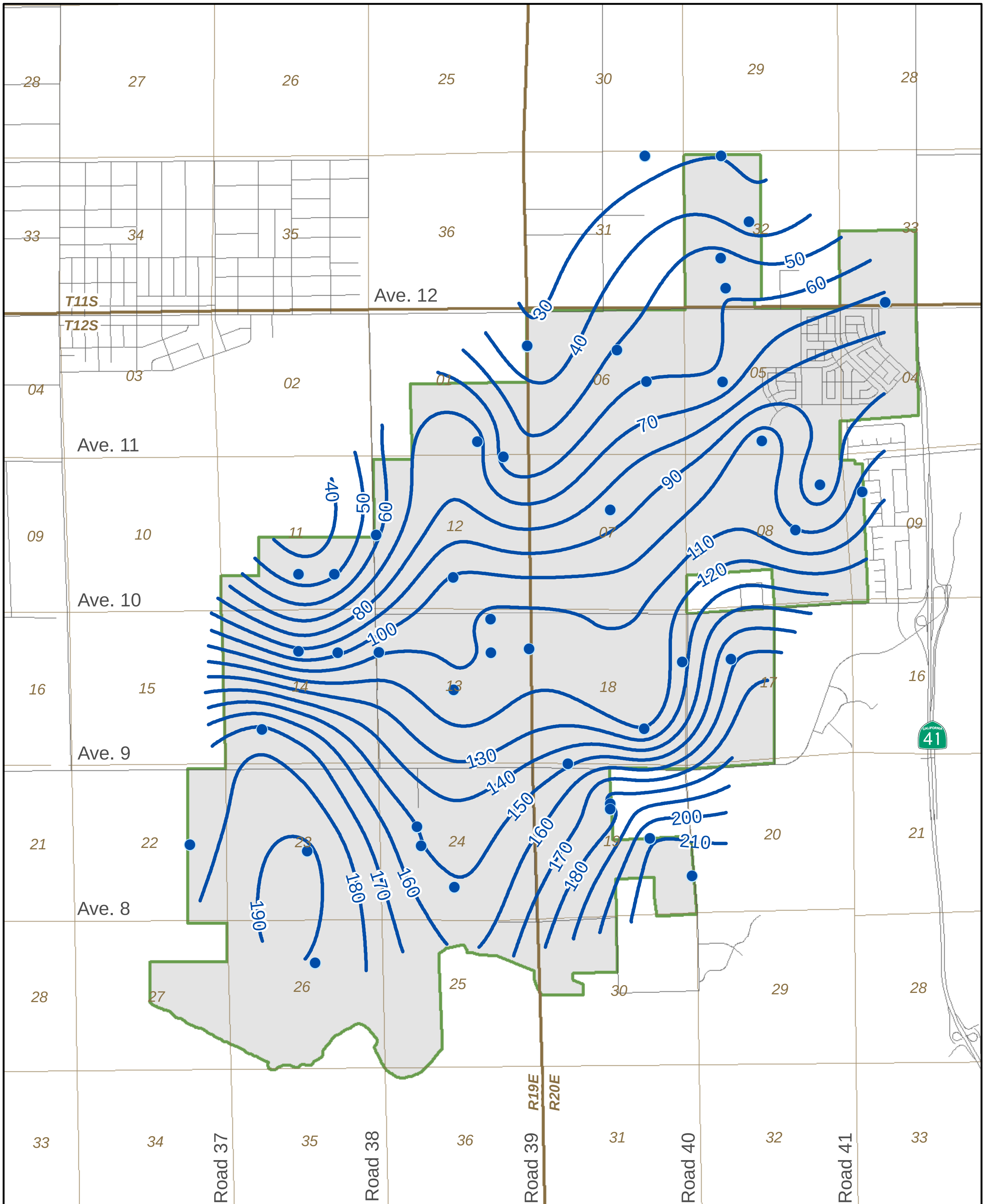
Elevation of Water in Wells (feet above sea level)

Line of Equal Elevation (10 ft interval)

ROOT CREEK WATER DISTRICT

Elevation of Water in Wells

Spring 2020



Legend

Root Creek WD

Well Used In Analysis

Elevation of Water in Wells (feet above sea level)

Line of Equal Elevation (10 ft interval)

0 0.5 1

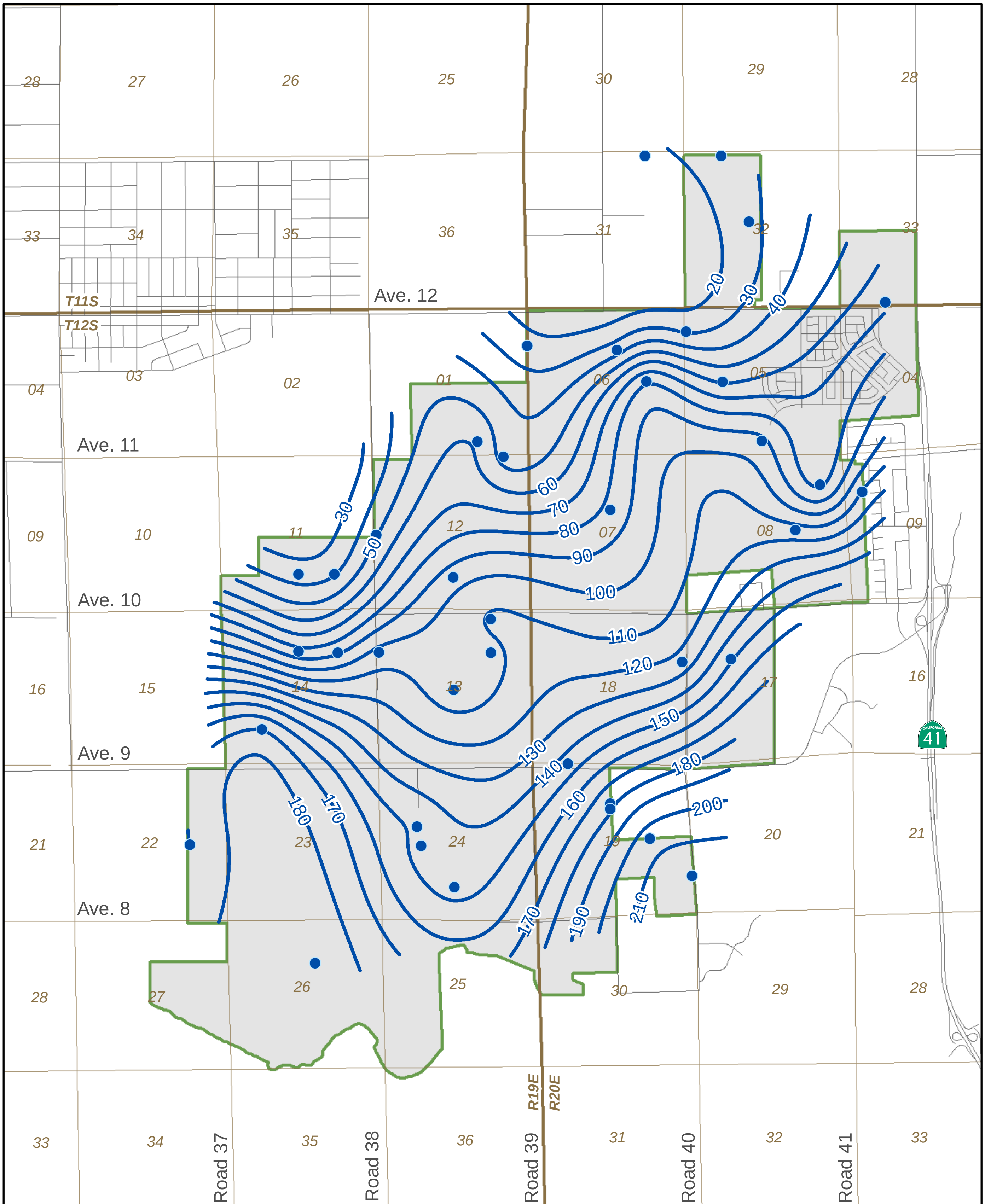
Miles

ROOT CREEK WATER DISTRICT

Elevation of Water in Wells

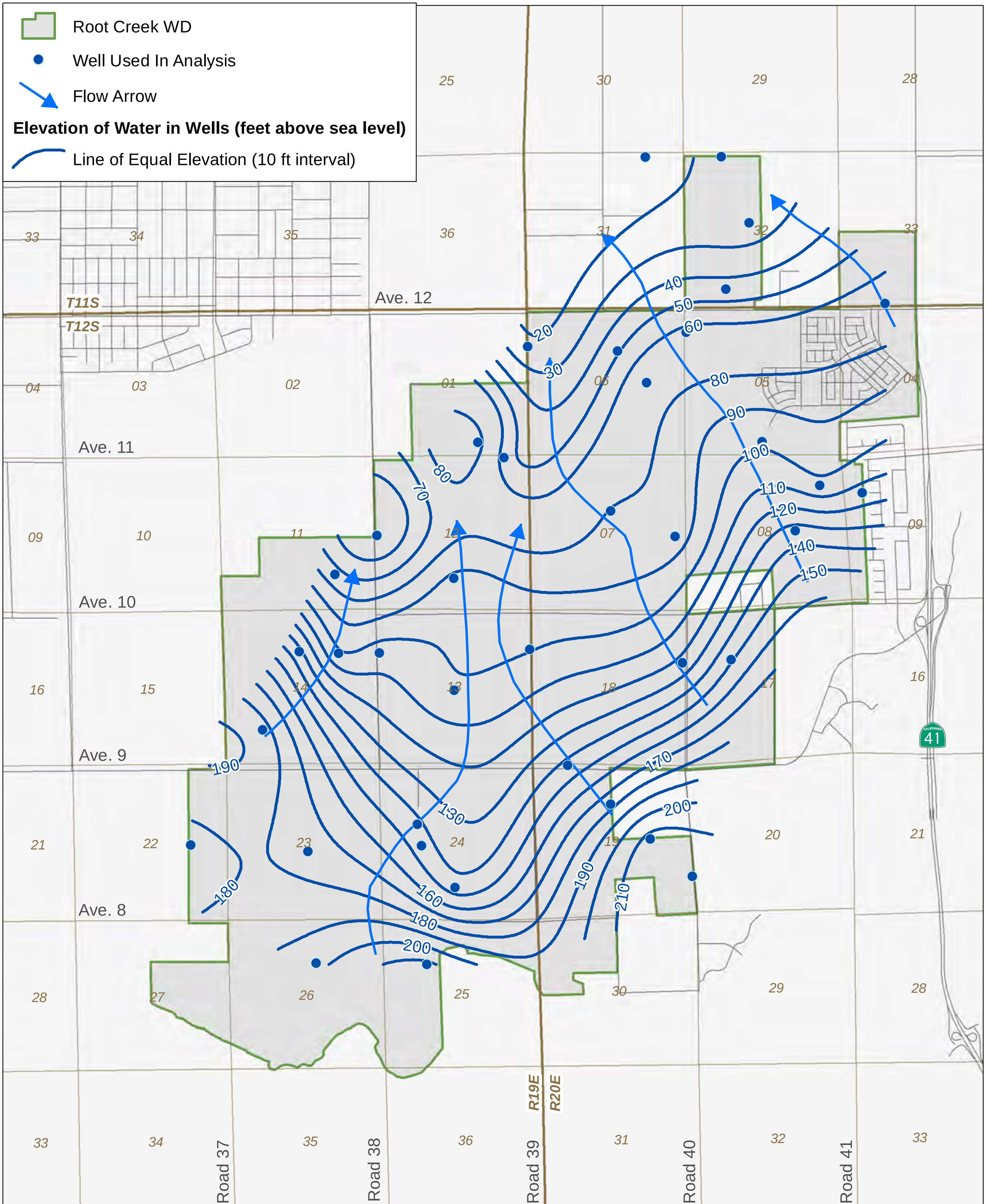
Spring 2021

10/25/2021: G:\Root Creek WD-1249\GIS\12491001-E\Groundwater Analysis\Map\Spring21_WSE.mxd



PROVOST & PRITCHARD CONSULTING GROUP EST. 1968 An Employee Owned Company 0 0.5 1 Miles N	**Legend** Root Creek WD Well Used In Analysis **Elevation of Water in Wells (feet above sea level)** Line of Equal Elevation (10 ft interval)	**ROOT CREEK WATER DISTRICT** Elevation of Water in Wells Spring 2022

3/18/2022: G:\Root Creek WD-1249\GIS\12491001-E\Groundwater Analysis\Map\Spring22_WSE.mxd



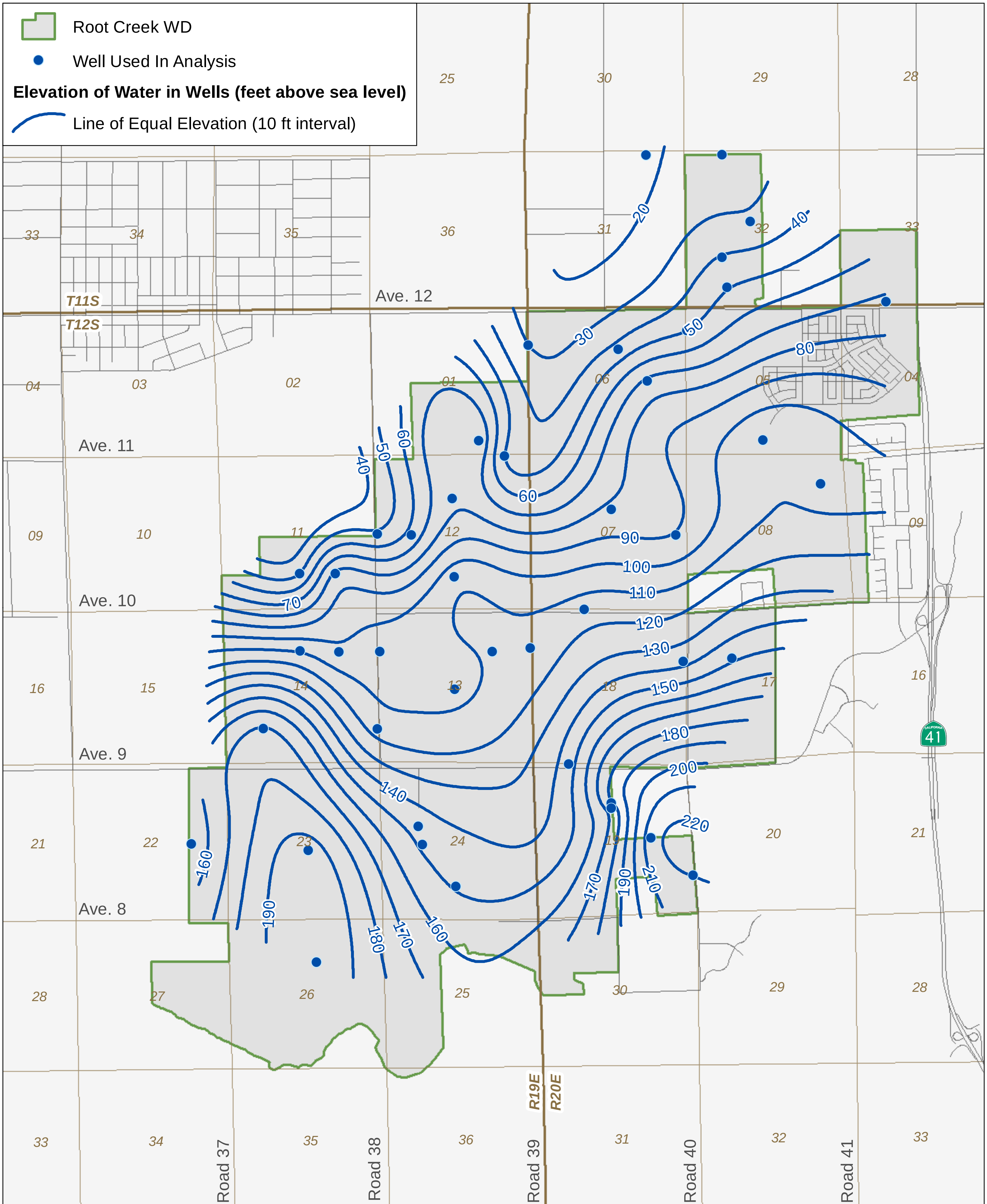
0 0.5 1
Miles

Root Creek Water District

Spring 2023 - Elevation of Water in Wells

PROVOST& PRITCHARD

2/28/2024 G:\Root Creek WD-1249\GIS\12491001-E\Groundwater Analysis\Map\Spring23_WSE.mxd



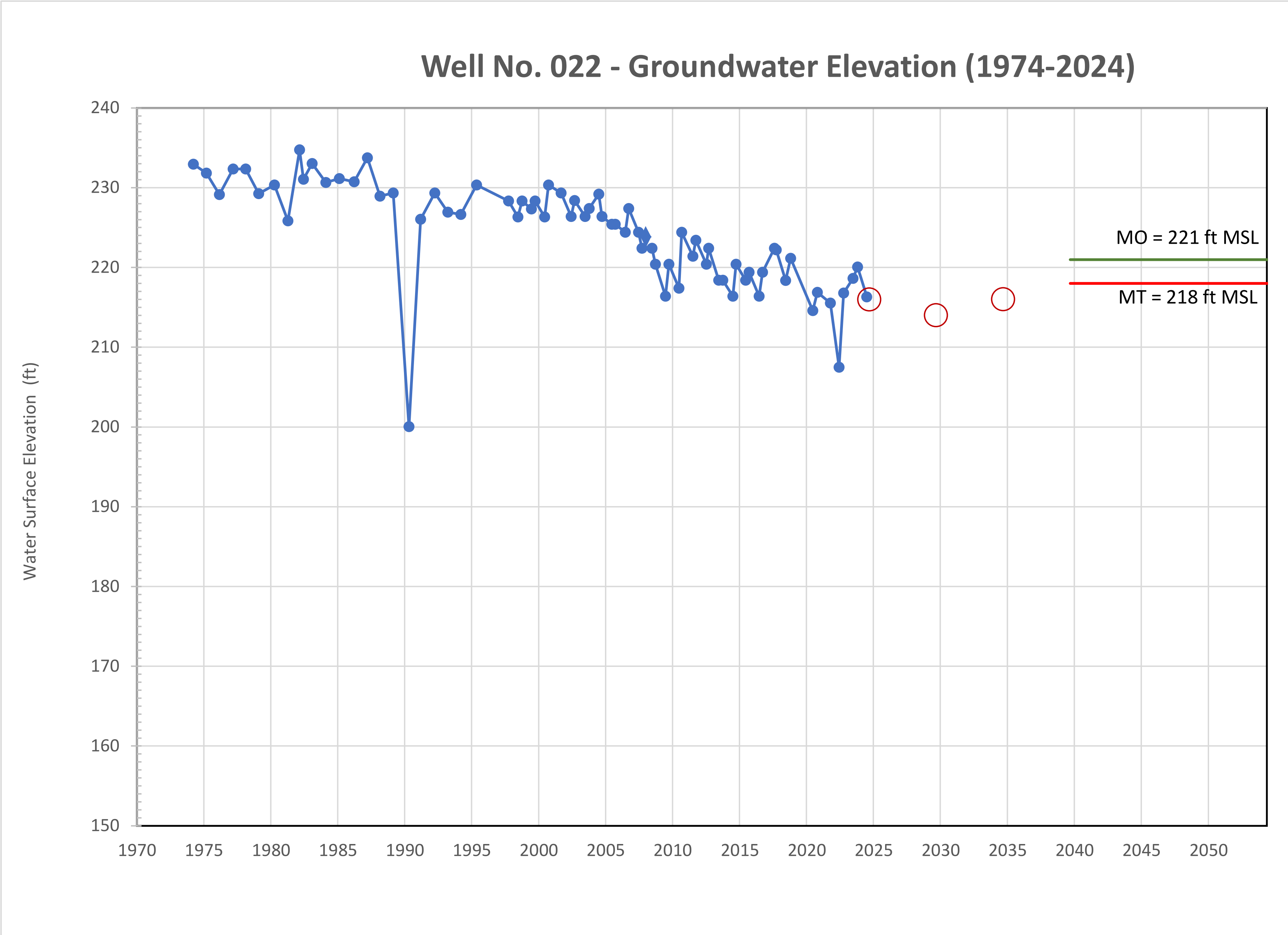
Root Creek Water District

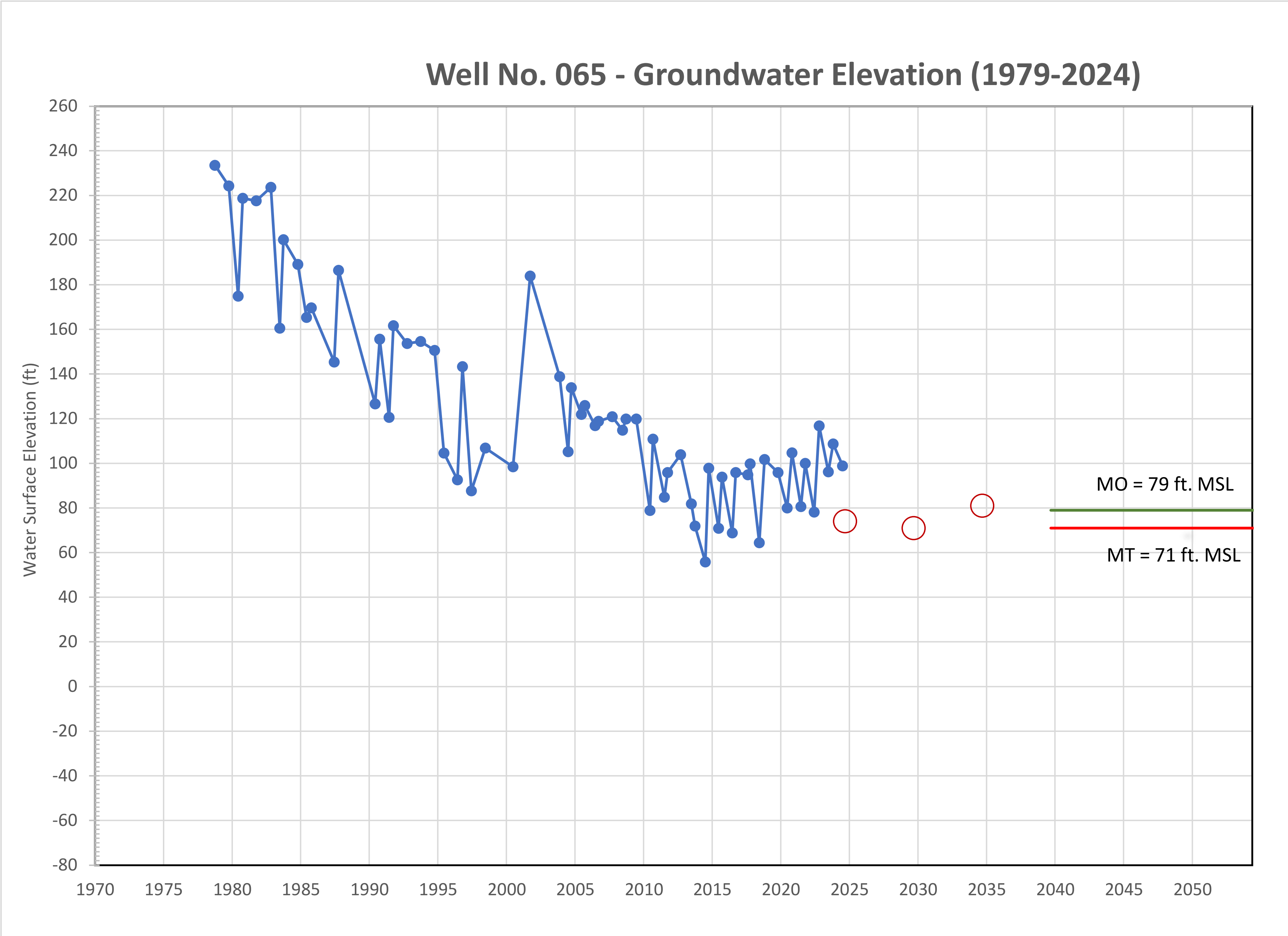
Spring 2024 - Elevation of Water in Wells

PROVOST & PRITCHARD

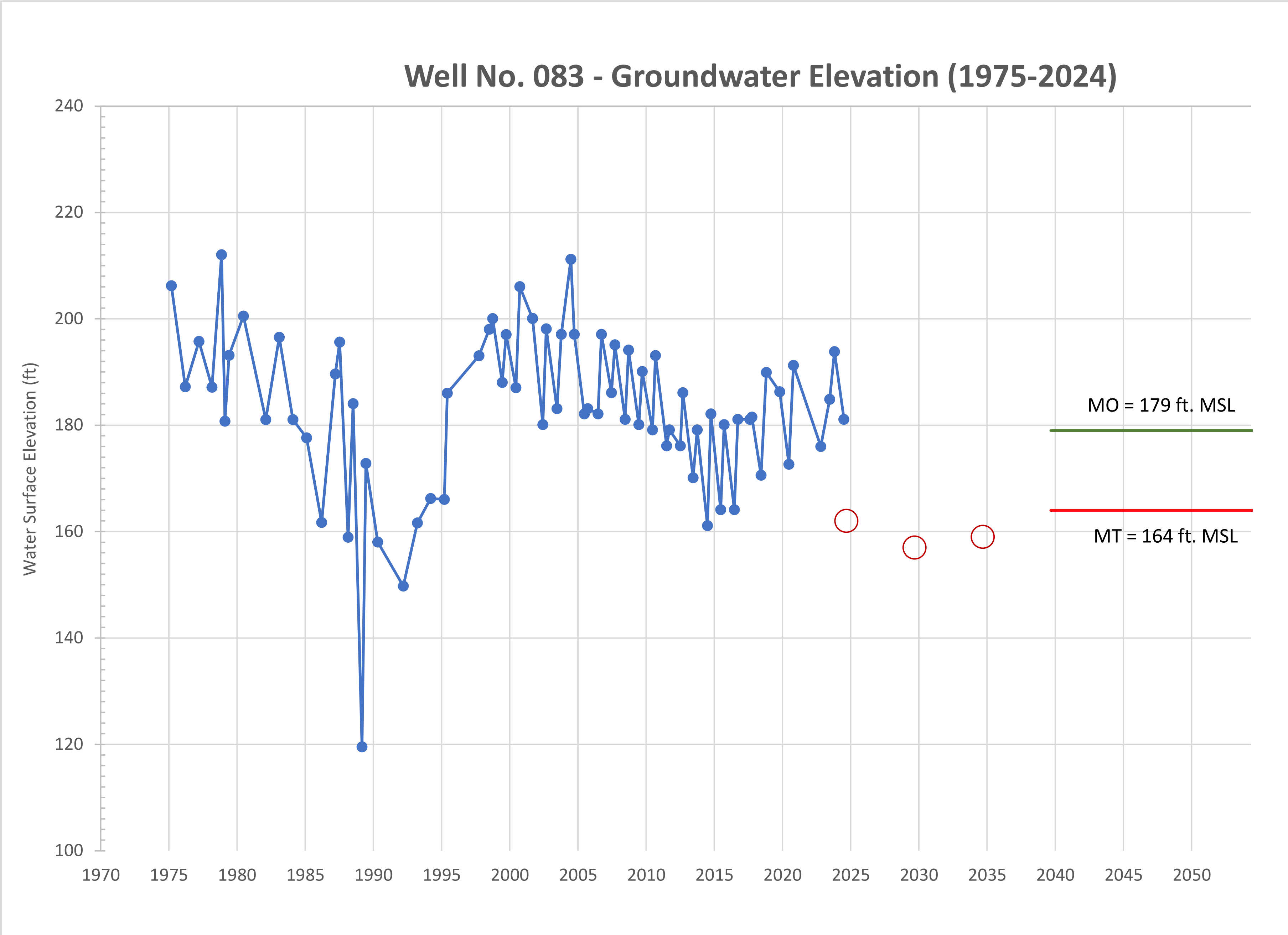
4/1/2024 G:\Root Creek WD-1249\GIS\12491001-E\Groundwater Analysis\Map\Spring24_WSE.mxd

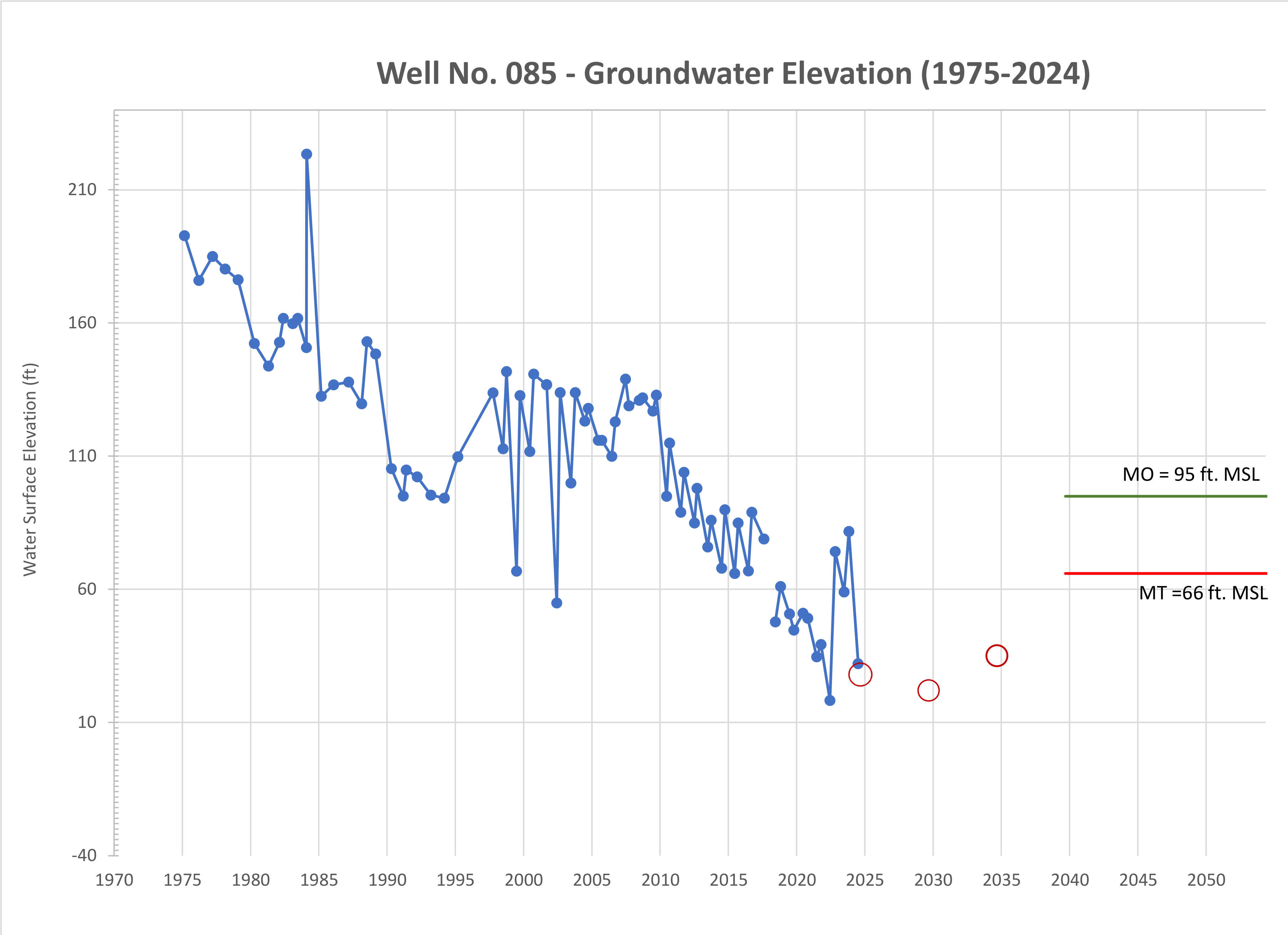
Appendix B - Hydrographs


Well No. 022 - Groundwater Elevation (1974-2024)
Water Surface Elevation (ft)
MO = 221 ft MSL
MT = 218 ft MSL
240
230
220
210
200
190
180
170
160
150
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050

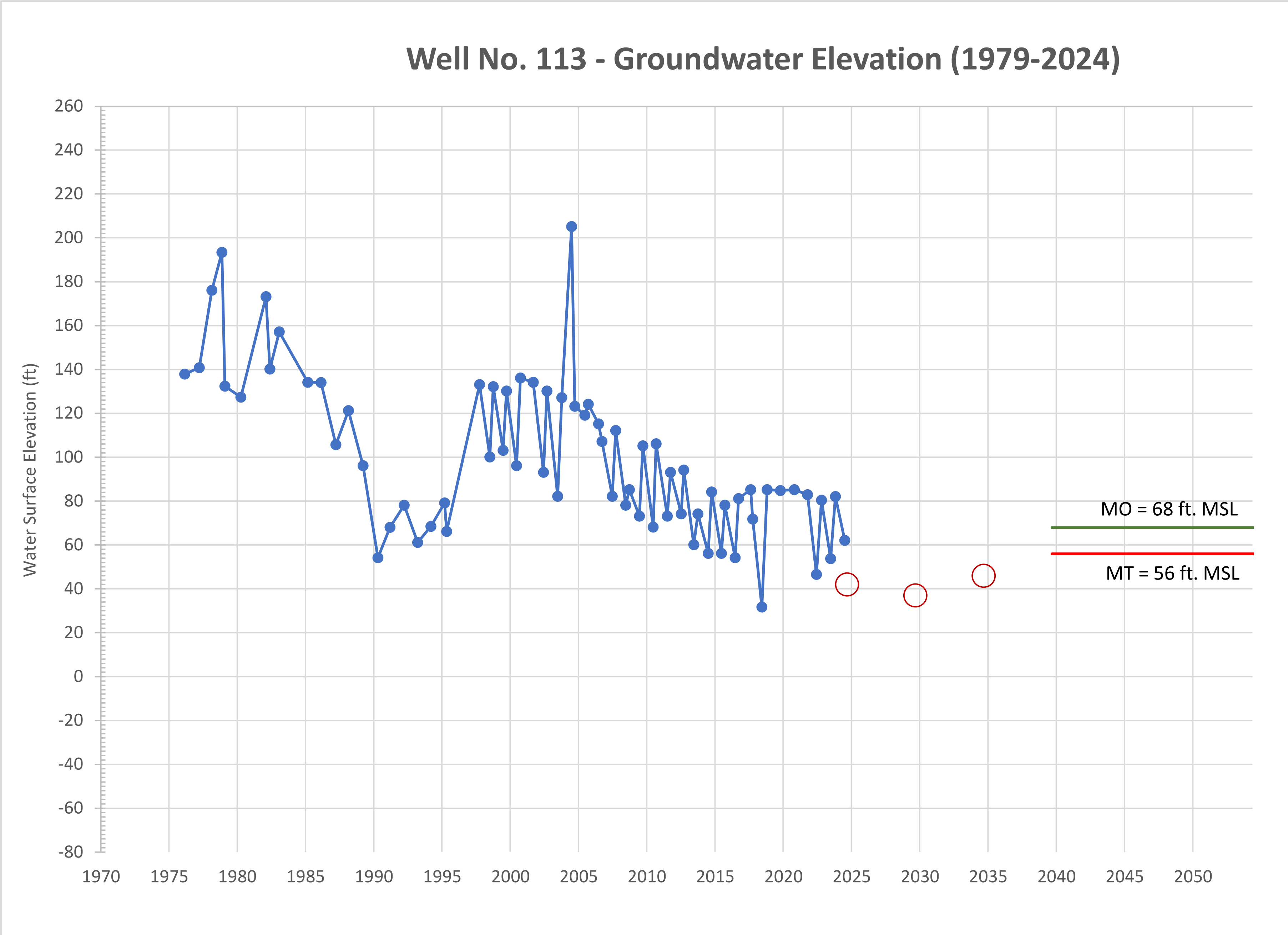


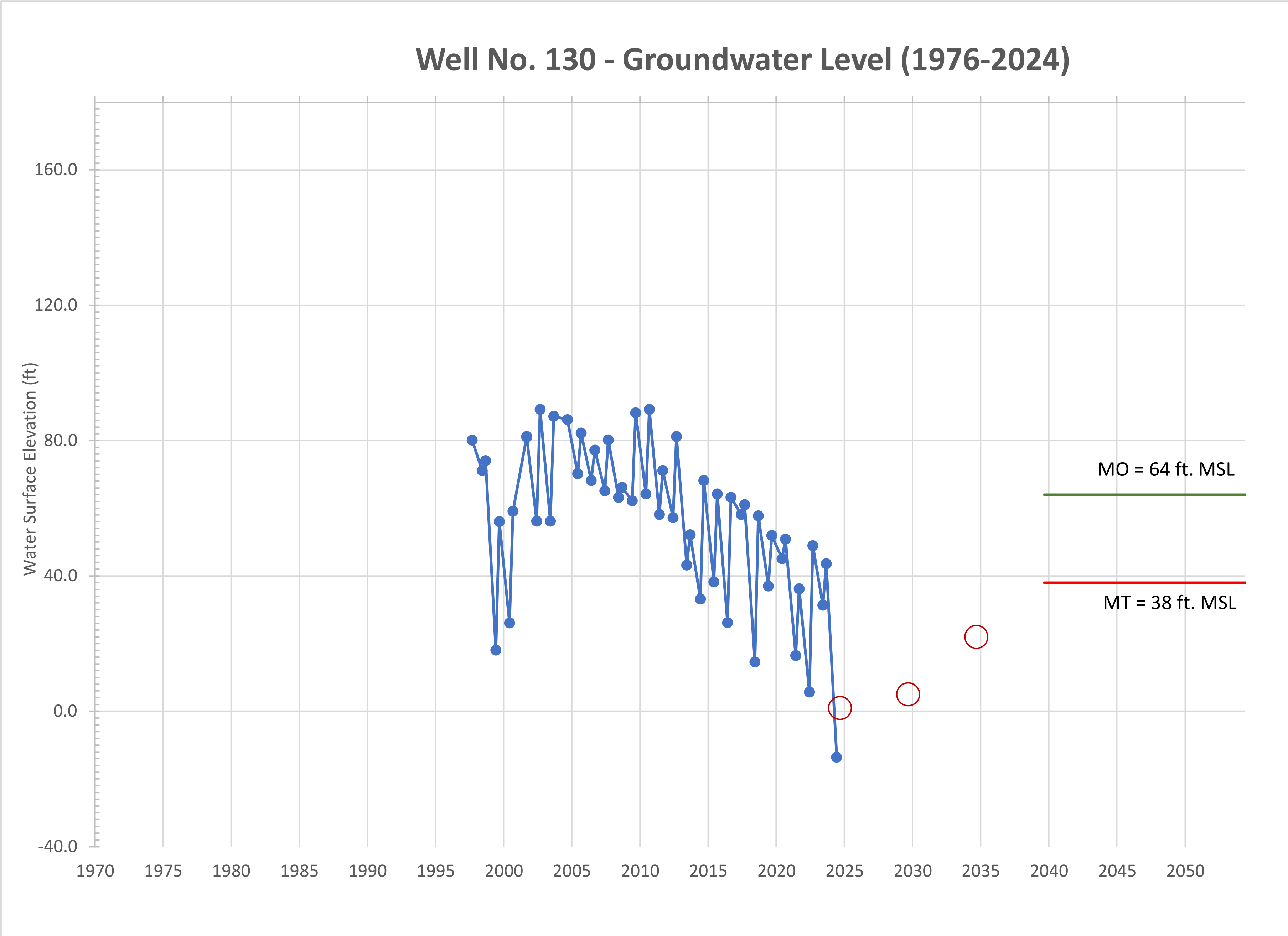
Well No. 065 - Groundwater Elevation (1979-2024)
Water Surface Elevation (ft)
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
MO = 79 ft. MSL
MT = 71 ft. MSL


Well No. 083 - Groundwater Elevation (1975-2024)
Water Surface Elevation (ft)
240
220
200
180
160
140
120
100
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
MO = 179 ft. MSL
MT = 164 ft. MSL



Well No. 085 - Groundwater Elevation (1975-2024)
Water Surface Elevation (ft)
210
160
110
60
10
-40
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
MO = 95 ft. MSL
MT =66 ft. MSL


Well No. 113 - Groundwater Elevation (1979-2024)
Water Surface Elevation (ft)
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
MO = 68 ft. MSL
MT = 56 ft. MSL

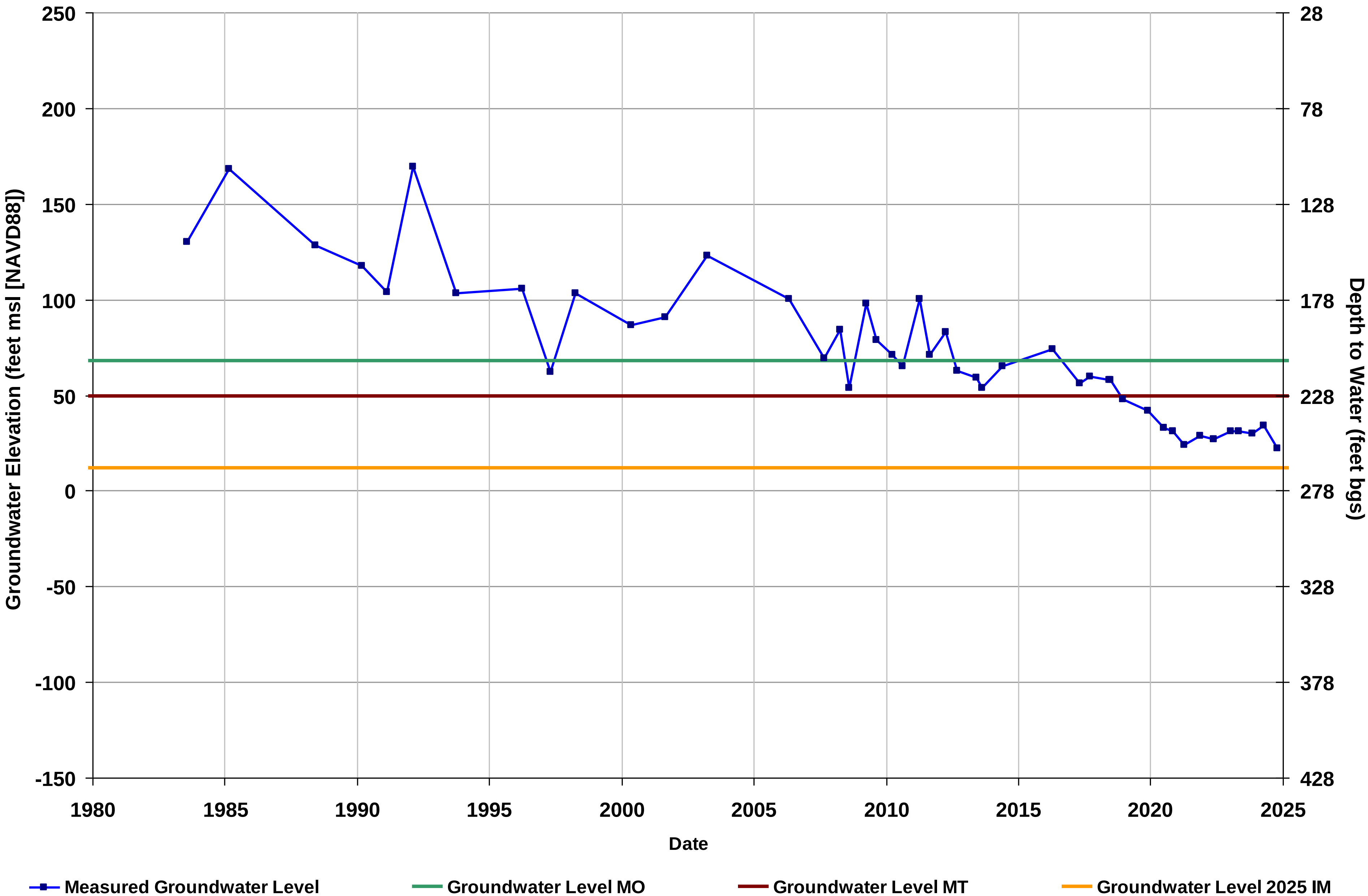

Well No. 130 - Groundwater Level (1976-2024)
Water Surface Elevation (ft)
160.0
120.0
80.0
40.0
0.0
-40.0
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
MO = 64 ft. MSL
MT = 38 ft. MSL

Appendix 2. Groundwater Conditions Relative to Sustainable Management Criteria (§356.4(a))

Appendix 2.A. Groundwater Elevation Hydrographs for Groundwater Level Representative Monitoring Site Wells

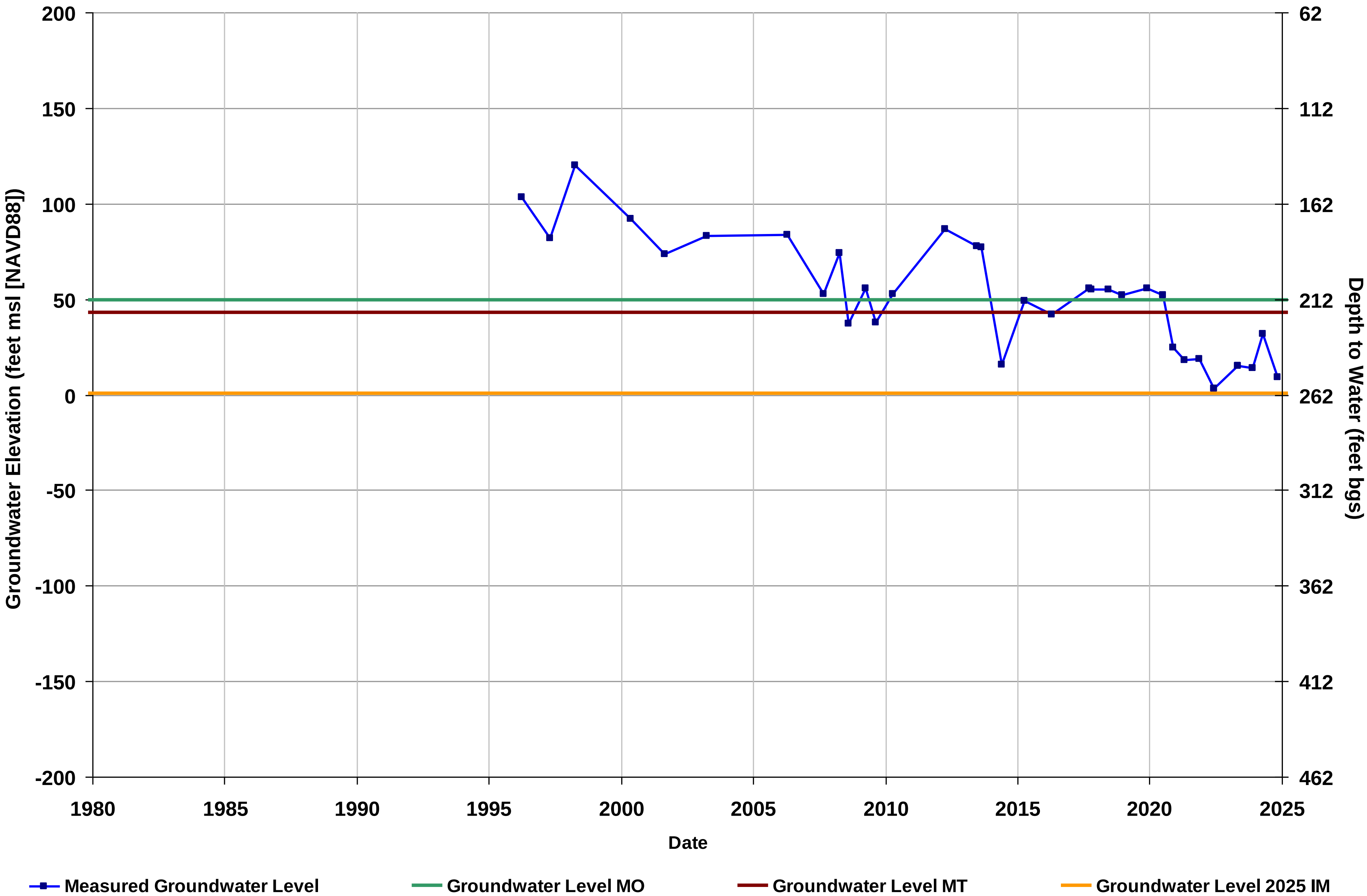
Well Name: COM RMS-1
Depth Zone: Lower
Subbasin: Madera
GSA: City of Madera

Total Depth (ft bgs): 520
Perf. Top (ft bgs): 210
Perf. Bottom (ft bgs): 510
GSE (ft, msl): 278



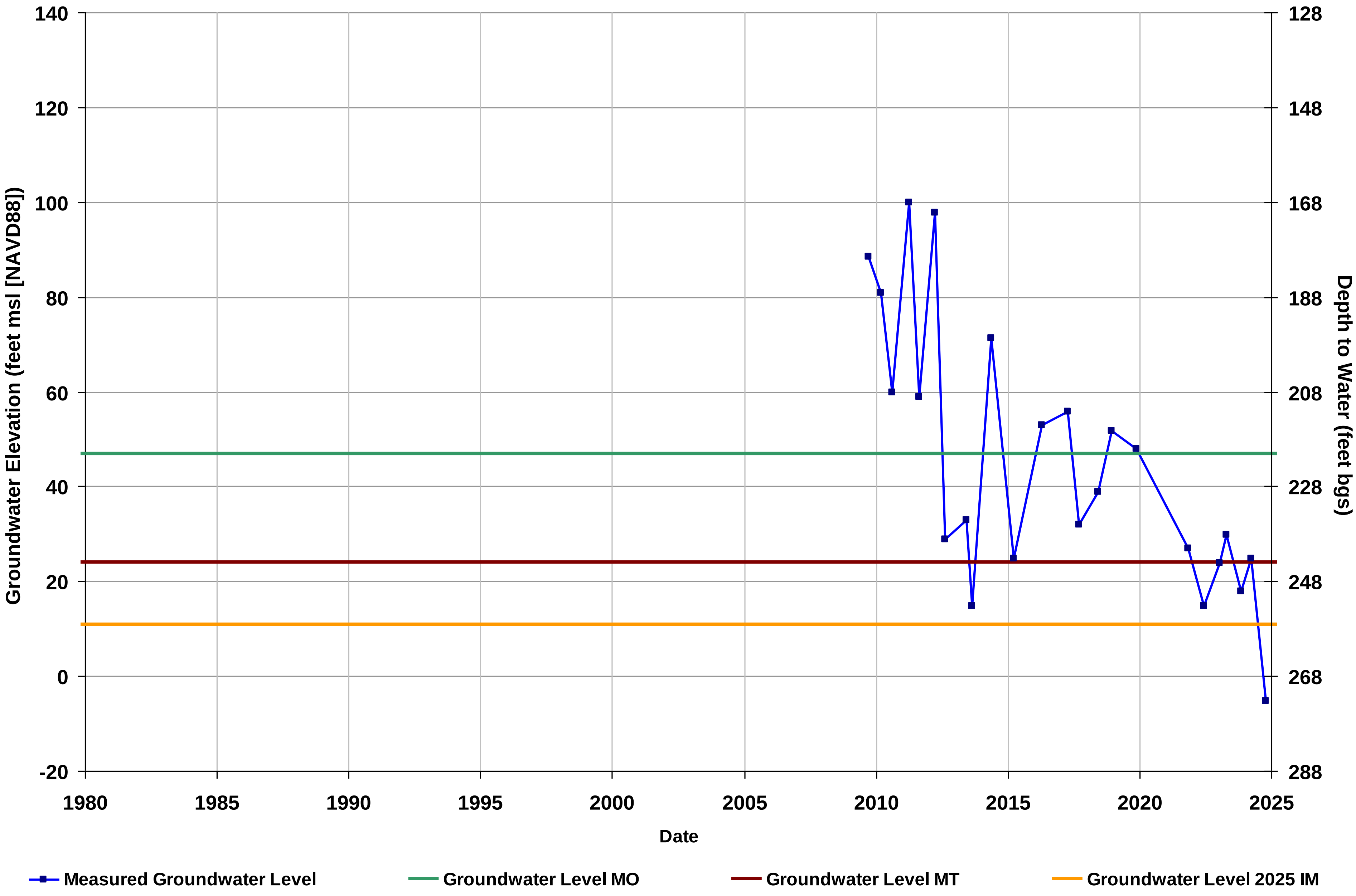
Well Name: COM RMS-2
Depth Zone: Lower
Subbasin: Madera
GSA: City of Madera

Total Depth (ft bgs): 590
Perf. Top (ft bgs): 370
Perf. Bottom (ft bgs): 590
GSE (ft, msl): 262



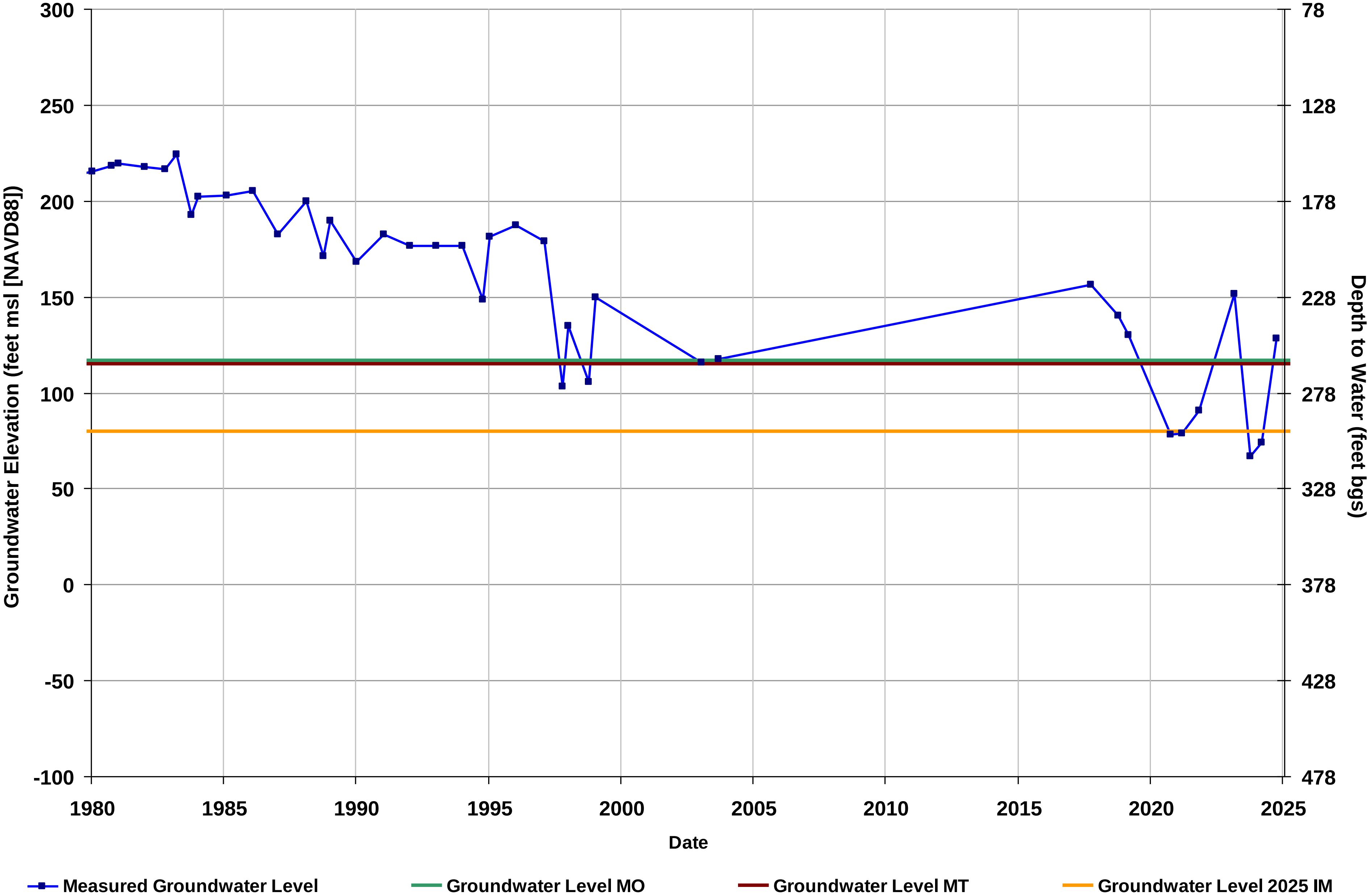
Well Name: COM RMS-4
Depth Zone: Lower
Subbasin: Madera
GSA: City of Madera

Total Depth (ft bgs): 588
Perf. Top (ft bgs): 433
Perf. Bottom (ft bgs): 568
GSE (ft, msl): 268



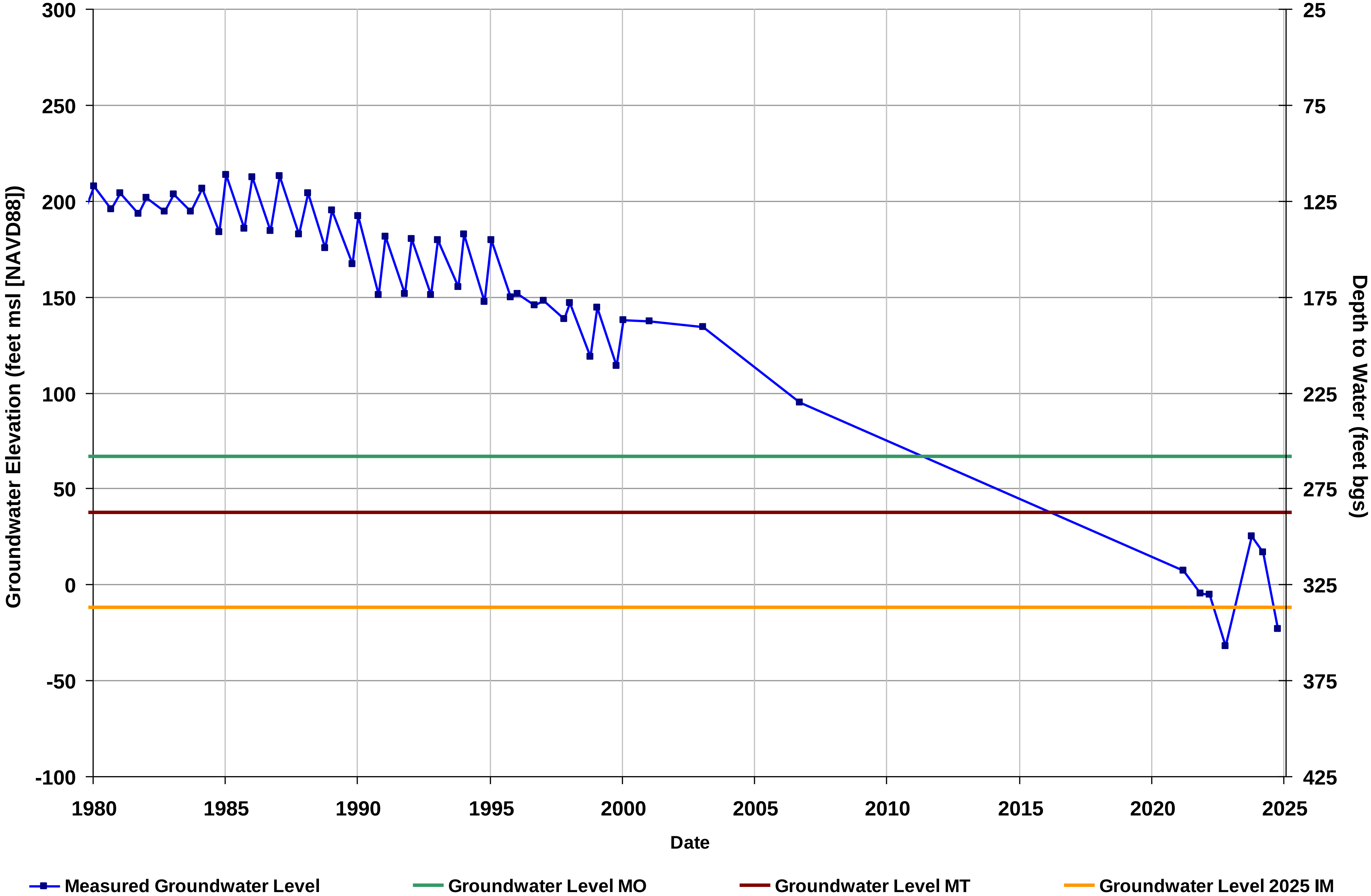
Well Name: MCE RMS-2
Depth Zone: Upper
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 378



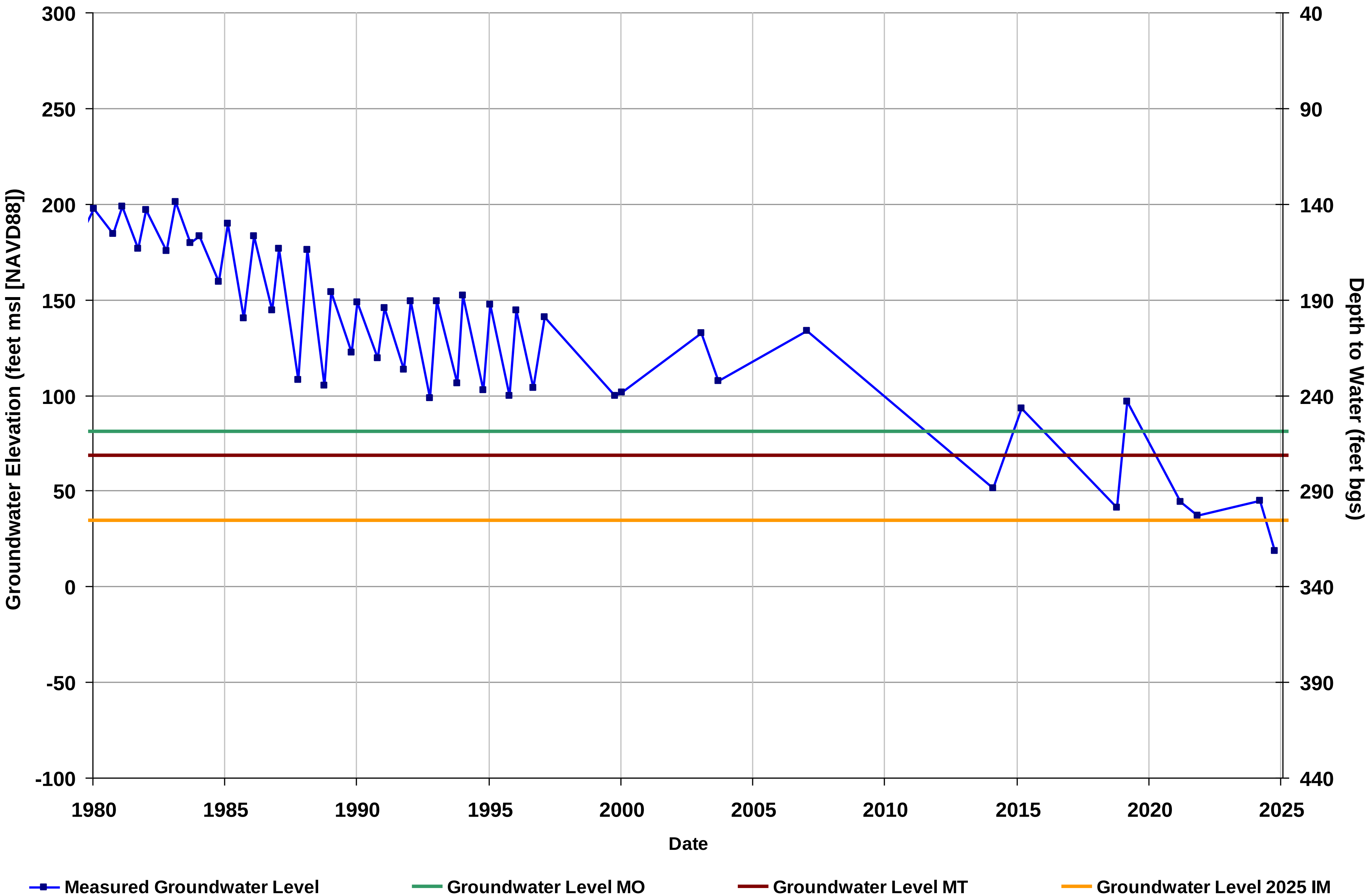
Well Name: MCE RMS-3
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 325



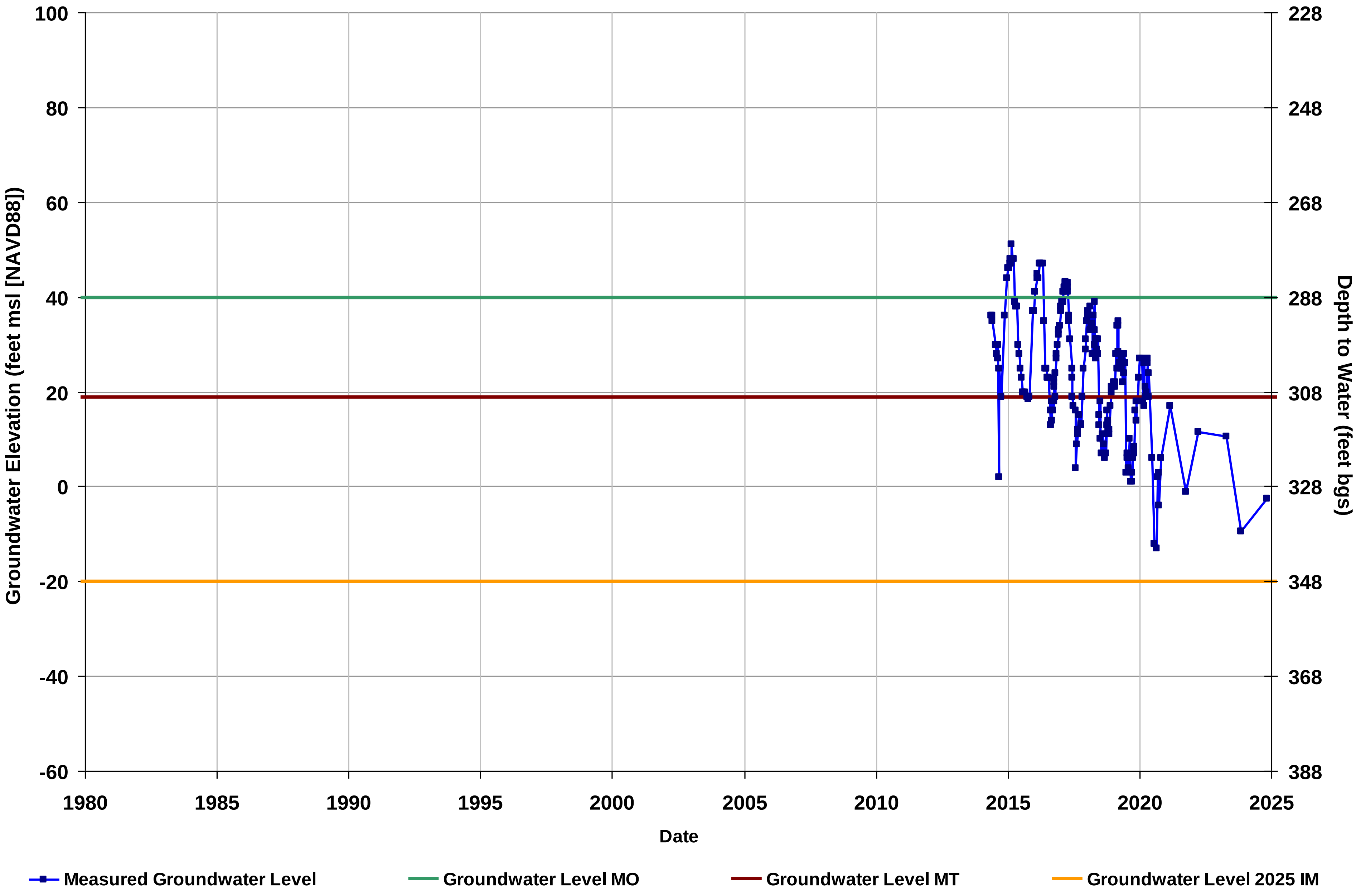
Well Name: MCE RMS-5
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 340



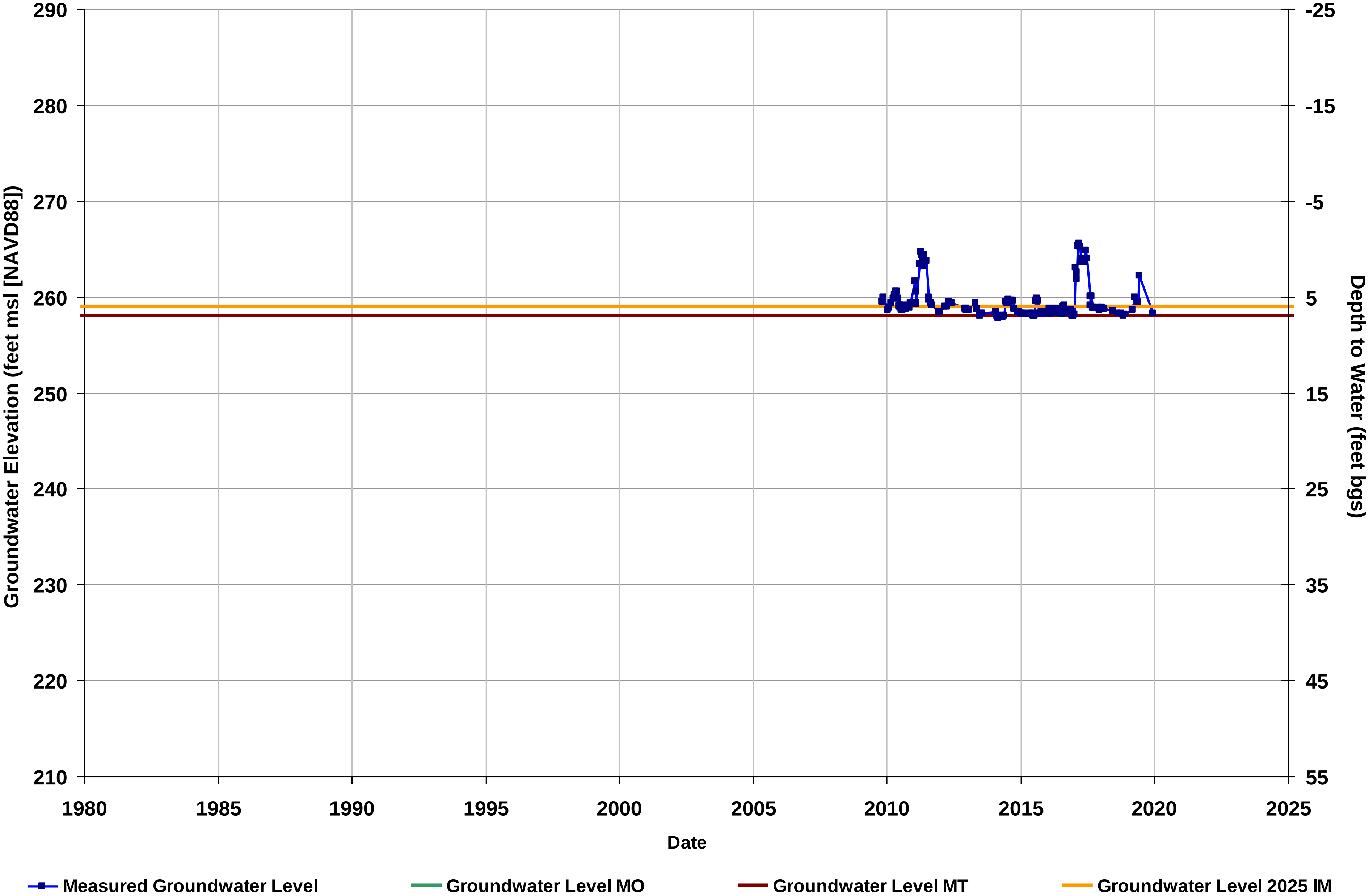
Well Name: MCE RMS-6
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 550
Perf. Top (ft bgs): 450
Perf. Bottom (ft bgs): 550
GSE (ft, msl): 328



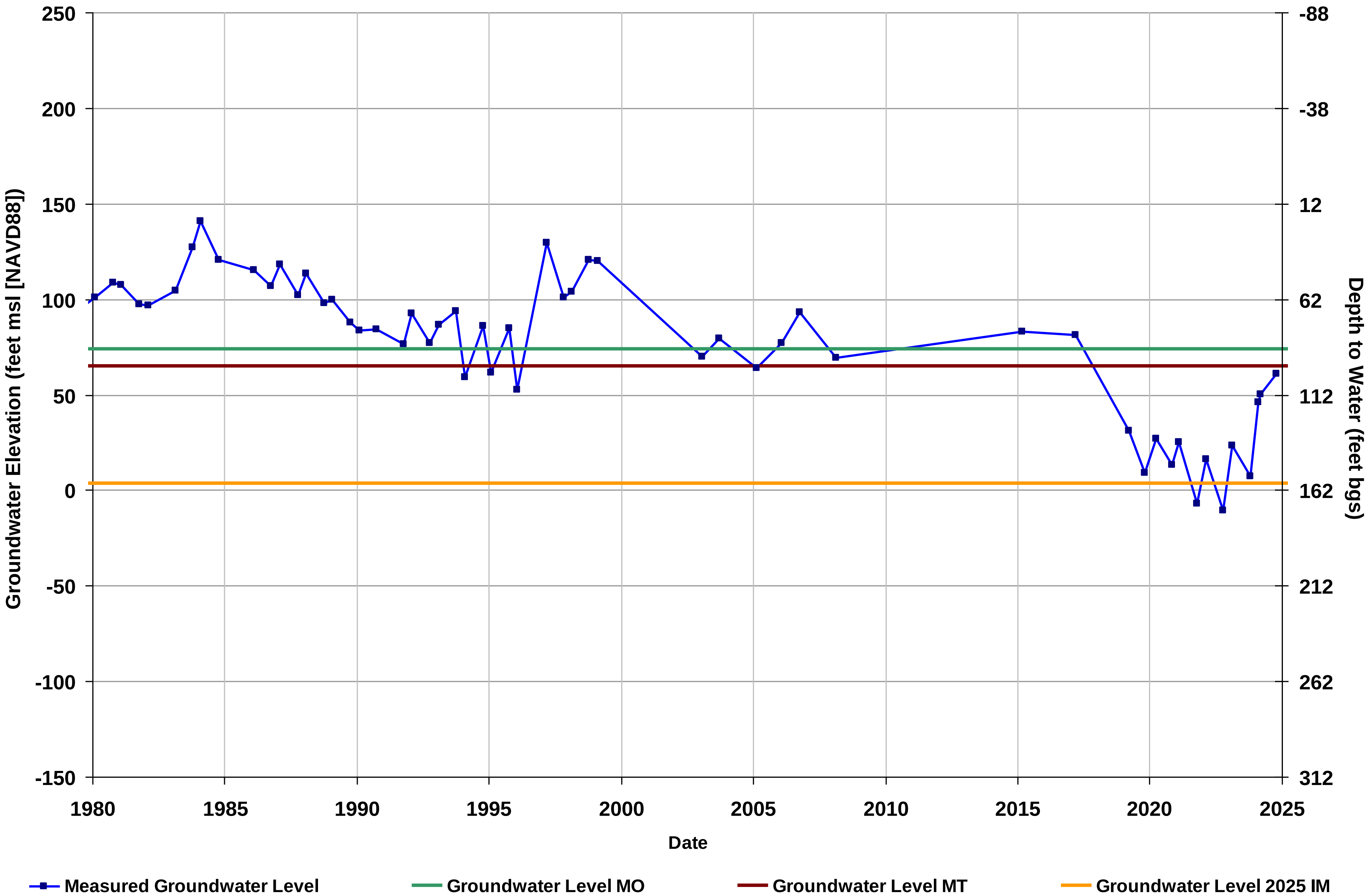
Well Name: MCE RMS-9
Depth Zone: Shallow
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 37
Perf. Top (ft bgs): 17
Perf. Bottom (ft bgs): 37
GSE (ft, msl): 271



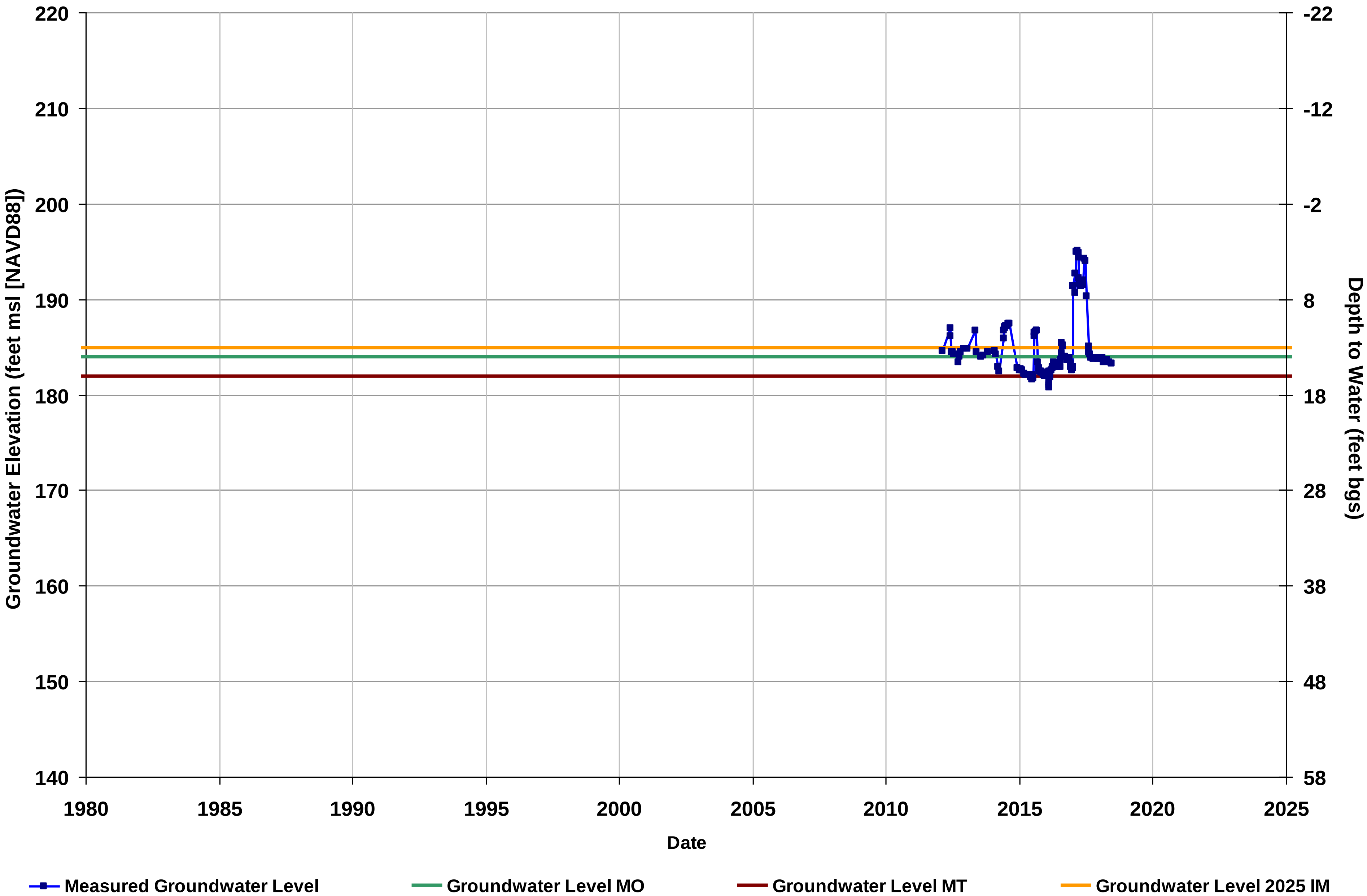
Well Name: MCW RMS-3
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 162



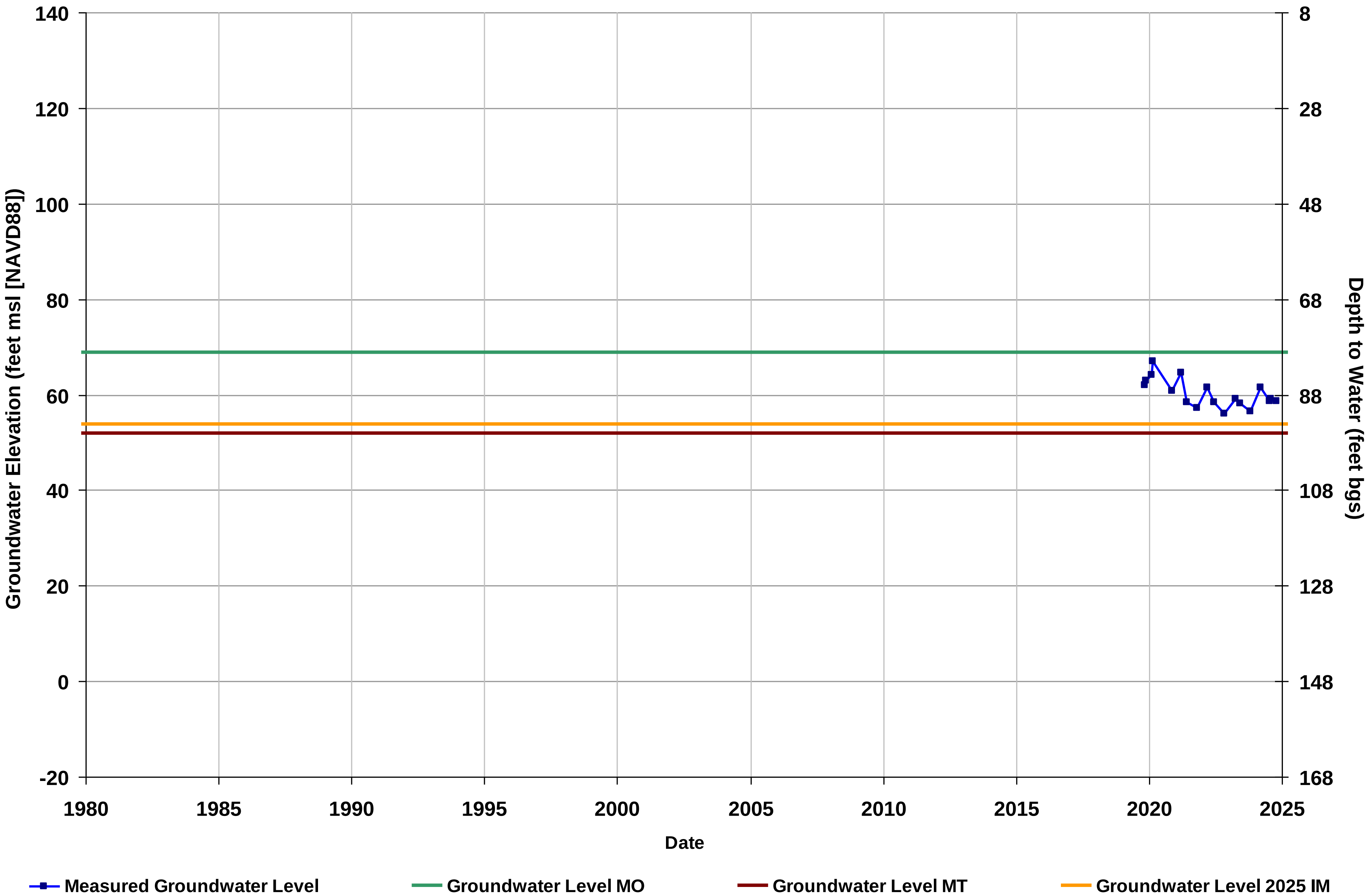
Well Name: MCW RMS-5
Depth Zone: Shallow
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 30
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 202



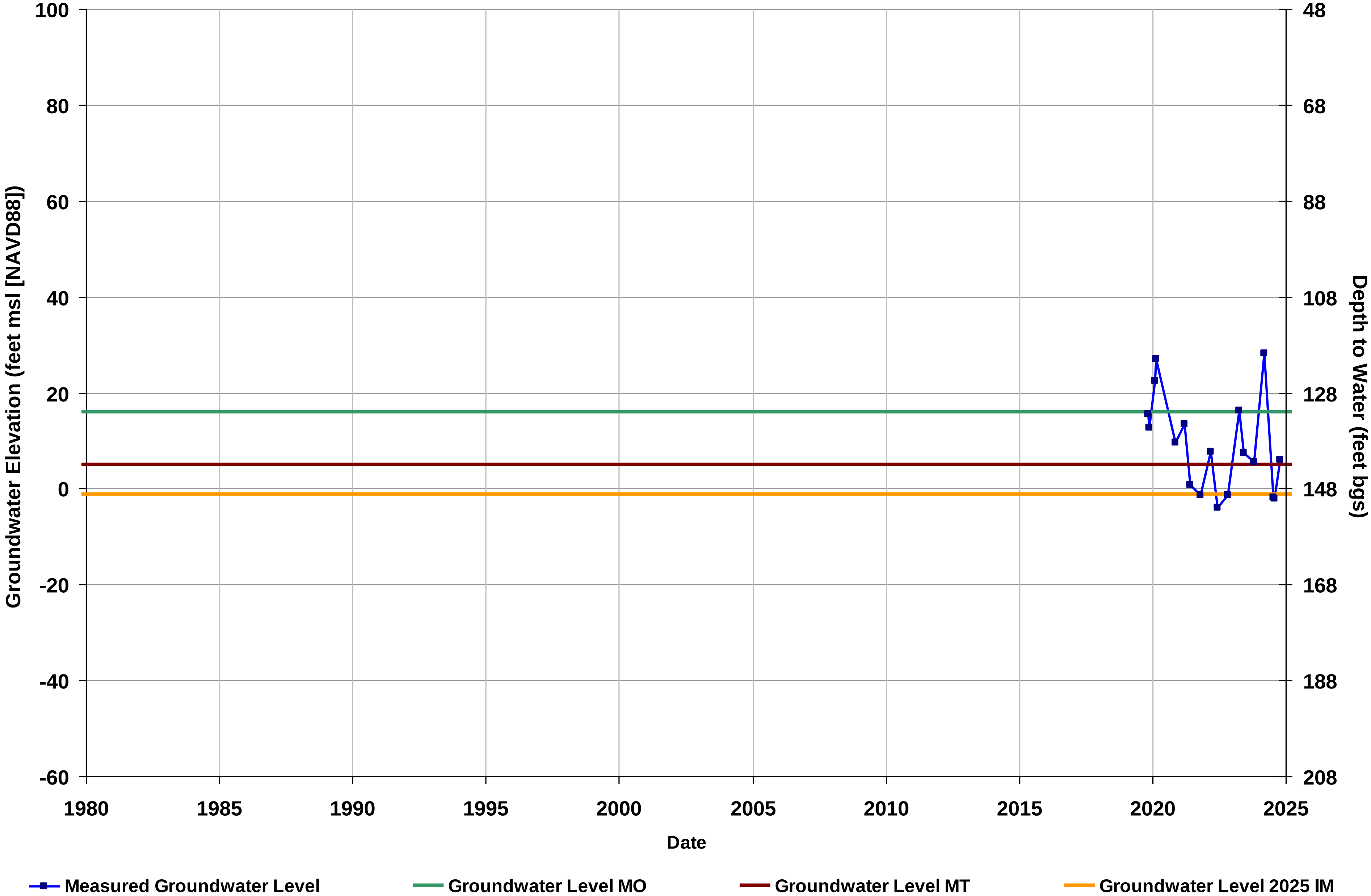
Well Name: MSB03B
Depth Zone: Upper
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 295
Perf. Top (ft bgs): 215
Perf. Bottom (ft bgs): 285
GSE (ft, msl): 148



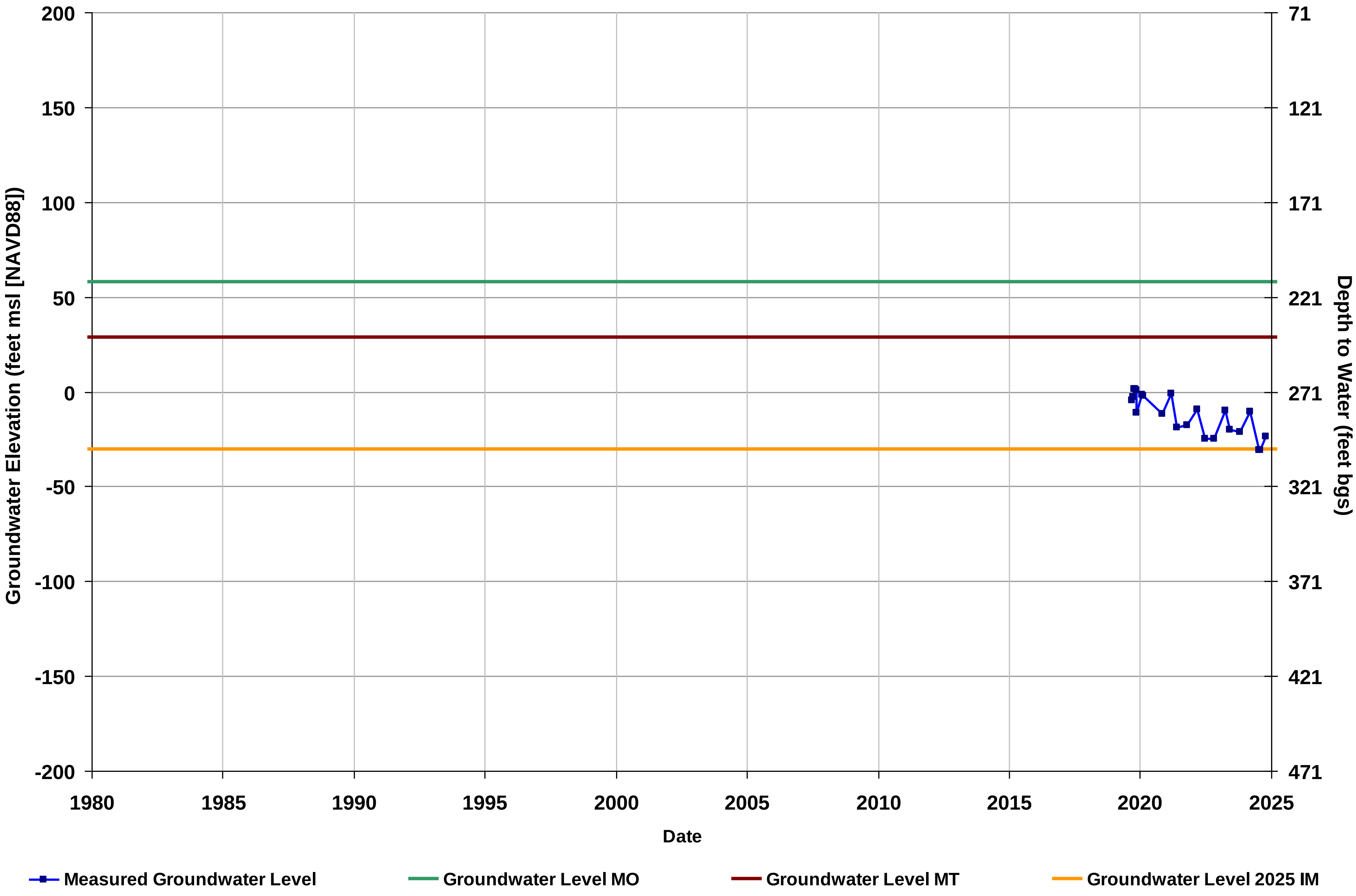
Well Name: MSB03C
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 430
Perf. Top (ft bgs): 355
Perf. Bottom (ft bgs): 420
GSE (ft, msl): 148



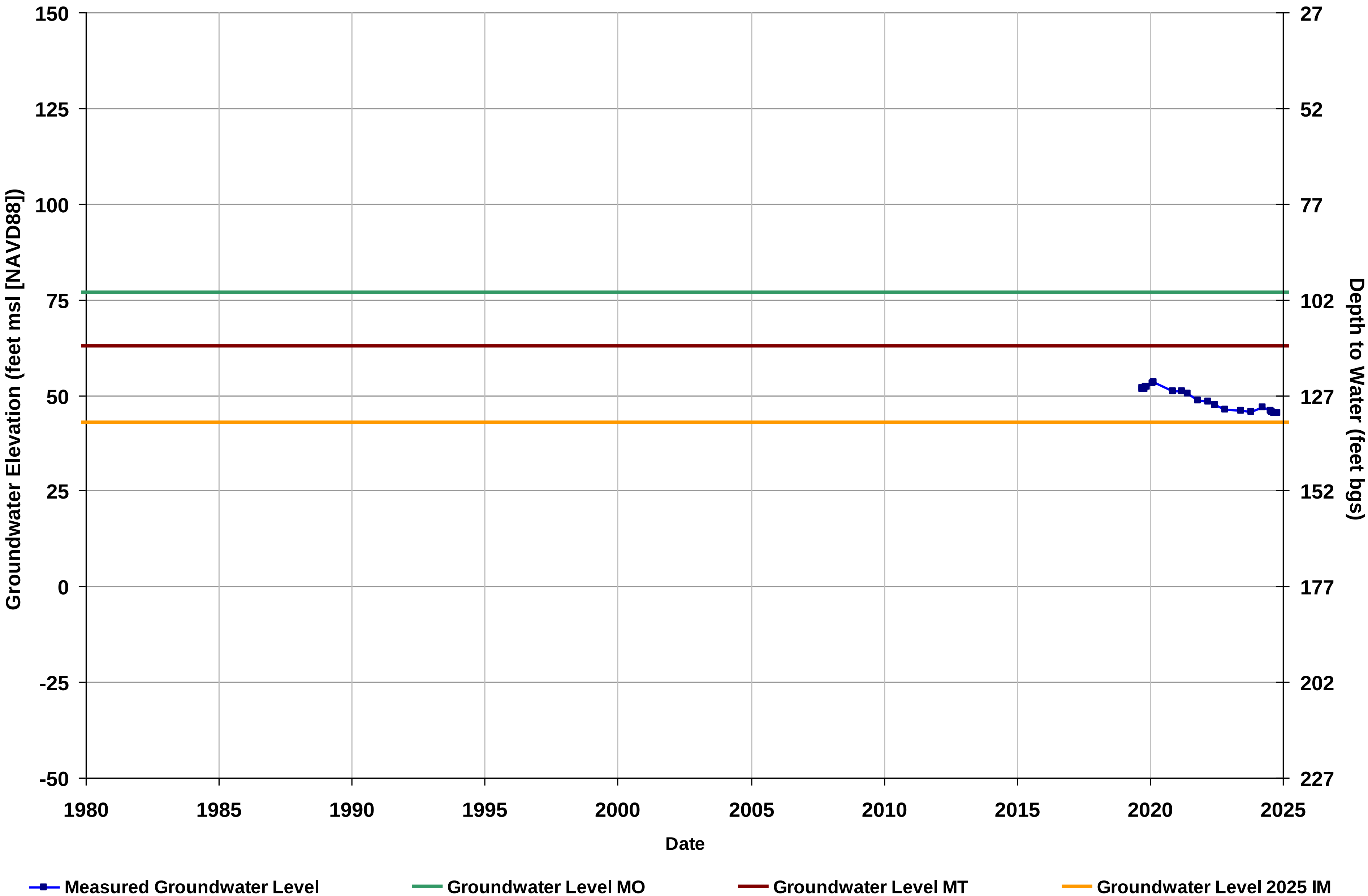
Well Name: MSB04B
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 695
Perf. Top (ft bgs): 530
Perf. Bottom (ft bgs): 685
GSE (ft, msl): 271



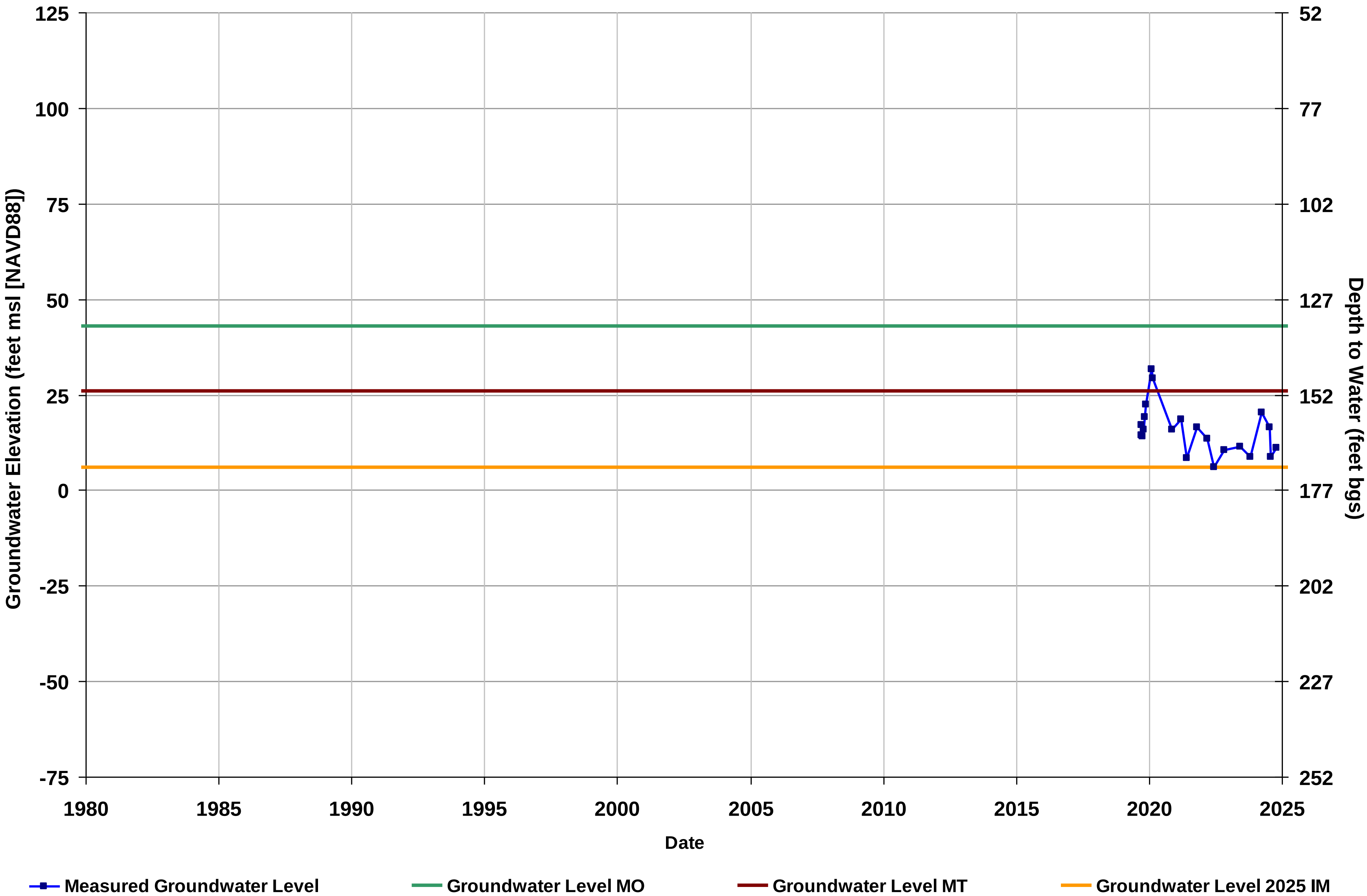
Well Name: MSB05A
Depth Zone: Upper
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 210
Perf. Top (ft bgs): 140
Perf. Bottom (ft bgs): 200
GSE (ft, msl): 177



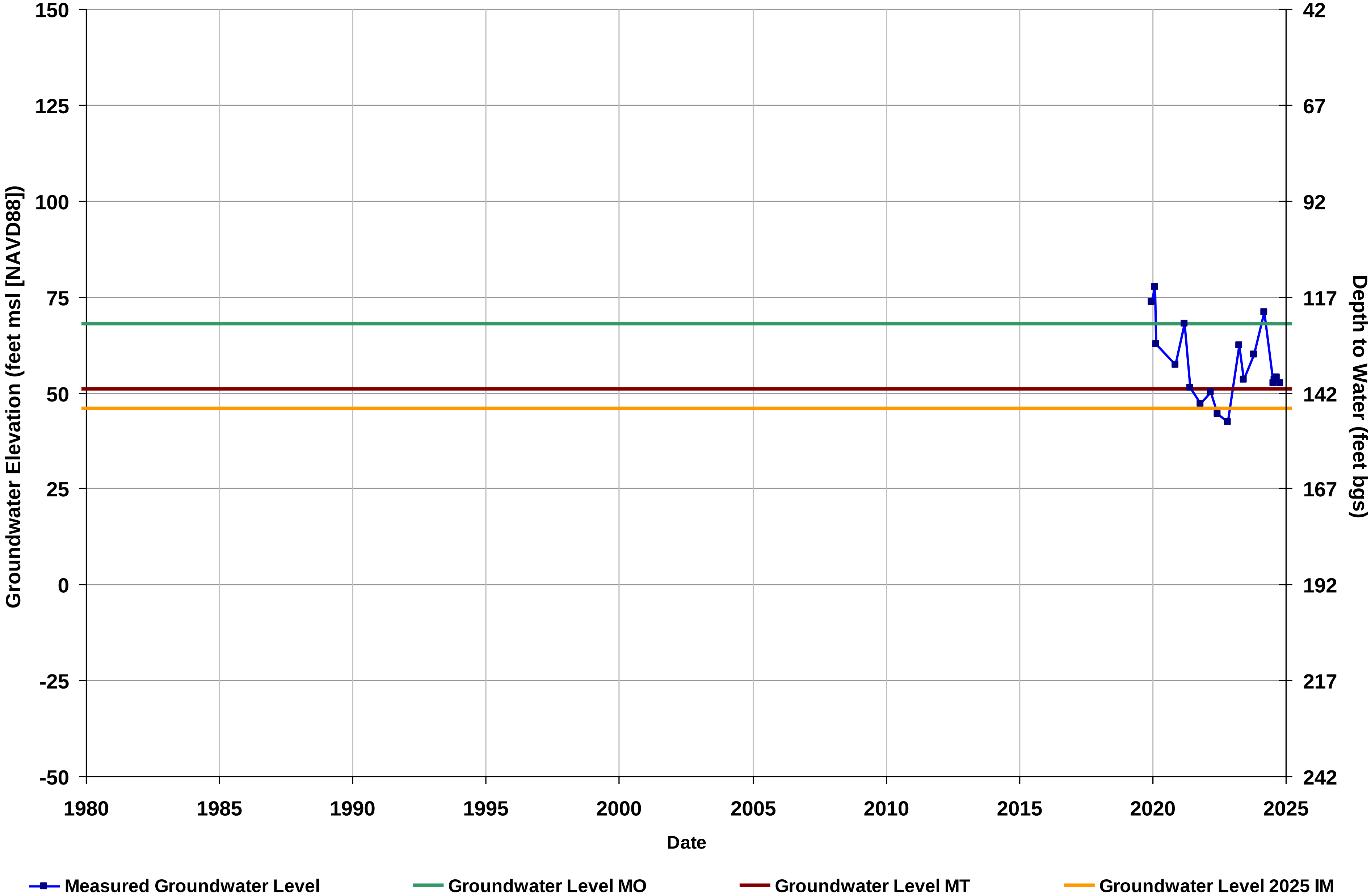
Well Name: MSB05B
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 375
Perf. Top (ft bgs): 240
Perf. Bottom (ft bgs): 365
GSE (ft, msl): 177



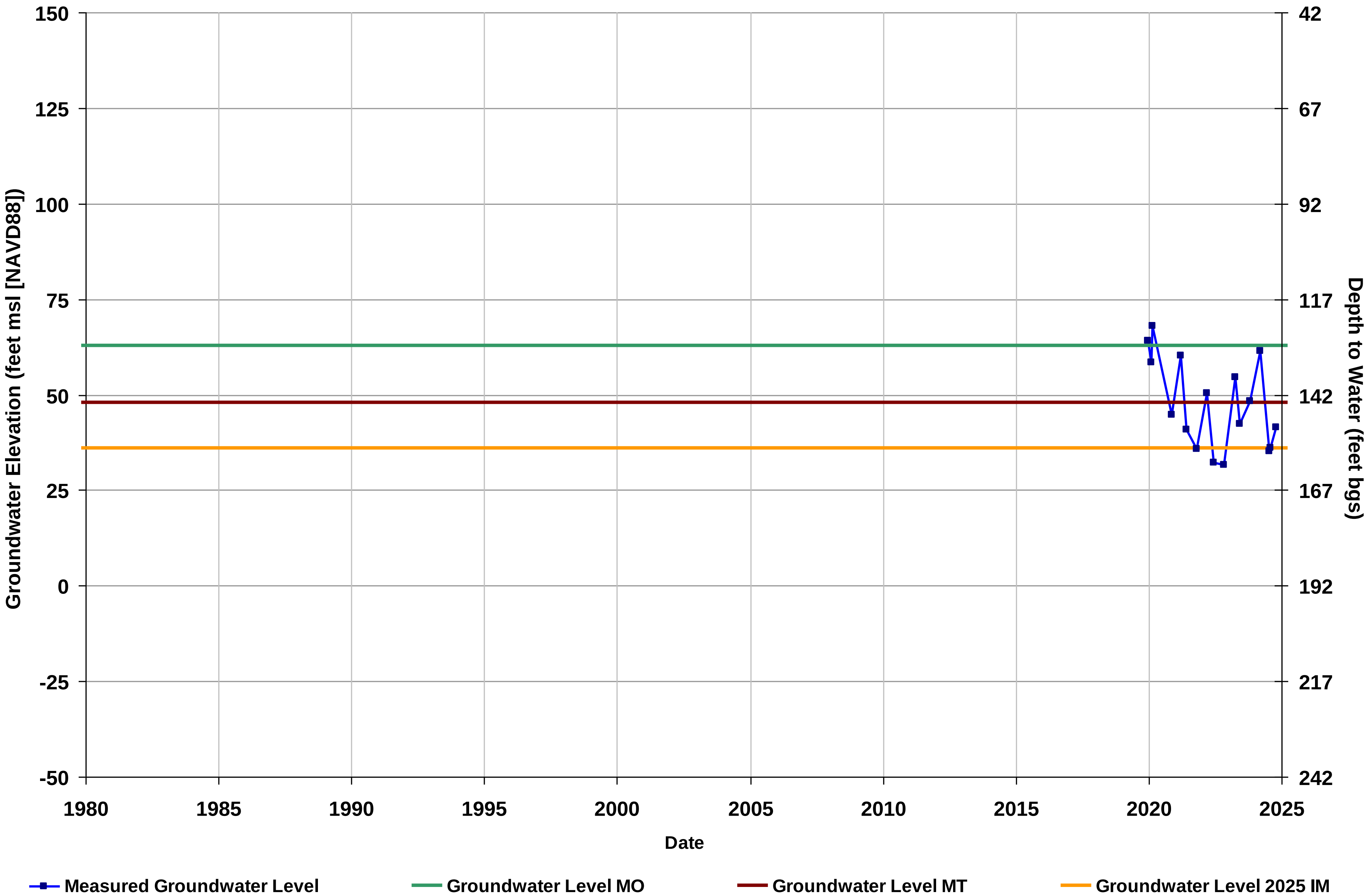
Well Name: MSB06A
Depth Zone: Upper
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 350
Perf. Top (ft bgs): 135
Perf. Bottom (ft bgs): 340
GSE (ft, msl): 192



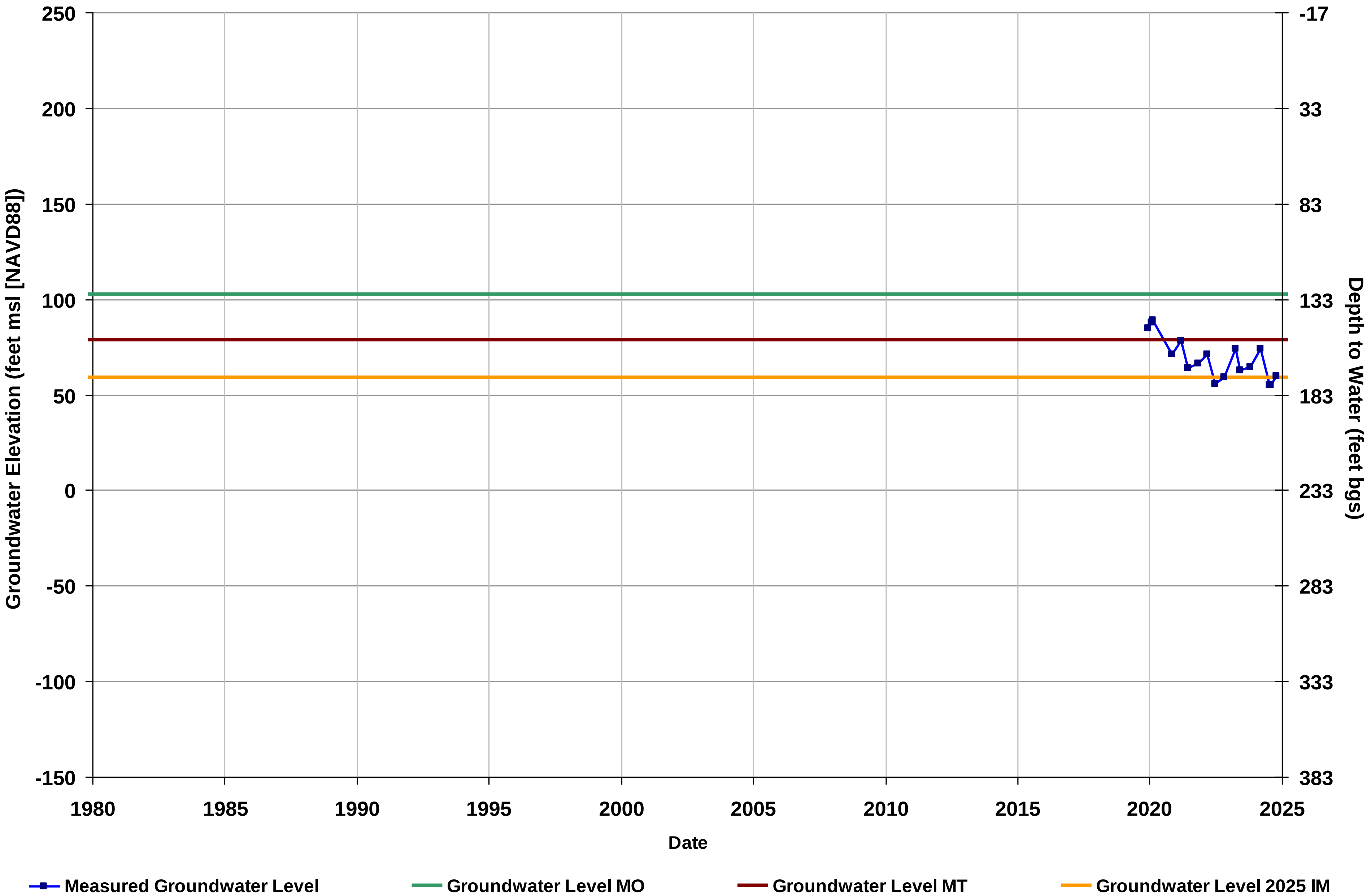
Well Name: MSB06C
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 715
Perf. Top (ft bgs): 630
Perf. Bottom (ft bgs): 705
GSE (ft, msl): 192



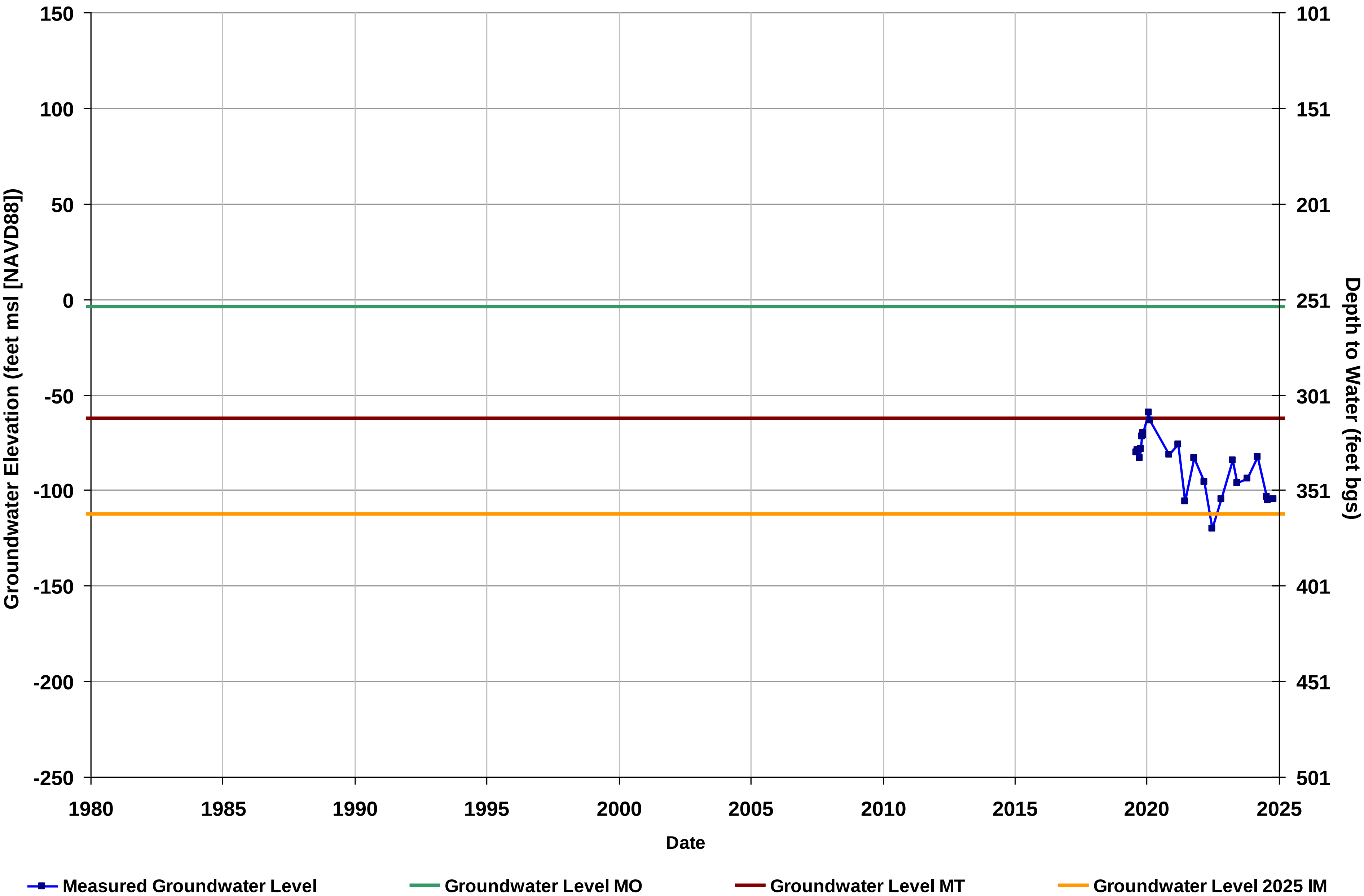
Well Name: MSB09C
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 955
Perf. Top (ft bgs): 880
Perf. Bottom (ft bgs): 945
GSE (ft, msl): 233



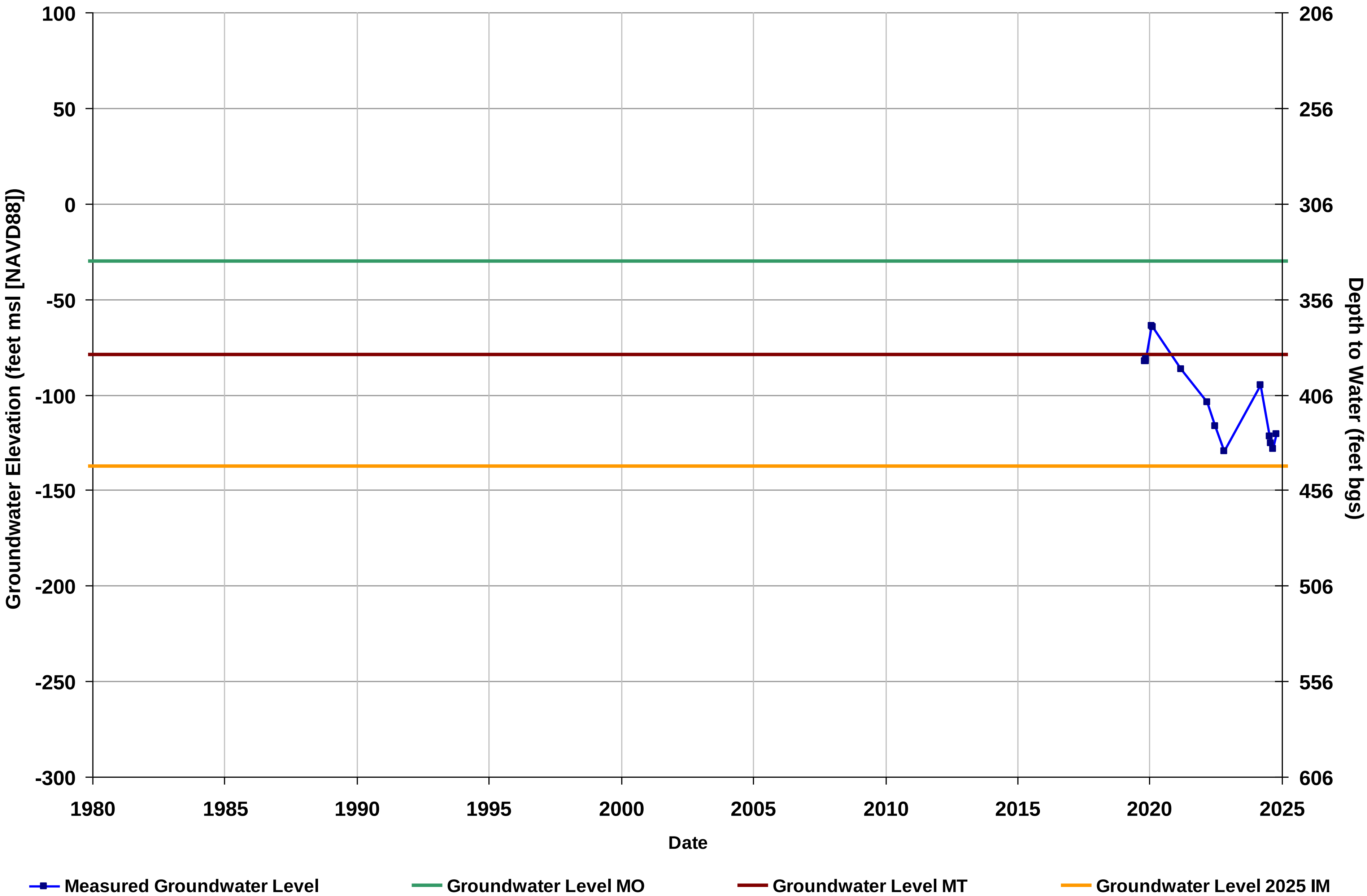
Well Name: MSB10C
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 880
Perf. Top (ft bgs): 790
Perf. Bottom (ft bgs): 870
GSE (ft, msl): 251



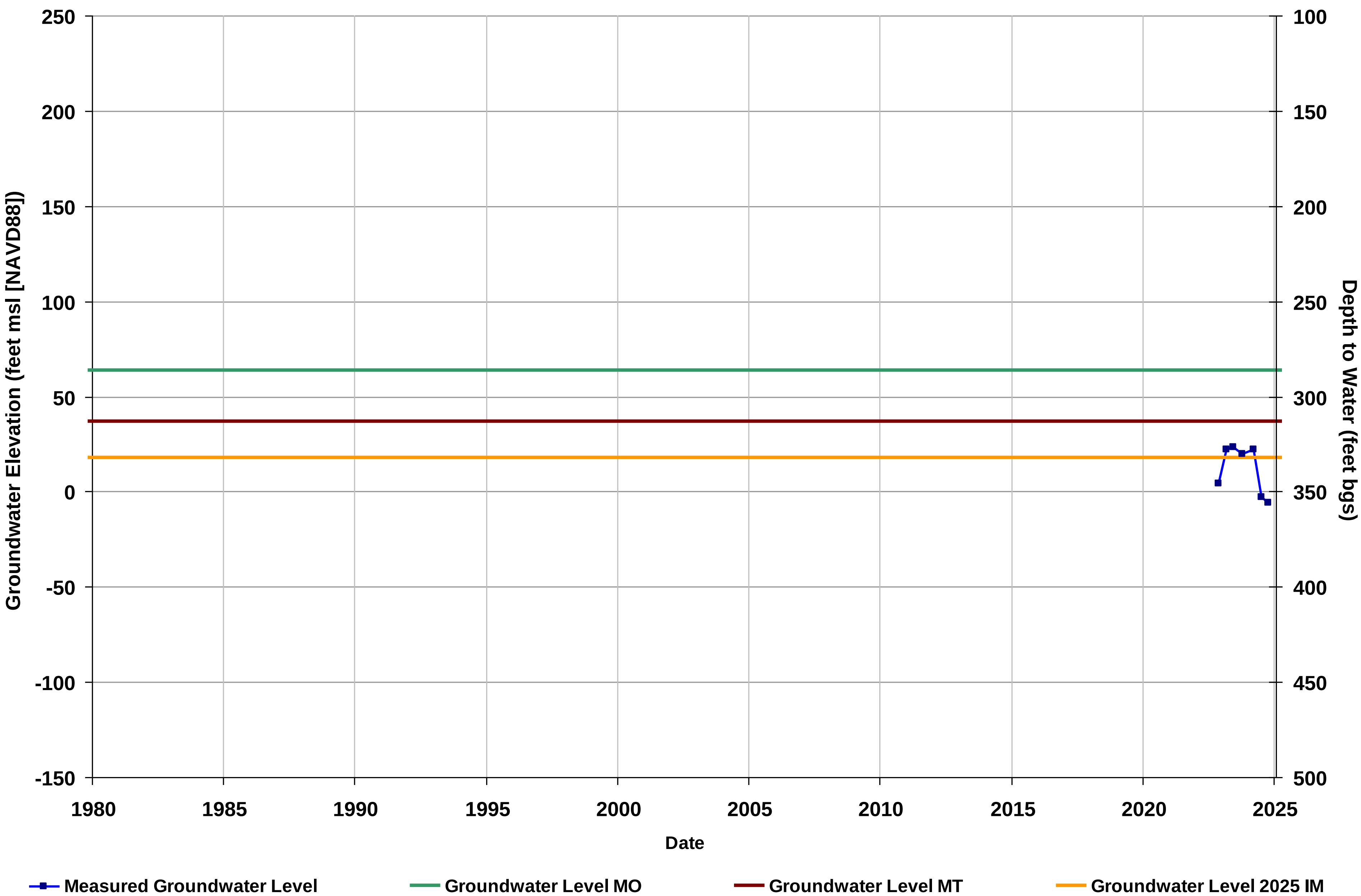
Well Name: MSB11C
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 880
Perf. Top (ft bgs): 775
Perf. Bottom (ft bgs): 870
GSE (ft, msl): 306



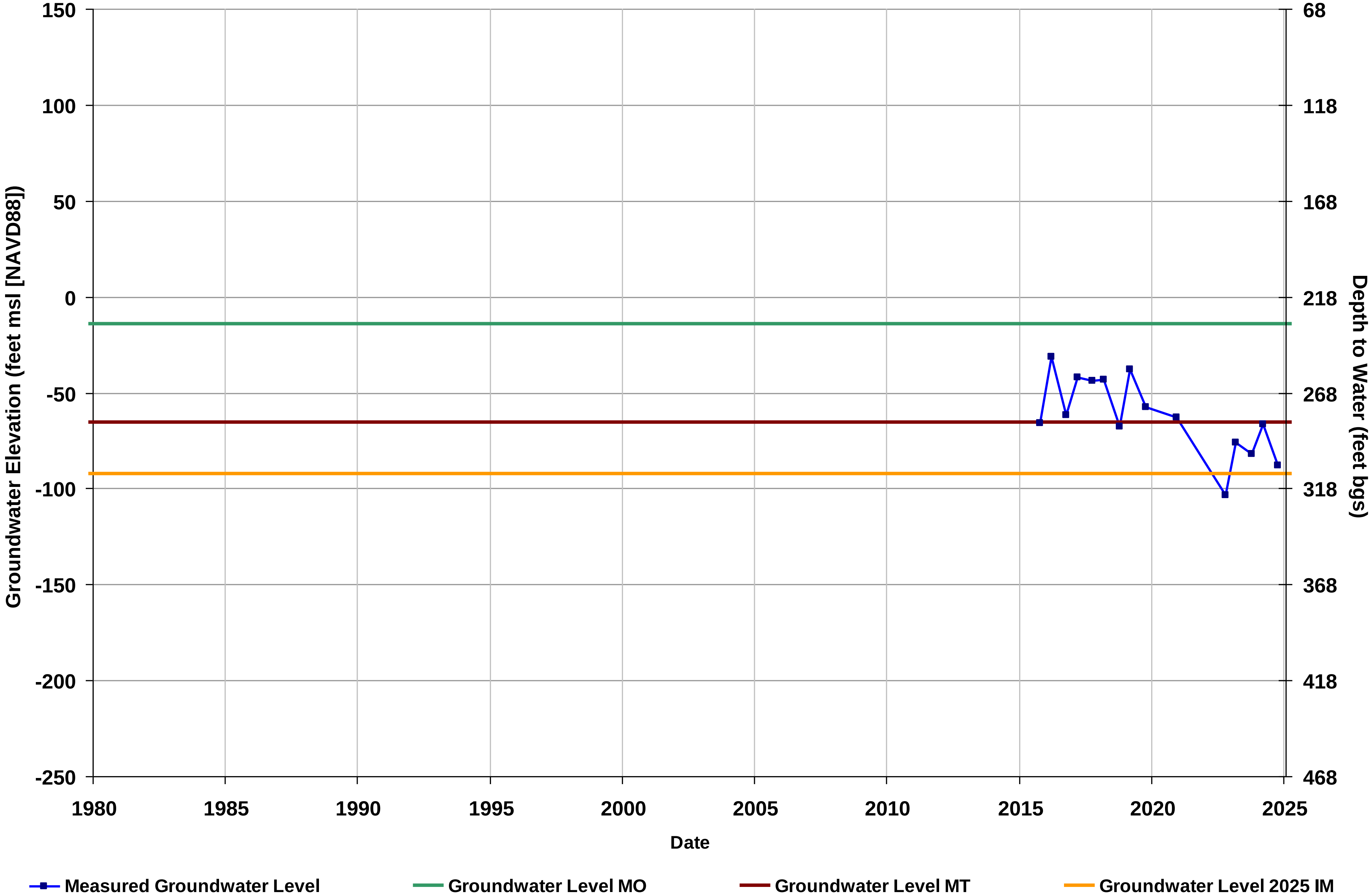
Well Name: MSB12
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 465
Perf. Top (ft bgs): 355
Perf. Bottom (ft bgs): 465
GSE (ft, msl): 350



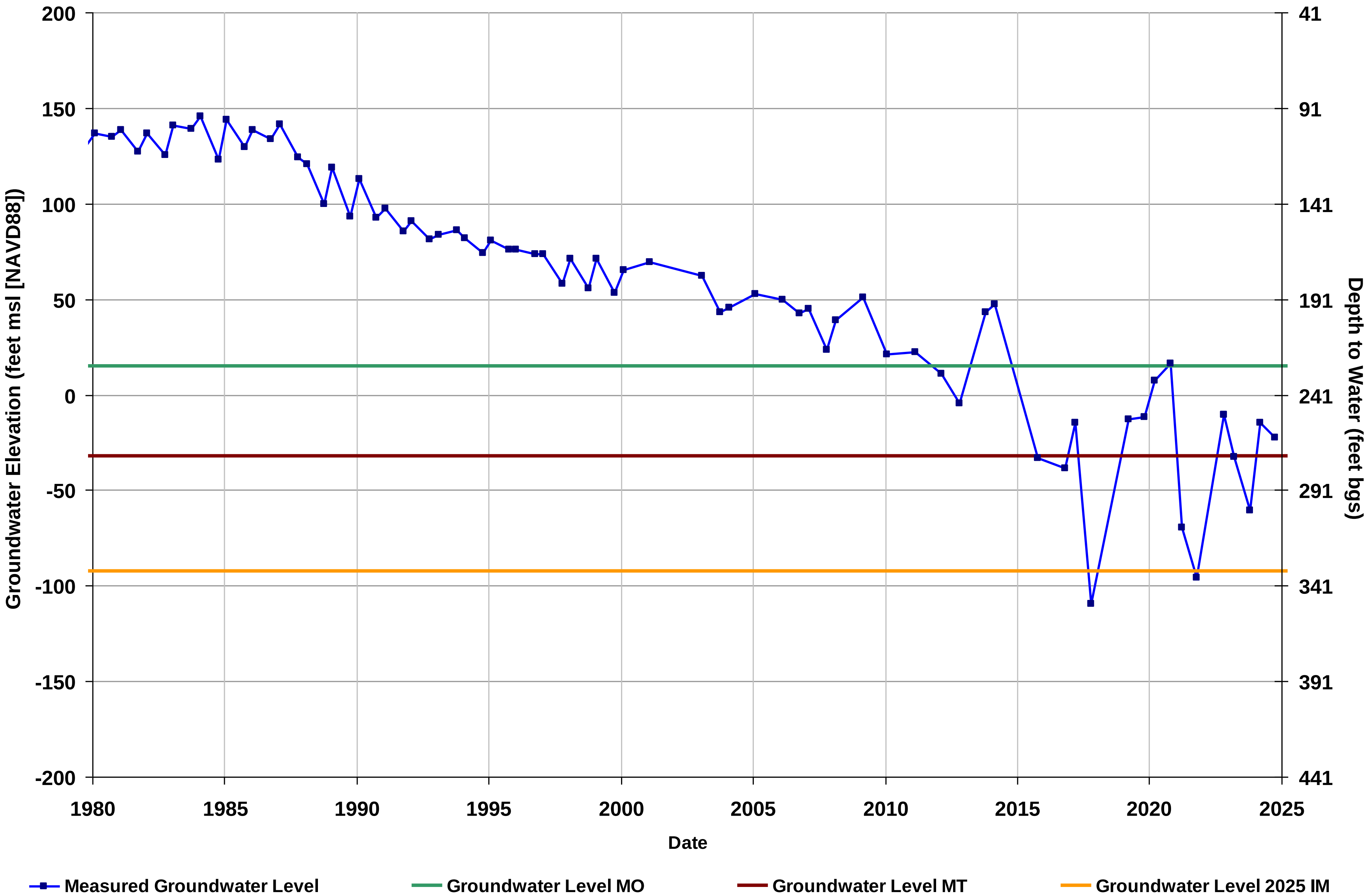
Well Name: MID RMS-2
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 563
Perf. Top (ft bgs): 298
Perf. Bottom (ft bgs): 509
GSE (ft, msl): 218



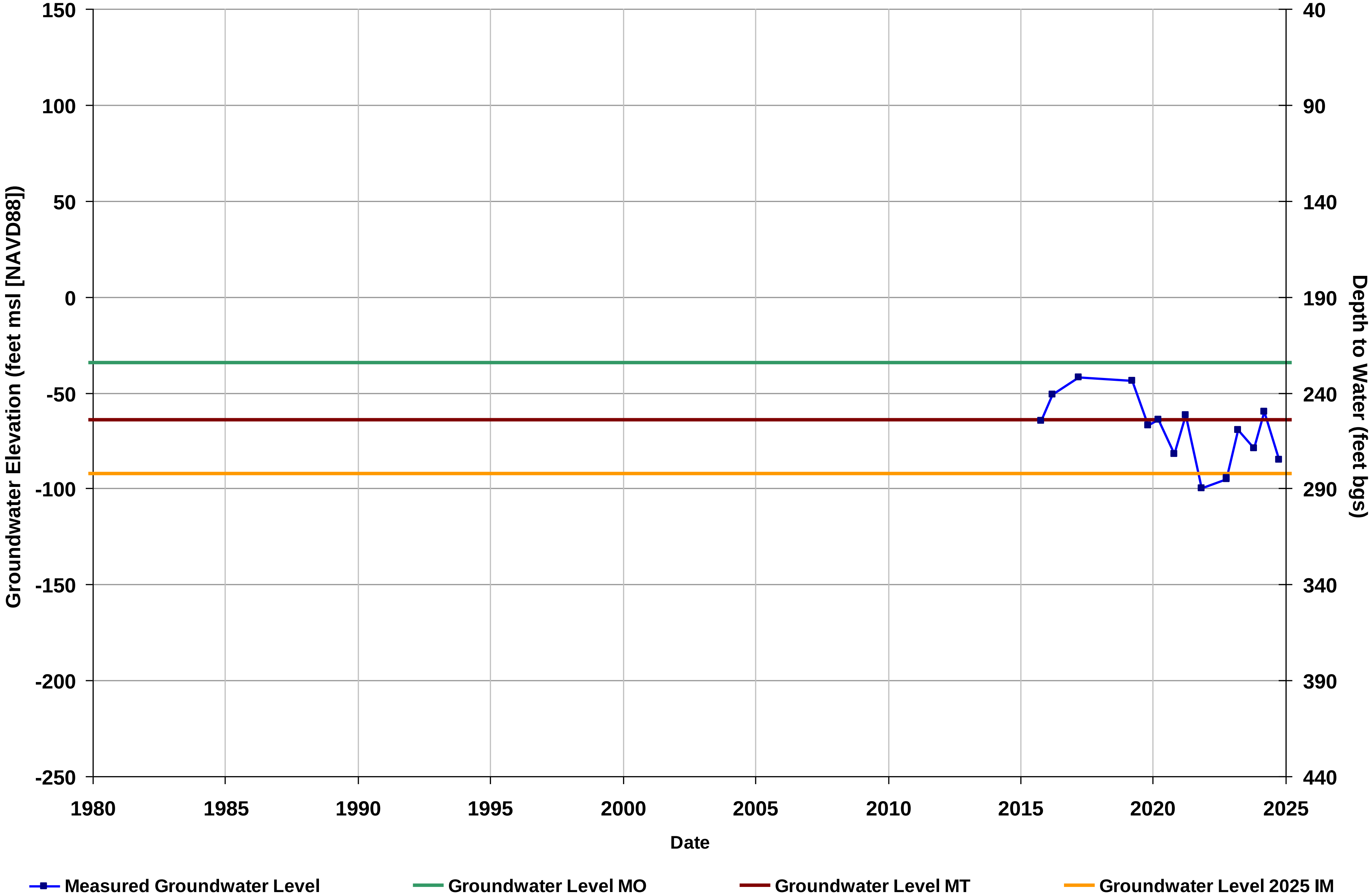
Well Name: MID RMS-3
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 516
Perf. Top (ft bgs): 260
Perf. Bottom (ft bgs): 507
GSE (ft, msl): 241



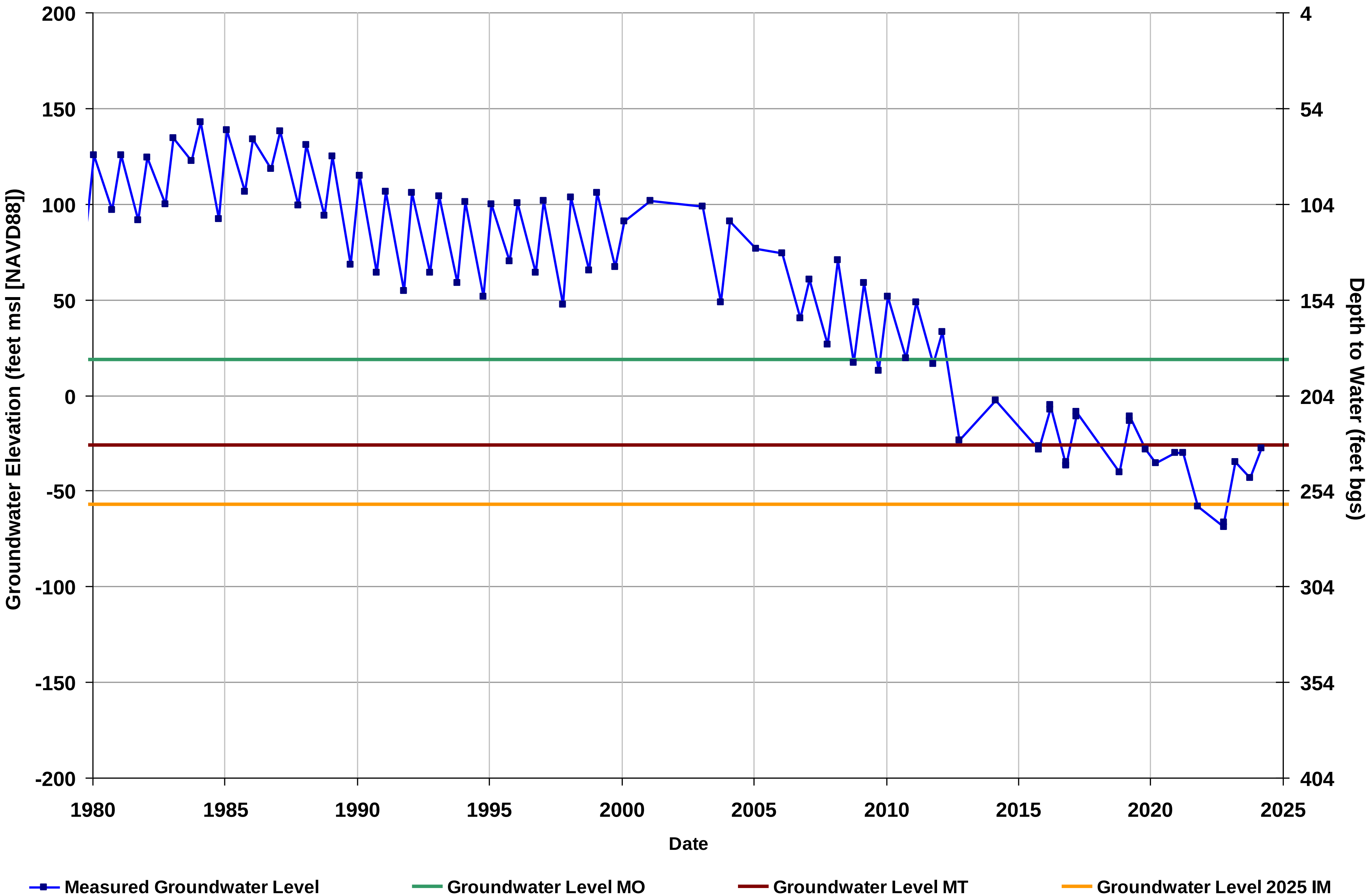
Well Name: MID RMS-4
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 698
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 667
GSE (ft, msl): 190



Well Name: MID RMS-5
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 570
Perf. Top (ft bgs): 270
Perf. Bottom (ft bgs): 570
GSE (ft, msl): 204

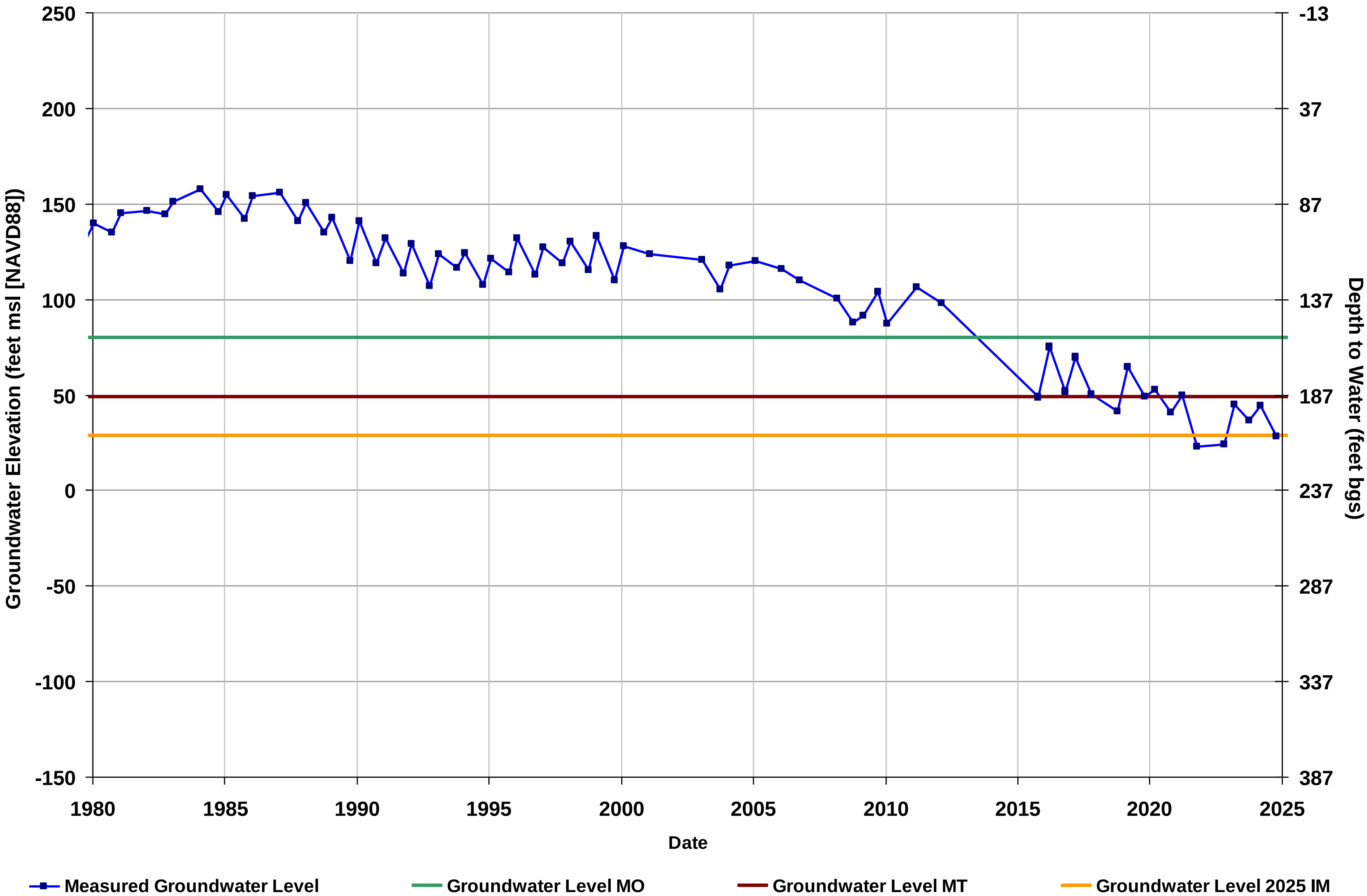


Well Name: MID RMS-6
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 680
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 680
GSE (ft, msl): 237

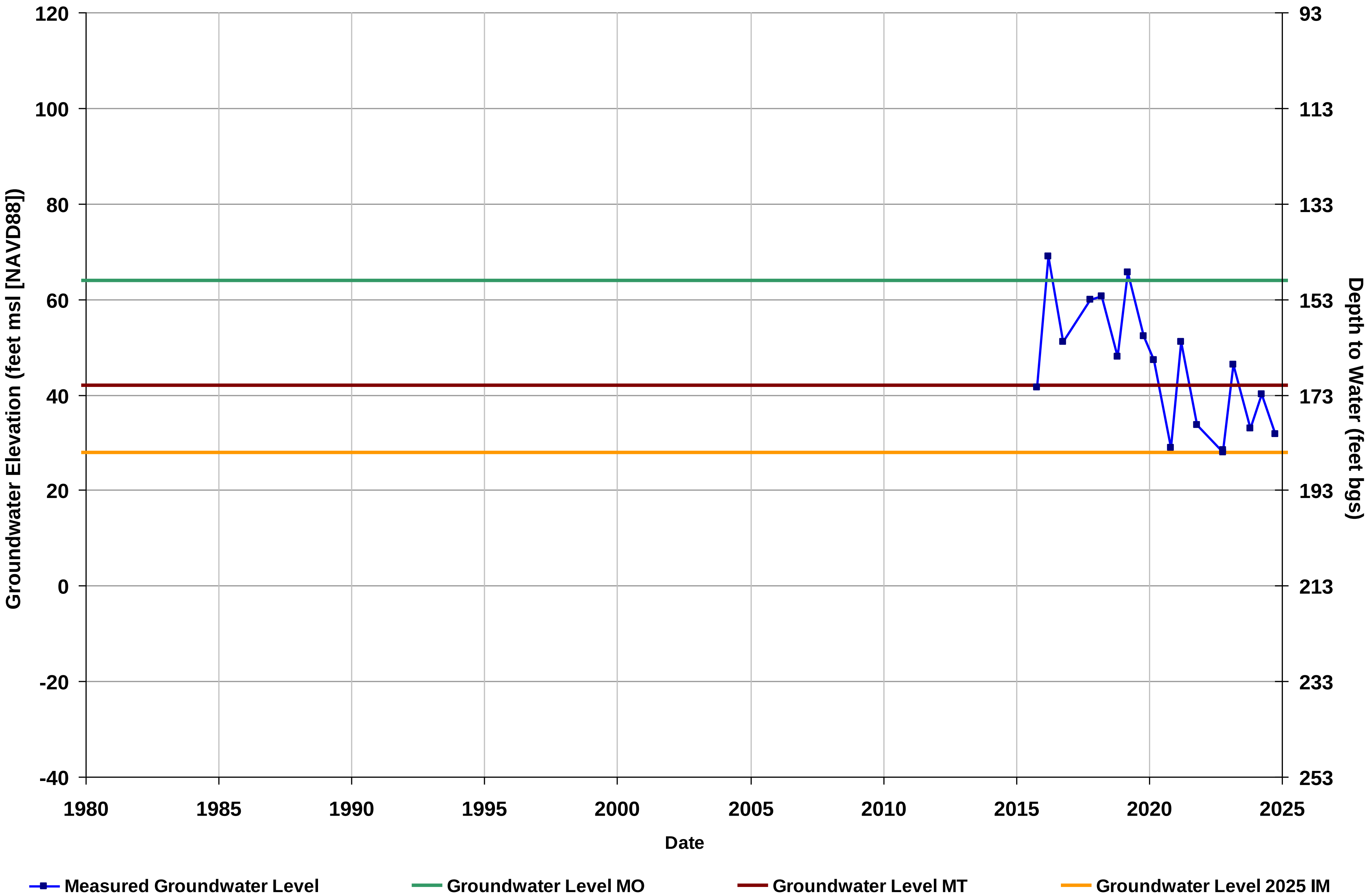
Well Name: MID RMS-7
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 656
Perf. Top (ft bgs): 290
Perf. Bottom (ft bgs): 635
GSE (ft, msl): 237



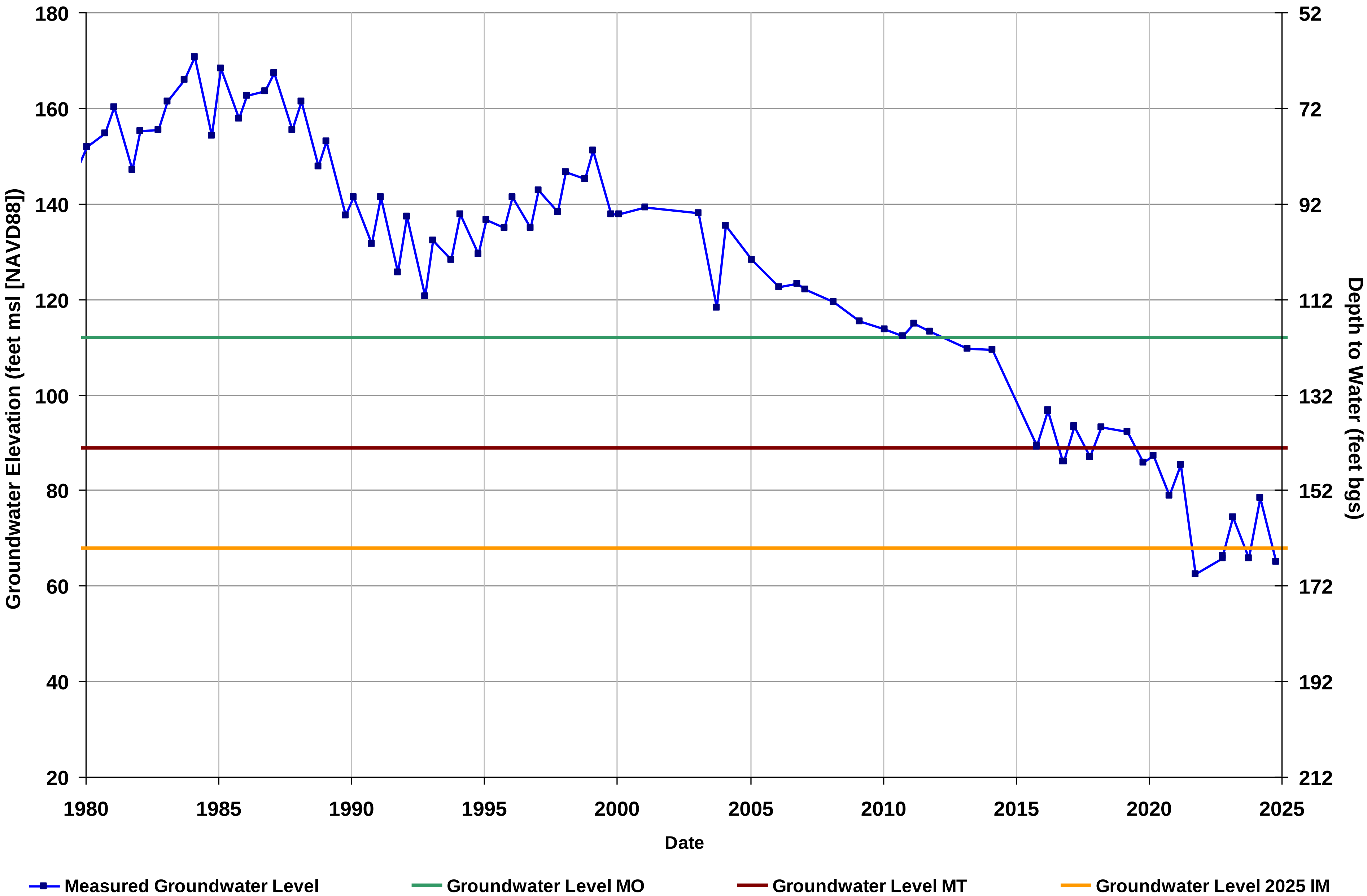
Well Name: MID RMS-10
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 615
Perf. Top (ft bgs): 315
Perf. Bottom (ft bgs): 615
GSE (ft, msl): 213



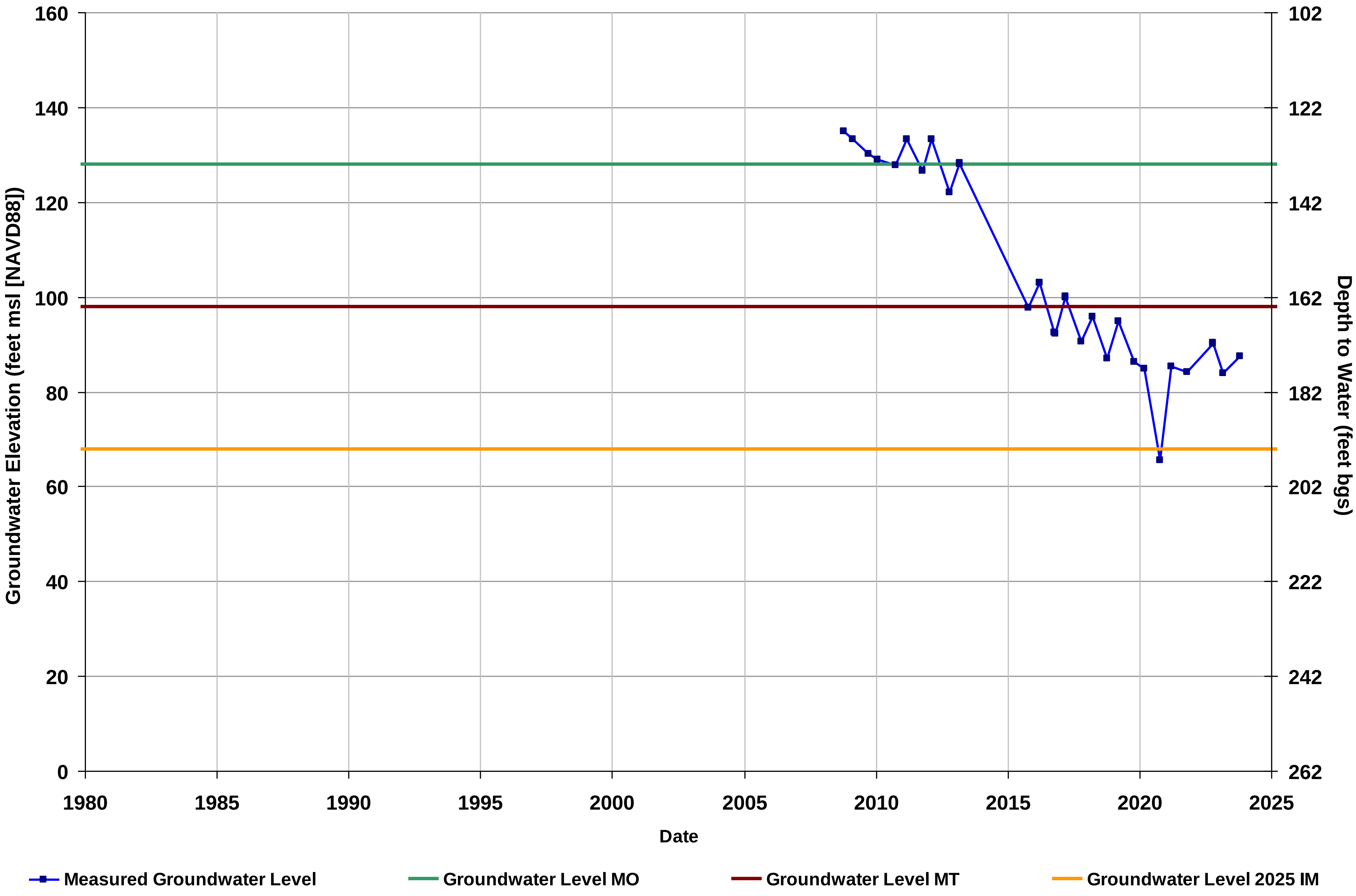
Well Name: MID RMS-11
Depth Zone: Upper
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 315
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 232



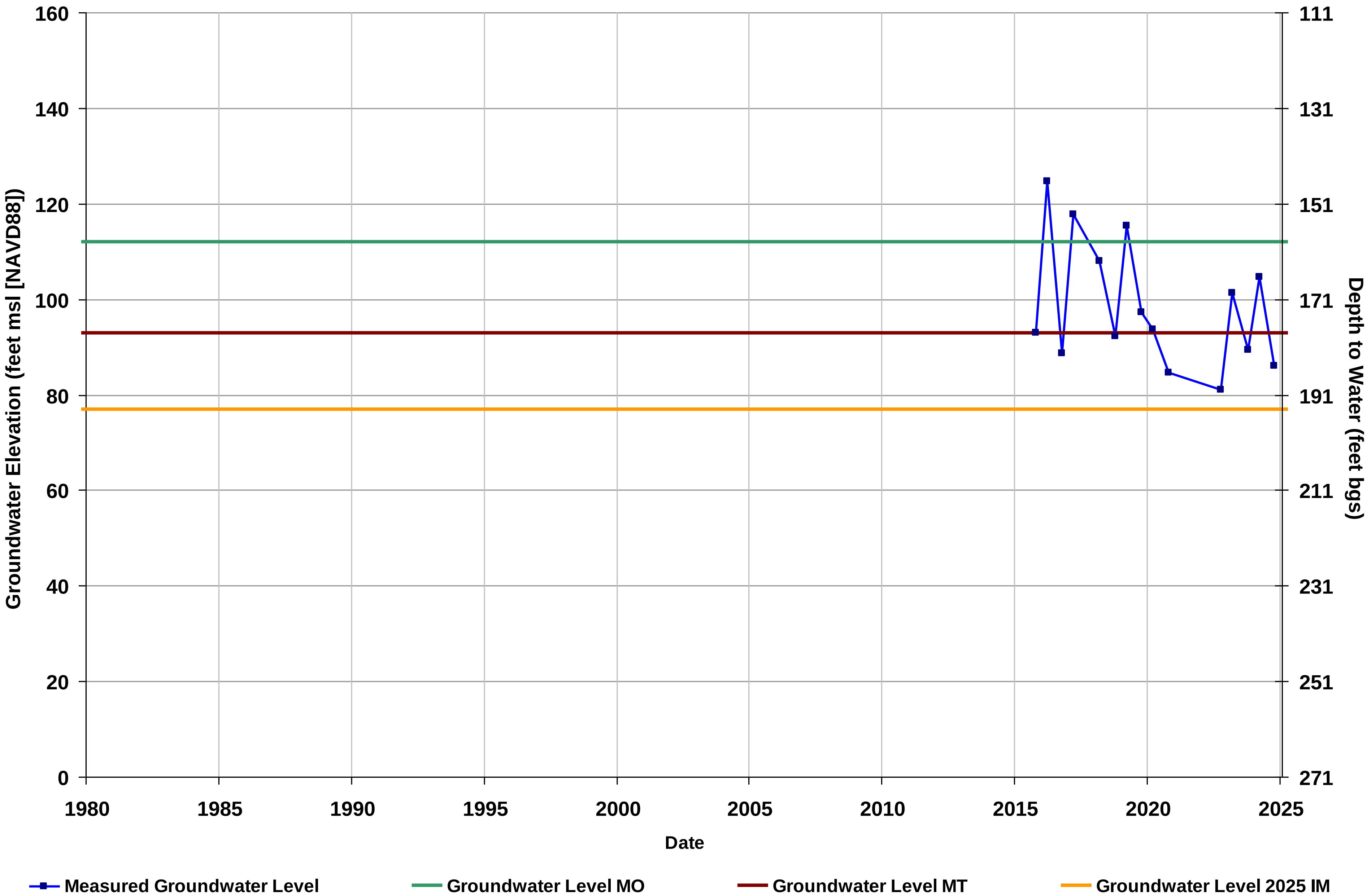
Well Name: MID RMS-12
Depth Zone: Upper
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 176
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 262



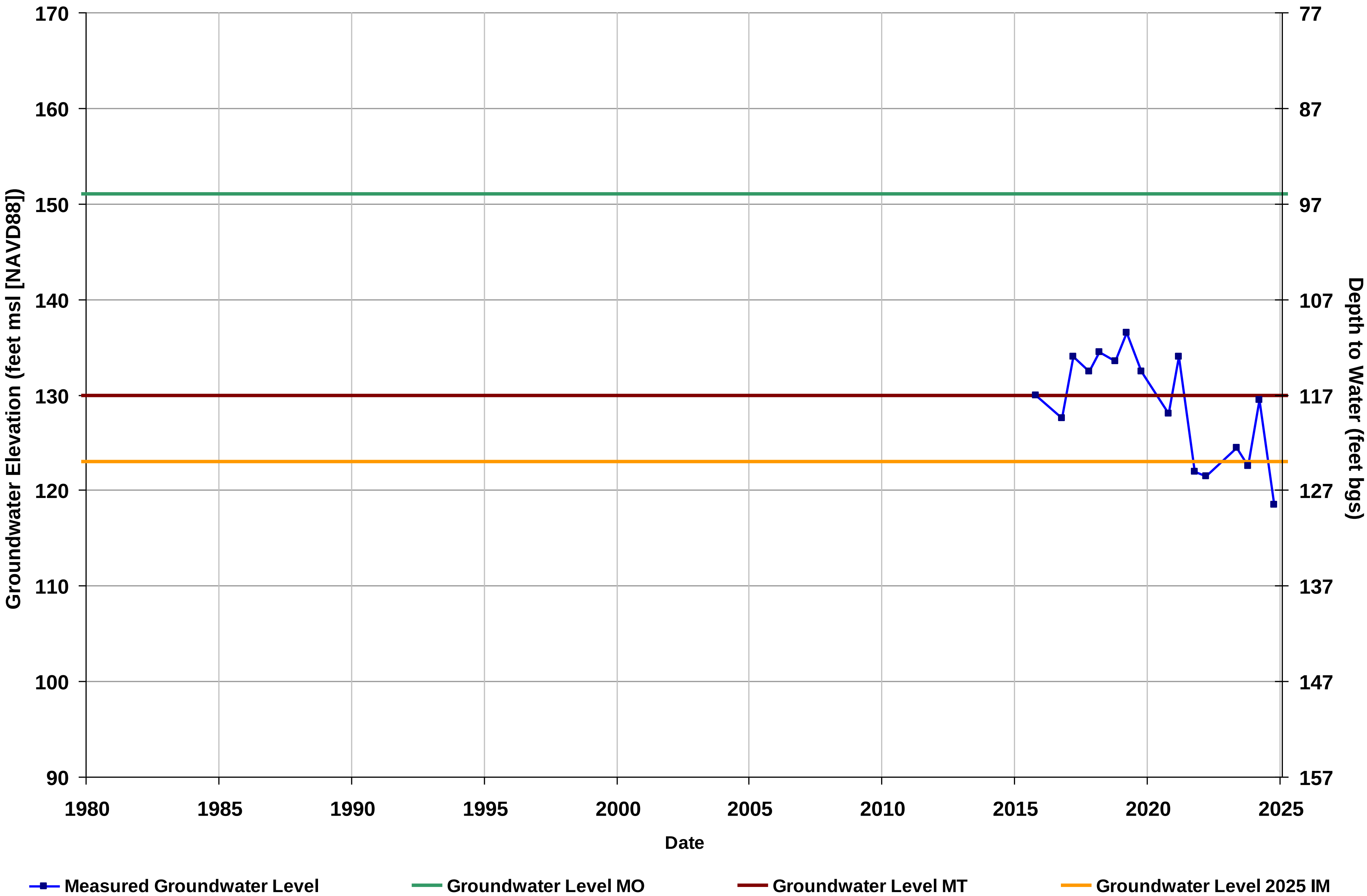
Well Name: MID RMS-13
Depth Zone: Composite
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 600
Perf. Top (ft bgs): 228
Perf. Bottom (ft bgs): 552
GSE (ft, msl): 271



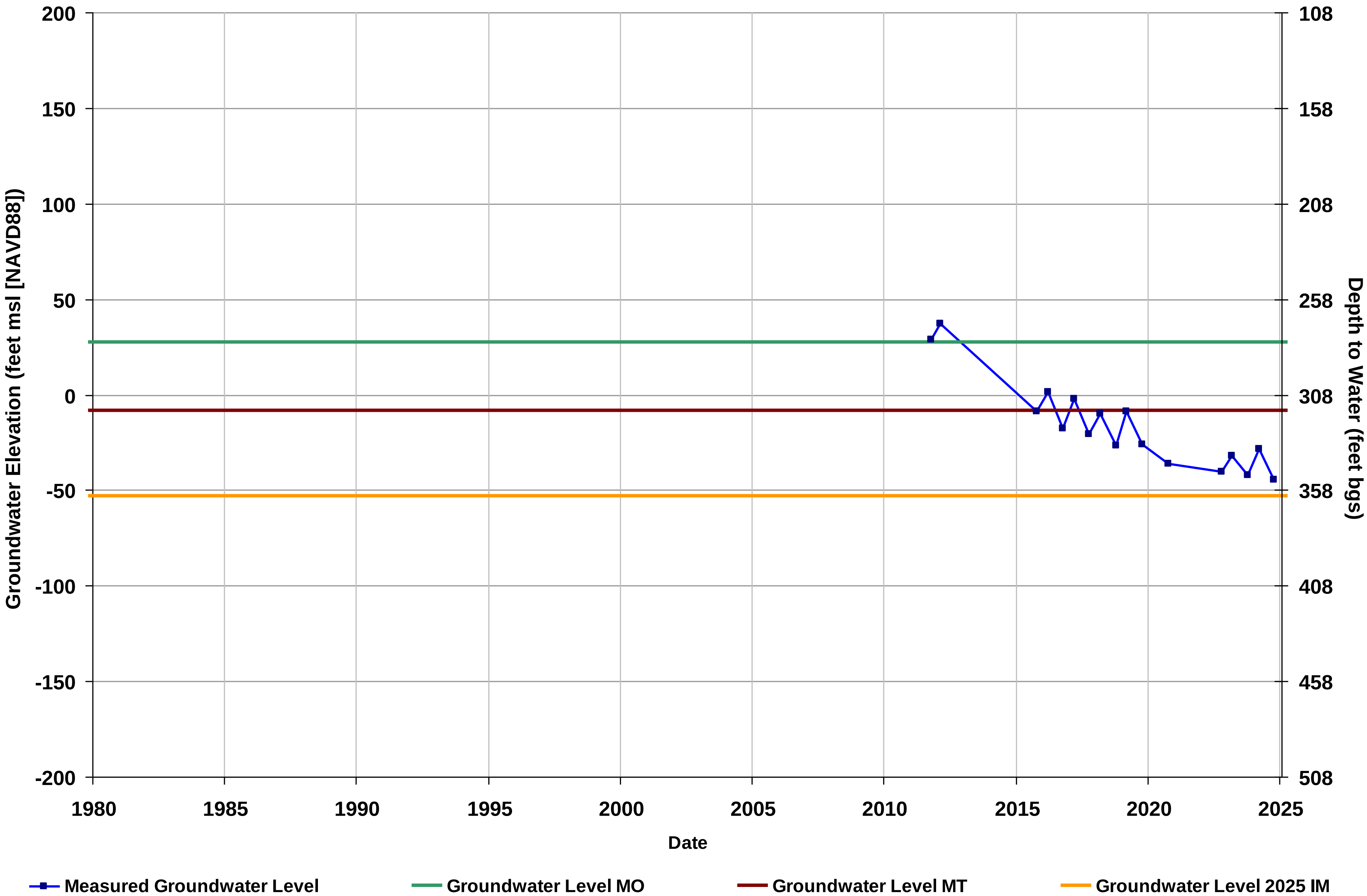
Well Name: MID RMS-15
Depth Zone: Upper
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 502
Perf. Top (ft bgs): 160
Perf. Bottom (ft bgs): 200
GSE (ft, msl): 247



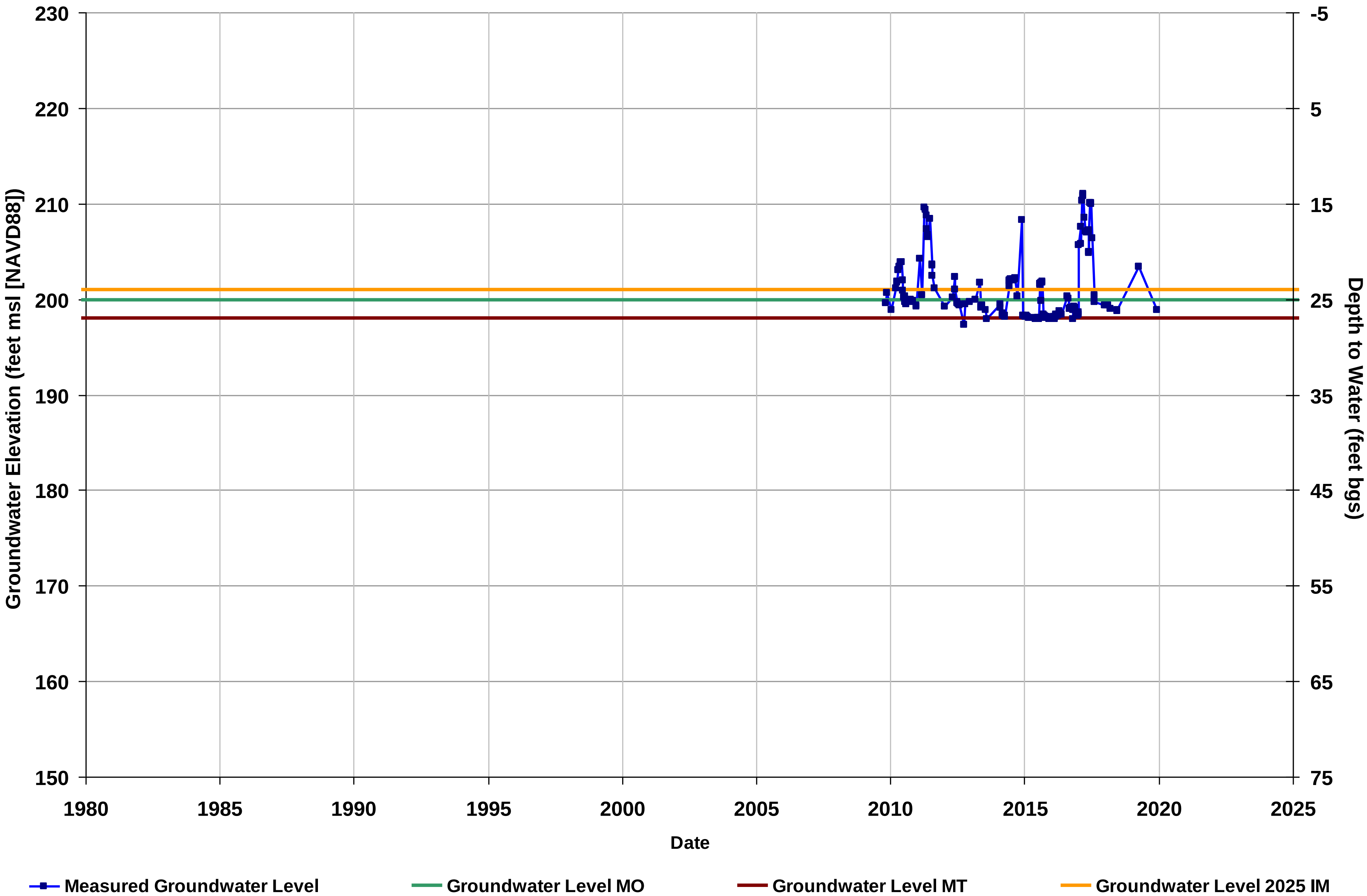
Well Name: MID RMS-16
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 452
Perf. Top (ft bgs): 348
Perf. Bottom (ft bgs): 388
GSE (ft, msl): 308



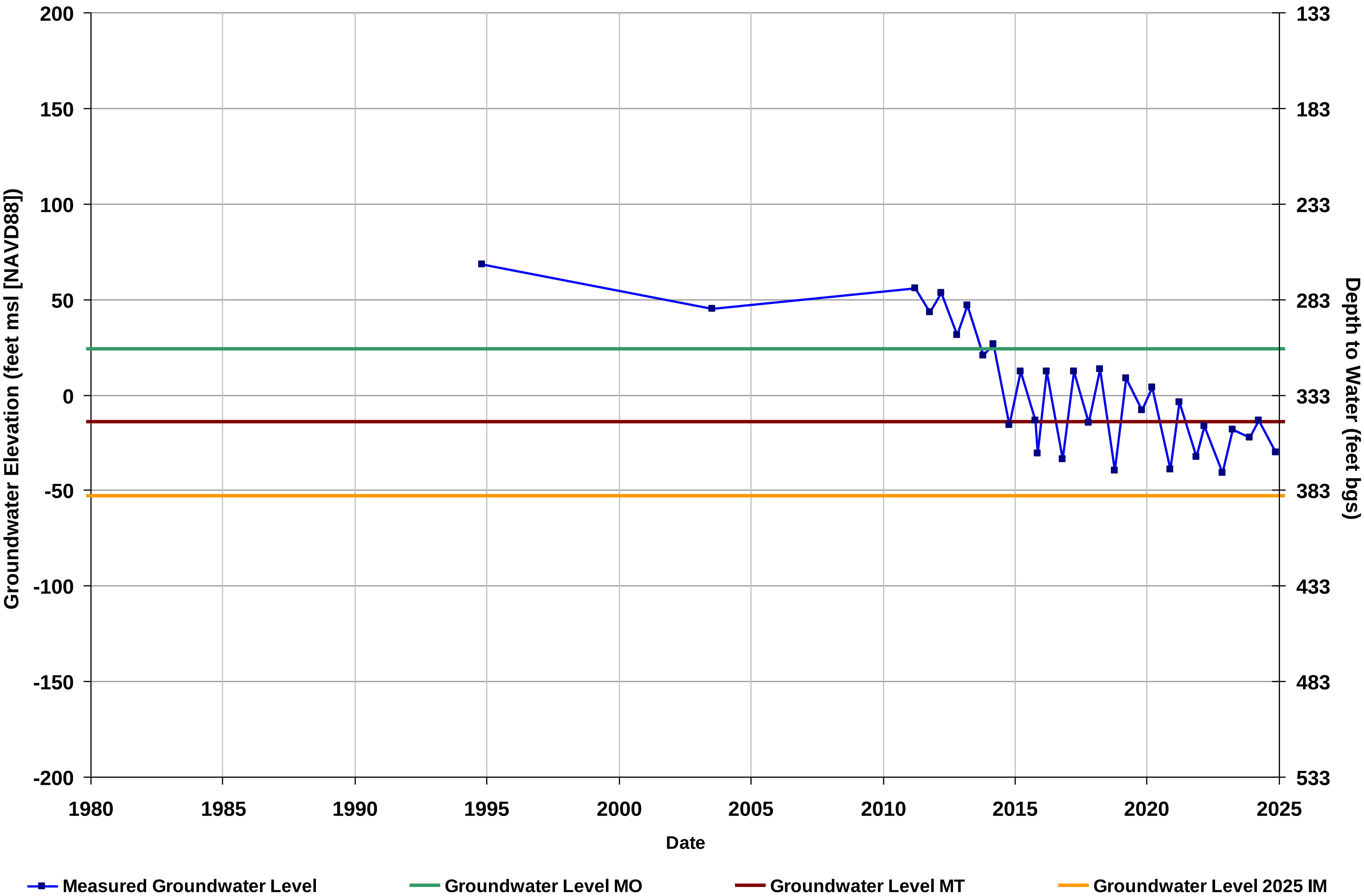
Well Name: MID RMS-17
Depth Zone: Shallow
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 47
Perf. Top (ft bgs): 26
Perf. Bottom (ft bgs): 46
GSE (ft, msl): 224



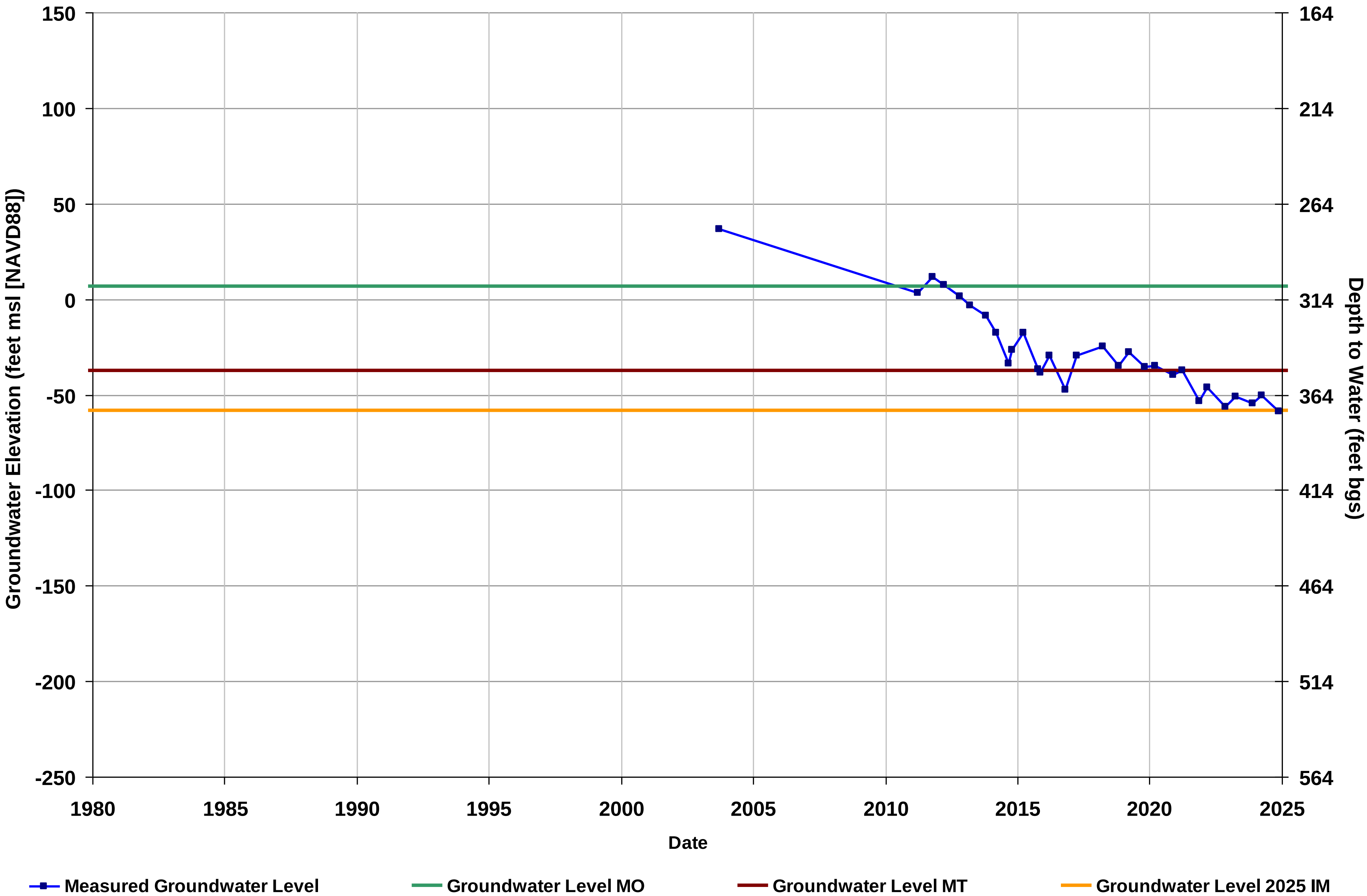
Well Name: MWD RMS-1
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Water District

Total Depth (ft bgs): 504
Perf. Top (ft bgs): 200
Perf. Bottom (ft bgs): 500
GSE (ft, msl): 330



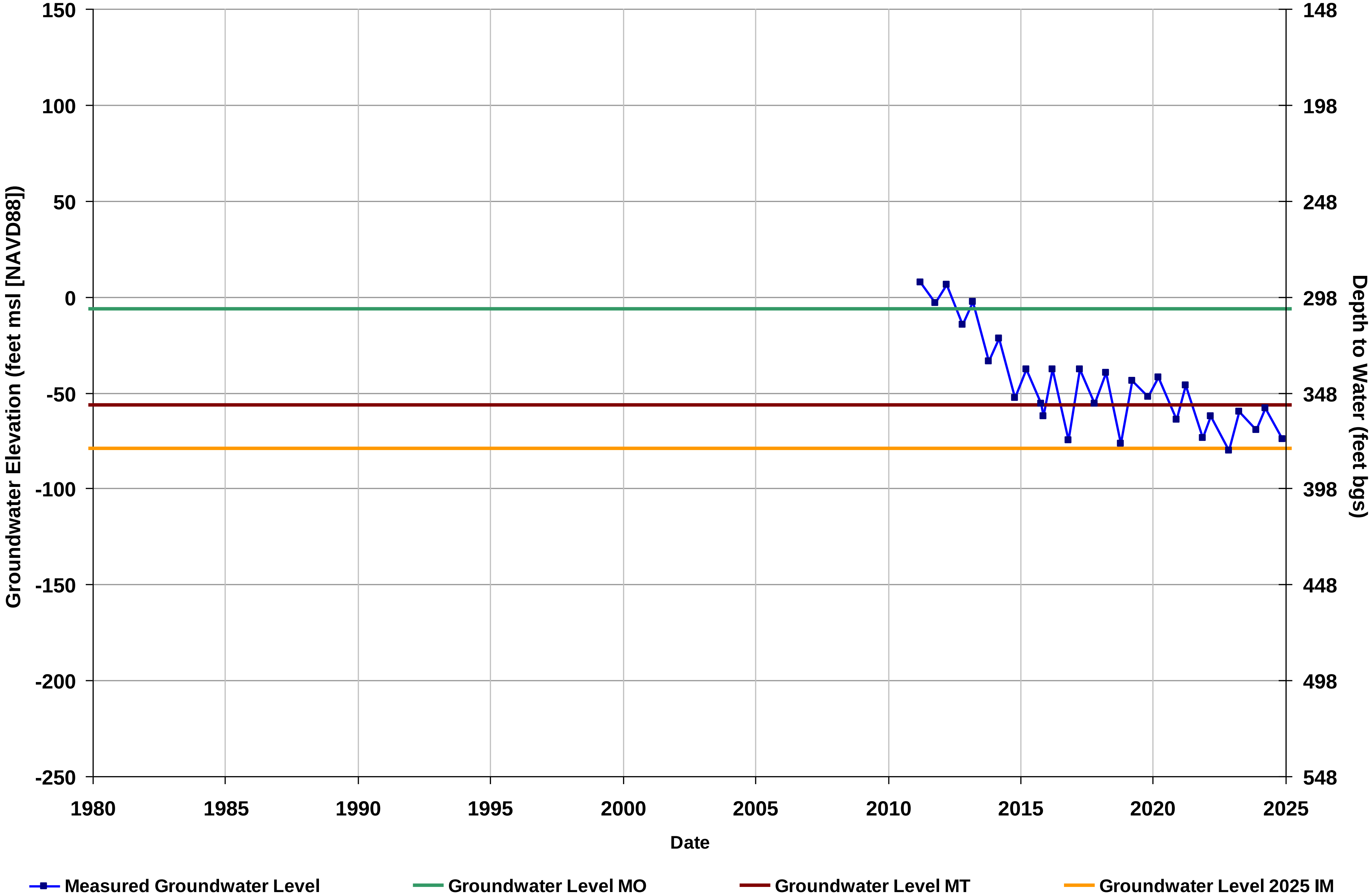
Well Name: MWD RMS-2
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Water District

Total Depth (ft bgs): 537
Perf. Top (ft bgs): 200
Perf. Bottom (ft bgs): 537
GSE (ft, msl): 310



Well Name: MWD RMS-3
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Water District

Total Depth (ft bgs): 800
Perf. Top (ft bgs): 380
Perf. Bottom (ft bgs): 800
GSE (ft, msl): 295



Appendix 2. Groundwater Conditions Relative to Sustainable Management Criteria (§356.4(a))

Appendix 2.B. Groundwater Quality Measurements for Groundwater Quality Representative Monitoring Site Wells

Table 2.B-1. Summary of Arsenic Measurements for Groundwater Quality RMS Wells.

	Arsenic (ug/L)								
RMS Well ID	First Msmt.	Most Recent Msmt.	Msmt. Count	Min. Conc.	Max. Conc.	Average Conc.	Baseline Conc.	MO Conc.	MT Conc.
MCE RMS-3	8/18/2021	7/30/2024	5	150	160	155	155	155	186
MID RMS-4	8/22/2024	8/22/2024	1	n/a	n/a	n/a	n/a[†]	8[†]	10[†]
MID RMS-5B	n/a	n/a	n/a	n/a	n/a	n/a	n/a[†]	8[†]	10[†]
MID RMS-6	7/12/2022	8/22/2024	2	5.4	5.4	5.4	n/a[†]	8[†]	10[†]
MID RMS-7	7/12/2022	7/25/2024	2	n/a	n/a	n/a	n/a[†]	8[†]	10[†]
MID RMS-13	n/a	n/a	n/a	n/a	n/a	n/a	n/a[†]	8[†]	10[†]
MWD RMS-1	7/18/2019	8/19/2022	4	2	3	2.8	3	3	10
MSB03A	2/12/2020	7/23/2024	9	2.2	4.7	2.8	3	4	10
MSB03B	2/12/2020	7/23/2024	6	3.9	5.5	4.6	5	5	10
MSB03C	2/12/2020	7/23/2024	6	4.3	5.5	5.1	5	6	10
MSB04A	2/13/2020	6/15/2023	9	2	3.3	2.7	3	3	10
MSB04B	2/13/2020	7/24/2024	6	45	57	48.3	47	47	56
MSB04C	2/13/2020	7/24/2024	6	48	60	54	53	54	65
MSB05A	2/12/2020	7/23/2024	6	1.9	10	5.2	4	5	10
MSB05B	2/12/2020	7/23/2024	4	9	49	27.5	34	34	41
MSB05C	2/12/2020	7/23/2024	4	5.3	9	7.6	8	8	10
MSB06A	2/12/2020	7/23/2024	14	1.3	3.2	2.2	2	3	10
MSB06B	2/12/2020	7/23/2024	8	3.4	47	36.1	34	35	42
MSB06C	2/12/2020	7/23/2024	8	2	20	13.1	12	13	15
MSB09A	2/11/2020	7/25/2024	9	1.3	2.1	1.7	2	2	10
MSB09B	2/11/2020	7/25/2024	6	2.1	3.3	2.5	3	3	10
MSB09C	2/11/2020	7/25/2024	6	110	120	113.3	113	113	135
MSB10B	2/13/2020	7/26/2024	8	2	3	2.4	2	3	10
MSB10C	2/13/2020	7/26/2024	6	2.1	3.8	2.7	3	3	10
MSB11C	2/11/2020	7/31/2024	3	4.5	8.5	6.5	6	6	10
MSB13A	n/a	n/a	n/a	n/a	n/a	n/a	n/a[†]	8[†]	10[†]
MSB13B	6/15/2023	7/24/2024	2	3.1	3.6	3.4	n/a[†]	8[†]	10[†]
MSB13C	6/15/2023	7/24/2024	2	3.6	4.7	4.2	n/a[†]	8[†]	10[†]
2000507-001	12/23/2008	5/11/2023	4	2.6	4.6	3.8	4	4	10
2000553-001	5/27/2008	2/14/2024	6	1.5	2.6	2	2	3	10
2000682-002	5/20/2008	8/23/2023	4	2.1	3.8	2.7	3	3	10
2000727-001	5/27/2008	2/21/2024	8	1.4	2.1	1.8	2	2	10
2000938-001	12/17/2008	8/23/2022	6	2	2	2	2	2	10
2010002-014	3/4/1986	5/22/2023	13	2	30	11.4	11	12	14
2010002-032	11/16/2006	3/25/2024	12	2	3.9	3	4	4	10
2010008-005	5/1/1997	3/25/2024	8	2	4.4	3	3	4	10
2010009-002	10/22/1985	7/15/2013	7	4.1	10	6	6	6	10

Table 2.B-1. Summary of Arsenic Measurements for Groundwater Quality RMS Wells.

	Arsenic (ug/L)								
RMS Well ID	First Msmt.	Most Recent Msmt.	Msmt. Count	Min. Conc.	Max. Conc.	Average Conc.	Baseline Conc.	MO Conc.	MT Conc.
2010010-007	10/18/2005	9/9/2022	7	2	3.2	2.4	2	3	10
2010801-001	3/4/1998	7/2/2024	150	4.3	22	14.8	15	15	18
2801077-001	4/3/2002	4/3/2002	1	5	5	5	n/a[†]	8[†]	10[†]
ESJ12	7/27/2021	7/27/2021	2	0.6	0.6	0.6	n/a	n/a	n/a
ESJ17	7/27/2021	7/27/2021	2	2	2	2	n/a	n/a	n/a

[†] Insufficient data available to calculate baseline value. SMC values will be confirmed and/or adjusted as needed after a baseline has been calculated.

Table 2.B-2. Summary of Nitrate as N Measurements for Groundwater Quality RMS Wells.

	Nitrate as N (mg/L)								
RMS Well ID	First Msmt.	Most Recent Msmt.	Msmt. Count	Min. Conc.	Max. Conc.	Average Conc.	Baseline Conc.	MO Conc.	MT Conc.
MCE RMS-3	8/18/2021	7/30/2024	4	0.5	0.5	0.5	1	1	10
MID RMS-4	8/22/2024	8/22/2024	1	2	2	2	n/a†	8†	10†
MID RMS-5B	n/a	n/a	n/a	n/a	n/a	n/a	n/a†	8†	10†
MID RMS-6	7/12/2022	8/22/2024	2	4.4	5.4	4.9	n/a†	8†	10†
MID RMS-7	7/12/2022	7/25/2024	2	0.7	0.8	0.7	n/a†	8†	10†
MID RMS-13	n/a	n/a	n/a	n/a	n/a	n/a	n/a†	8†	10†
MWD RMS-1	7/18/2019	8/19/2022	4	1.4	2.8	2.2	2	3	10
MSB03A	6/22/2022	7/23/2024	6	6.9	8.1	7.5	8	8	10
MSB03B	6/15/2021	7/23/2024	4	0.4	0.5	0.4	0	1	10
MSB03C	6/15/2021	7/23/2024	4	n/a	n/a	n/a	ND	1	10
MSB04A	6/15/2021	6/15/2023	5	5	6.5	5.8	6	6	10
MSB04B	6/15/2021	7/24/2024	4	n/a	n/a	n/a	ND	1	10
MSB04C	6/15/2021	7/24/2024	4	n/a	n/a	n/a	ND	1	10
MSB05A	6/22/2022	7/23/2024	3	3.2	18	9.5	12	13	15
MSB05B	6/22/2022	7/23/2024	3	0.3	2.3	1	0	1	10
MSB05C	6/22/2022	7/23/2024	3	0.9	0.9	0.9	1	1	10
MSB06A	6/15/2021	7/23/2024	7	8.5	16	9.8	9	10	12
MSB06B	6/15/2021	7/23/2024	5	0.3	4	1.4	2	2	10
MSB06C	6/15/2021	7/23/2024	5	0.3	1	0.6	1	1	10
MSB09A	6/17/2021	7/25/2024	5	7.7	9.9	8.5	7	8	10
MSB09B	6/17/2021	7/25/2024	4	1.3	1.7	1.5	2	2	10
MSB09C	6/17/2021	7/25/2024	4	n/a	n/a	n/a	ND	1	10
MSB10B	6/15/2021	7/26/2024	4	1.5	2.3	2	2	2	10
MSB10C	6/15/2021	7/26/2024	4	1.7	1.7	1.7	2	2	10
MSB11C	6/21/2022	7/31/2024	2	n/a	n/a	n/a	n/a†	8†	10†
MSB13A	n/a	n/a	n/a	n/a	n/a	n/a	n/a†	8†	10†
MSB13B	6/15/2023	7/24/2024	2	3.5	3.7	3.6	n/a†	8†	10†
MSB13C	6/15/2023	7/24/2024	2	n/a	n/a	n/a	n/a†	8†	10†
2000507-001	11/5/2004	6/28/2024	10	2.8	9.7	5.4	6	6	10
2000553-001	12/8/2005	7/9/2024	36	3.8	22	7.7	8	9	10
2000682-002	5/20/2008	1/16/2024	18	0.8	13.8	6.7	7	7	10
2000727-001	5/24/2006	2/21/2024	25	1.5	7.8	4.8	5	6	10
2000938-001	6/25/2008	1/17/2023	21	1.1	6.5	3.2	3	4	10
2010002-014	3/4/1986	6/3/2024	35	0.9	14	4.6	5	5	10
2010002-032	11/16/2006	3/25/2024	23	1.9	12	6.1	6	7	10
2010008-005	5/1/1997	3/25/2024	37	1.8	22.3	11.9	12	13	15
2010009-002	10/22/1985	1/26/2017	20	1.6	8.7	6.4	6	7	10

Table 2.B-2. Summary of Nitrate as N Measurements for Groundwater Quality RMS Wells.

	Nitrate as N (mg/L)								
RMS Well ID	First Msmt.	Most Recent Msmt.	Msmt. Count	Min. Conc.	Max. Conc.	Average Conc.	Baseline Conc.	MO Conc.	MT Conc.
2010010-007	10/18/2005	1/2/2024	21	0.2	20	8.2	9	9	11
2010801-001	3/4/1998	8/15/2023	31	0.6	4.6	2.3	2	3	10
2801077-001	4/3/2002	4/24/2024	22	0.1	75	21	26	27	32
ESJ12	n/a	n/a	n/a	n/a	n/a	n/a	7	7	11
ESJ17	n/a	n/a	n/a	n/a	n/a	n/a	n/a[†]	8[†]	10[†]

[†] Insufficient data available to calculate baseline value. SMC values will be confirmed and/or adjusted as needed after a baseline has been calculated.

Table 2.B-3. Summary of Total Dissolved Solids Measurements for Groundwater Quality RMS Wells.

	Total Dissolved Solids (mg/L)								
RMS Well ID	First Msmt.	Most Recent Msmt.	Msmt. Count	Min. Conc.	Max. Conc.	Average Conc.	Baseline Conc.	MO Conc.	MT Conc.
MCE RMS-3	8/18/2021	7/30/2024	4	590	720	640	643	650	772
MID RMS-4	8/22/2024	8/22/2024	1	310	310	310	n/a†	400†	500†
MID RMS-5B	n/a	n/a	n/a	n/a	n/a	n/a	n/a†	400†	500†
MID RMS-6	7/12/2022	8/22/2024	2	270	270	270	n/a†	400†	500†
MID RMS-7	7/12/2022	7/25/2024	2	190	220	205	n/a†	400†	500†
MID RMS-13	n/a	n/a	n/a	n/a	n/a	n/a	n/a†	400†	500†
MWD RMS-1	7/18/2019	8/19/2022	4	191	230	205	205	250	500
MSB03A	2/12/2020	7/23/2024	10	720	930	824	828	850	994
MSB03B	2/12/2020	7/23/2024	5	210	400	354	345	350	500
MSB03C	2/12/2020	7/23/2024	5	250	1400	990	963	1000	1155
MSB04A	2/13/2020	6/15/2023	7	200	250	220	218	250	500
MSB04B	2/13/2020	7/24/2024	5	360	420	386	380	400	500
MSB04C	2/13/2020	7/24/2024	5	340	400	364	355	400	500
MSB05A	2/12/2020	7/23/2024	7	330	720	558.571	568	600	682
MSB05B	2/12/2020	7/23/2024	4	230	320	260	240	250	500
MSB05C	2/12/2020	7/23/2024	4	99	270	209.75	247	250	500
MSB06A	2/12/2020	7/23/2024	12	330	1300	496.667	424	450	510
MSB06B	2/12/2020	7/23/2024	6	350	520	398.333	404	450	500
MSB06C	2/12/2020	7/23/2024	6	160	540	436.667	422	450	507
MSB09A	2/11/2020	7/25/2024	9	450	570	498.889	500	550	600
MSB09B	2/11/2020	7/25/2024	5	170	530	268	203	250	500
MSB09C	2/11/2020	7/25/2024	5	130	310	248	278	300	500
MSB10B	2/13/2020	7/26/2024	8	170	220	207.5	206	250	500
MSB10C	2/13/2020	7/26/2024	5	260	540	326	273	300	500
MSB11C	2/11/2020	7/31/2024	3	450	520	476.667	490	500	588
MSB13A	n/a	n/a	n/a	n/a	n/a	n/a	n/a†	400†	500†
MSB13B	6/15/2023	7/24/2024	2	290	290	290	n/a†	400†	500†
MSB13C	6/15/2023	7/24/2024	2	890	1000	945	n/a†	400†	500†
2000507-001	n/a	n/a	n/a	n/a	n/a	n/a	n/a†	400†	500†
2000553-001	12/8/2005	2/14/2024	8	180	420	281.25	261	300	500
2000682-002	5/20/2008	5/20/2008	1	220	220	220	n/a†	400†	500†
2000727-001	5/27/2008	2/21/2024	8	190	380	228.75	207	250	500
2000938-001	n/a	n/a	n/a	n/a	n/a	n/a	145	150	500
2010002-014	3/4/1986	5/22/2023	15	148	207	180.733	181	200	500
2010002-032	9/6/2006	11/10/2021	11	190	240	212.273	212	250	500
2010008-005	5/1/1997	3/25/2024	10	280	360	322.3	318	350	500
2010009-002	10/22/1985	7/15/2013	7	110	150	138.286	138	150	500

Table 2.B-3. Summary of Total Dissolved Solids Measurements for Groundwater Quality RMS Wells.

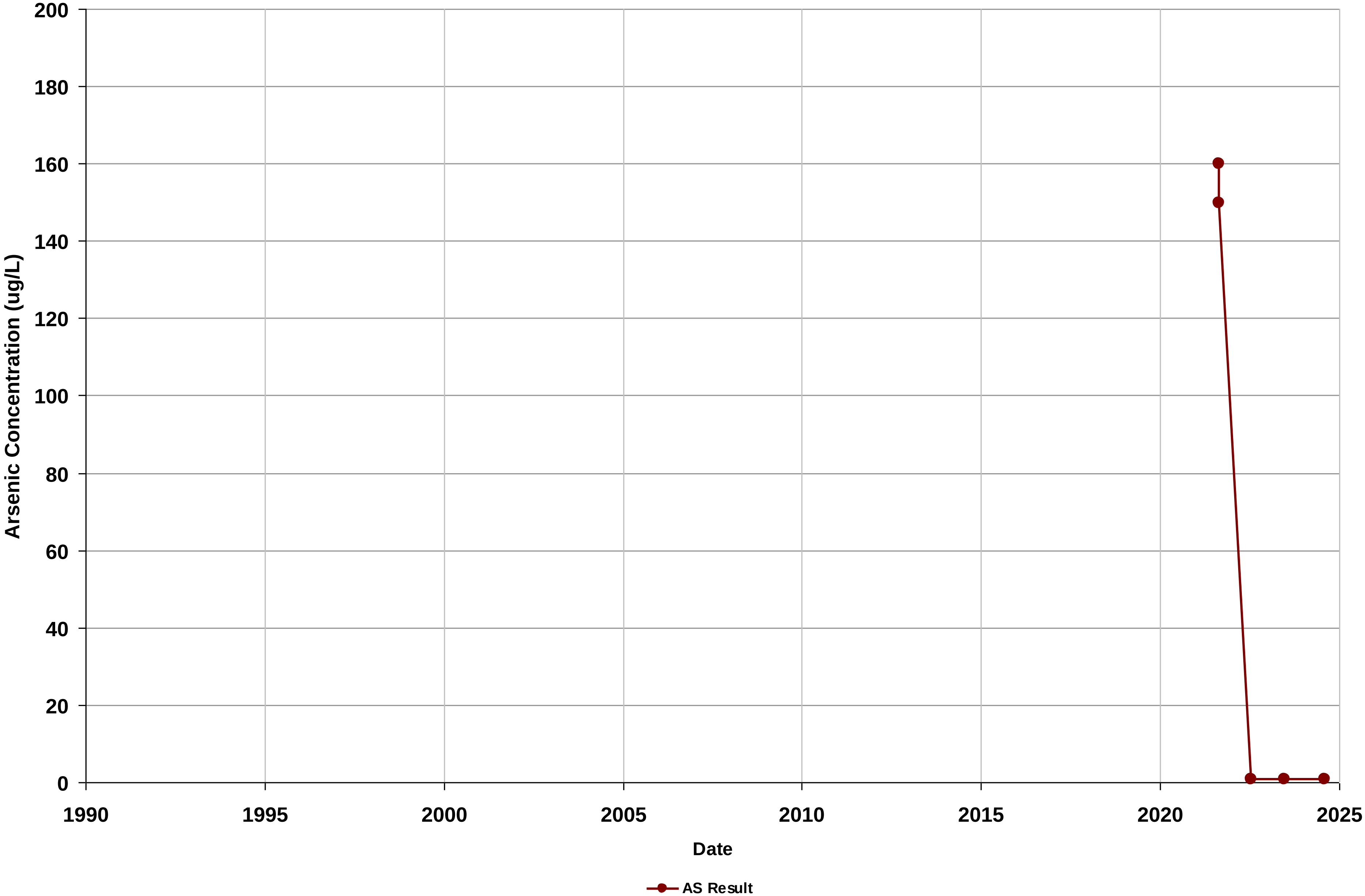
	Total Dissolved Solids (mg/L)								
RMS Well ID	First Msmt.	Most Recent Msmt.	Msmt. Count	Min. Conc.	Max. Conc.	Average Conc.	Baseline Conc.	MO Conc.	MT Conc.
2010010-007	10/18/2005	9/9/2022	7	190	220	204.286	204	250	500
2010801-001	3/4/1998	8/5/2021	11	220	270	241.818	242	250	500
2801077-001	n/a	n/a	n/a	n/a	n/a	n/a	n/a†	400†	500†
ESJ12	10/30/2018	7/25/2022	5	450	540	498	493	500	592
ESJ17	7/22/2019	7/22/2019	2	260	270	265	n/a†	400†	500†

† Insufficient data available to calculate baseline value. SMC values will be confirmed and/or adjusted as needed after a baseline has been calculated.

Arsenic Hydrographs for Groundwater Quality RMS Wells

Well Name: MCE RMS-3
Subbasin: Madera
Well Type: Unknown

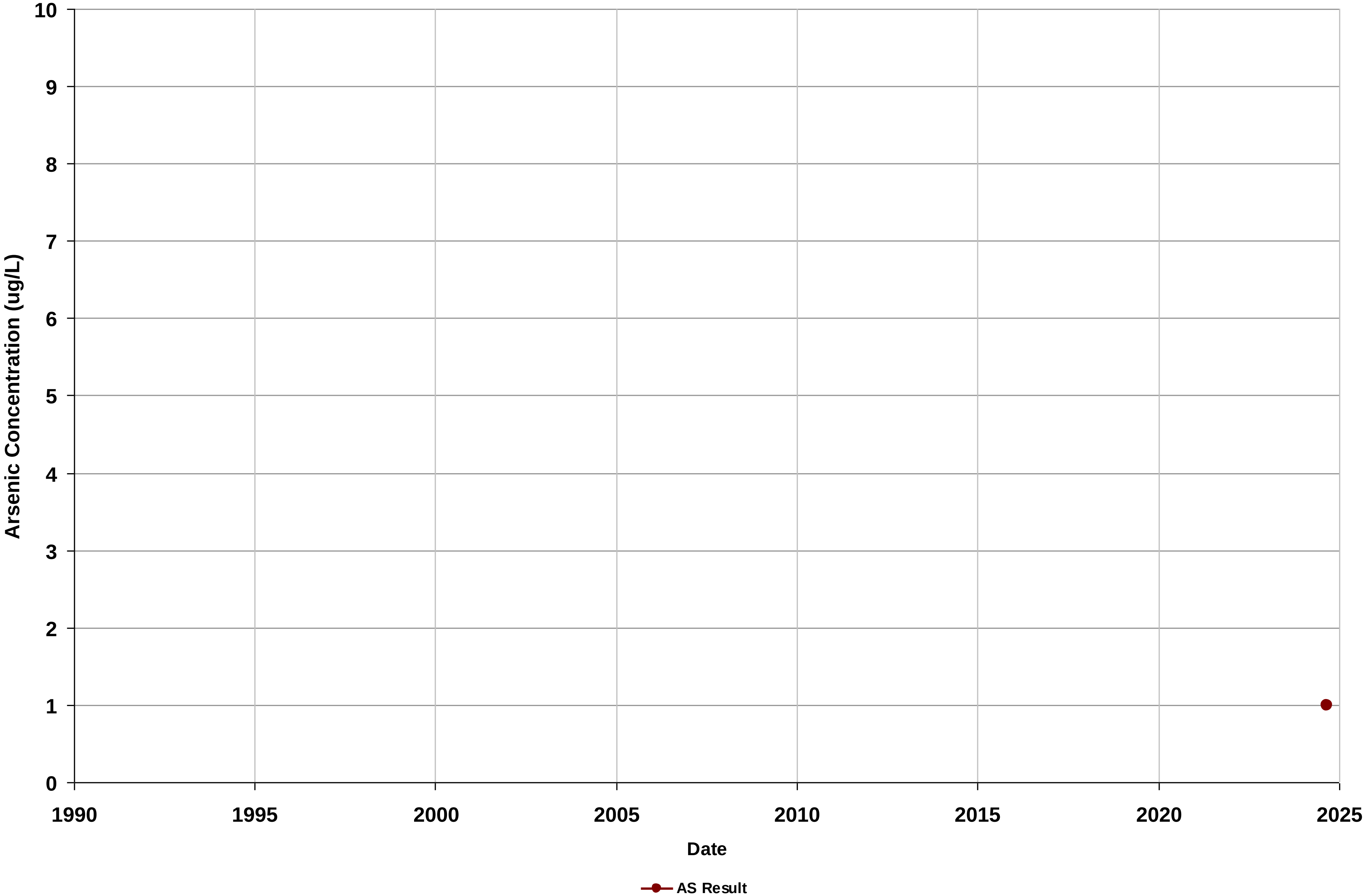
Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MID RMS-4
Subbasin: Madera
Well Type: Irrigation

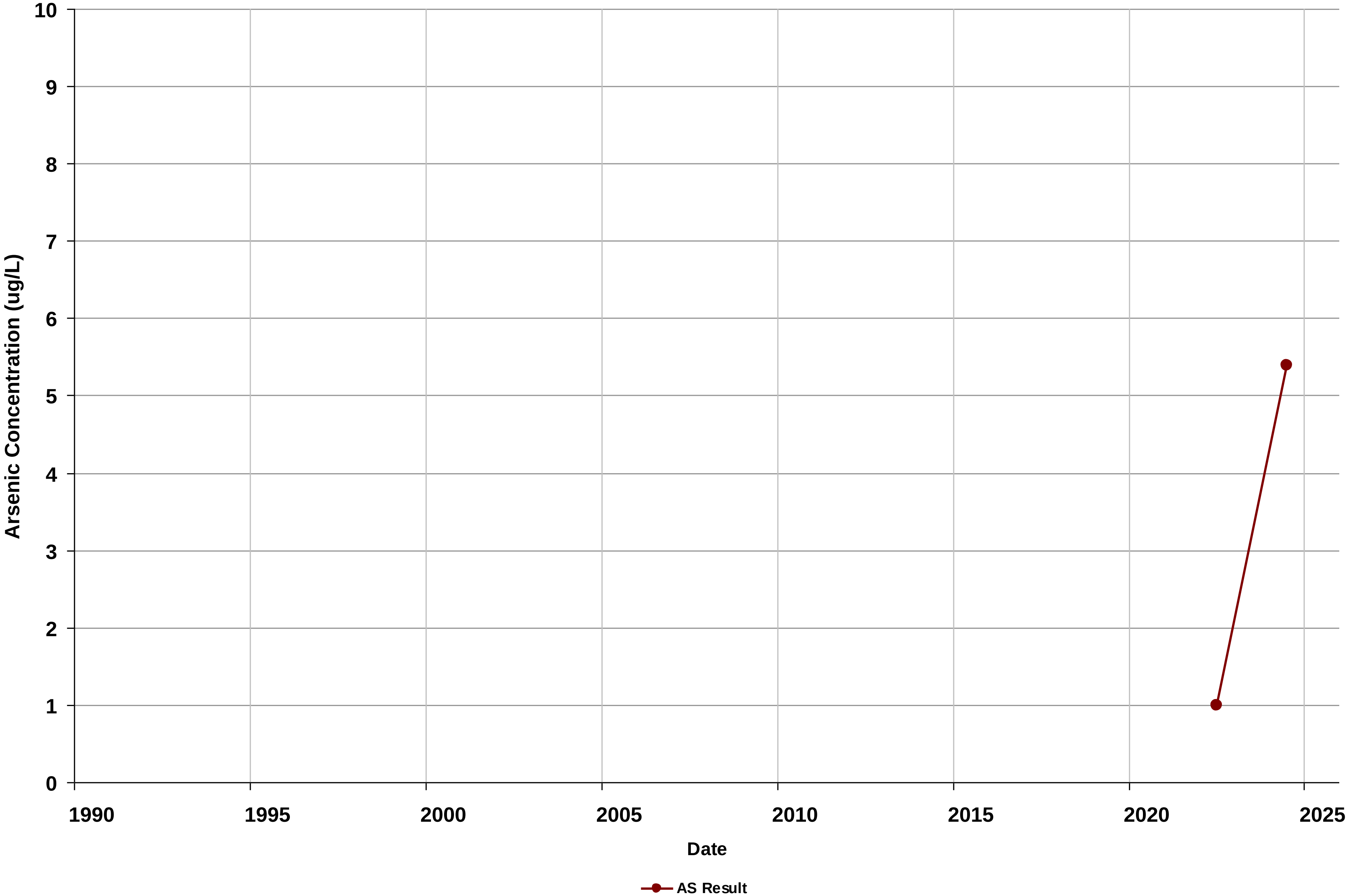
Total Depth (ft bgs): 698
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 667



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MID RMS-6
Subbasin: Madera
Well Type: Industrial

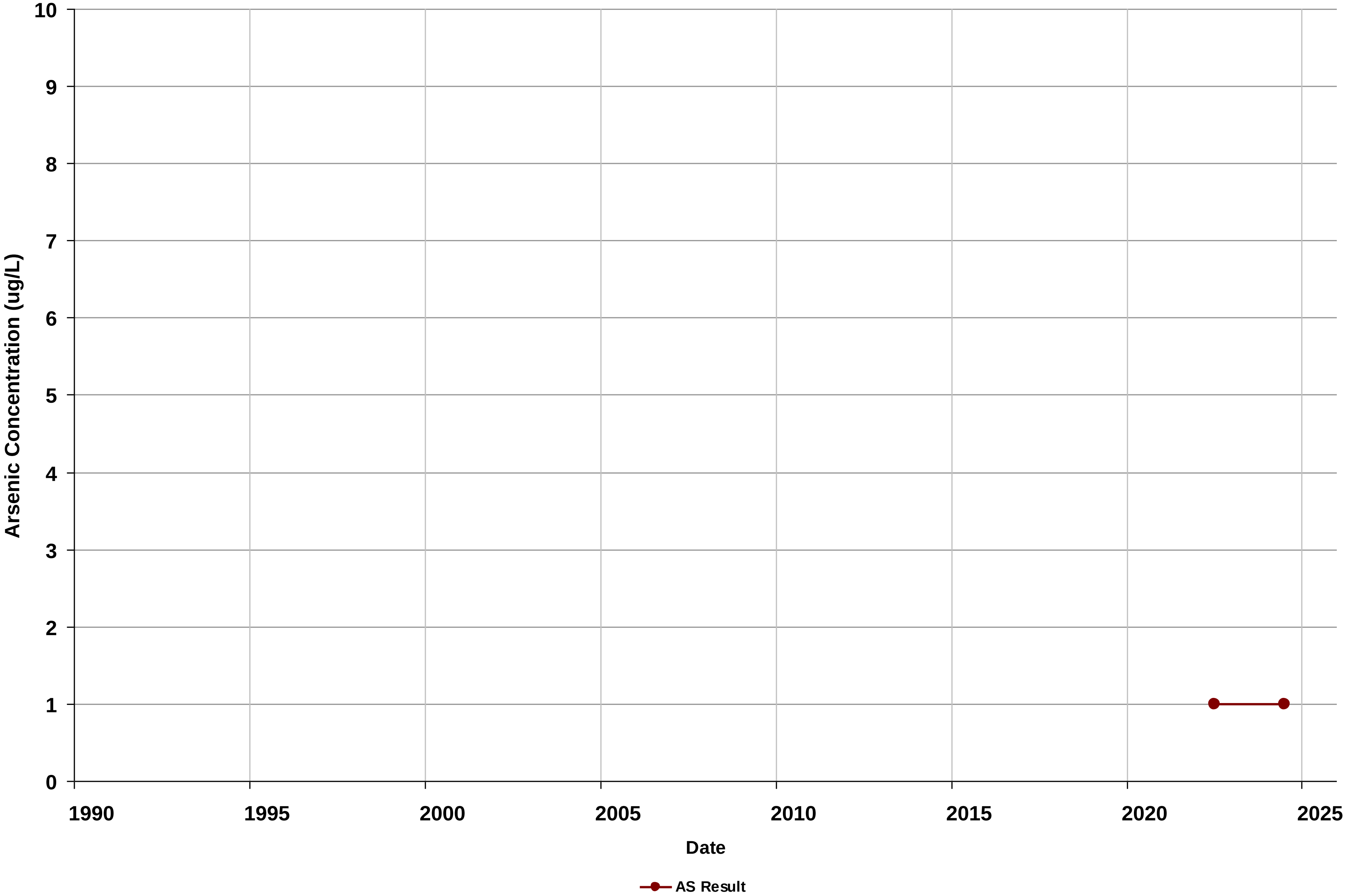
Total Depth (ft bgs): 680
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 680



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MID RMS-7
Subbasin: Madera
Well Type: Irrigation

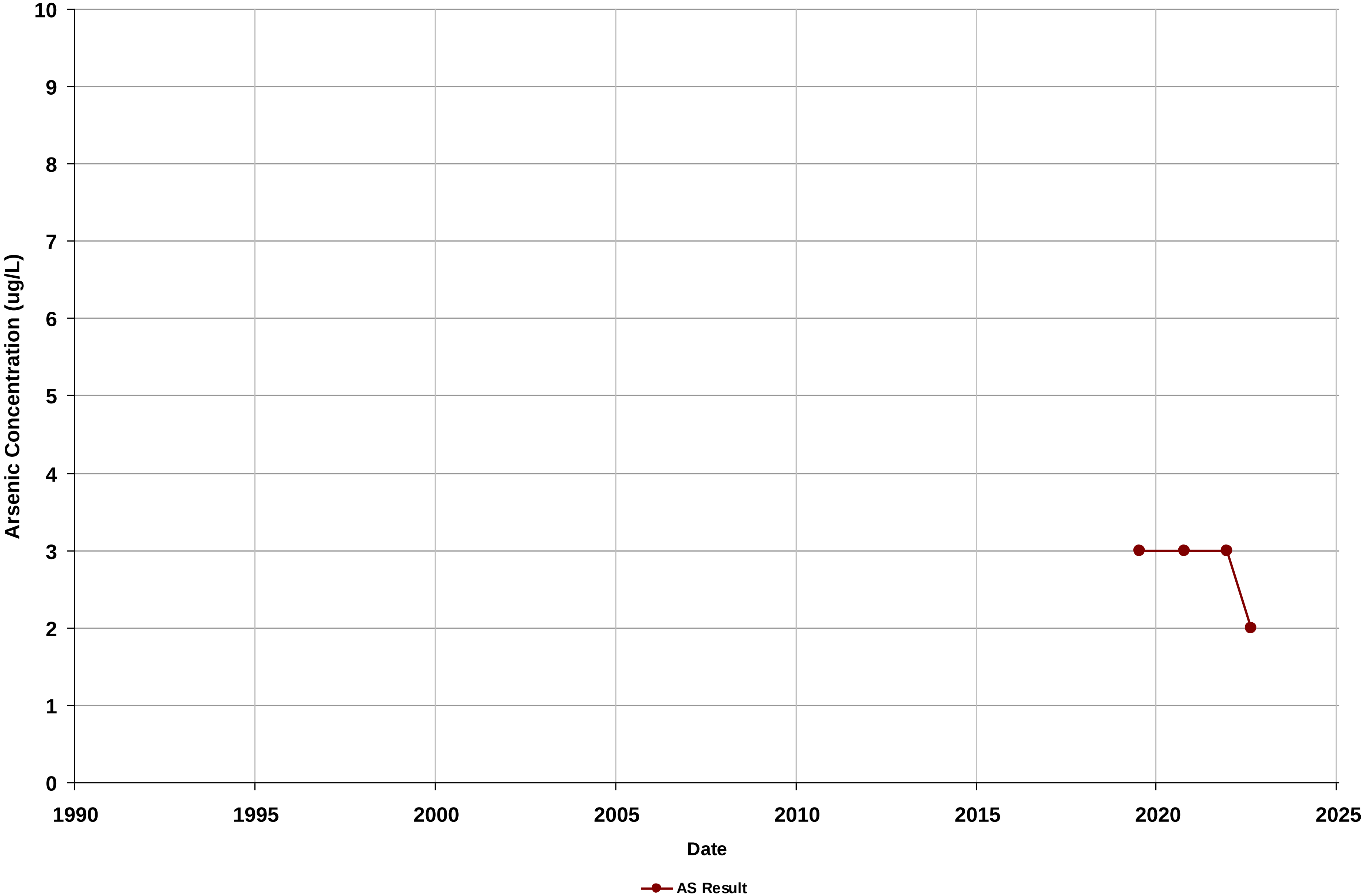
Total Depth (ft bgs): 656
Perf. Top (ft bgs): 290
Perf. Bottom (ft bgs): 635



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MWD RMS-1
Subbasin: Madera
Well Type: Irrigation

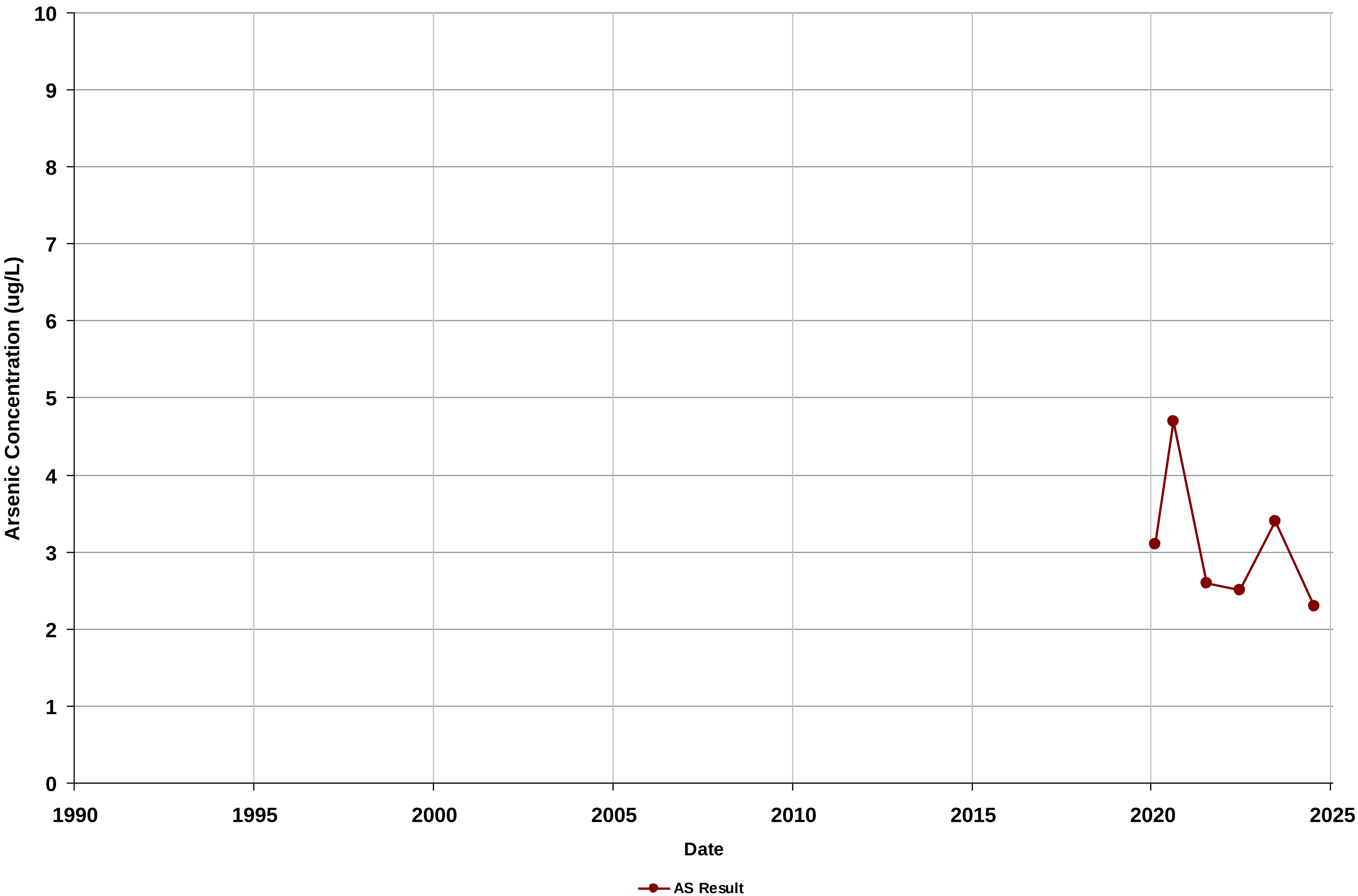
Total Depth (ft bgs): 504
Perf. Top (ft bgs): 200
Perf. Bottom (ft bgs): 500



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB03A
Subbasin: Madera
Well Type: Observation

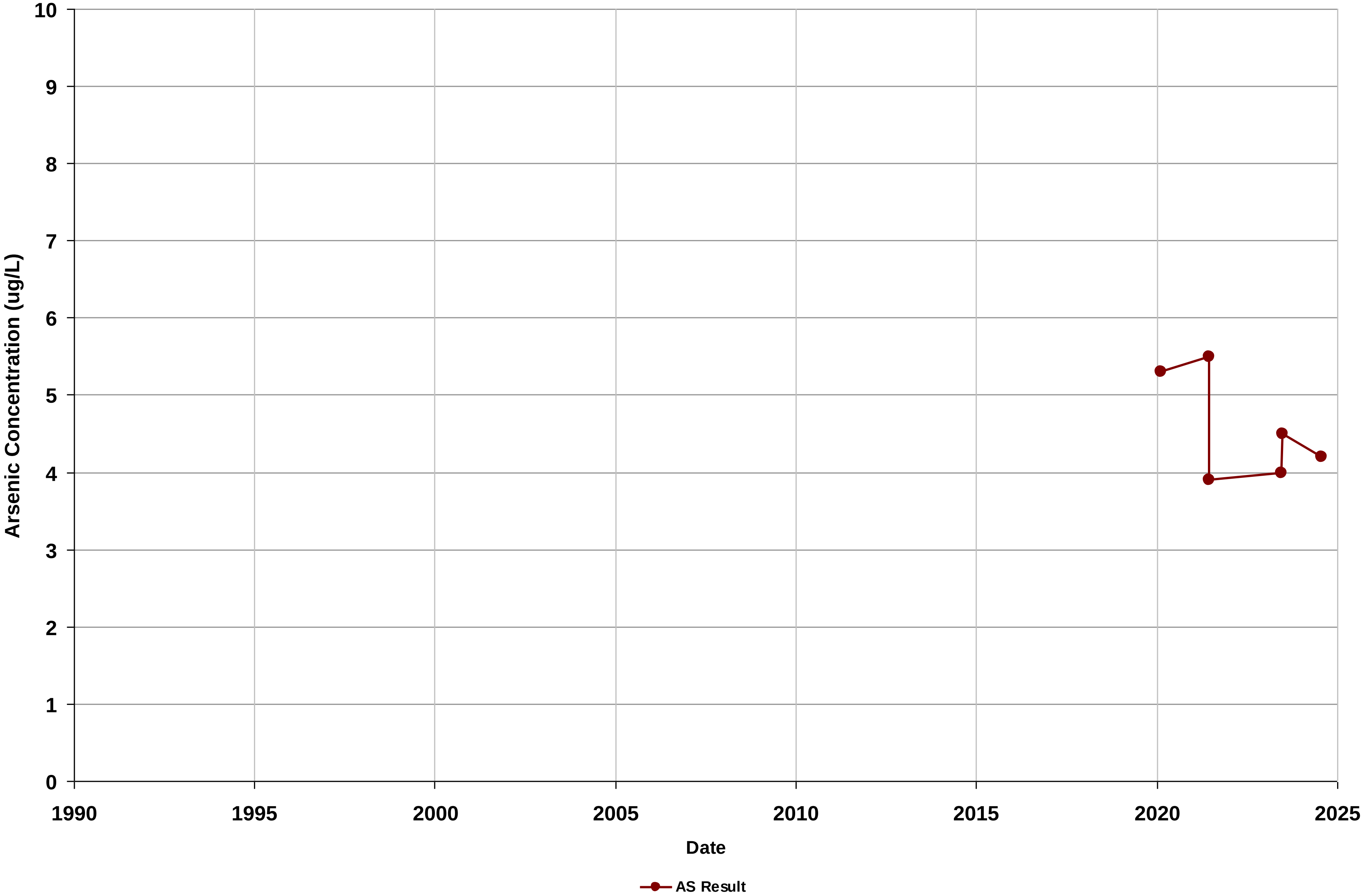
Total Depth (ft bgs): 139
Perf. Top (ft bgs): 74
Perf. Bottom (ft bgs): 134



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB03B
Subbasin: Madera
Well Type: Observation

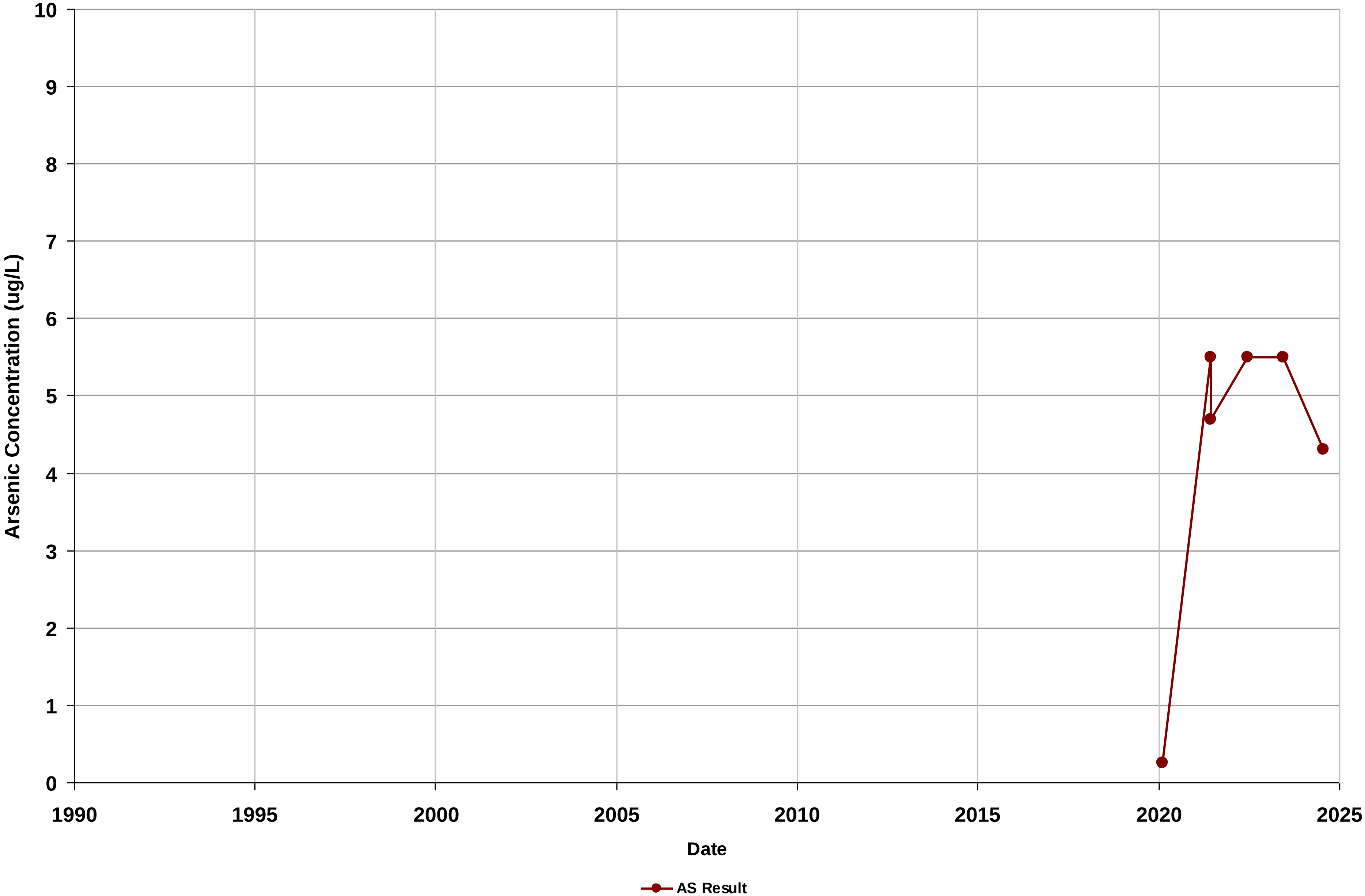
Total Depth (ft bgs): 295
Perf. Top (ft bgs): 215
Perf. Bottom (ft bgs): 285



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB03C
Subbasin: Madera
Well Type: Observation

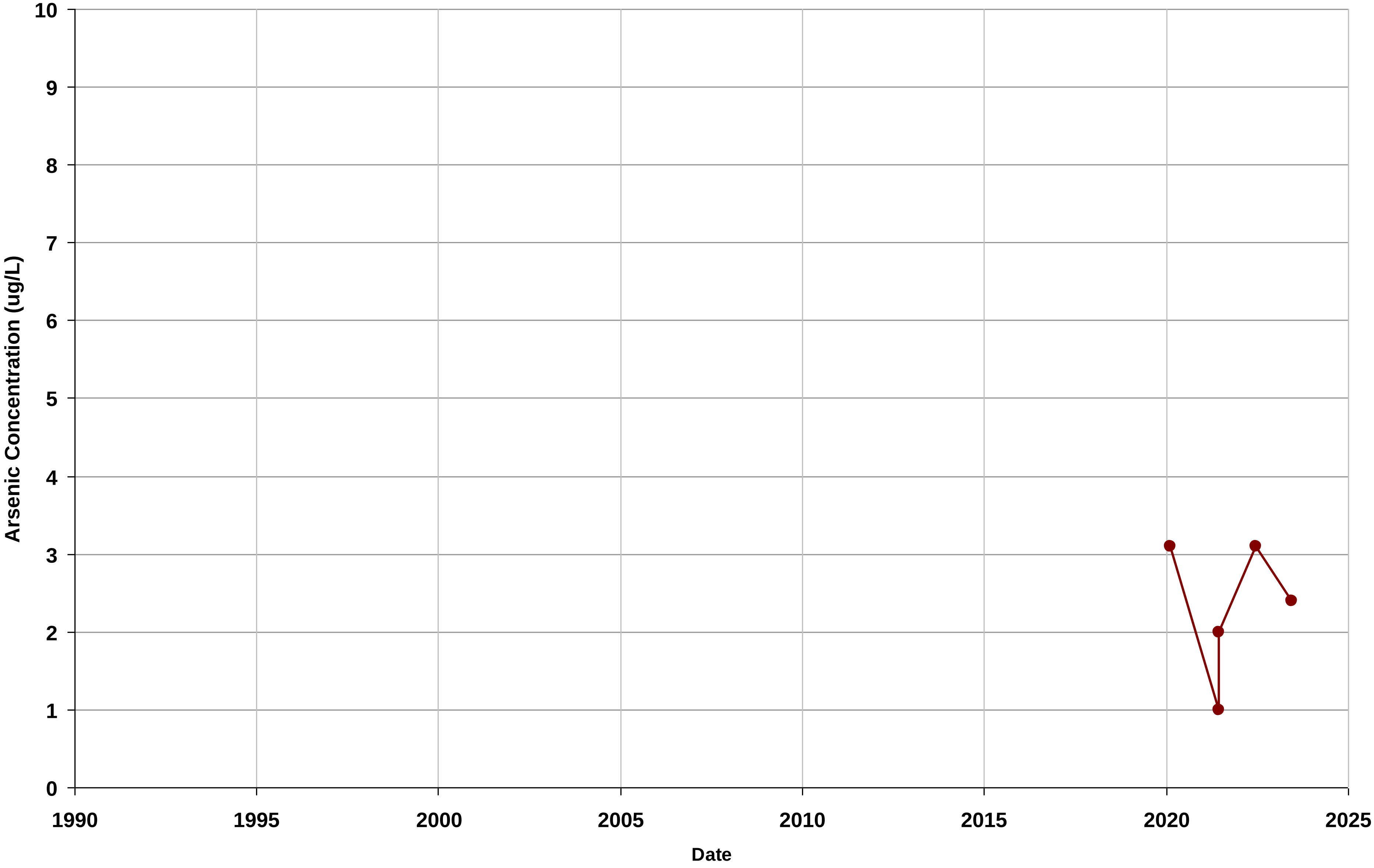
Total Depth (ft bgs): 430
Perf. Top (ft bgs): 355
Perf. Bottom (ft bgs): 420



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB04A
Subbasin: Madera
Well Type: Observation

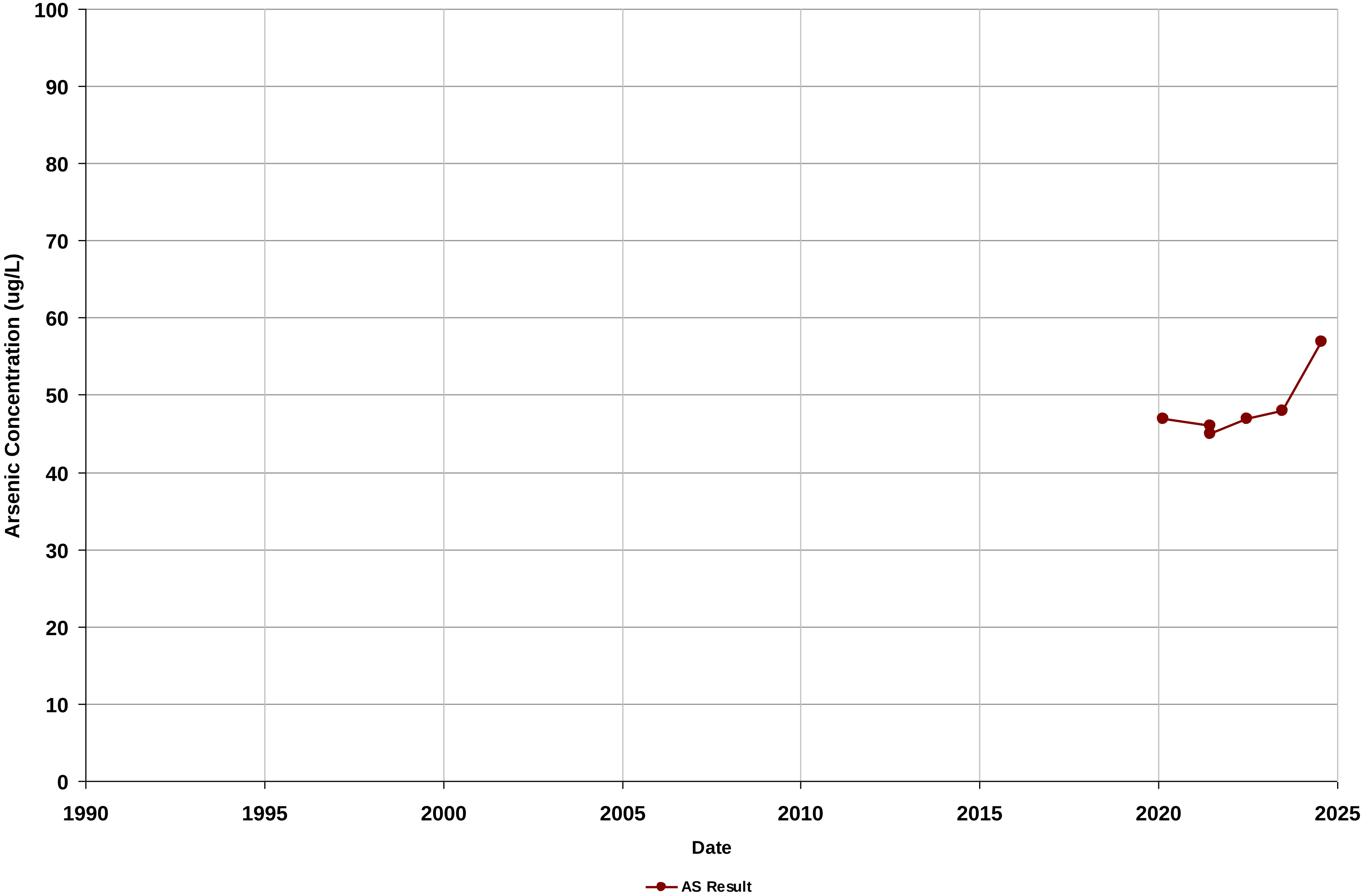
Total Depth (ft bgs): 375
Perf. Top (ft bgs): 180
Perf. Bottom (ft bgs): 365



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB04B
Subbasin: Madera
Well Type: Observation

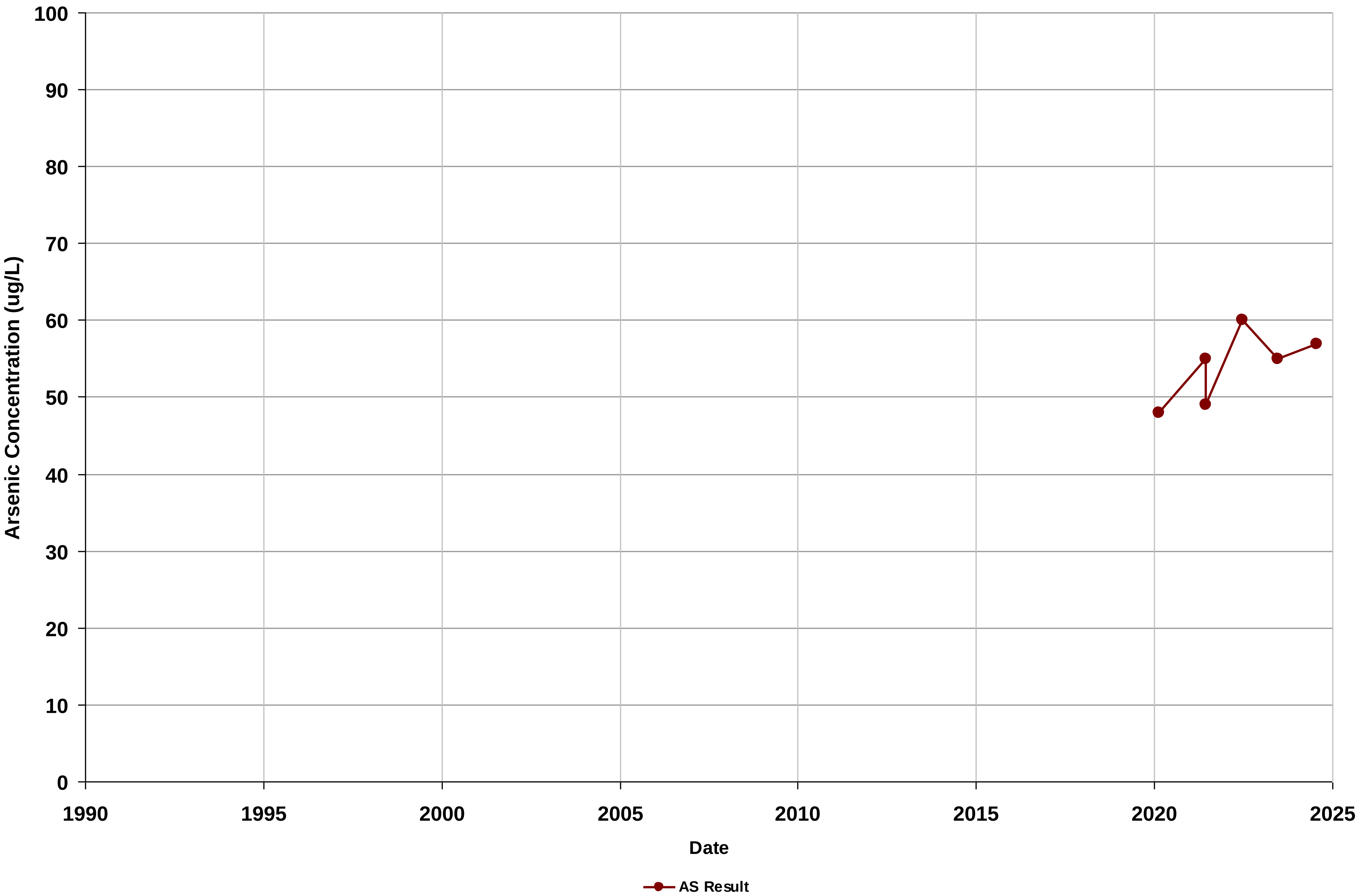
Total Depth (ft bgs): 695
Perf. Top (ft bgs): 530
Perf. Bottom (ft bgs): 685



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB04C
Subbasin: Madera
Well Type: Observation

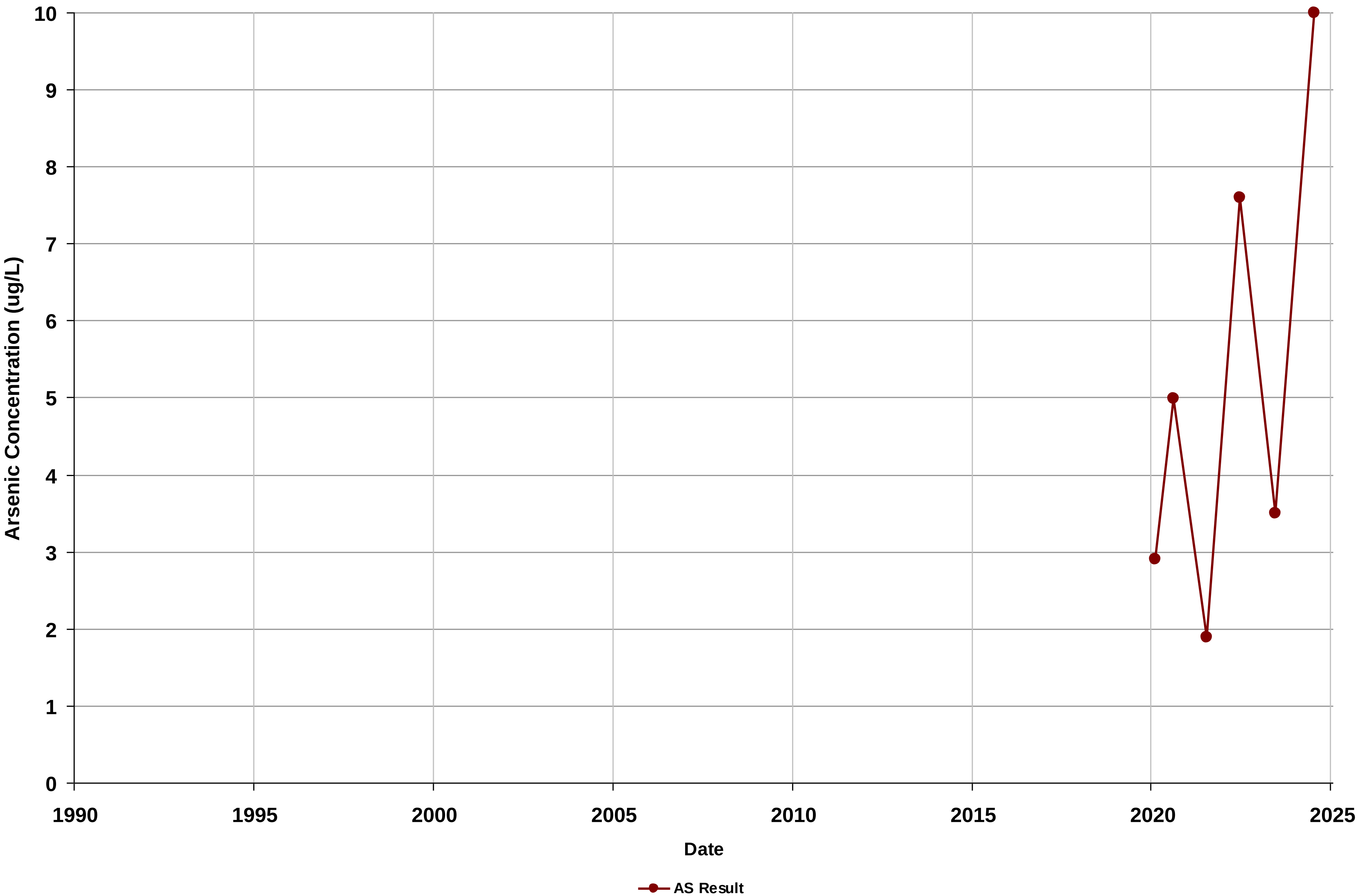
Total Depth (ft bgs): 905
Perf. Top (ft bgs): 750
Perf. Bottom (ft bgs): 895



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB05A
Subbasin: Madera
Well Type: Observation

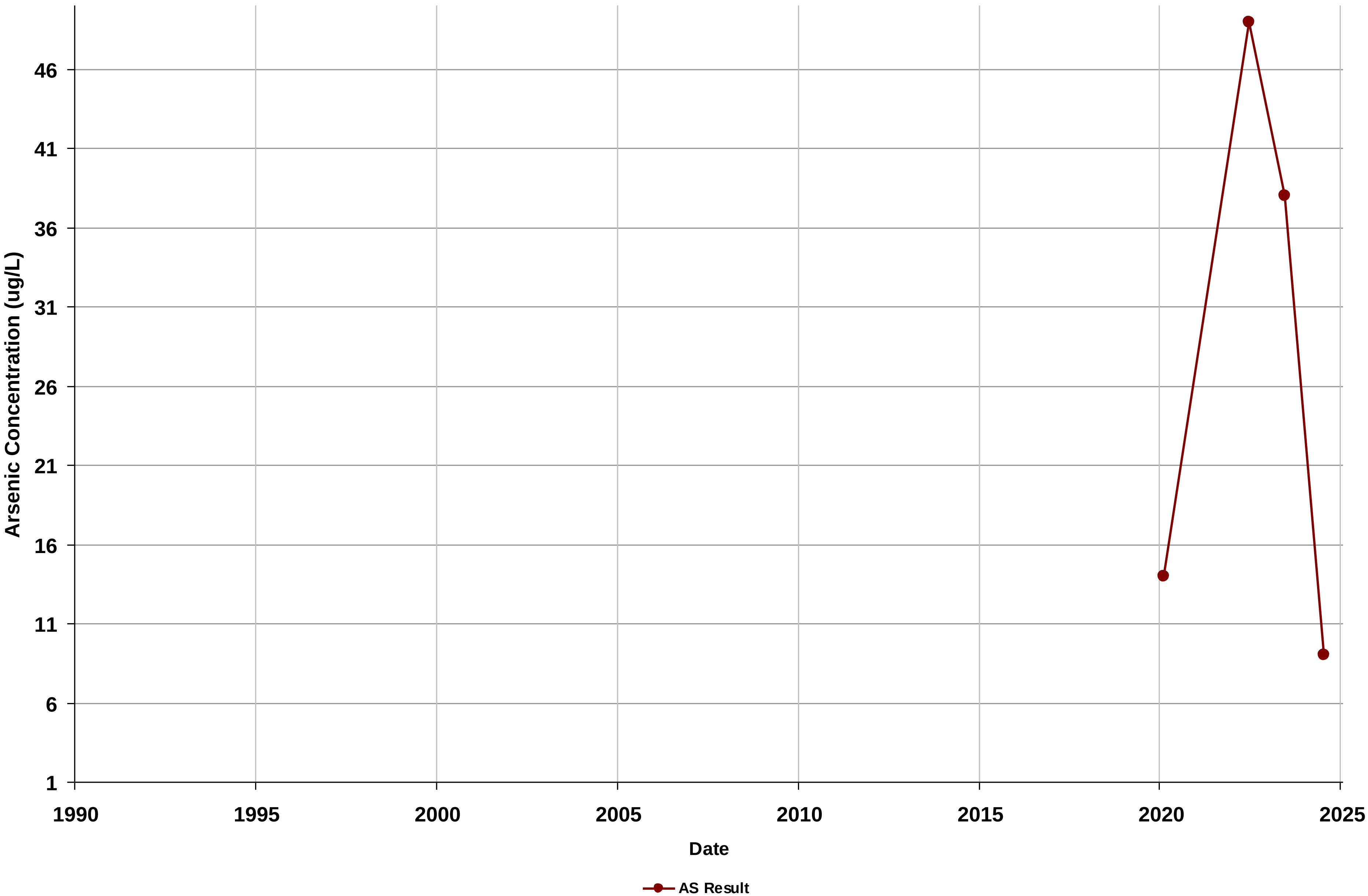
Total Depth (ft bgs): 210
Perf. Top (ft bgs): 140
Perf. Bottom (ft bgs): 200



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB05B
Subbasin: Madera
Well Type: Observation

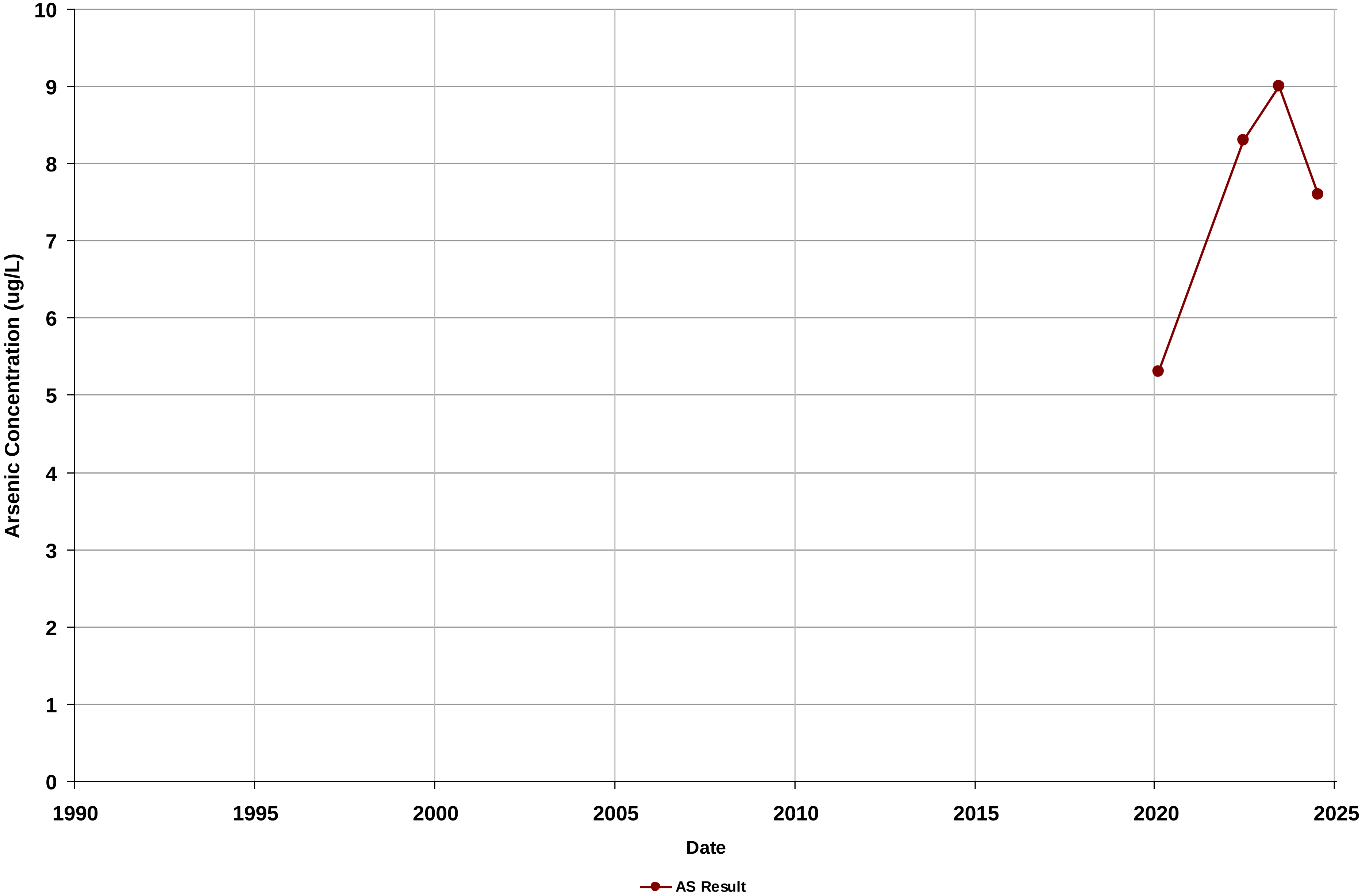
Total Depth (ft bgs): 375
Perf. Top (ft bgs): 240
Perf. Bottom (ft bgs): 365



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB05C
Subbasin: Madera
Well Type: Observation

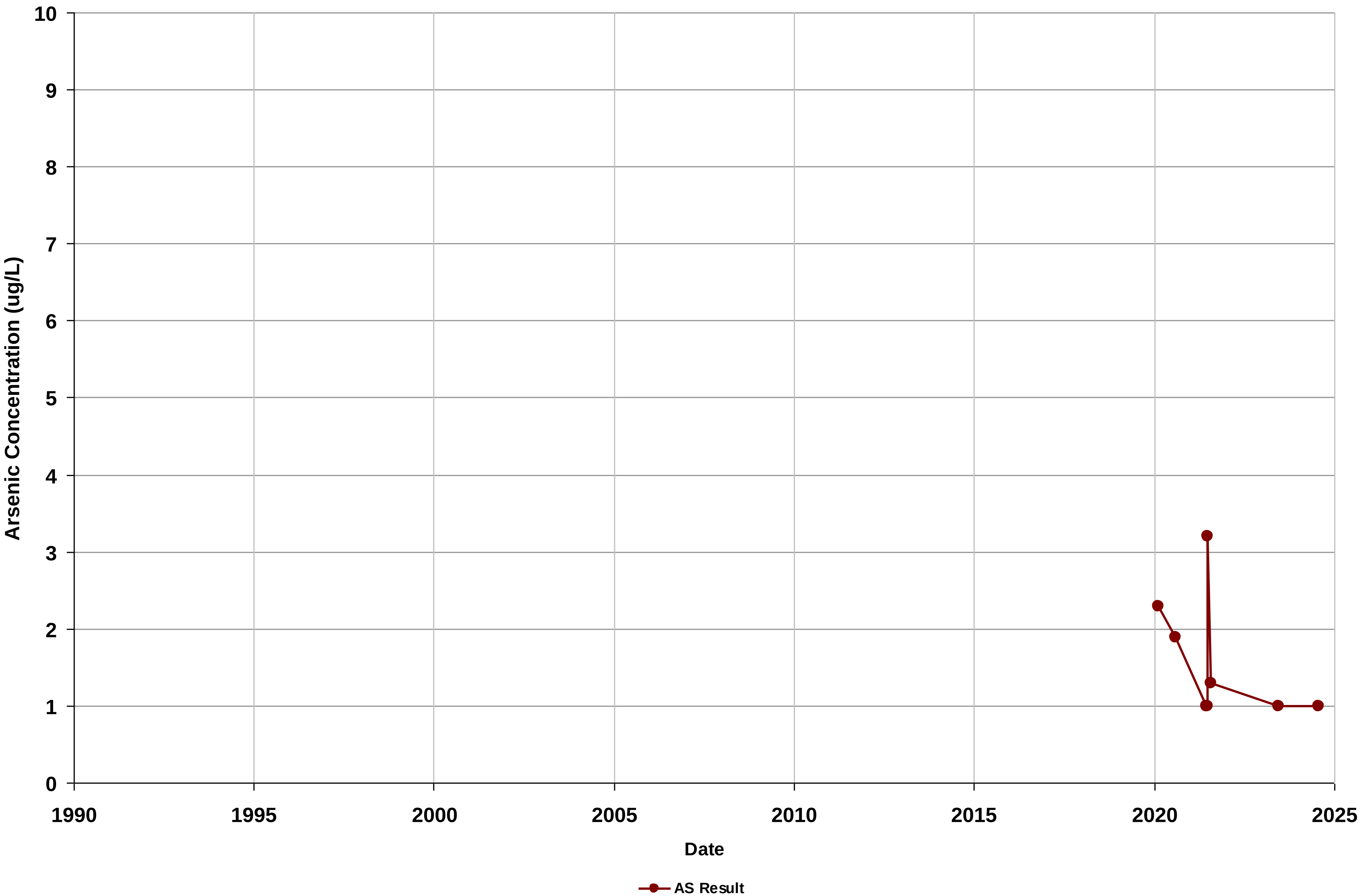
Total Depth (ft bgs): 585
Perf. Top (ft bgs): 420
Perf. Bottom (ft bgs): 585



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB06A
Subbasin: Madera
Well Type: Observation

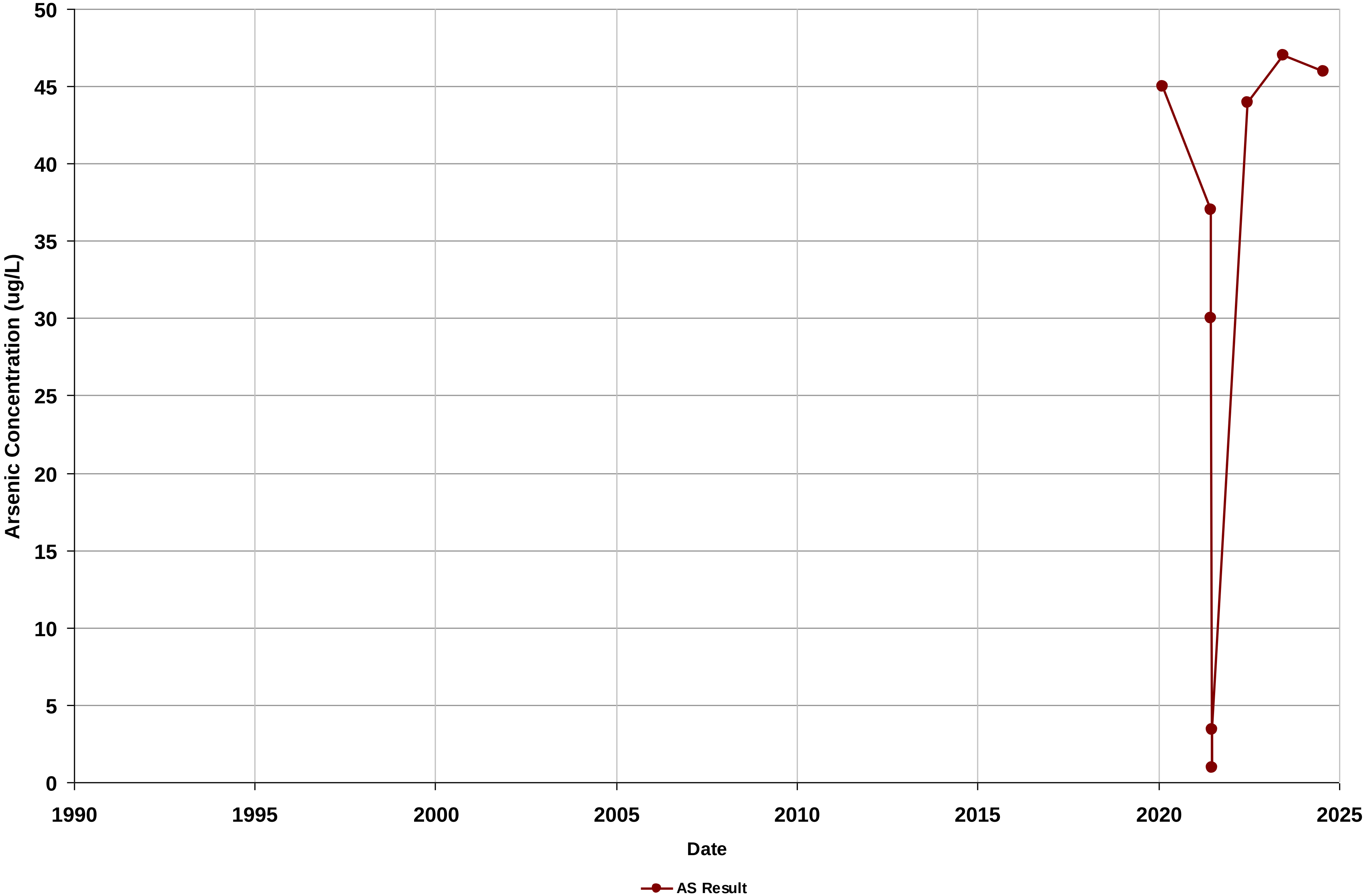
Total Depth (ft bgs): 350
Perf. Top (ft bgs): 135
Perf. Bottom (ft bgs): 340



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB06B
Subbasin: Madera
Well Type: Observation

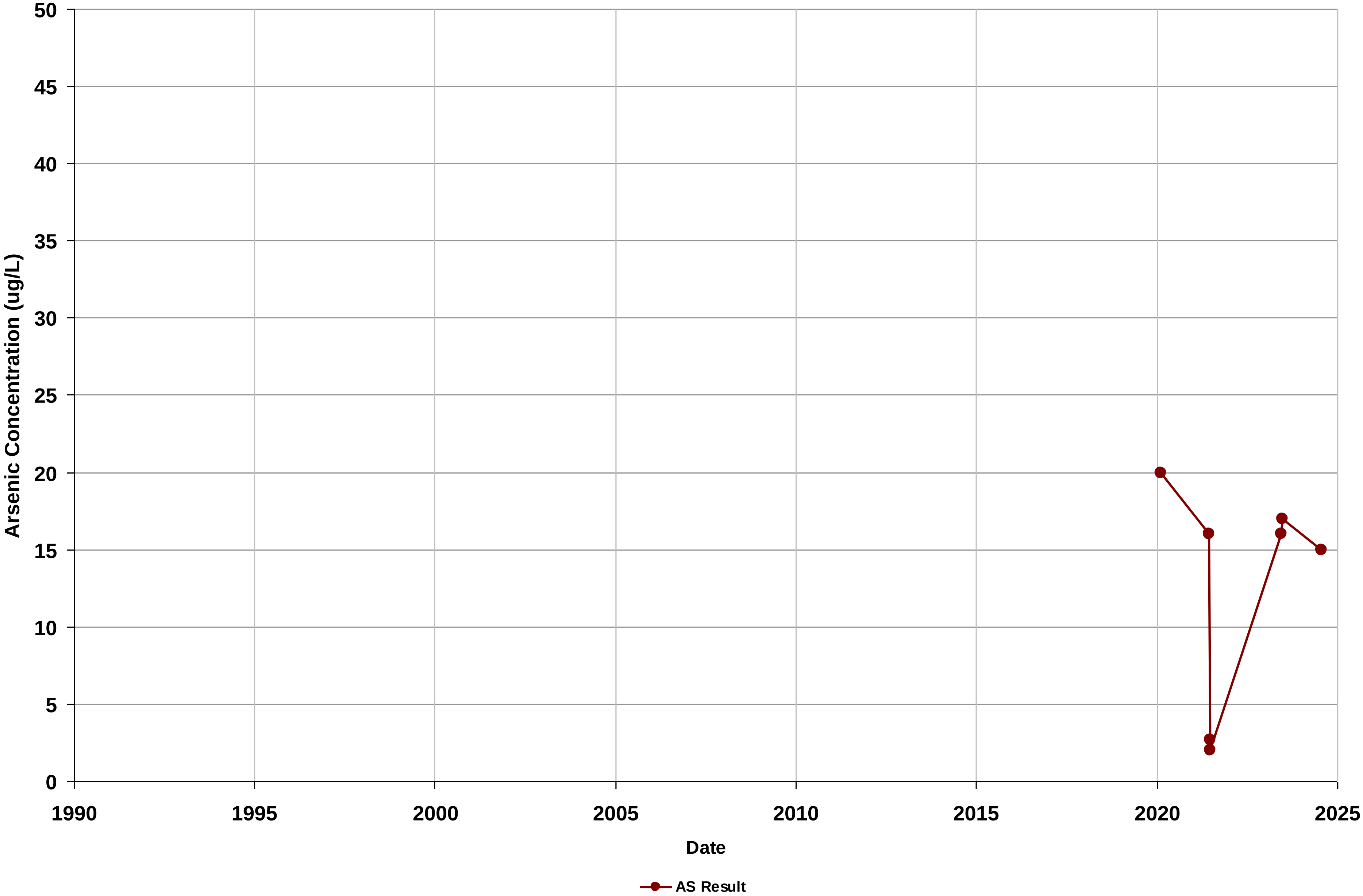
Total Depth (ft bgs): 520
Perf. Top (ft bgs): 425
Perf. Bottom (ft bgs): 510



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB06C
Subbasin: Madera
Well Type: Observation

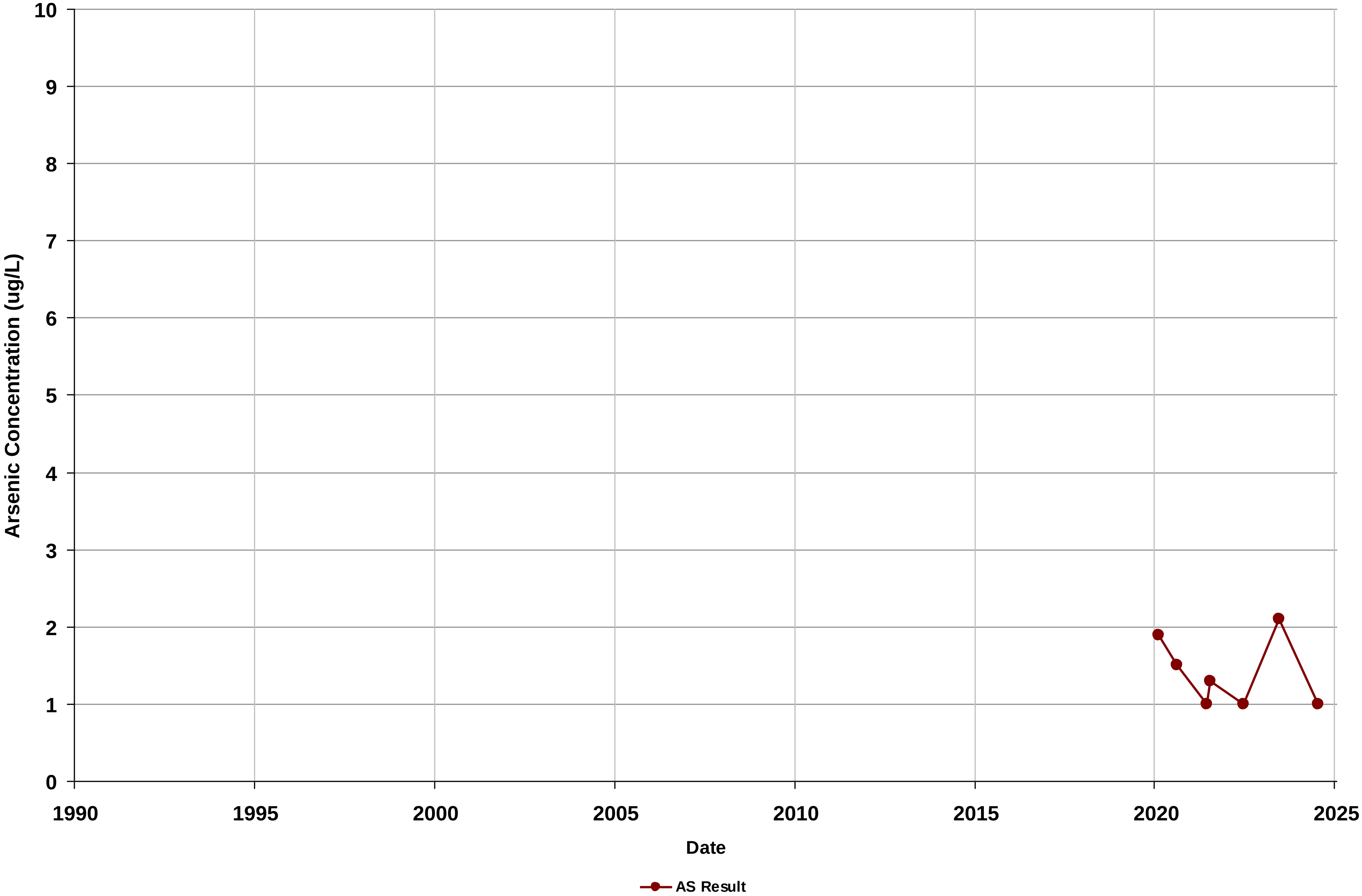
Total Depth (ft bgs): 715
Perf. Top (ft bgs): 630
Perf. Bottom (ft bgs): 705



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB09A
Subbasin: Madera
Well Type: Observation

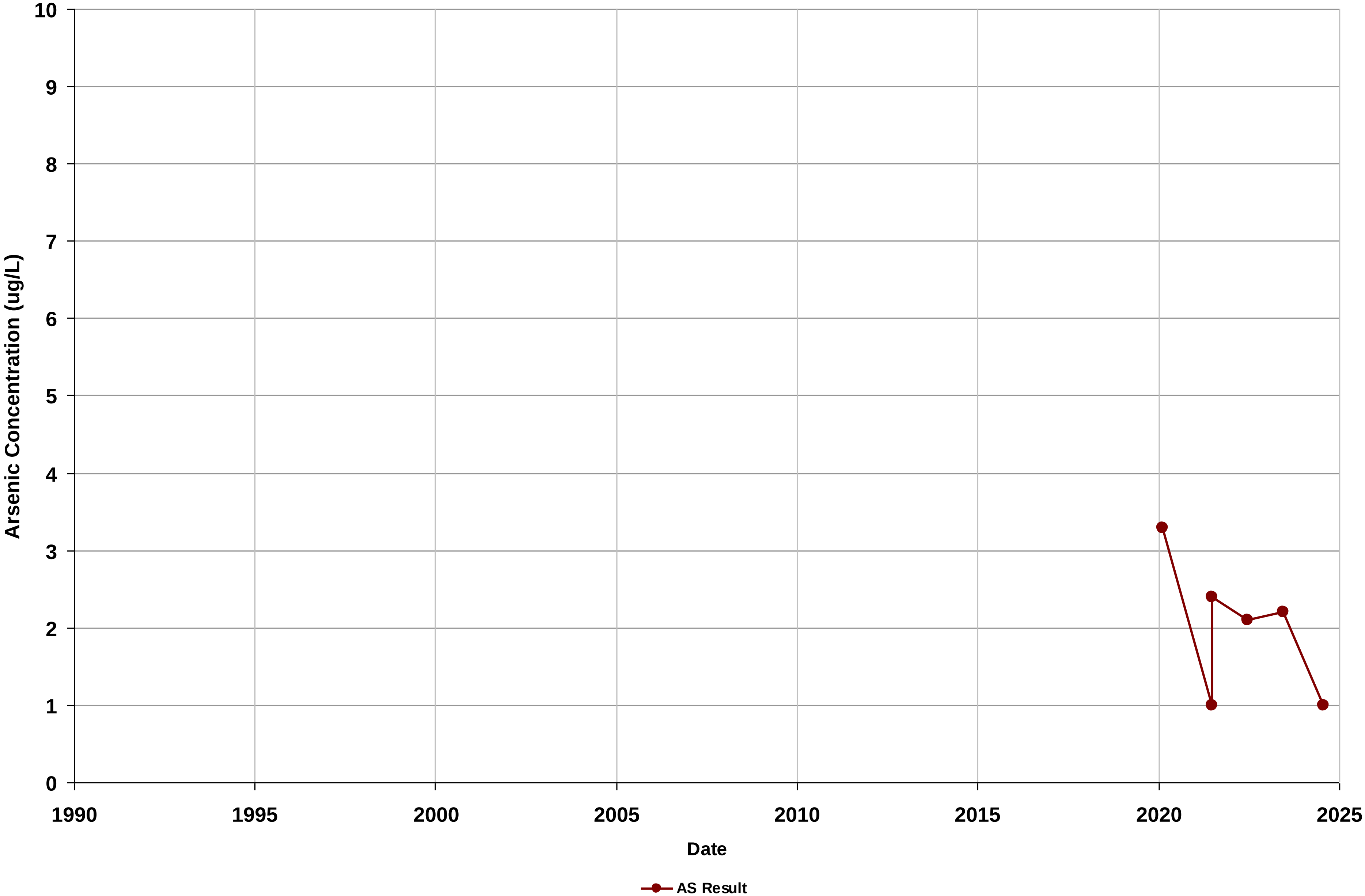
Total Depth (ft bgs): 320
Perf. Top (ft bgs): 200
Perf. Bottom (ft bgs): 310



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB09B
Subbasin: Madera
Well Type: Observation

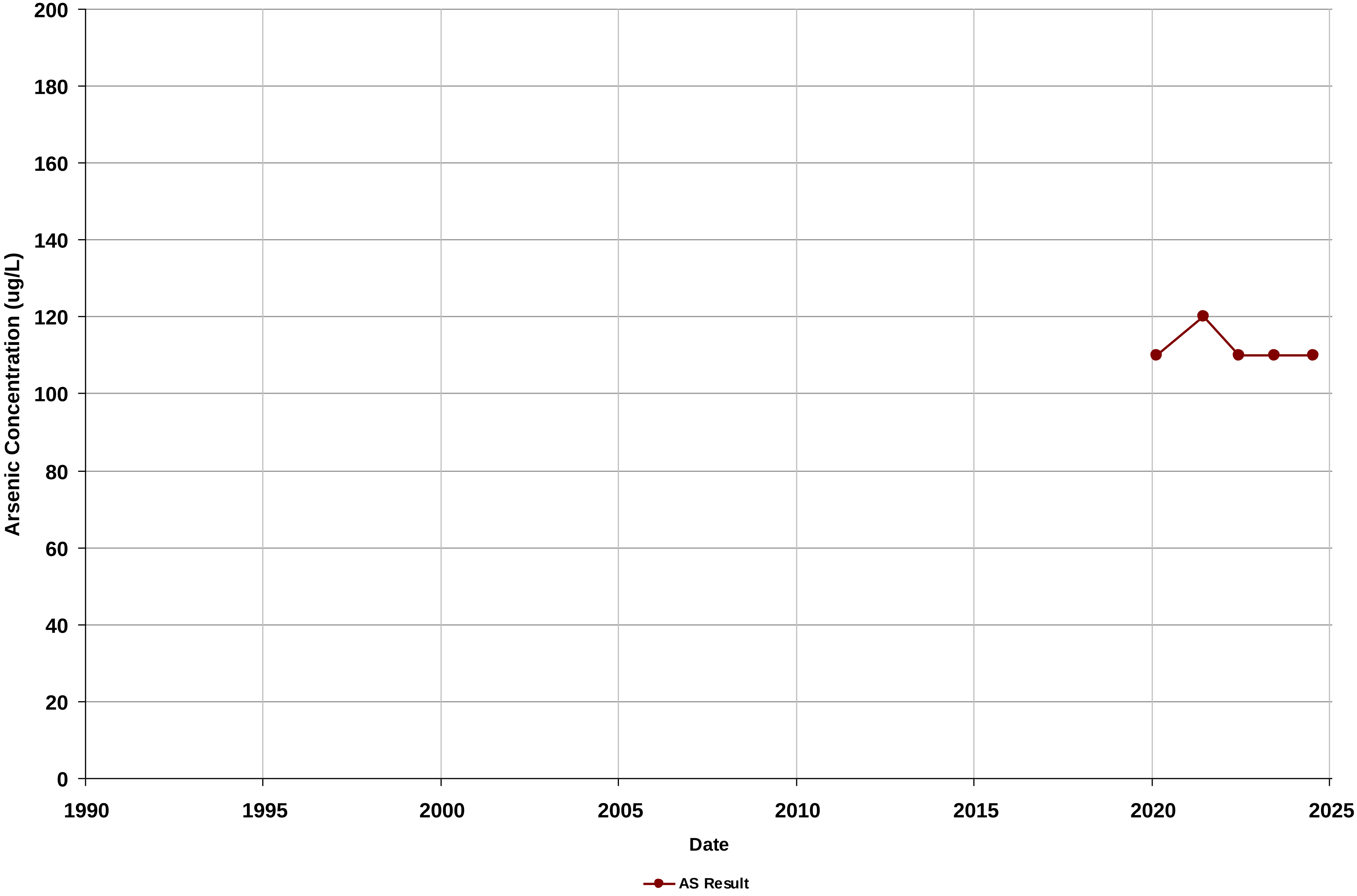
Total Depth (ft bgs): 725
Perf. Top (ft bgs): 520
Perf. Bottom (ft bgs): 715



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB09C
Subbasin: Madera
Well Type: Observation

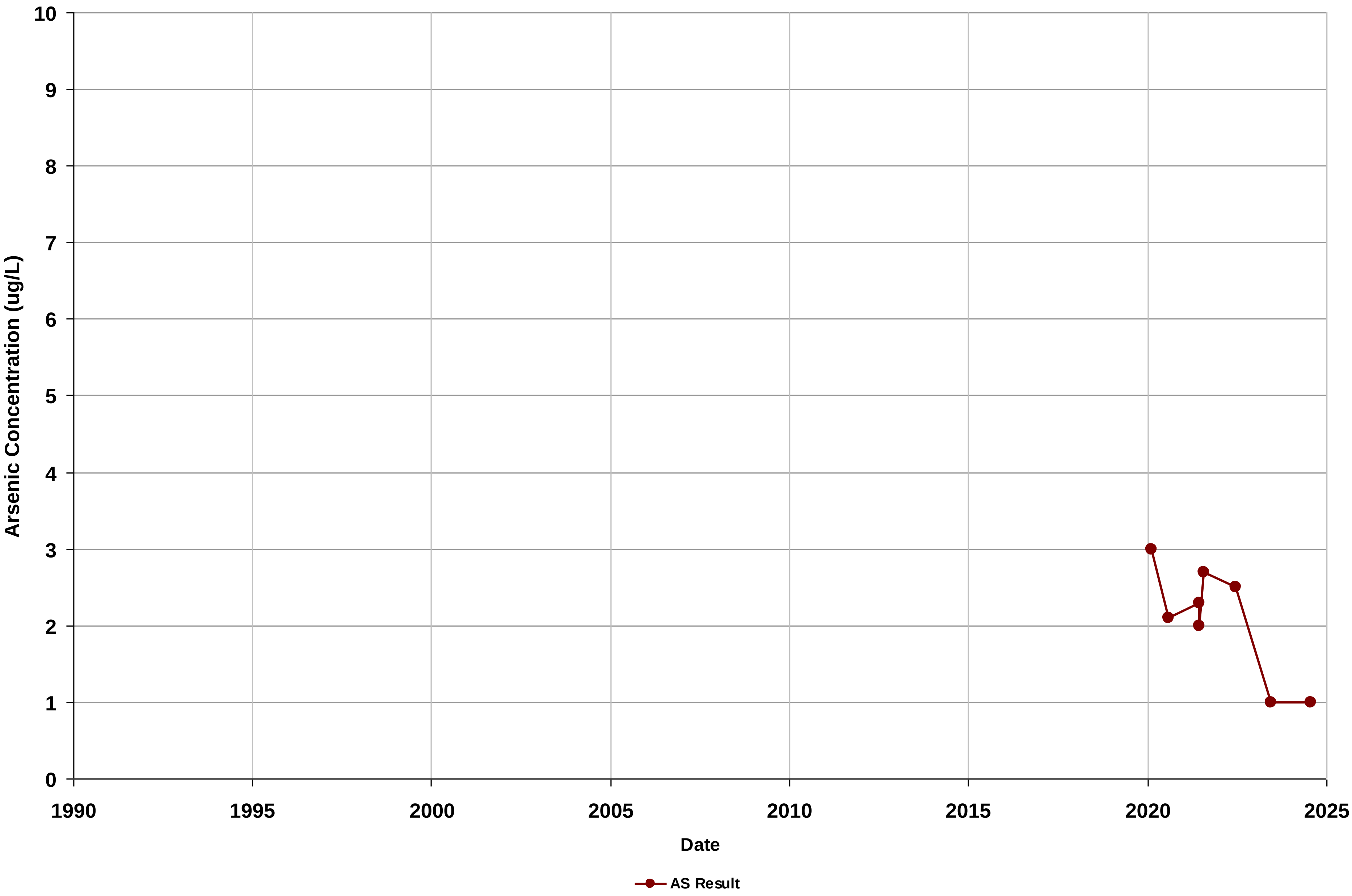
Total Depth (ft bgs): 955
Perf. Top (ft bgs): 880
Perf. Bottom (ft bgs): 945



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB10B
Subbasin: Madera
Well Type: Observation

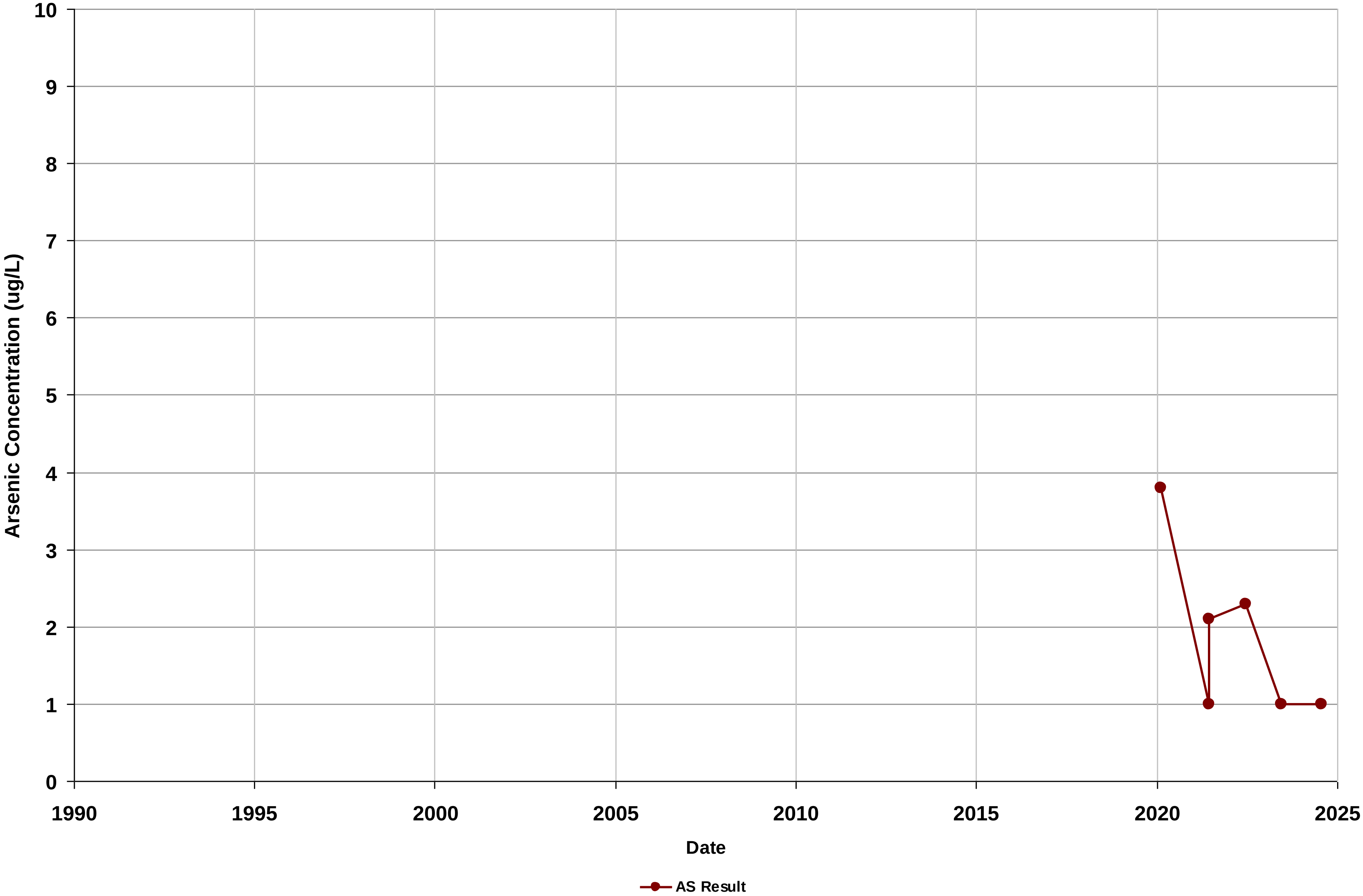
Total Depth (ft bgs): 510
Perf. Top (ft bgs): 400
Perf. Bottom (ft bgs): 500



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB10C
Subbasin: Madera
Well Type: Observation

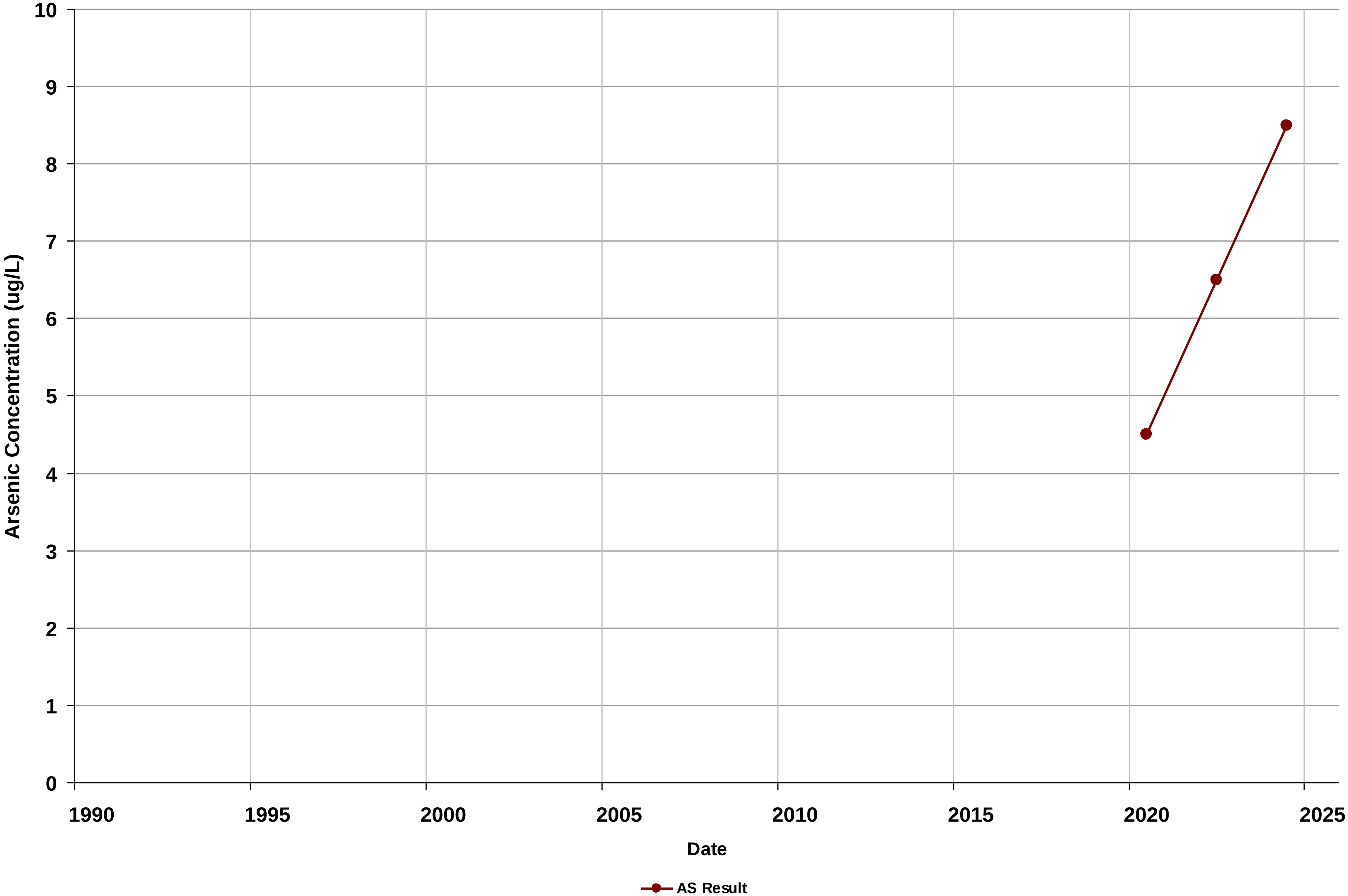
Total Depth (ft bgs): 880
Perf. Top (ft bgs): 790
Perf. Bottom (ft bgs): 870



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB11C
Subbasin: Madera
Well Type: Observation

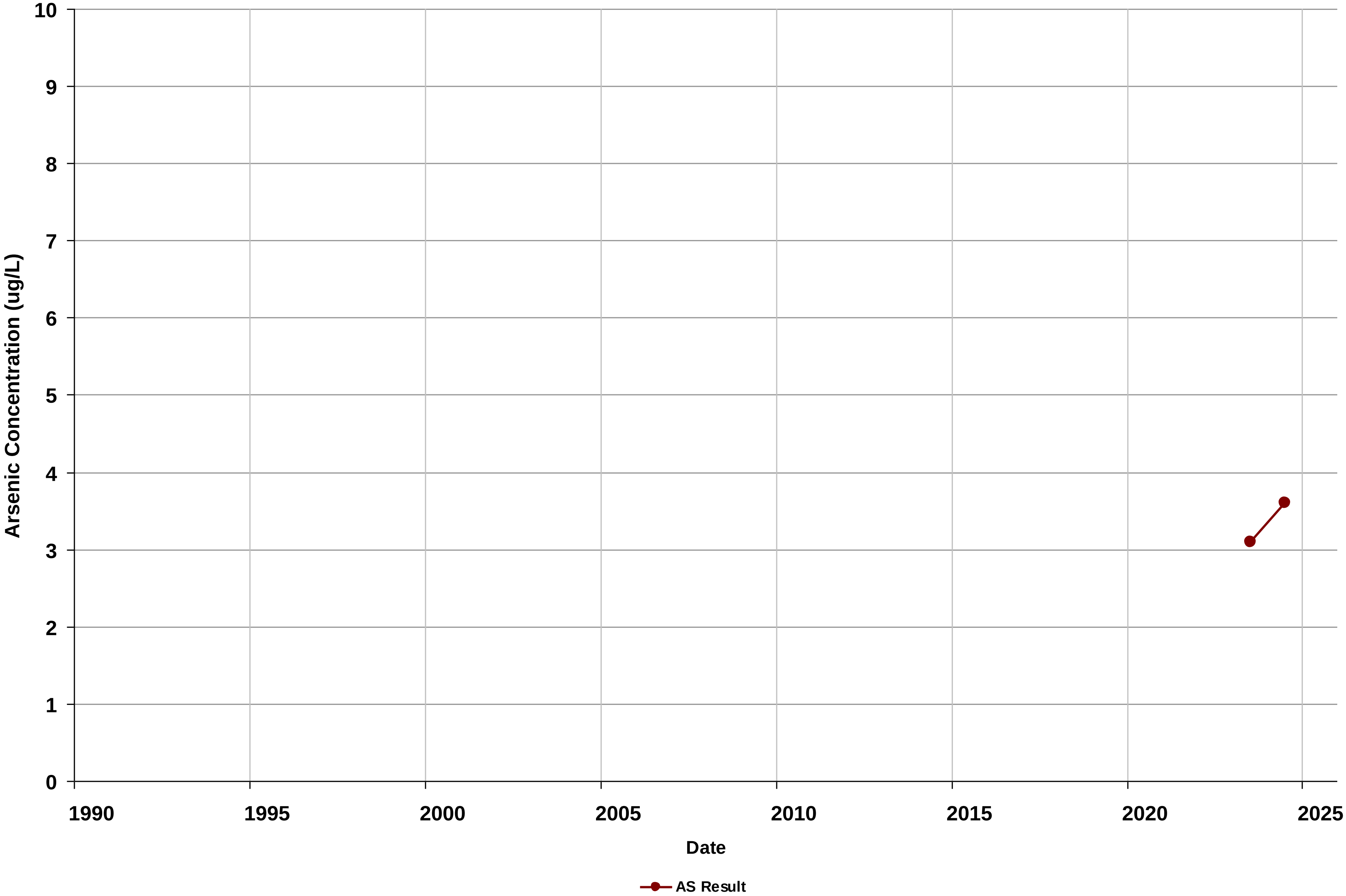
Total Depth (ft bgs): 880
Perf. Top (ft bgs): 775
Perf. Bottom (ft bgs): 870



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB13B
Subbasin: Madera
Well Type: Monitoring

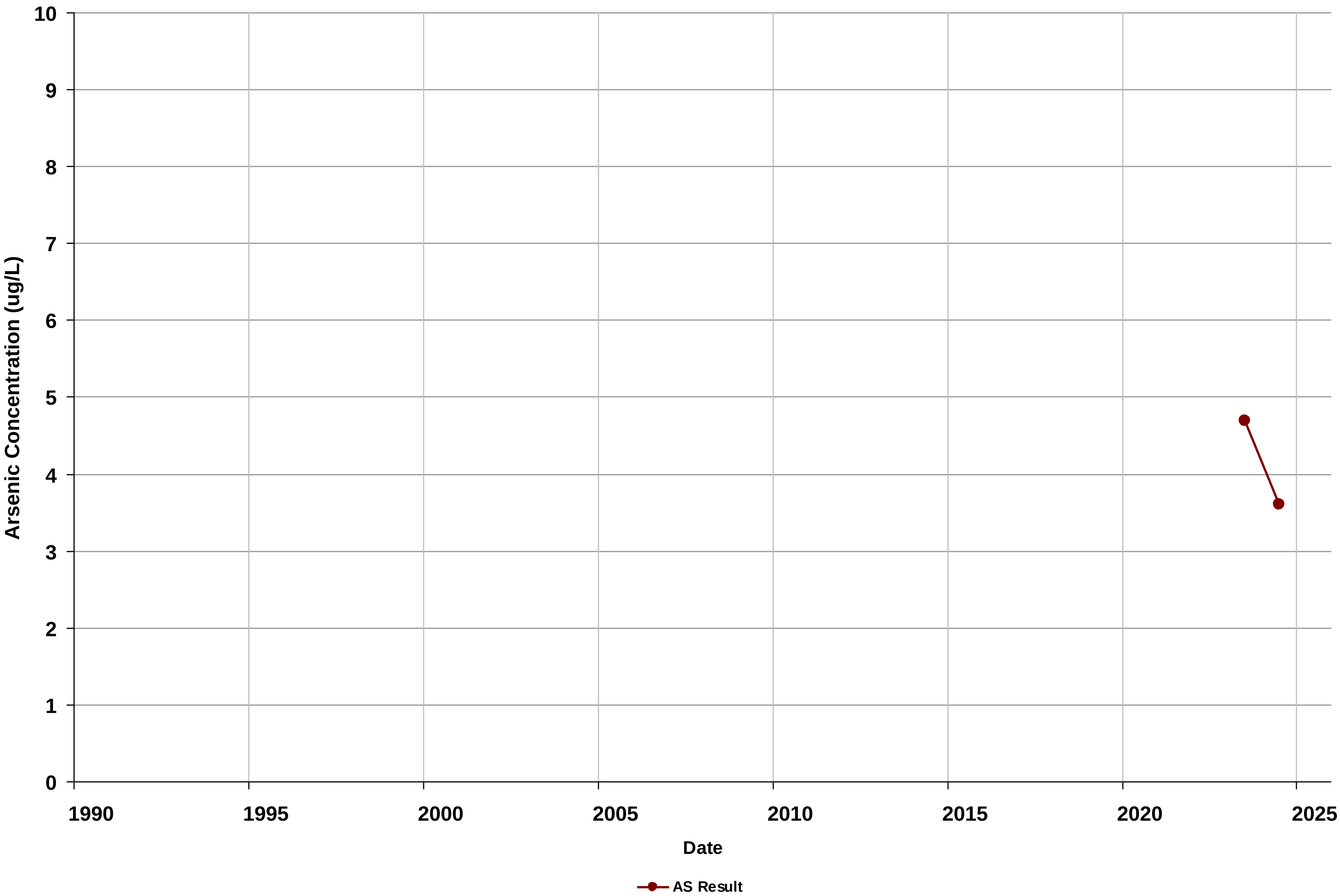
Total Depth (ft bgs): 446
Perf. Top (ft bgs): 396
Perf. Bottom (ft bgs): 436



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB13C
Subbasin: Madera
Well Type: Monitoring

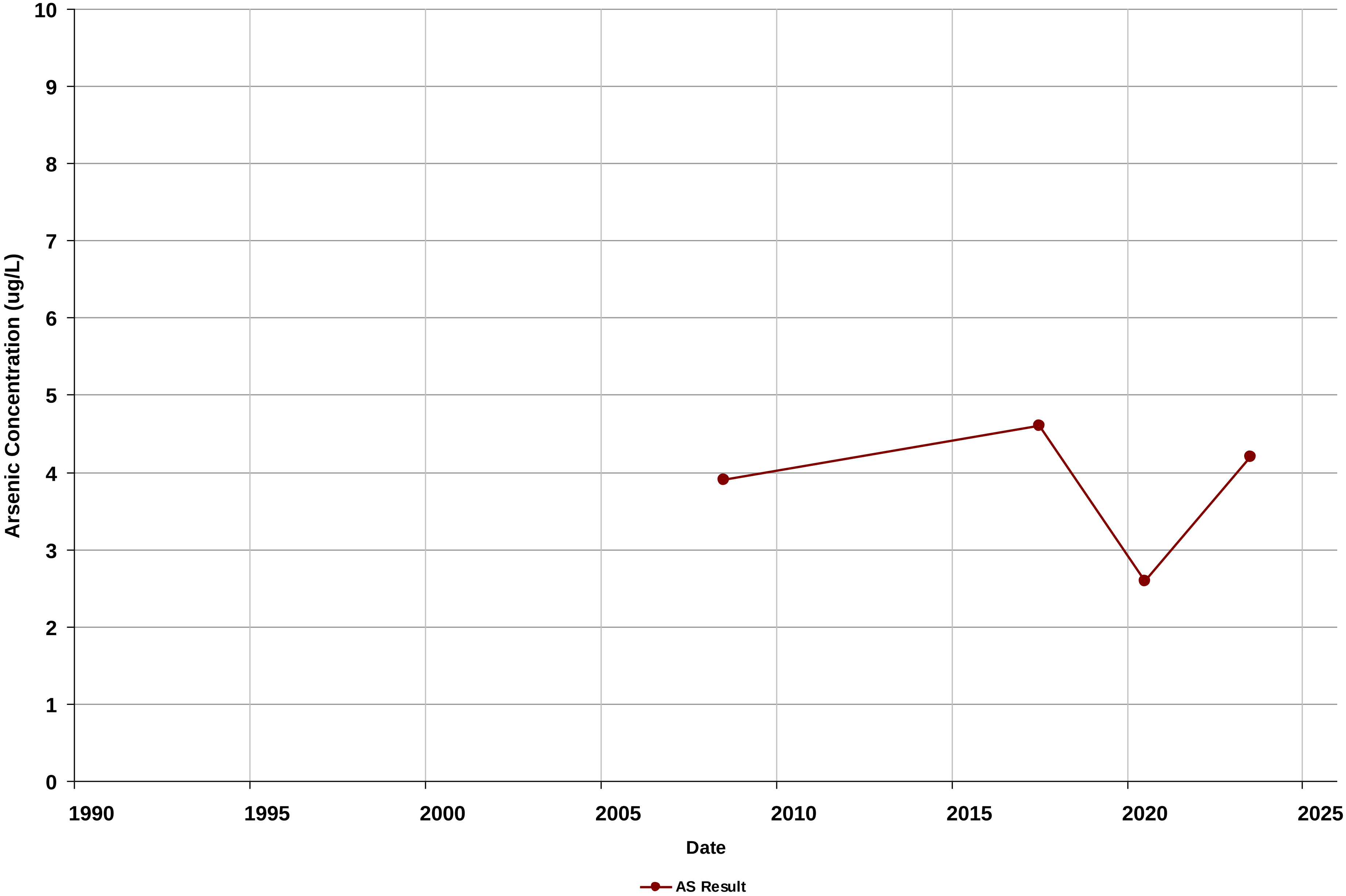
Total Depth (ft bgs): 532
Perf. Top (ft bgs): 522
Perf. Bottom (ft bgs): 532



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2000507-001
Subbasin: Madera
Well Type: Public Supply

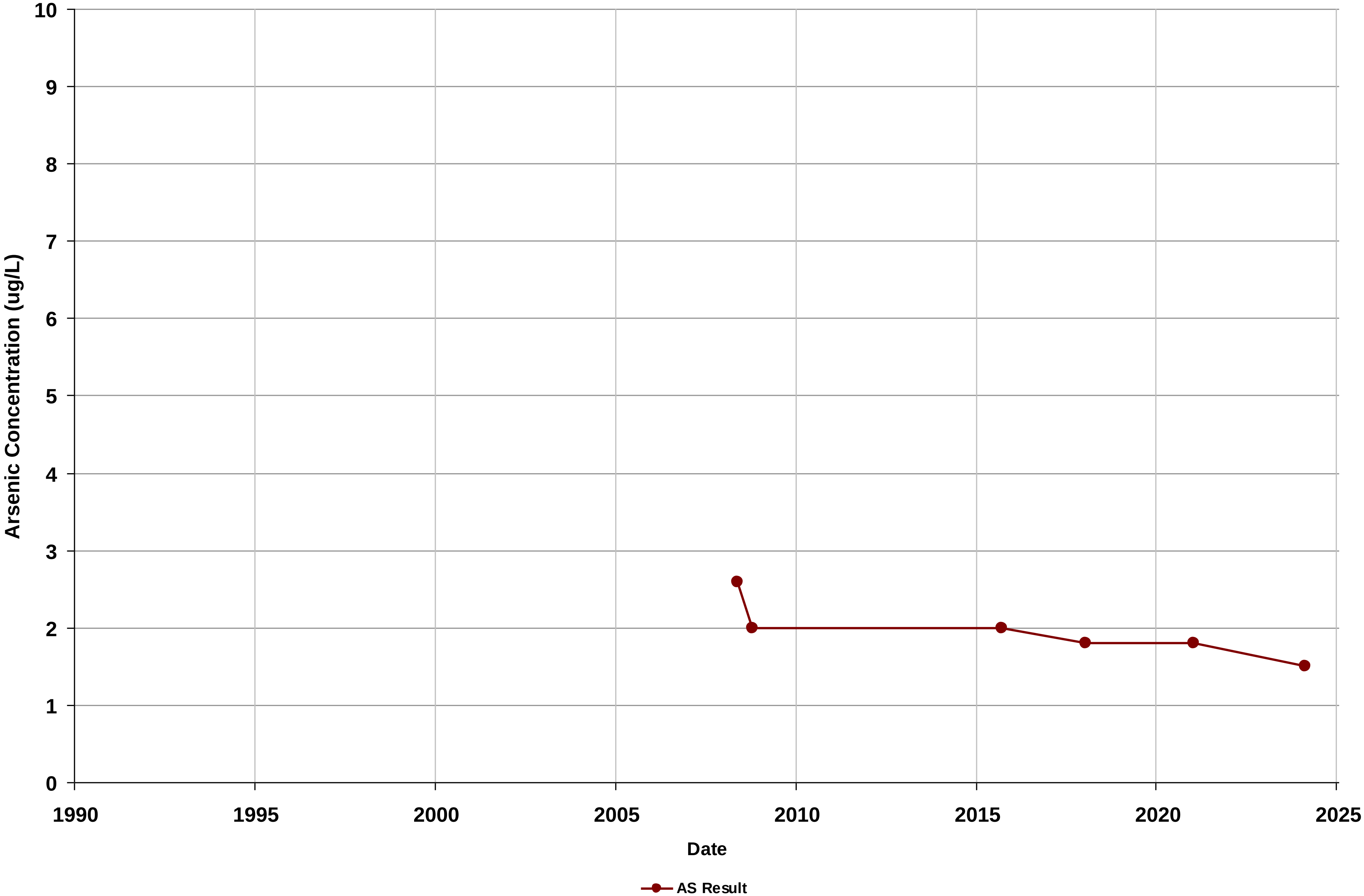
Total Depth (ft bgs):
Perf. Top (ft bgs): 372
Perf. Bottom (ft bgs): 372



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2000553-001
Subbasin: Madera
Well Type: Public Supply

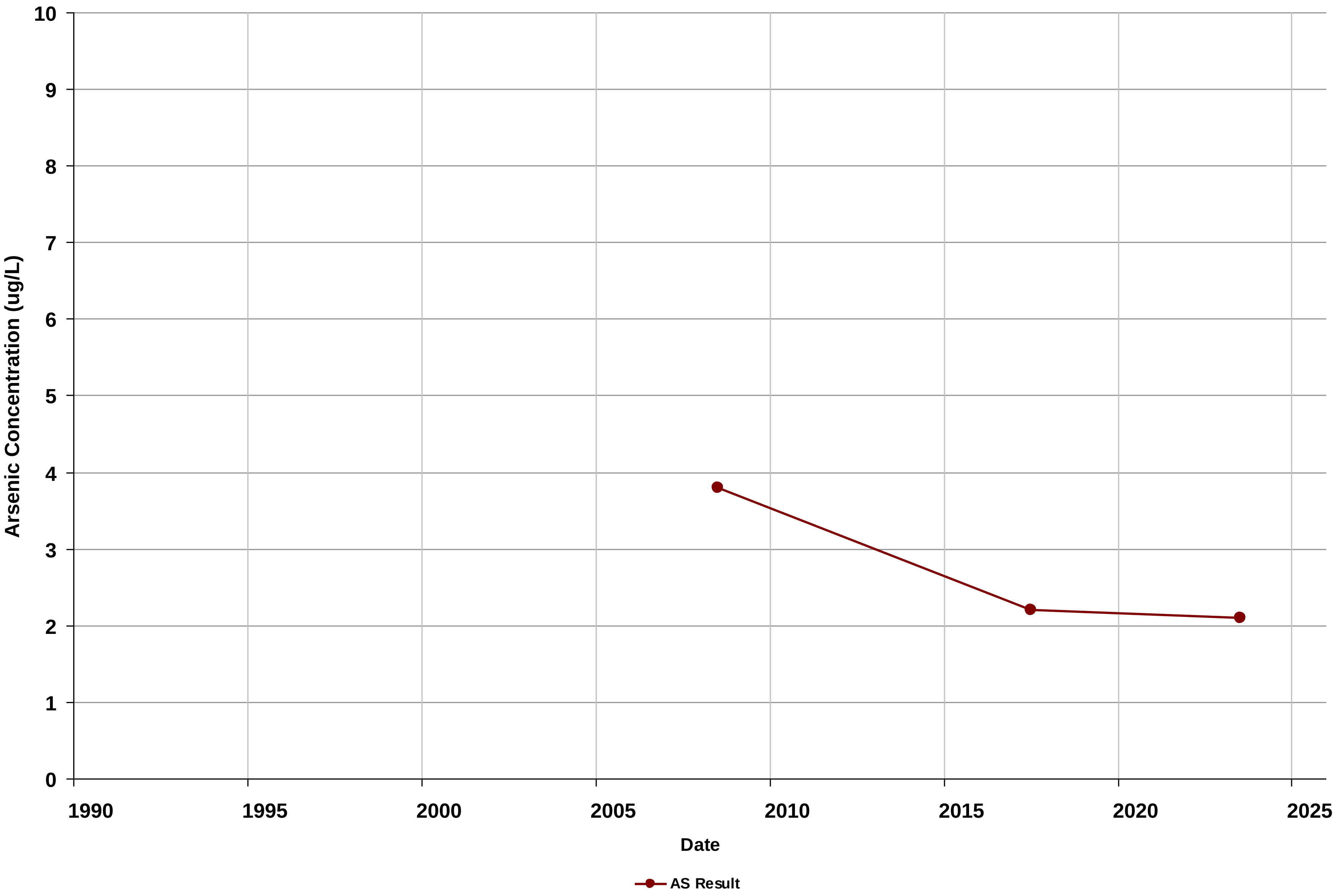
Total Depth (ft bgs):
Perf. Top (ft bgs): 450
Perf. Bottom (ft bgs): 500



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2000682-002
Subbasin: Madera
Well Type: Public Supply

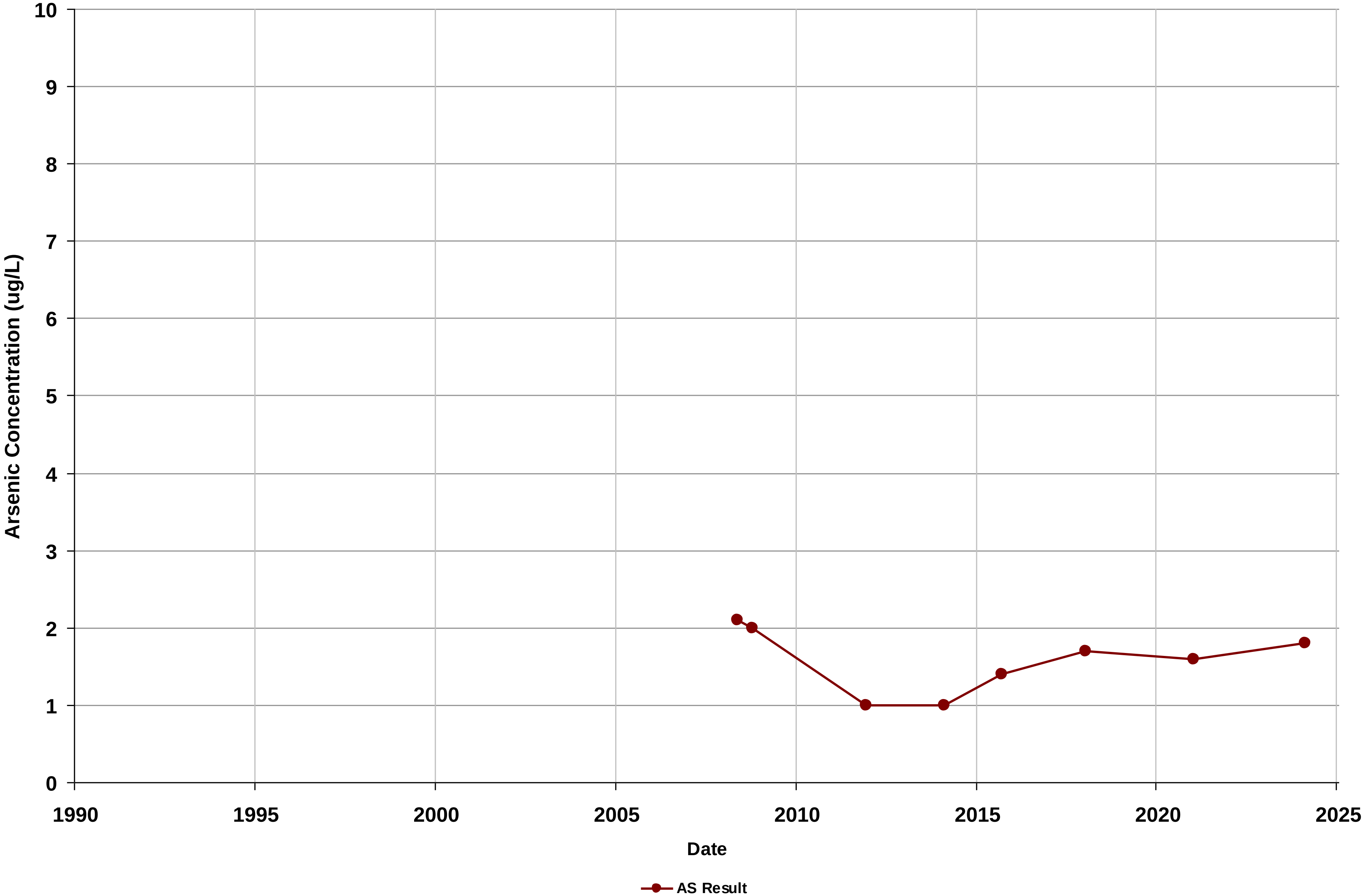
Total Depth (ft bgs):
Perf. Top (ft bgs): 295
Perf. Bottom (ft bgs): 420



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2000727-001
Subbasin: Madera
Well Type: Public Supply

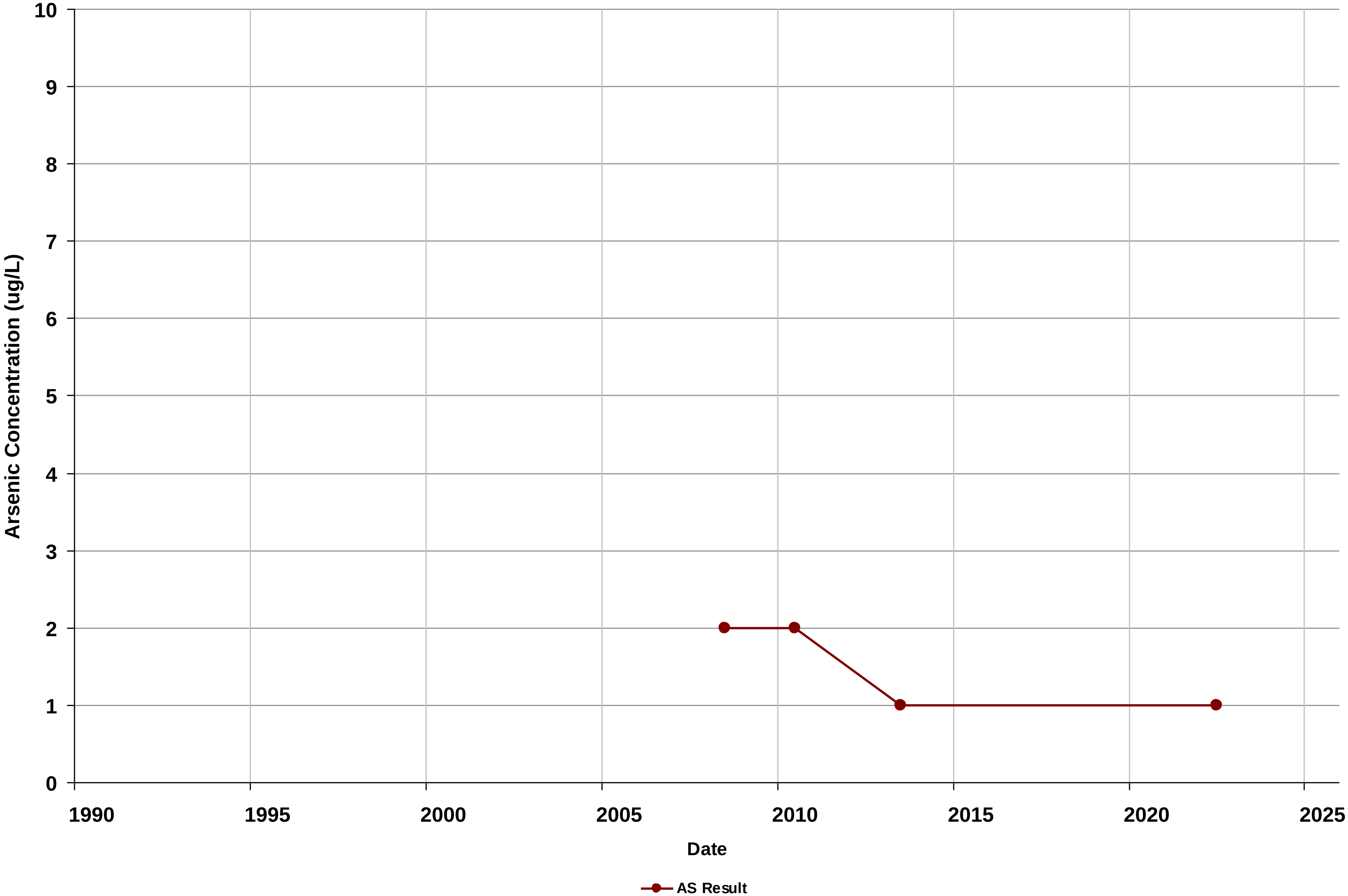
Total Depth (ft bgs):
Perf. Top (ft bgs): 280
Perf. Bottom (ft bgs): 360



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2000938-001
Subbasin: Madera
Well Type: Public Supply

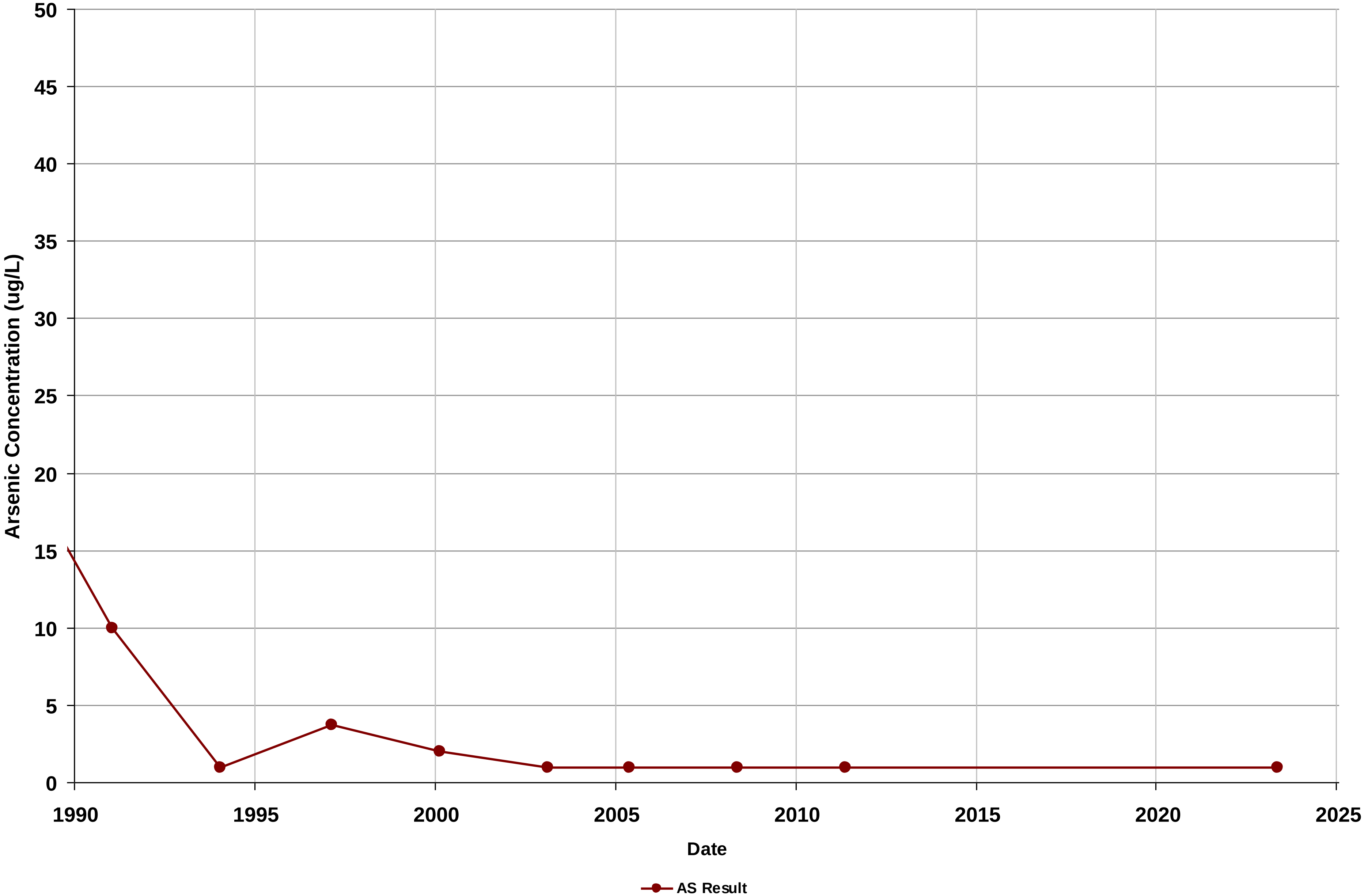
Total Depth (ft bgs):
Perf. Top (ft bgs): 420
Perf. Bottom (ft bgs): 560



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010002-014
Subbasin: Madera
Well Type: Public Supply

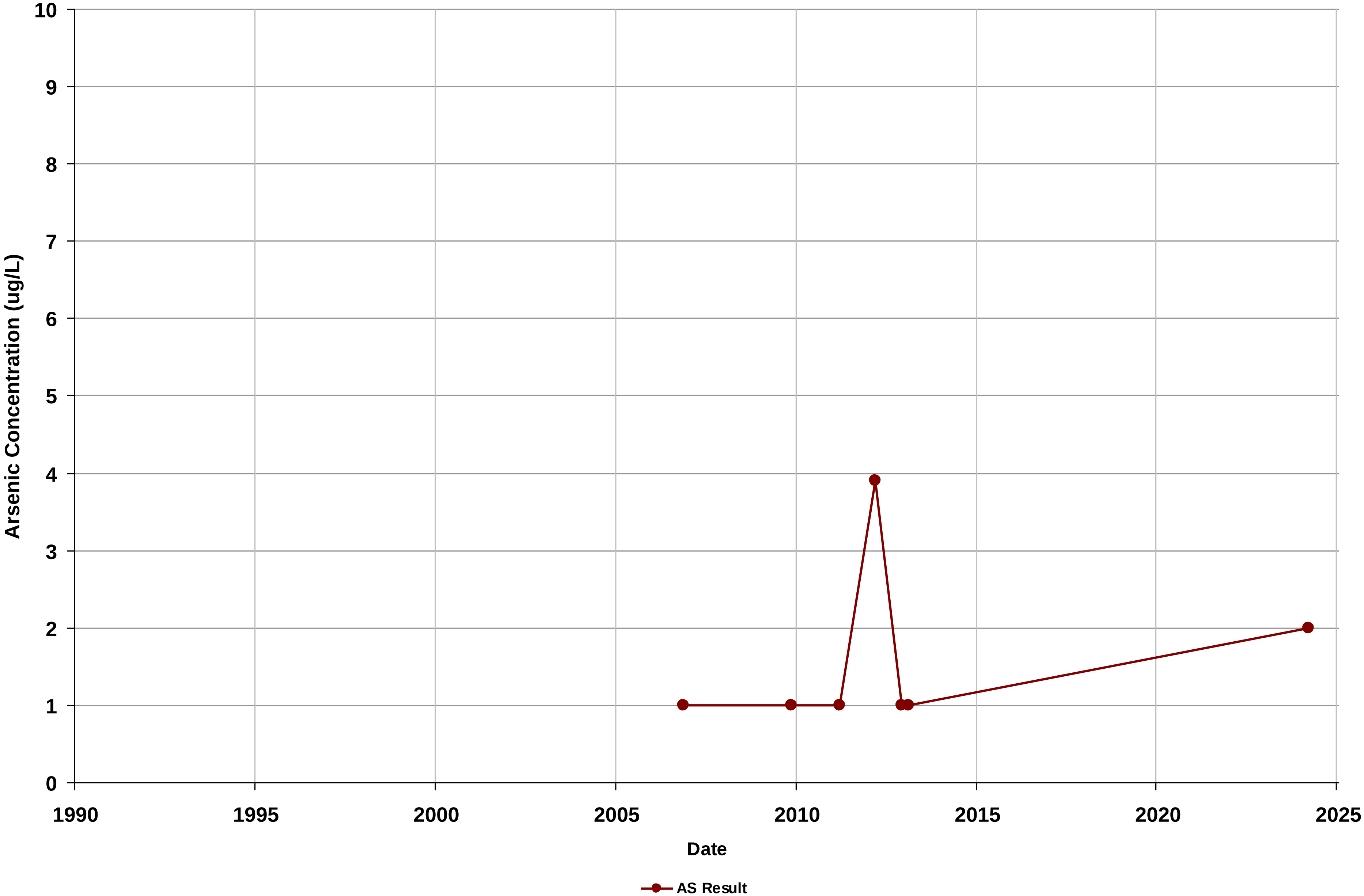
Total Depth (ft bgs):
Perf. Top (ft bgs): 280
Perf. Bottom (ft bgs): 610



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010002-032
Subbasin: Madera
Well Type: Public Supply

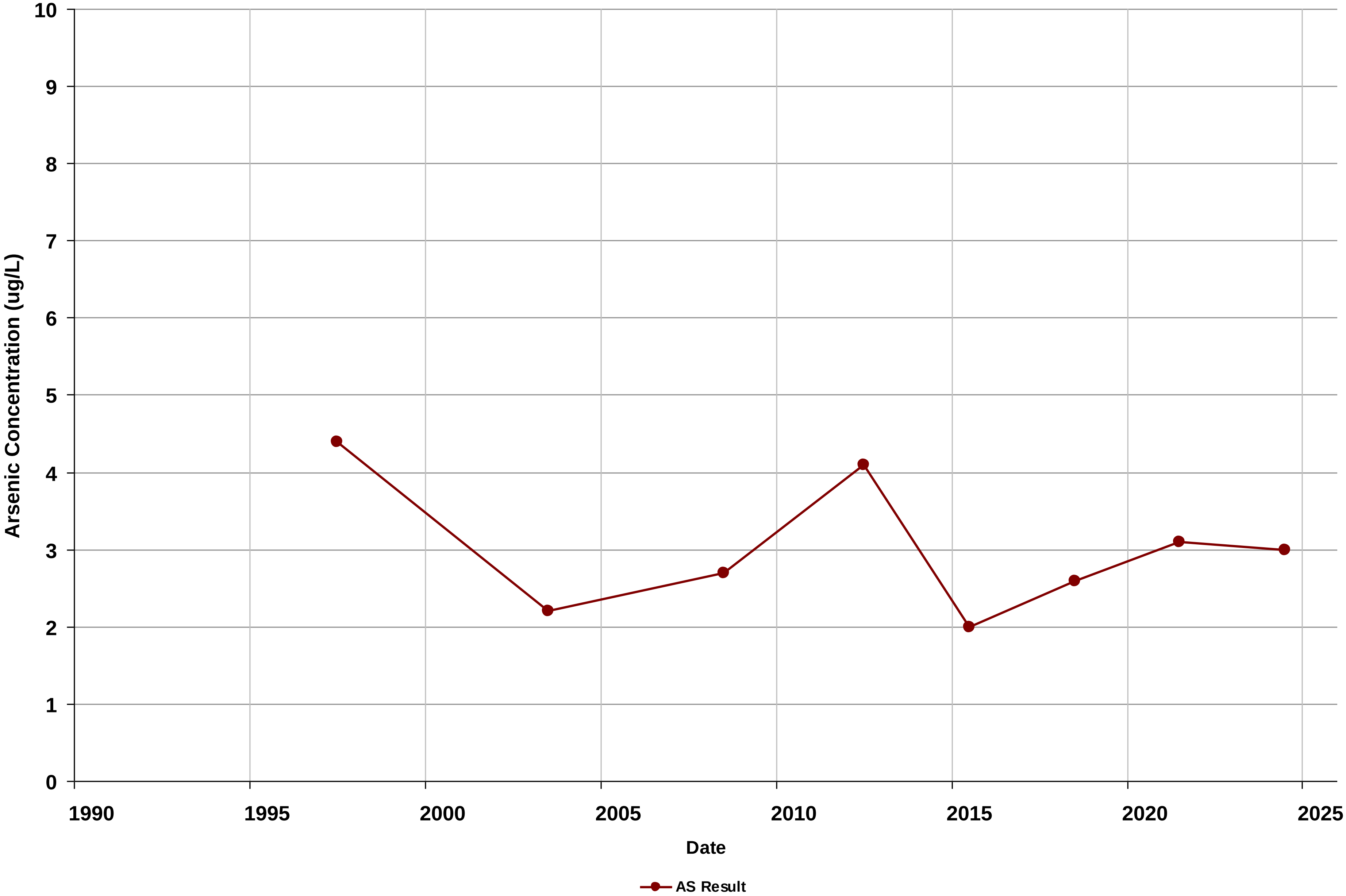
Total Depth (ft bgs):
Perf. Top (ft bgs): 310
Perf. Bottom (ft bgs): 600



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010008-005
Subbasin: Madera
Well Type: Public Supply

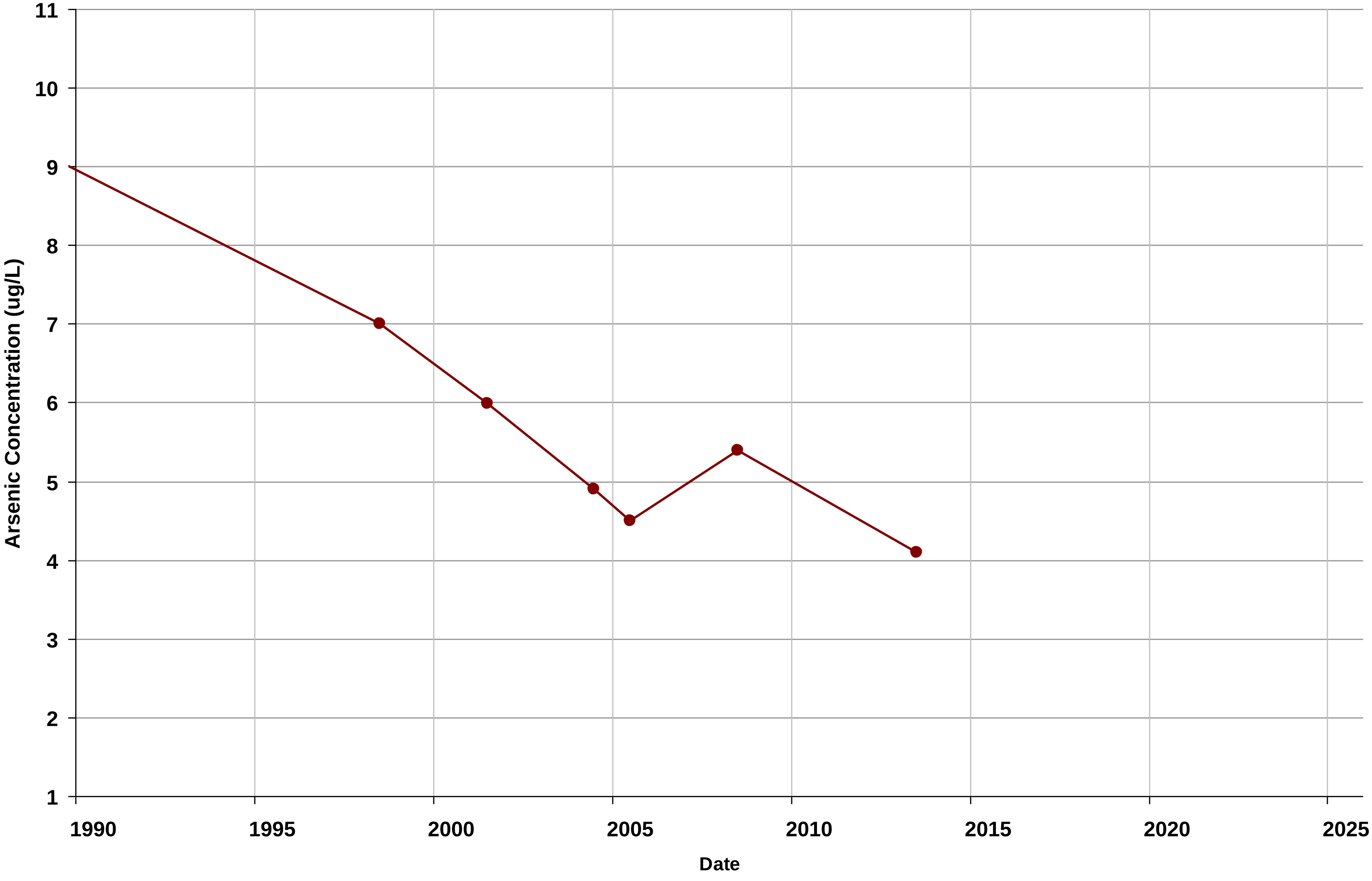
Total Depth (ft bgs):
Perf. Top (ft bgs): 250
Perf. Bottom (ft bgs): 465



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010009-002
Subbasin: Madera
Well Type: Public Supply

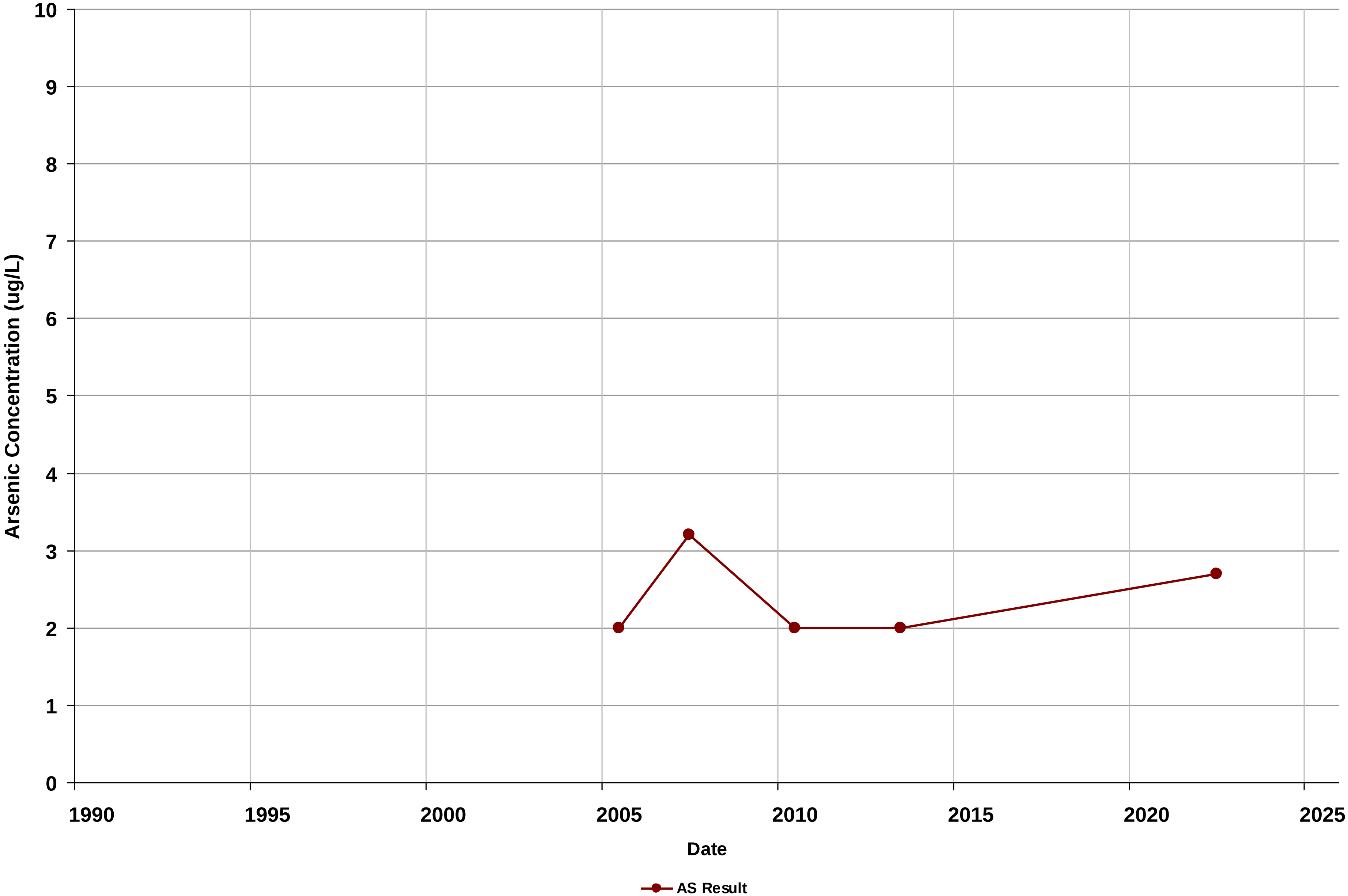
Total Depth (ft bgs):
Perf. Top (ft bgs): 324
Perf. Bottom (ft bgs): 369



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010010-007
Subbasin: Madera
Well Type: Public Supply

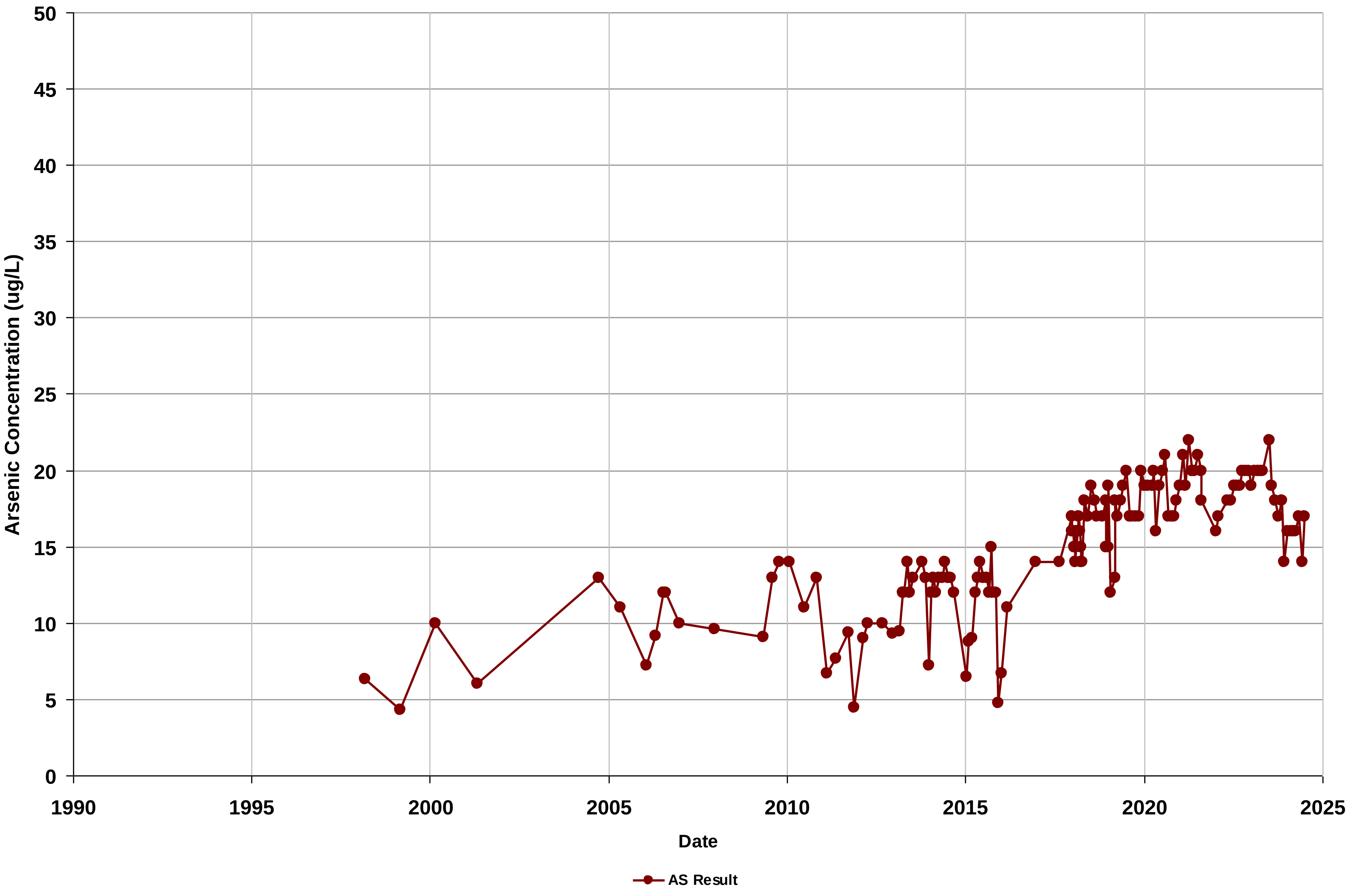
Total Depth (ft bgs):
Perf. Top (ft bgs): 242
Perf. Bottom (ft bgs): 374



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010801-001
Subbasin: Madera
Well Type: Public Supply

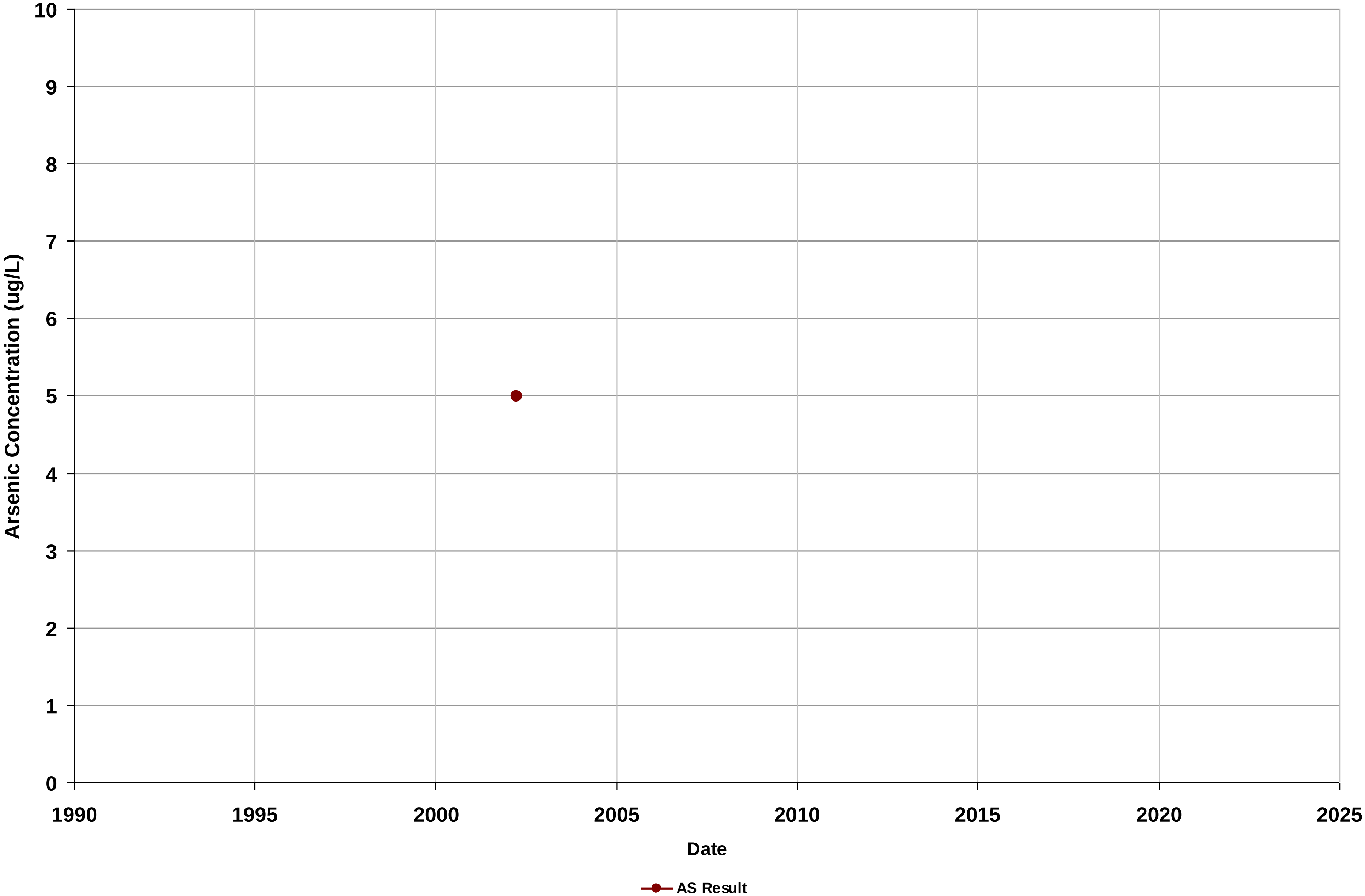
Total Depth (ft bgs):
Perf. Top (ft bgs): 375
Perf. Bottom (ft bgs): 760



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2801077-001
Subbasin: Madera
Well Type: Public Supply

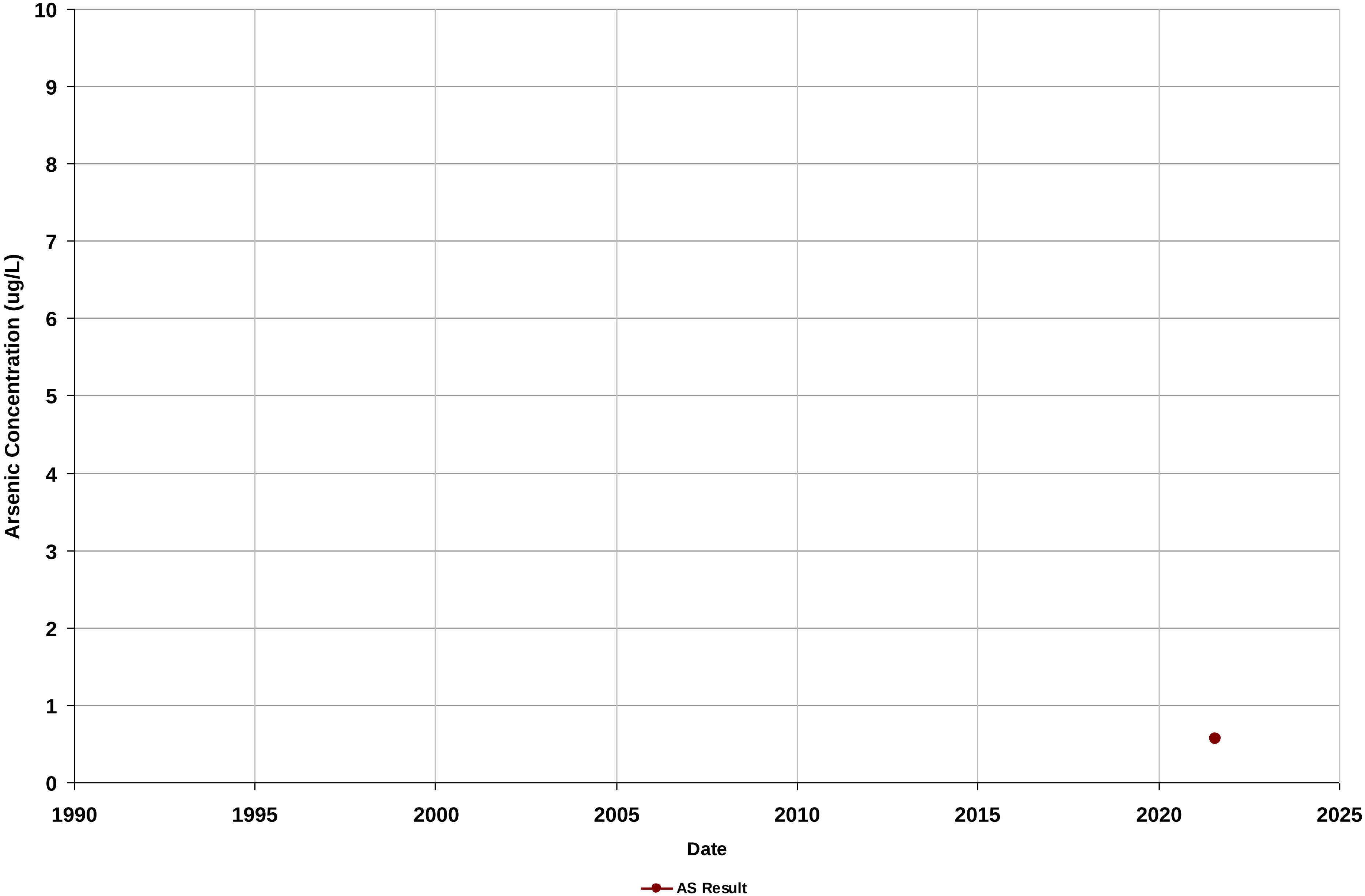
Total Depth (ft bgs):
Perf. Top (ft bgs): 60
Perf. Bottom (ft bgs): 500



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: ESJ12
Subbasin: Madera
Well Type: Domestic

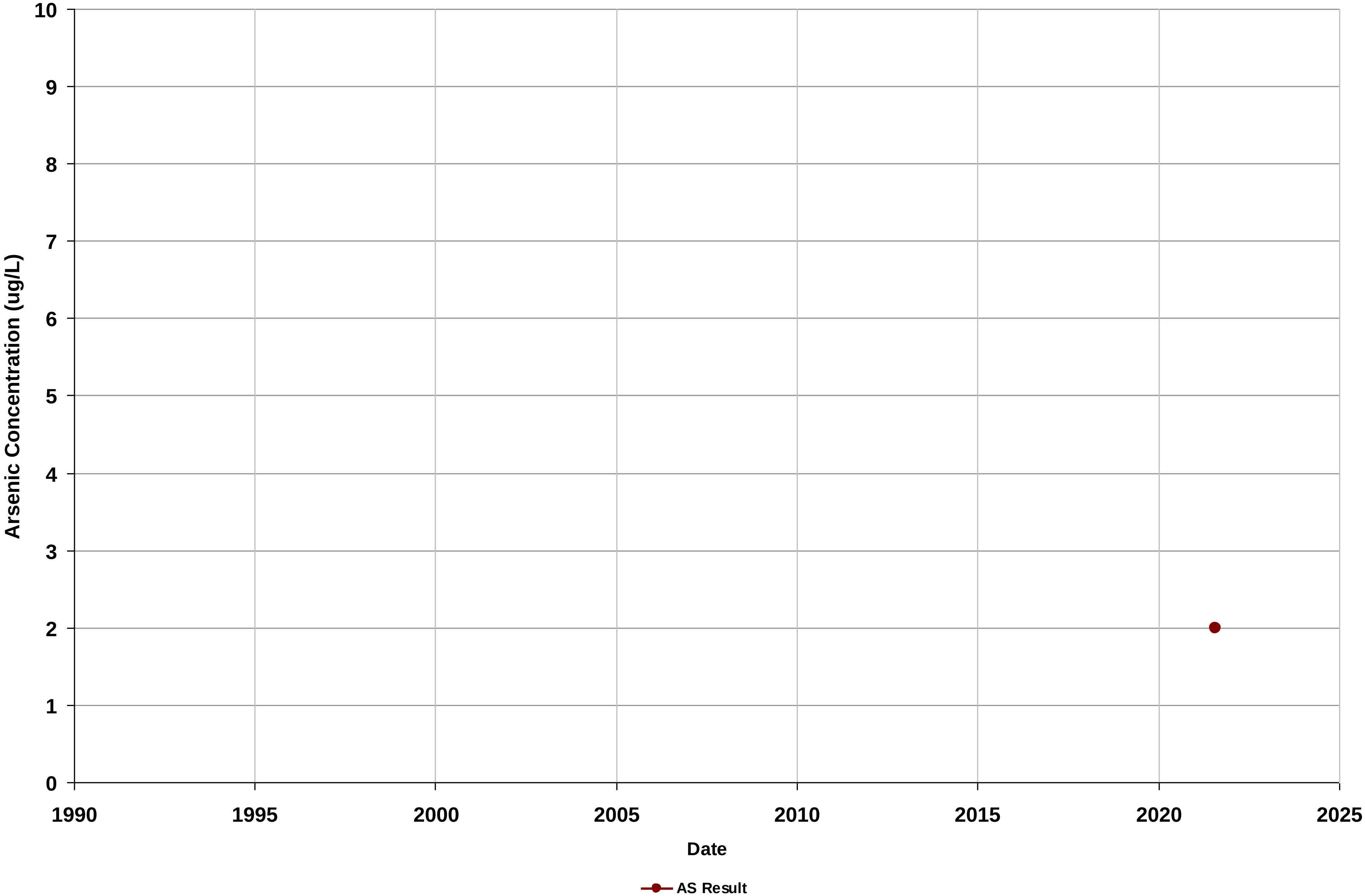
Total Depth (ft bgs): 276
Perf. Top (ft bgs): 160
Perf. Bottom (ft bgs): 172



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: ESJ17
Subbasin: Madera
Well Type: Domestic

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):

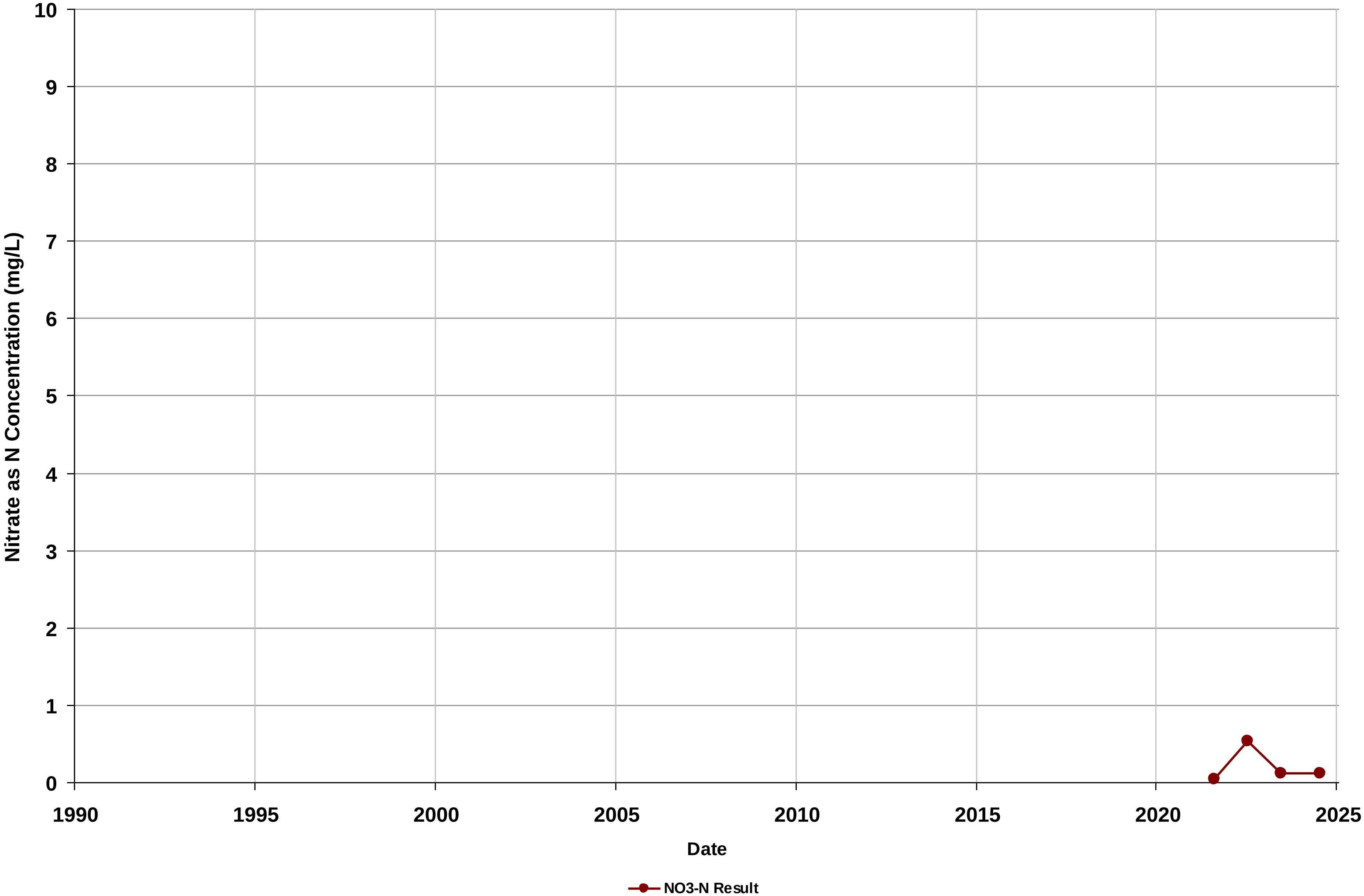


NOTE: Non-Detect results shown as half the reporting limit.

Nitrate as N Hydrographs for Groundwater Quality RMS Wells

Well Name: MCE RMS-3
Subbasin: Madera
Well Type: Unknown

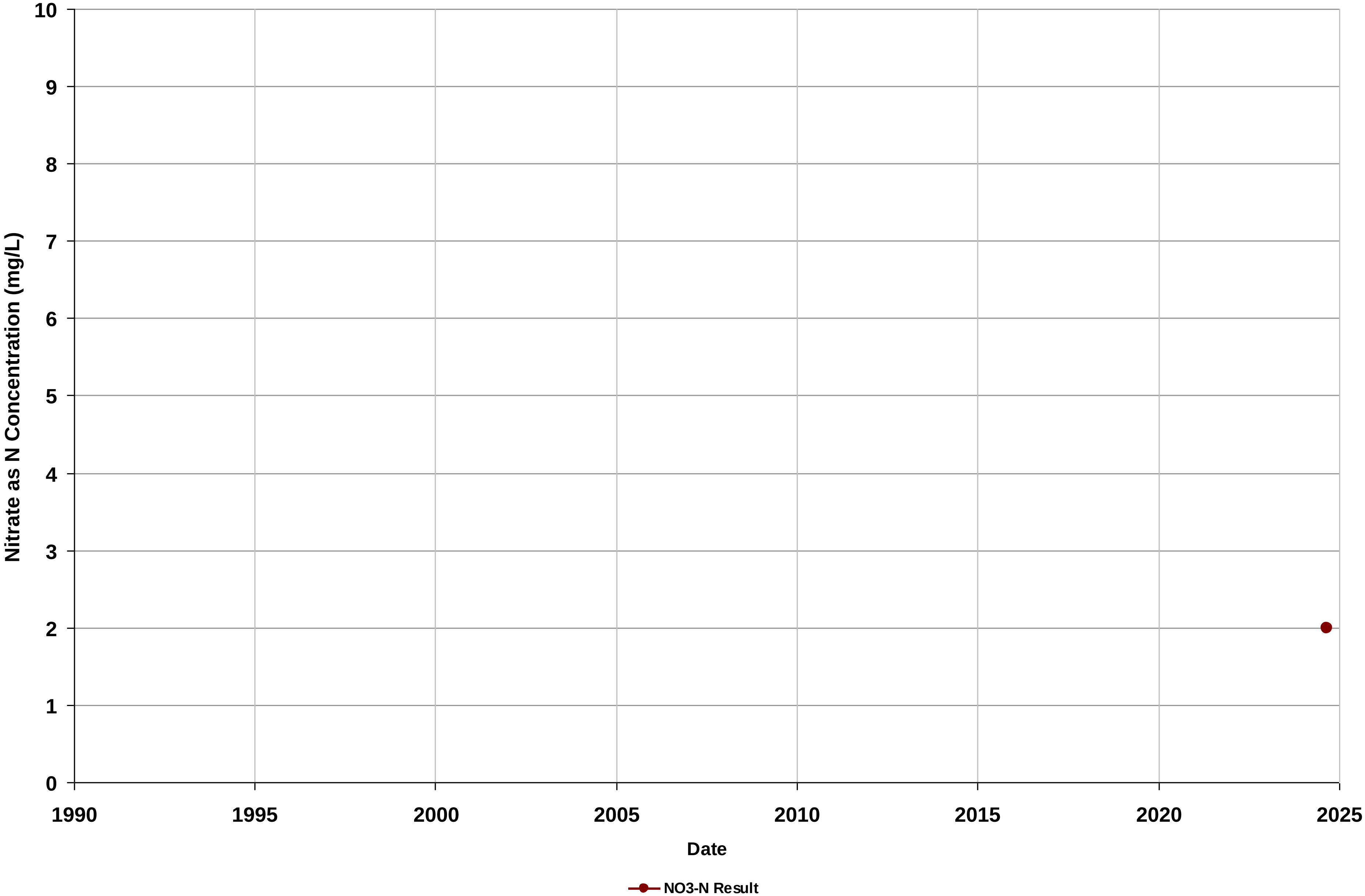
Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MID RMS-4
Subbasin: Madera
Well Type: Irrigation

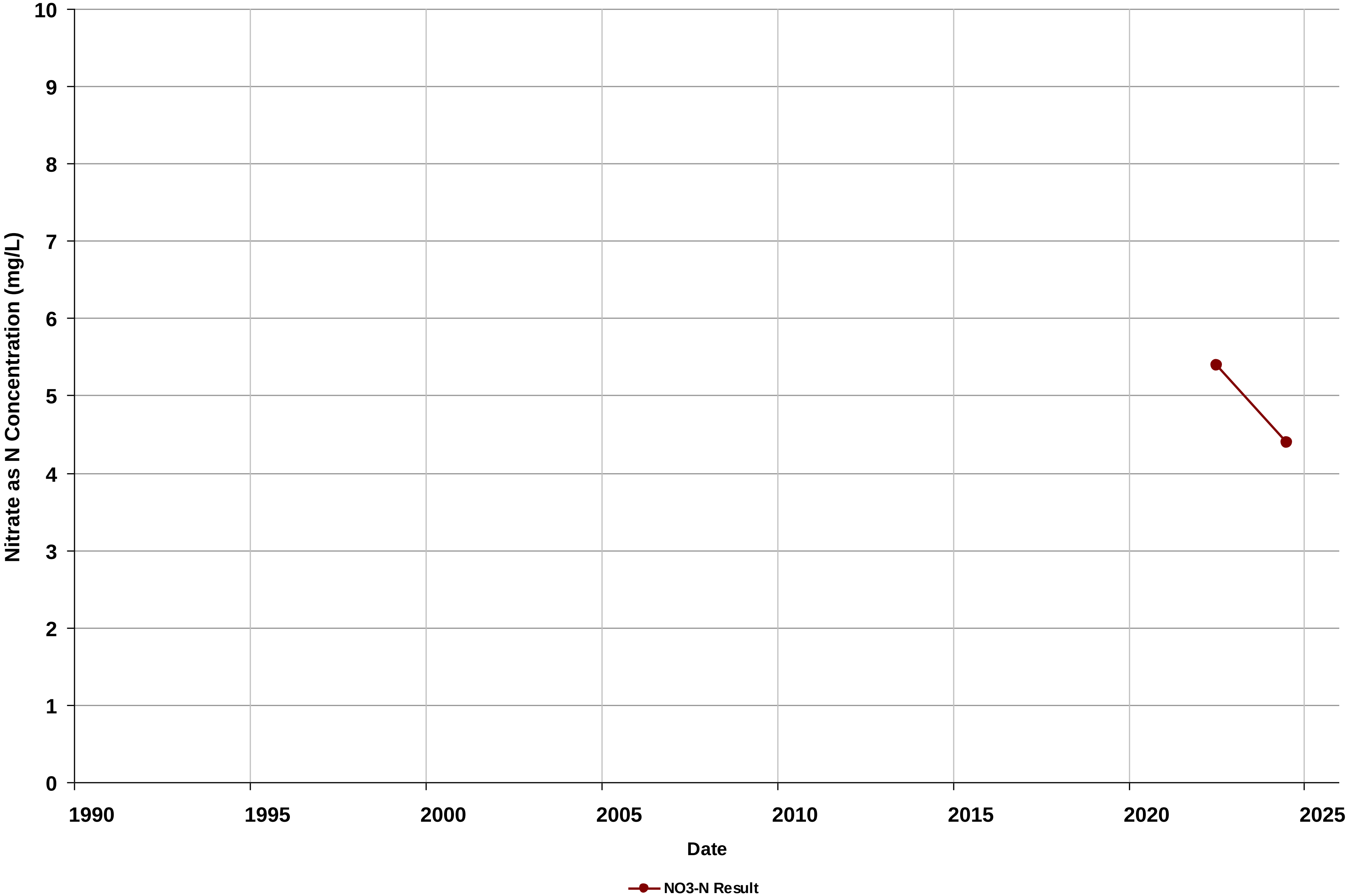
Total Depth (ft bgs): 698
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 667



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MID RMS-6
Subbasin: Madera
Well Type: Industrial

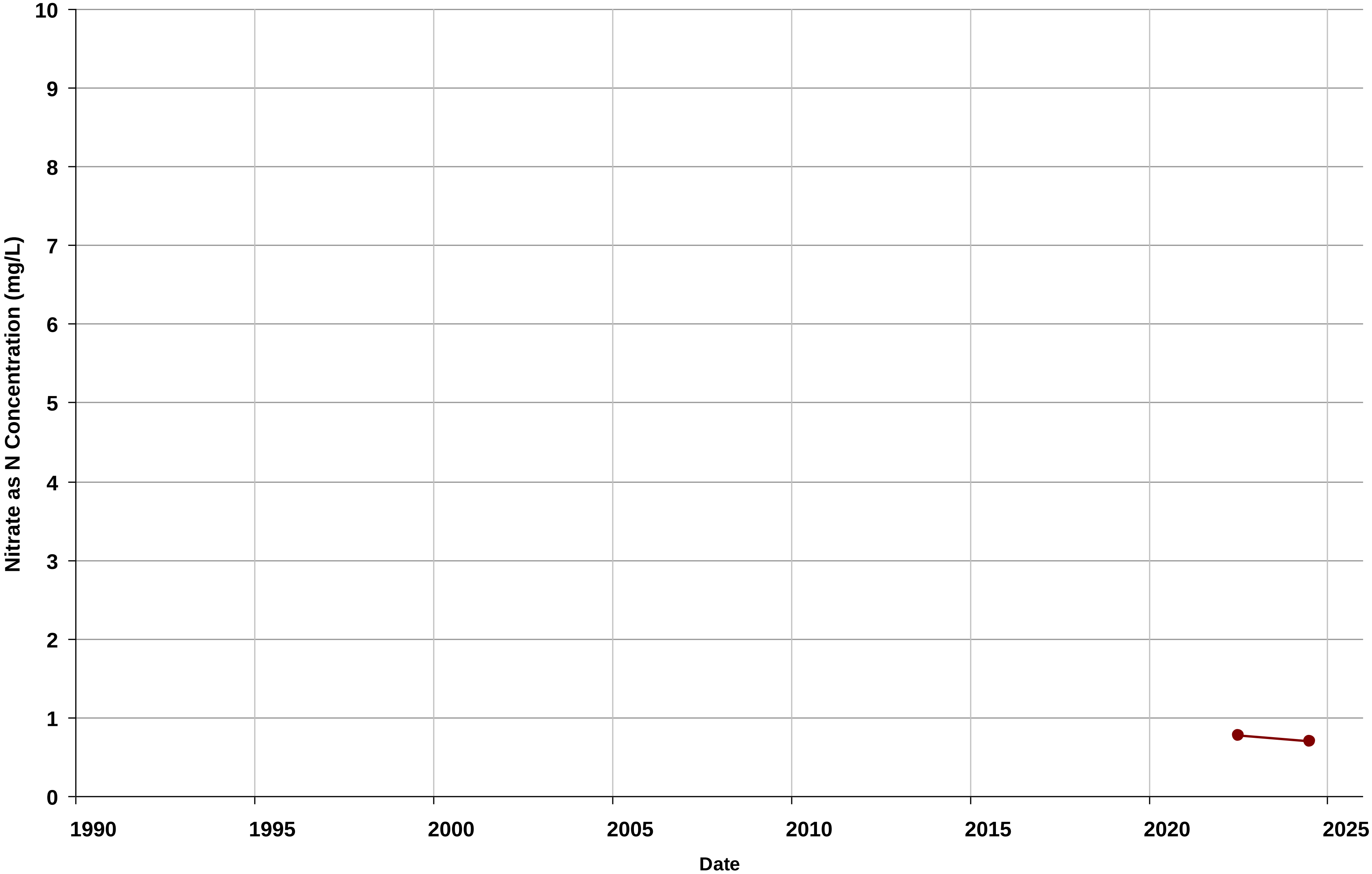
Total Depth (ft bgs): 680
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 680



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MID RMS-7
Subbasin: Madera
Well Type: Irrigation

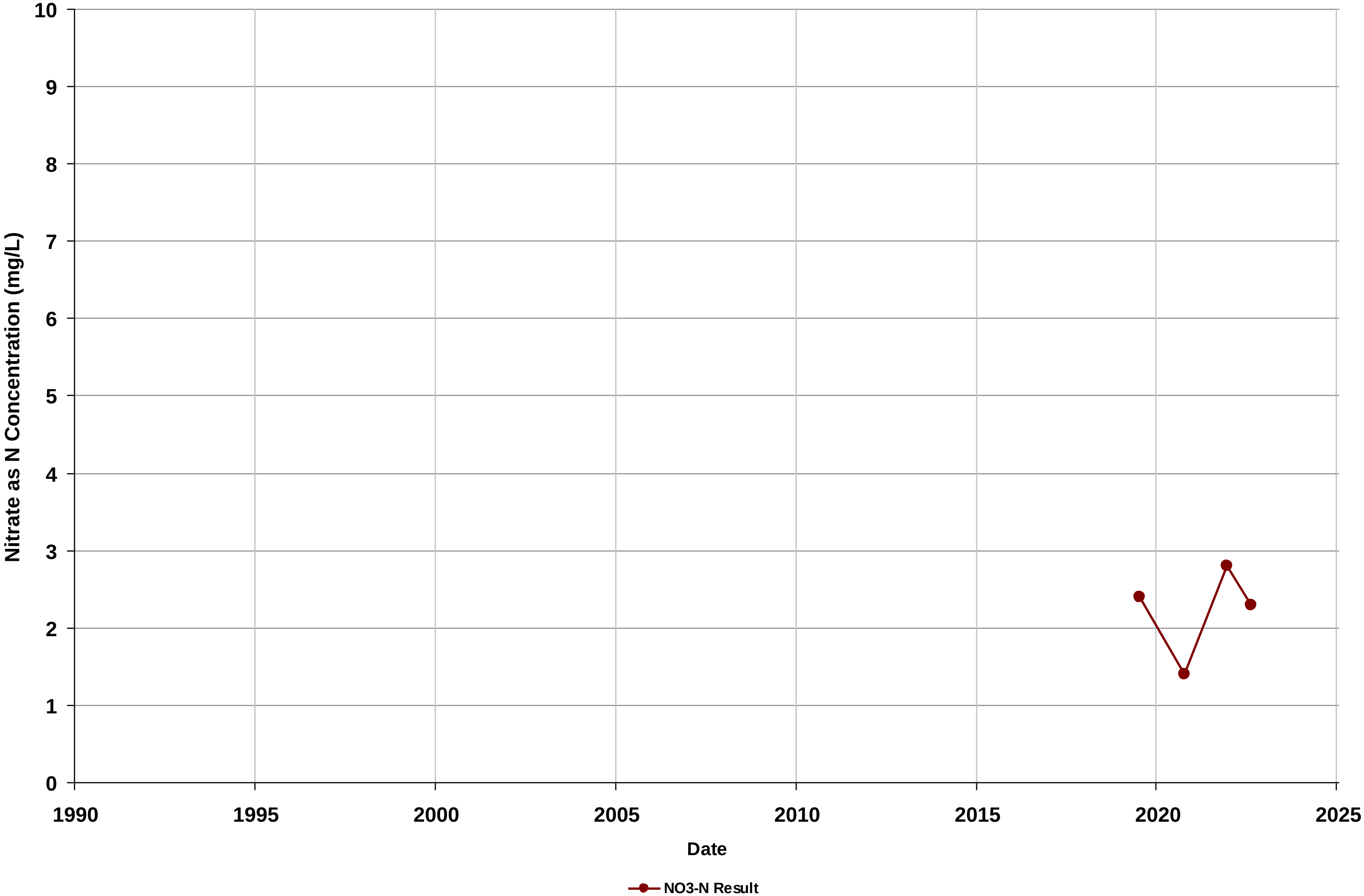
Total Depth (ft bgs): 656
Perf. Top (ft bgs): 290
Perf. Bottom (ft bgs): 635



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MWD RMS-1
Subbasin: Madera
Well Type: Irrigation

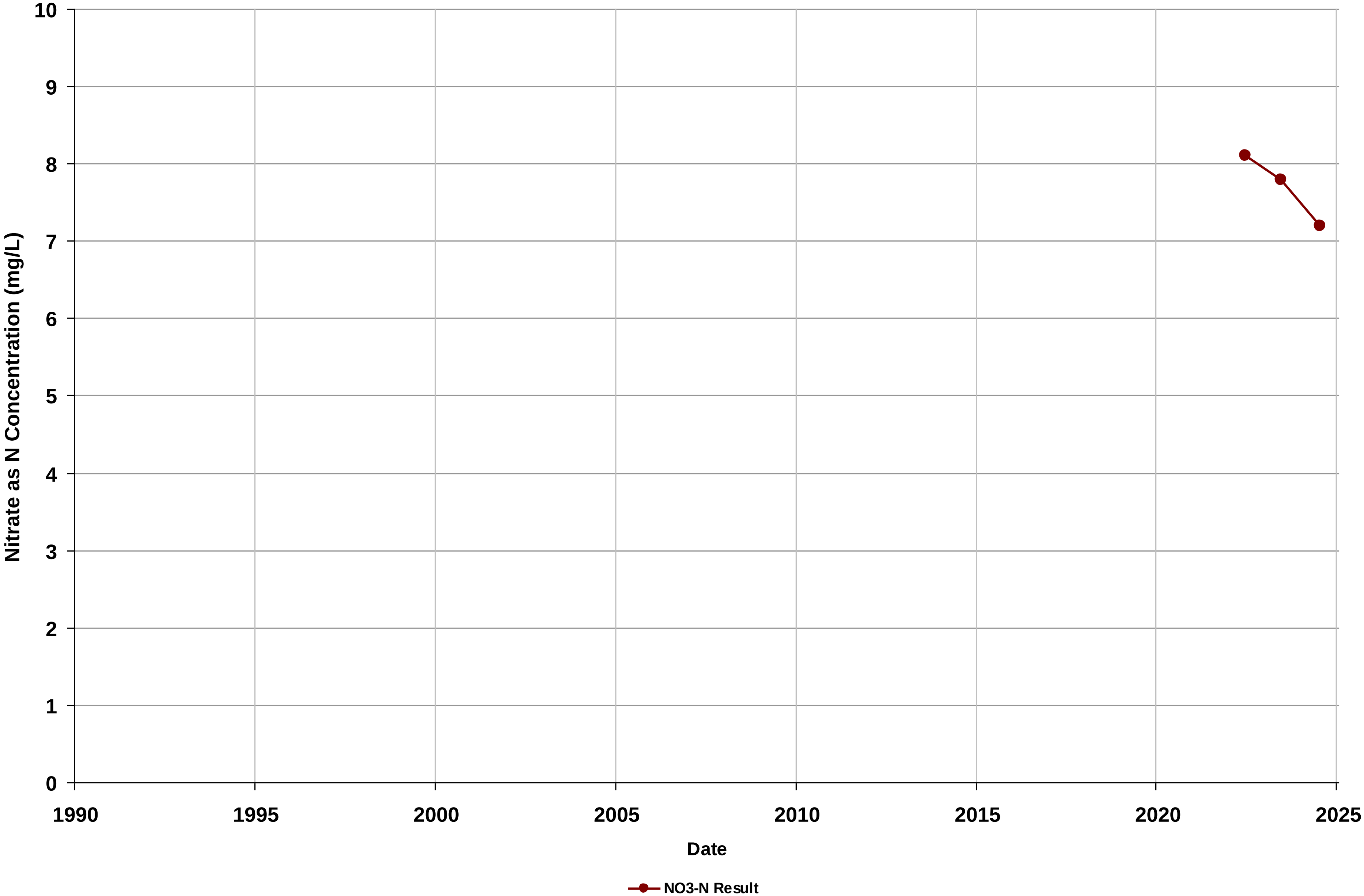
Total Depth (ft bgs): 504
Perf. Top (ft bgs): 200
Perf. Bottom (ft bgs): 500



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB03A
Subbasin: Madera
Well Type: Observation

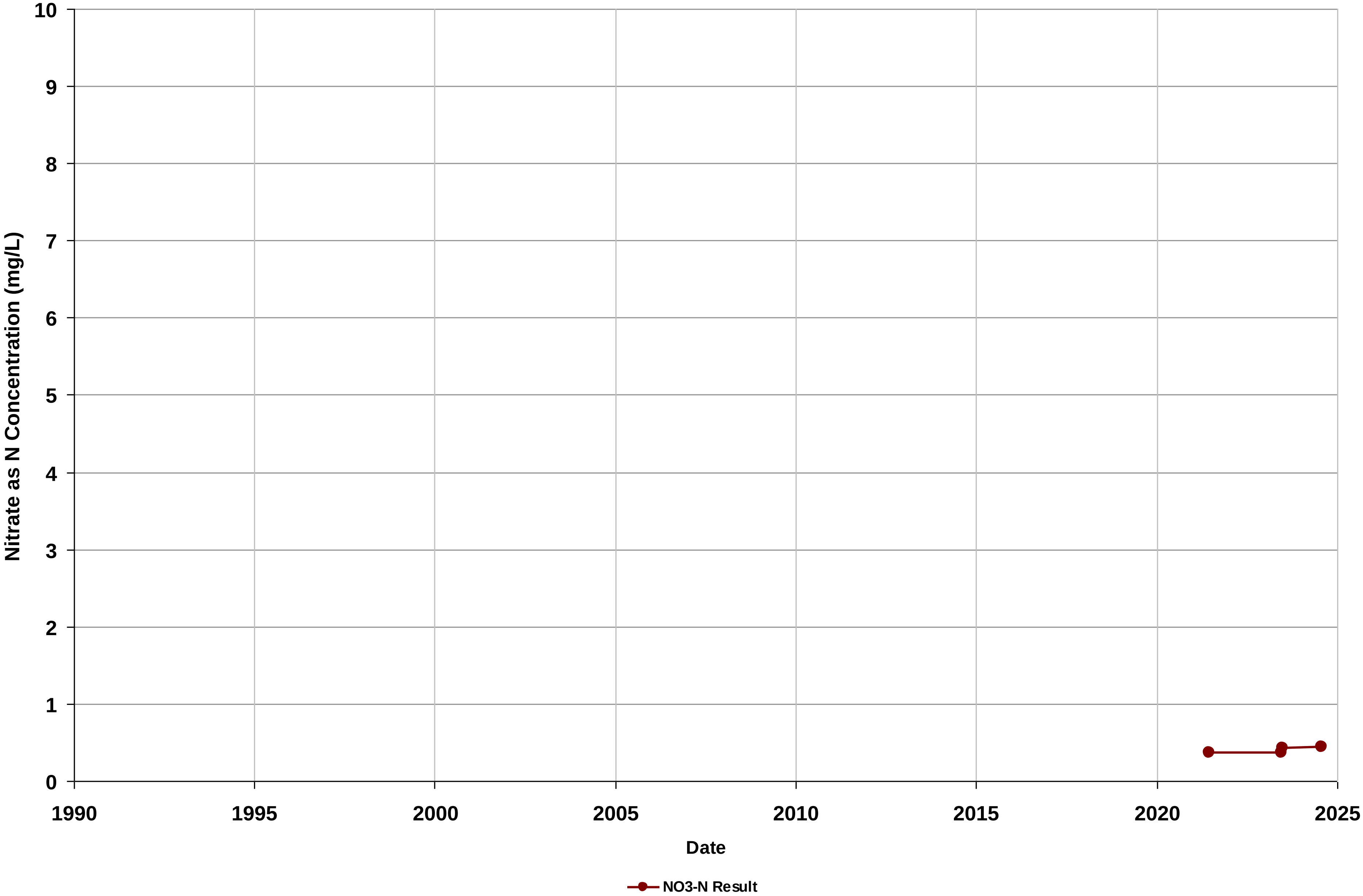
Total Depth (ft bgs): 139
Perf. Top (ft bgs): 74
Perf. Bottom (ft bgs): 134



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB03B
Subbasin: Madera
Well Type: Observation

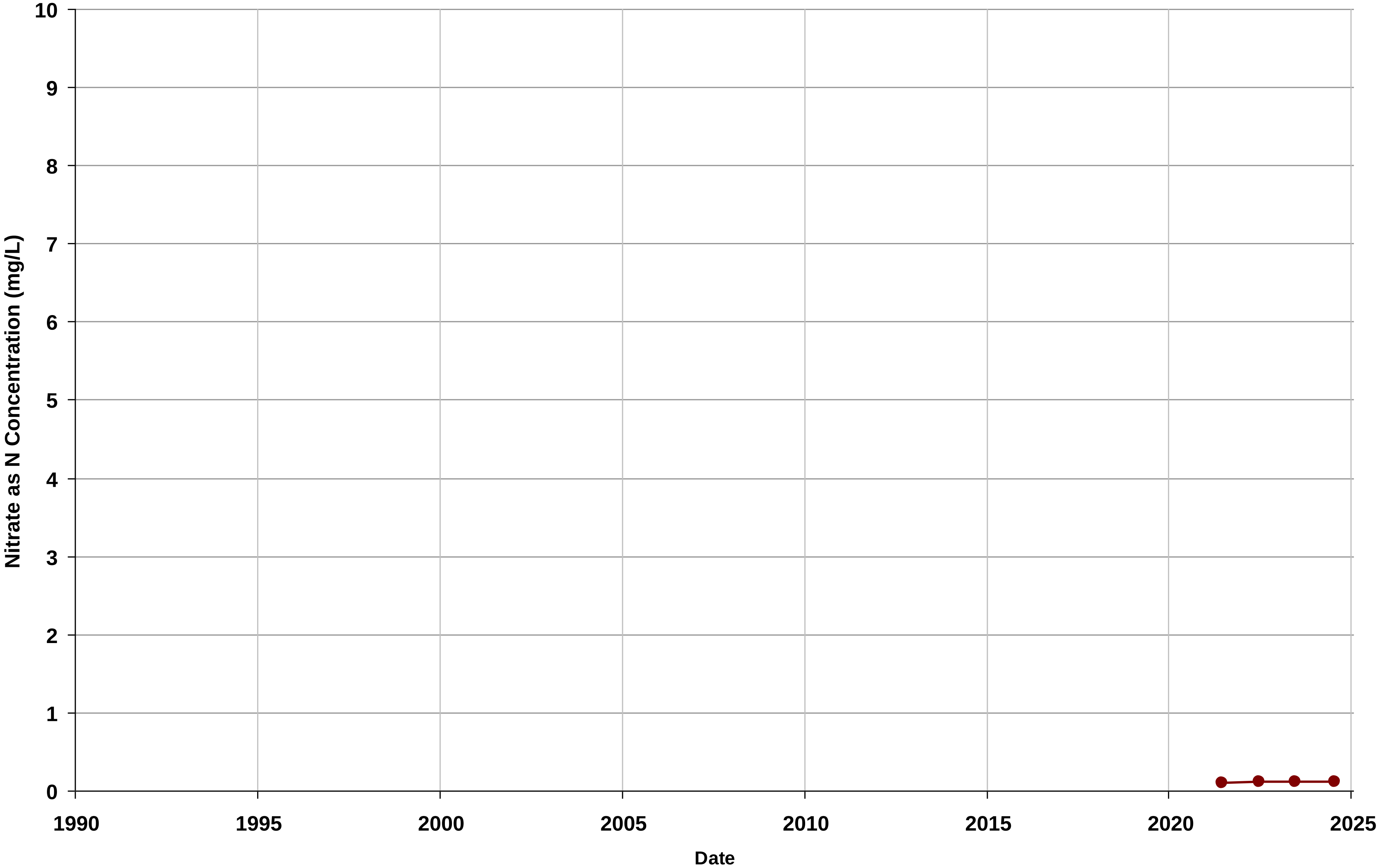
Total Depth (ft bgs): 295
Perf. Top (ft bgs): 215
Perf. Bottom (ft bgs): 285



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB03C
Subbasin: Madera
Well Type: Observation

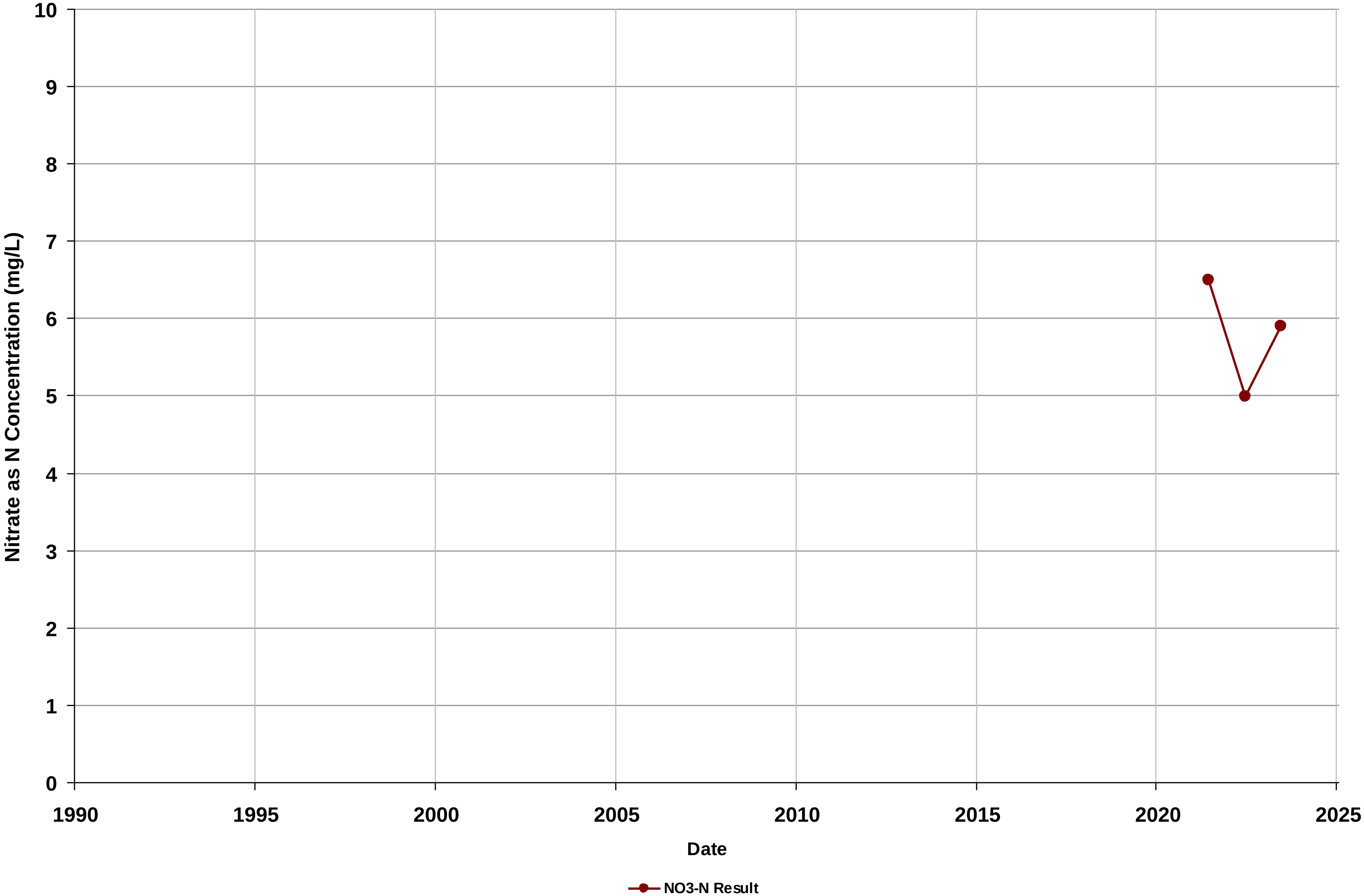
Total Depth (ft bgs): 430
Perf. Top (ft bgs): 355
Perf. Bottom (ft bgs): 420



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB04A
Subbasin: Madera
Well Type: Observation

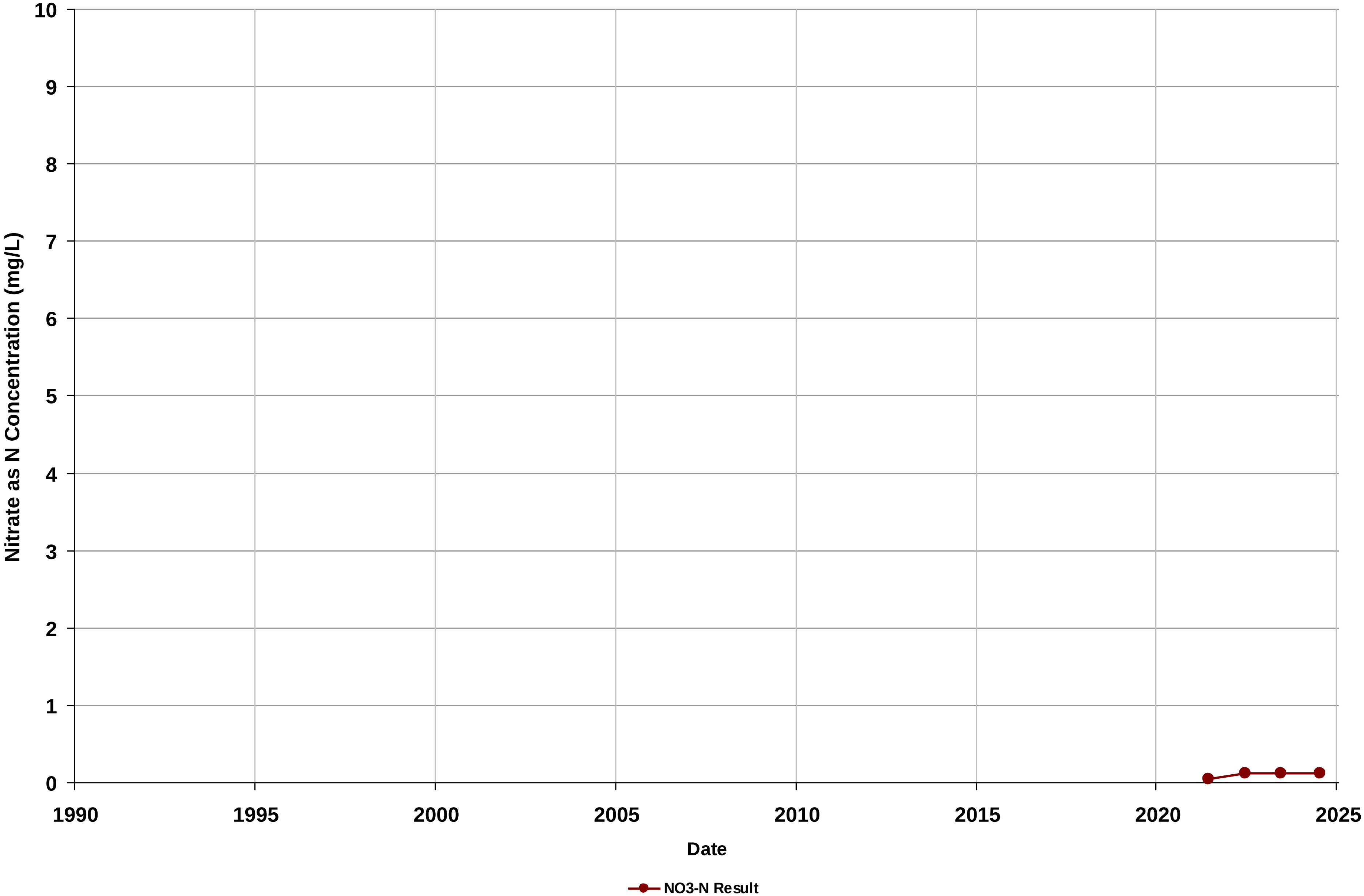
Total Depth (ft bgs): 375
Perf. Top (ft bgs): 180
Perf. Bottom (ft bgs): 365



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB04B
Subbasin: Madera
Well Type: Observation

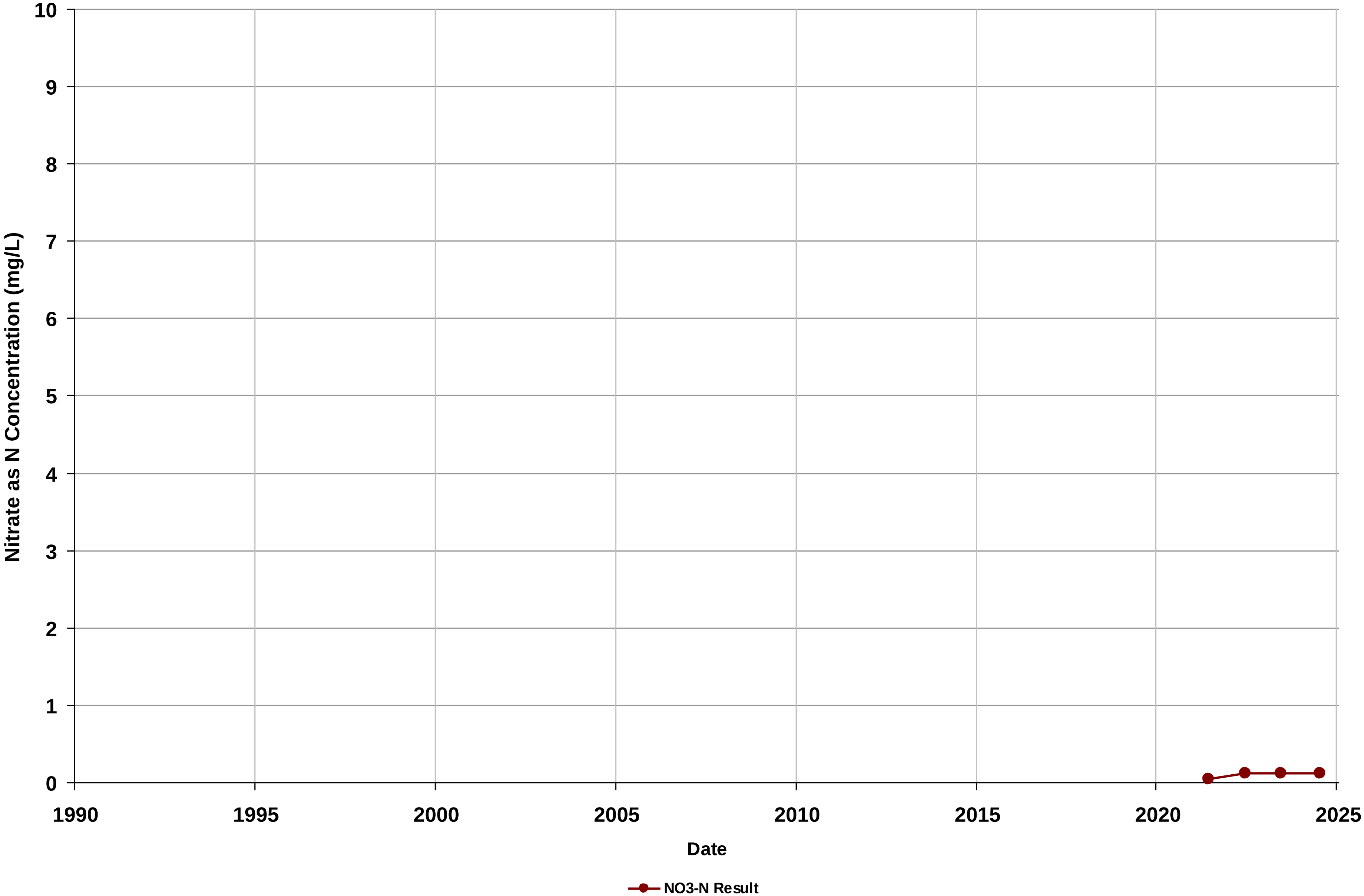
Total Depth (ft bgs): 695
Perf. Top (ft bgs): 530
Perf. Bottom (ft bgs): 685



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB04C
Subbasin: Madera
Well Type: Observation

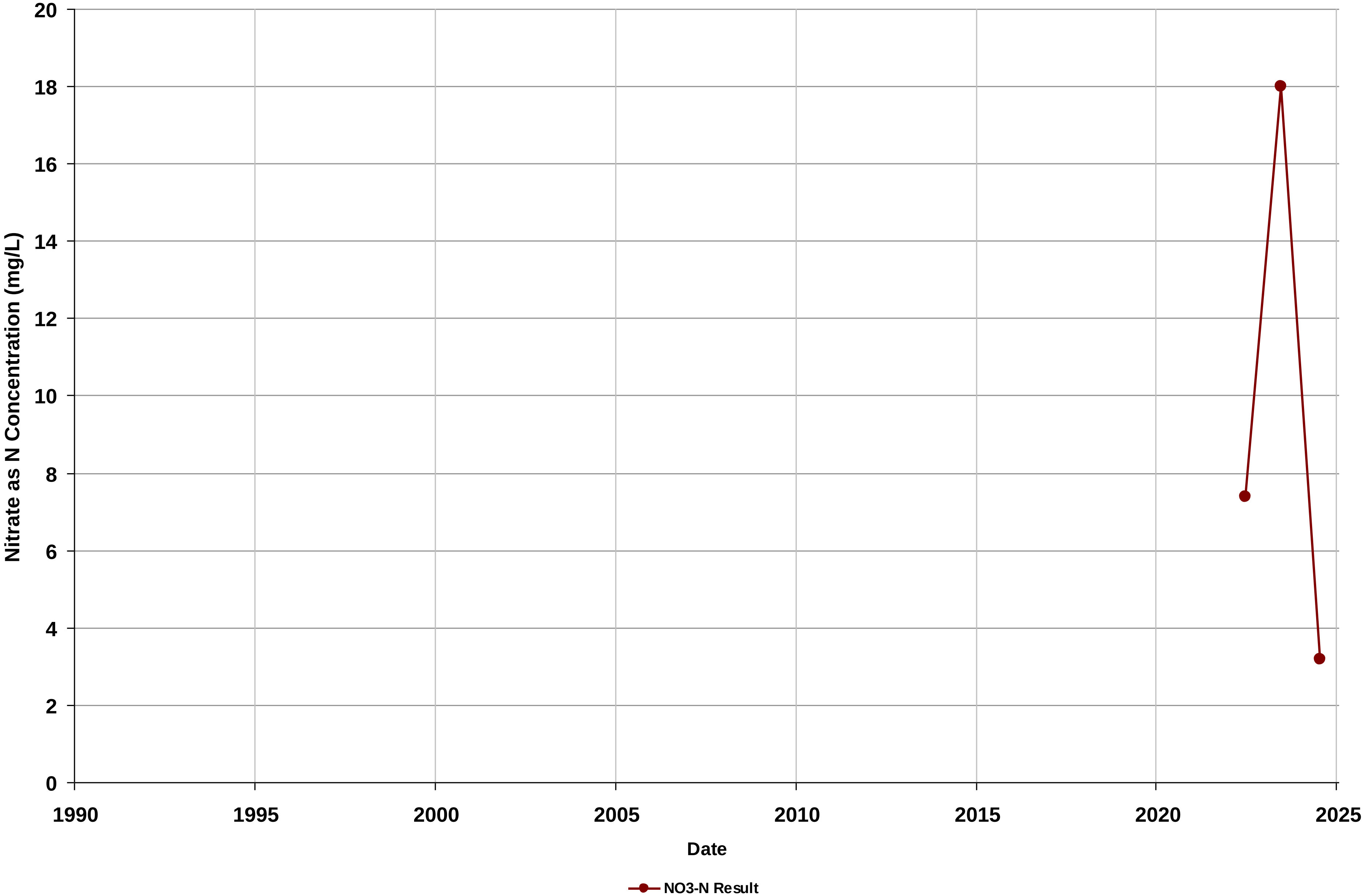
Total Depth (ft bgs): 905
Perf. Top (ft bgs): 750
Perf. Bottom (ft bgs): 895



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB05A
Subbasin: Madera
Well Type: Observation

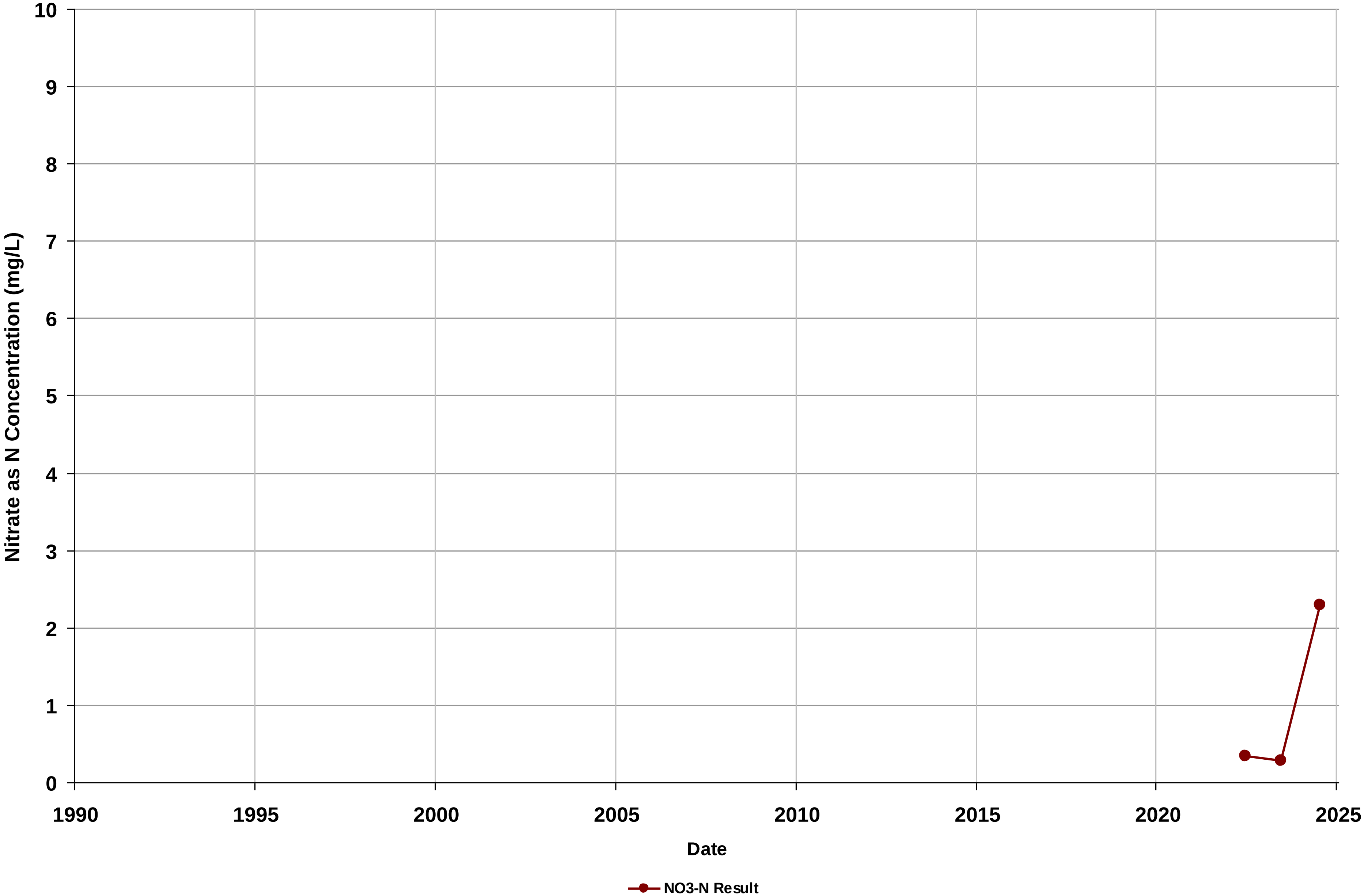
Total Depth (ft bgs): 210
Perf. Top (ft bgs): 140
Perf. Bottom (ft bgs): 200



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB05B
Subbasin: Madera
Well Type: Observation

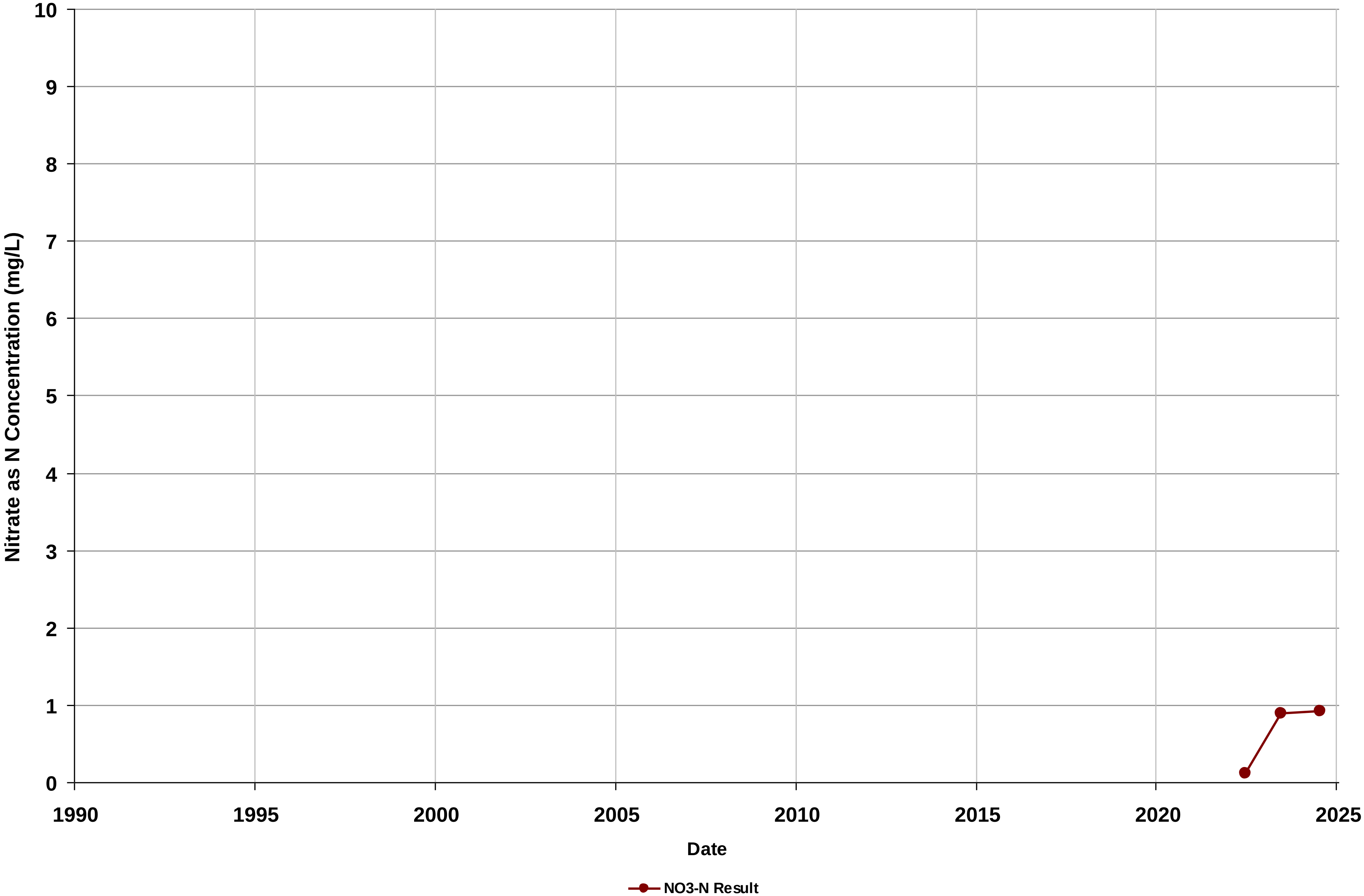
Total Depth (ft bgs): 375
Perf. Top (ft bgs): 240
Perf. Bottom (ft bgs): 365



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB05C
Subbasin: Madera
Well Type: Observation

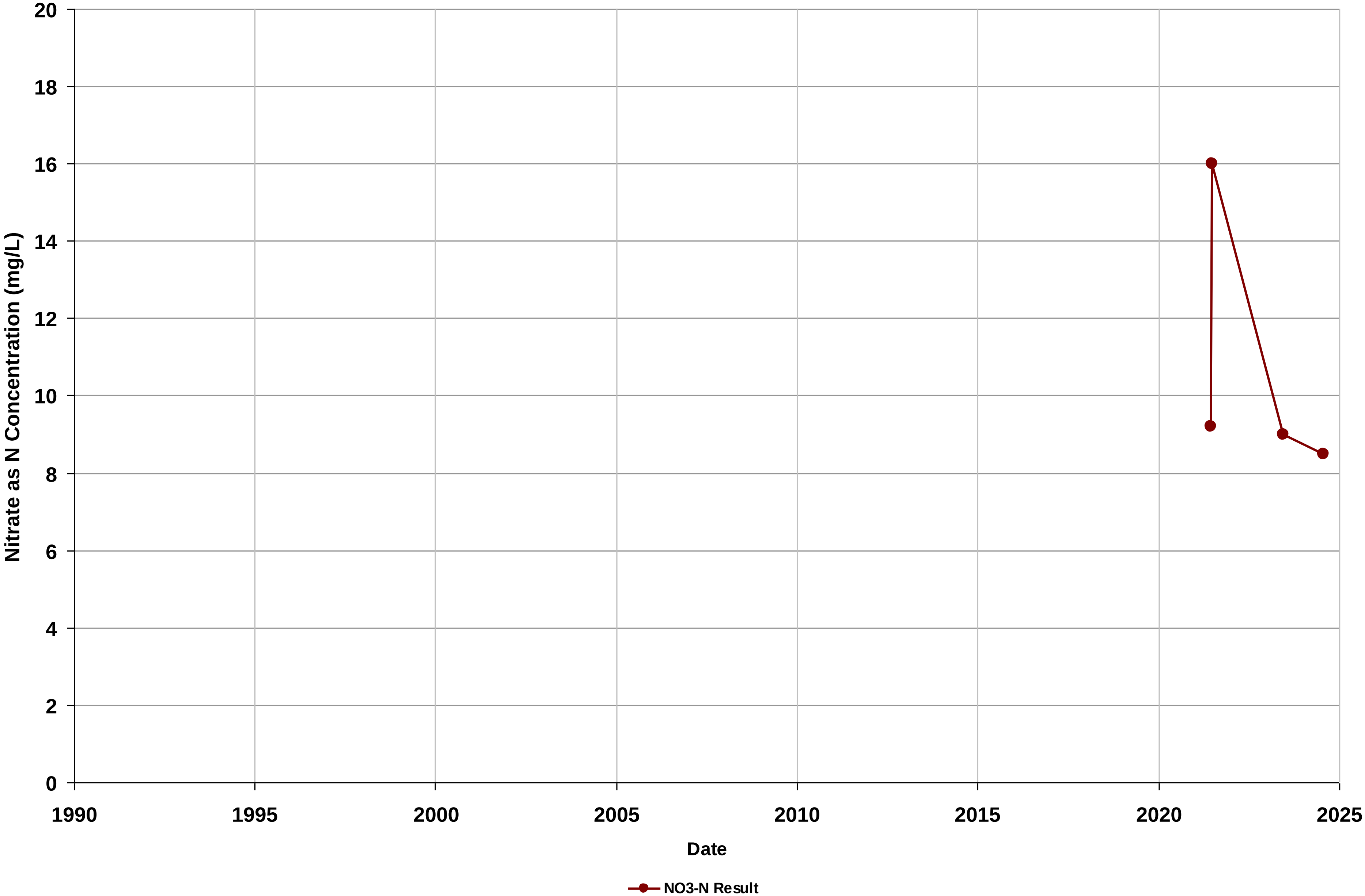
Total Depth (ft bgs): 585
Perf. Top (ft bgs): 420
Perf. Bottom (ft bgs): 585



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB06A
Subbasin: Madera
Well Type: Observation

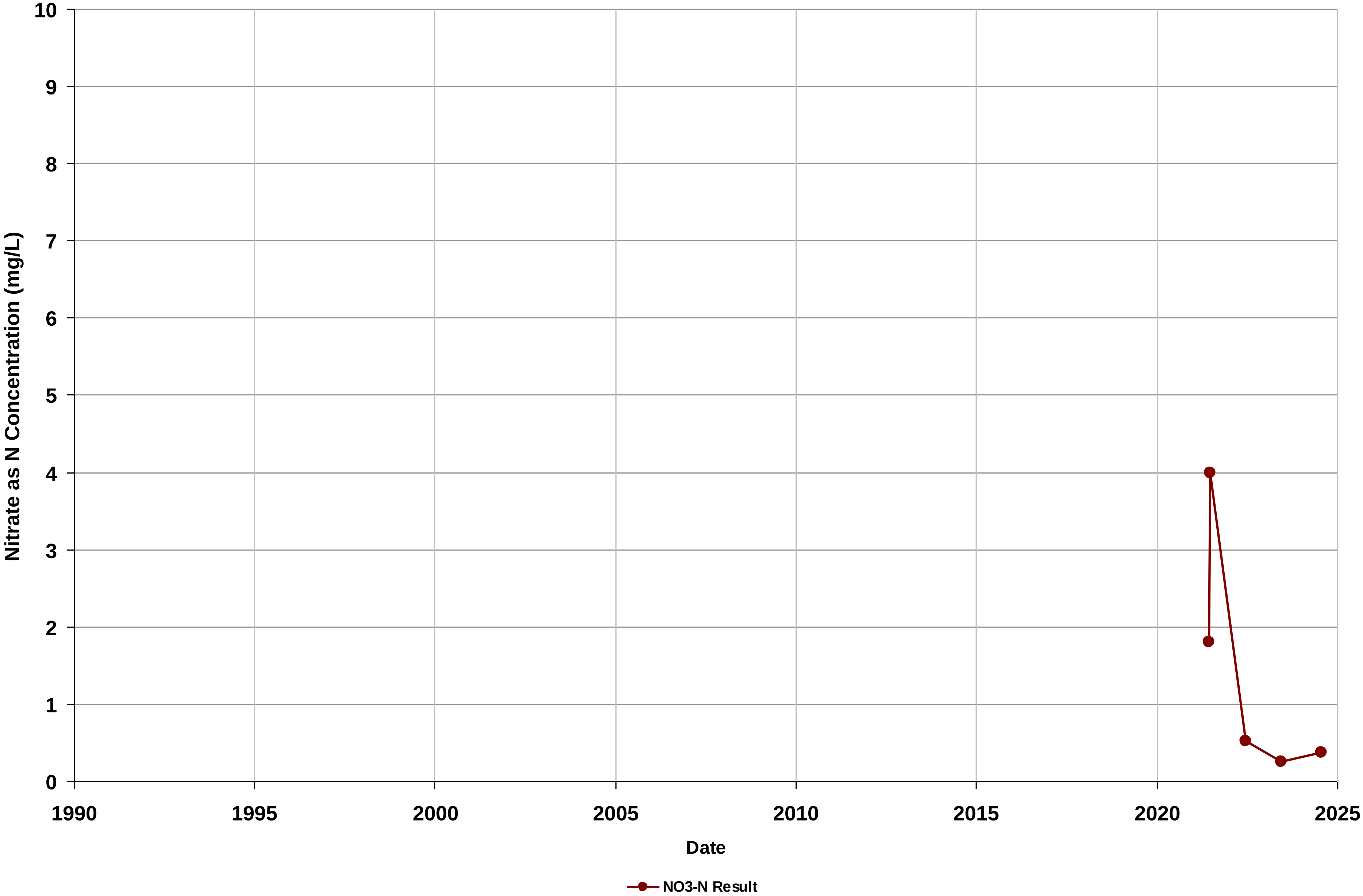
Total Depth (ft bgs): 350
Perf. Top (ft bgs): 135
Perf. Bottom (ft bgs): 340



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB06B
Subbasin: Madera
Well Type: Observation

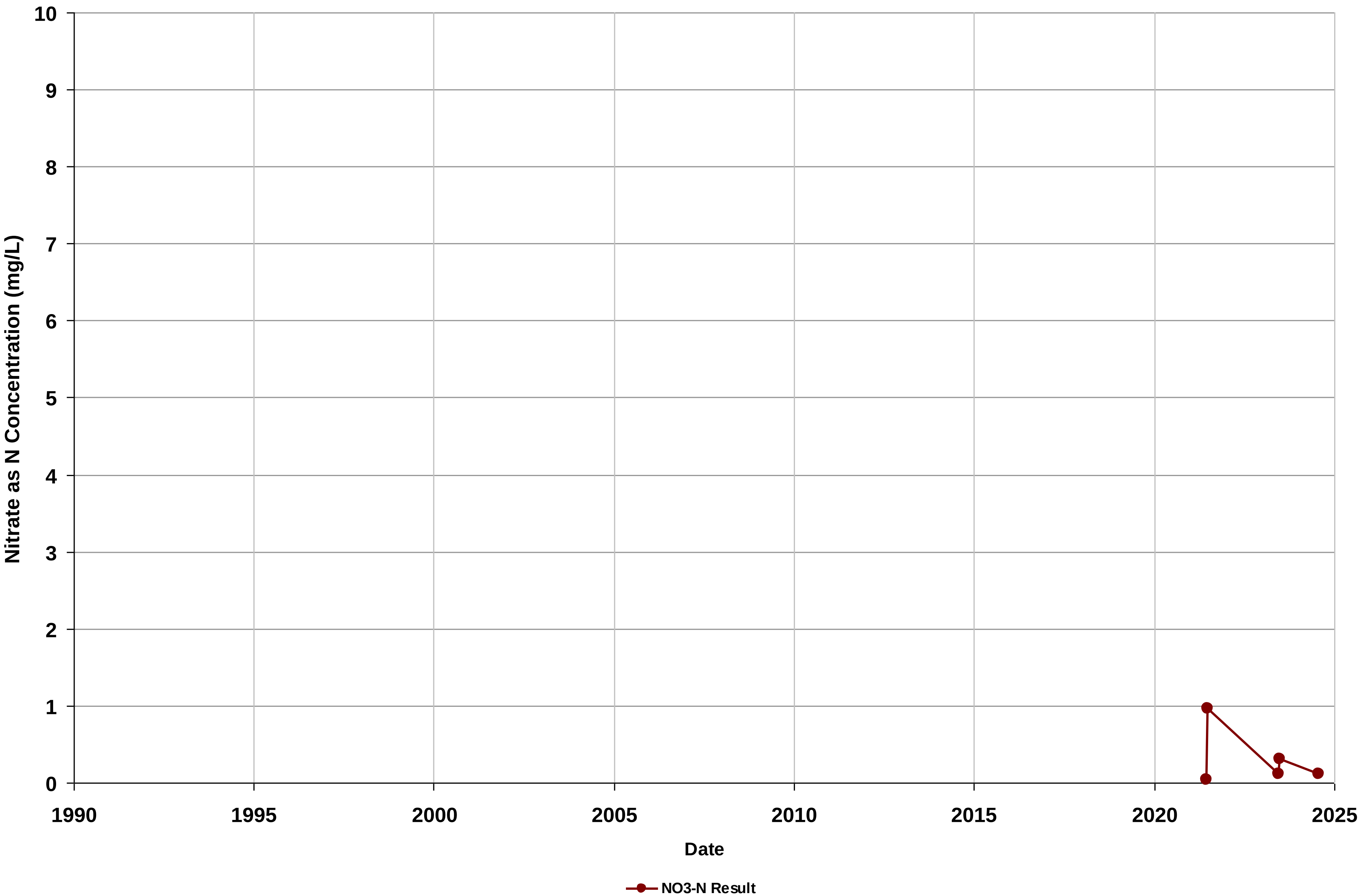
Total Depth (ft bgs): 520
Perf. Top (ft bgs): 425
Perf. Bottom (ft bgs): 510



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB06C
Subbasin: Madera
Well Type: Observation

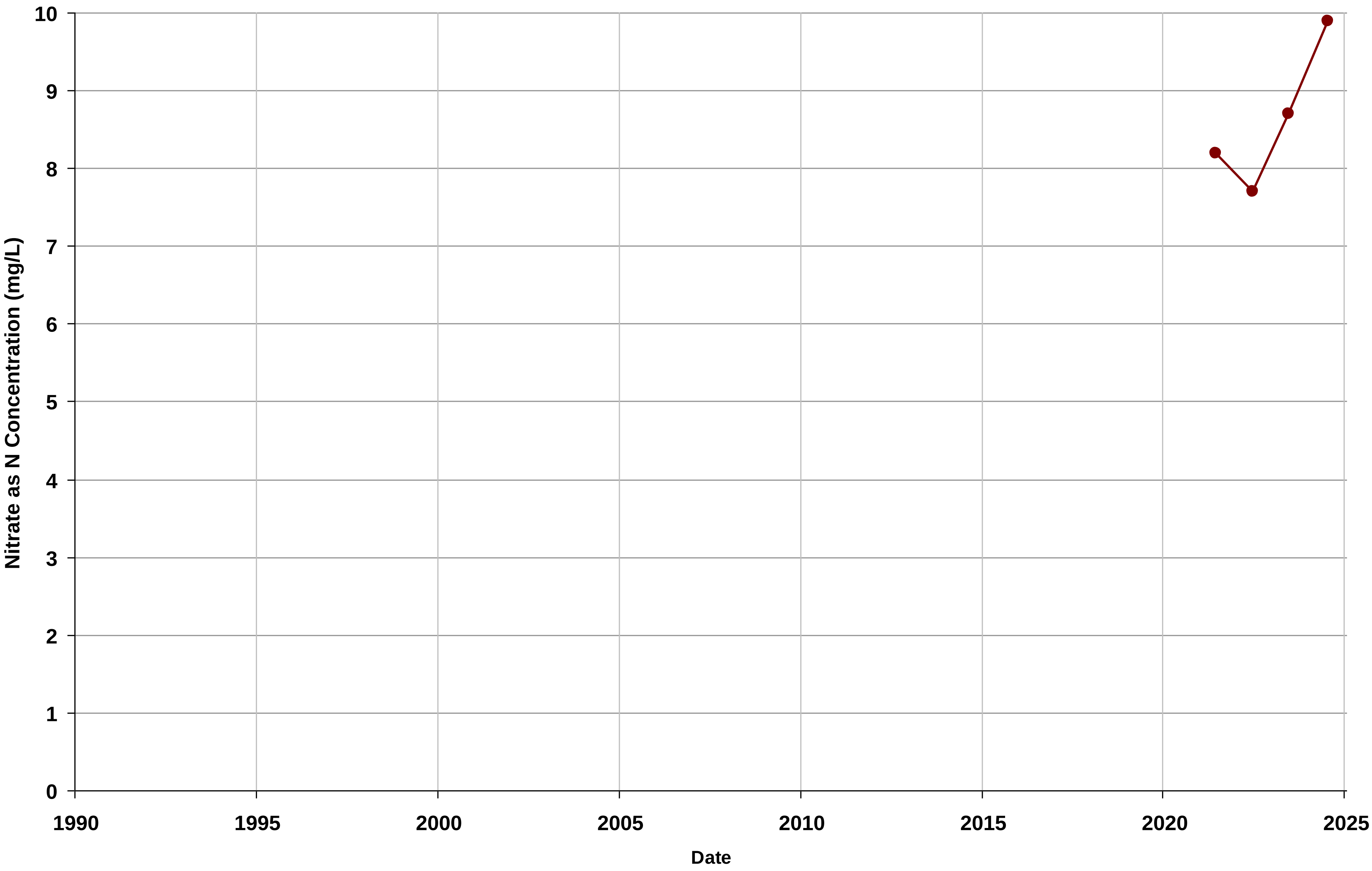
Total Depth (ft bgs): 715
Perf. Top (ft bgs): 630
Perf. Bottom (ft bgs): 705



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB09A
Subbasin: Madera
Well Type: Observation

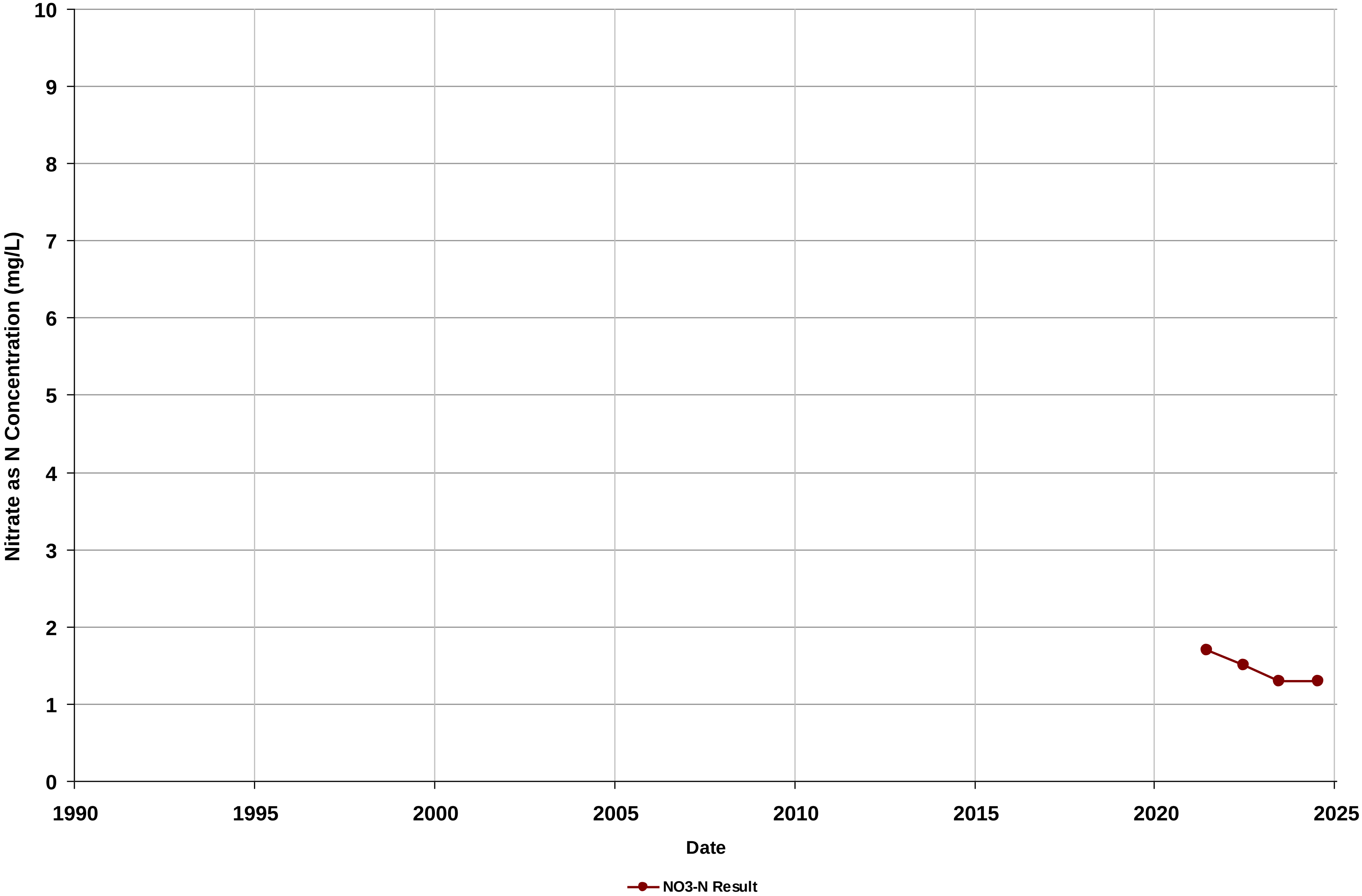
Total Depth (ft bgs): 320
Perf. Top (ft bgs): 200
Perf. Bottom (ft bgs): 310



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB09B
Subbasin: Madera
Well Type: Observation

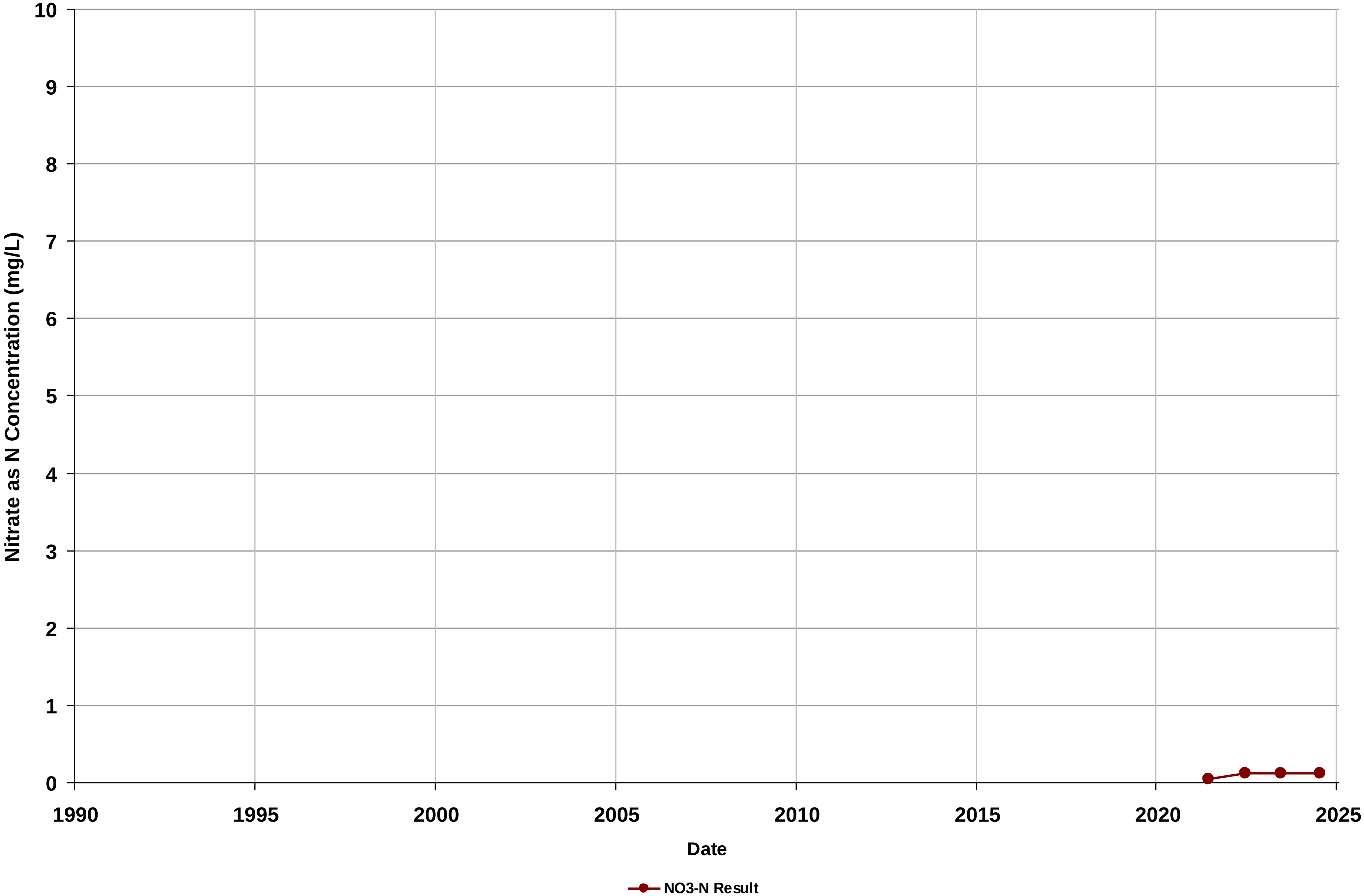
Total Depth (ft bgs): 725
Perf. Top (ft bgs): 520
Perf. Bottom (ft bgs): 715



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB09C
Subbasin: Madera
Well Type: Observation

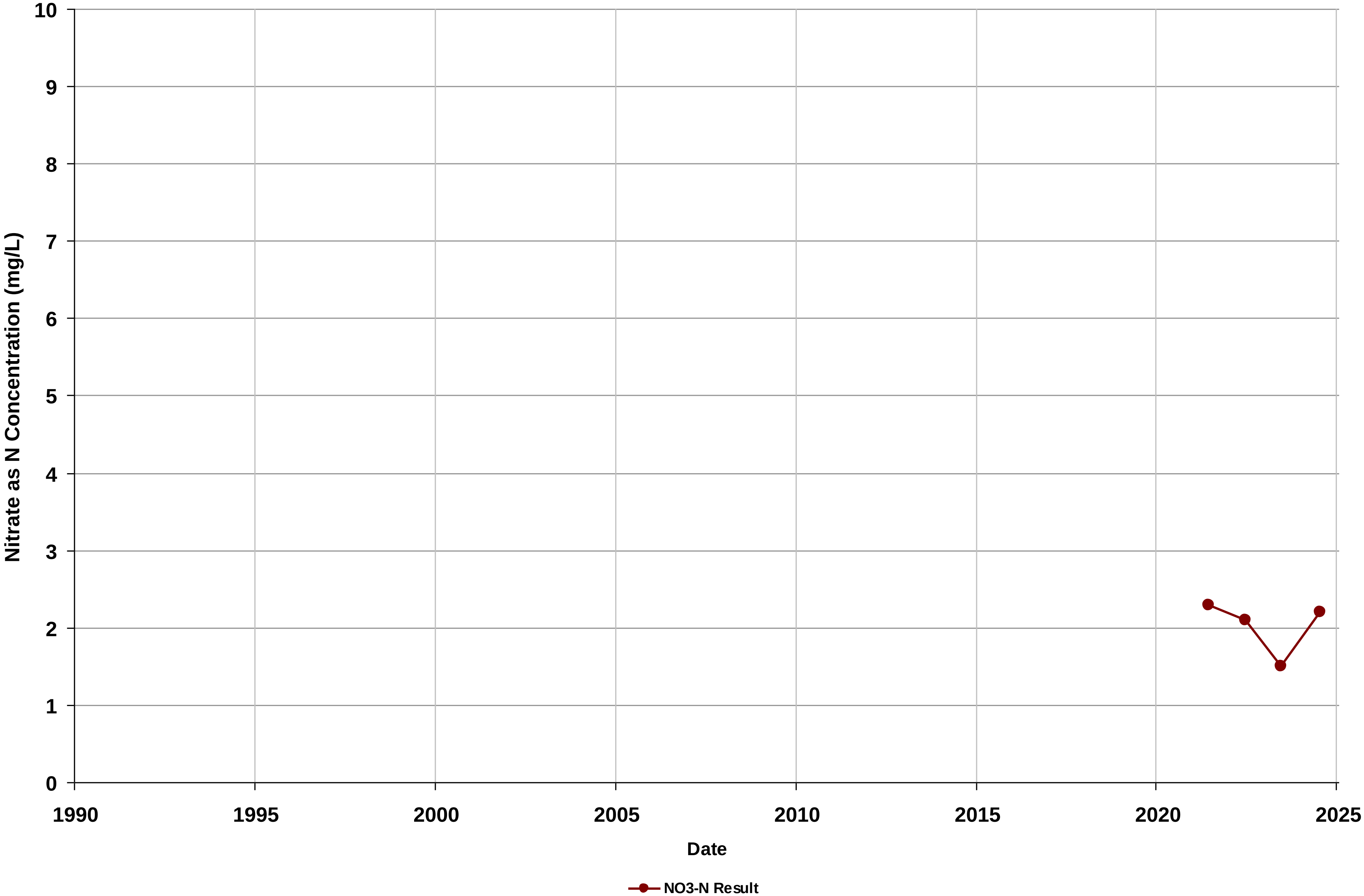
Total Depth (ft bgs): 955
Perf. Top (ft bgs): 880
Perf. Bottom (ft bgs): 945



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB10B
Subbasin: Madera
Well Type: Observation

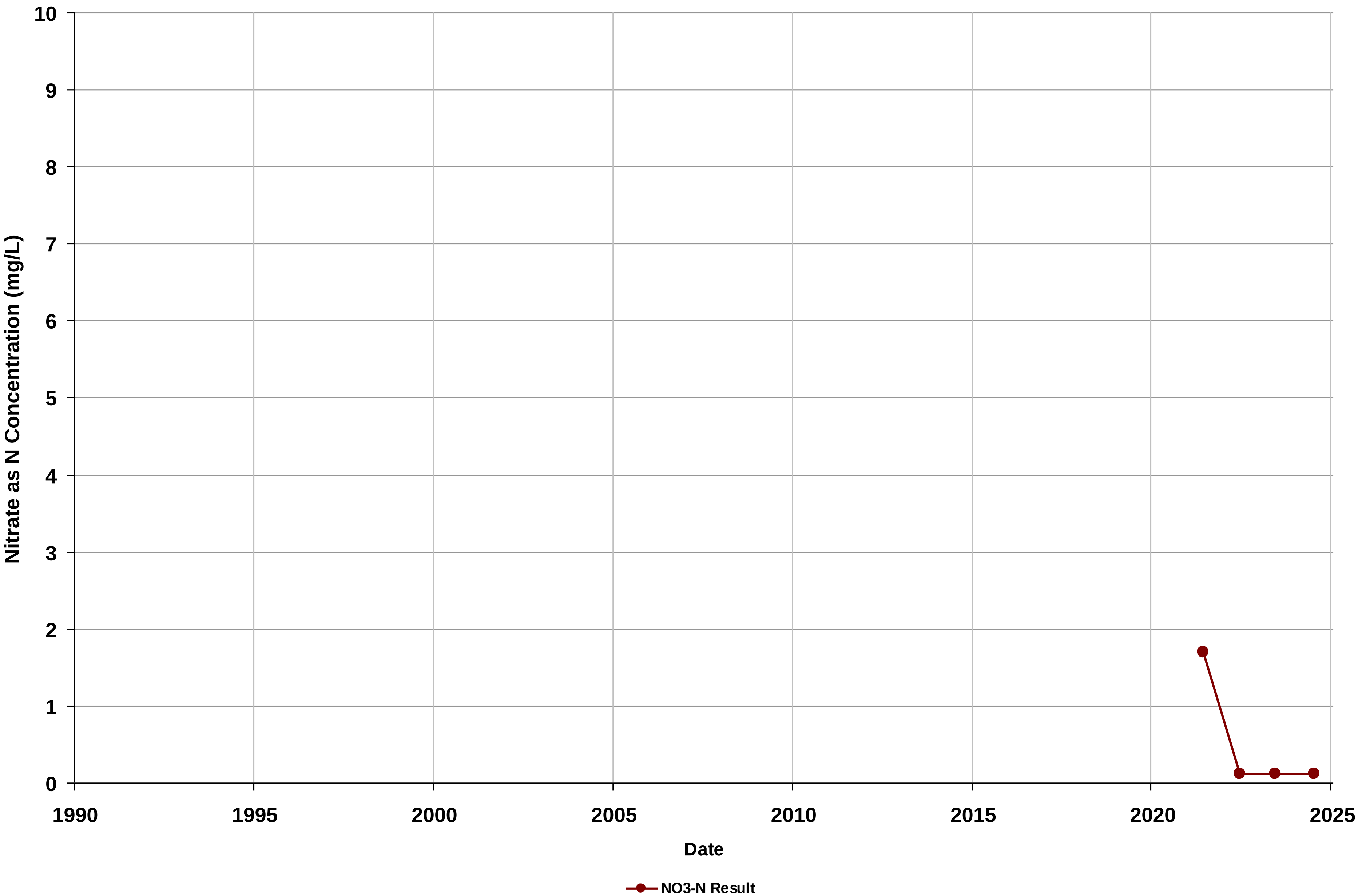
Total Depth (ft bgs): 510
Perf. Top (ft bgs): 400
Perf. Bottom (ft bgs): 500



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB10C
Subbasin: Madera
Well Type: Observation

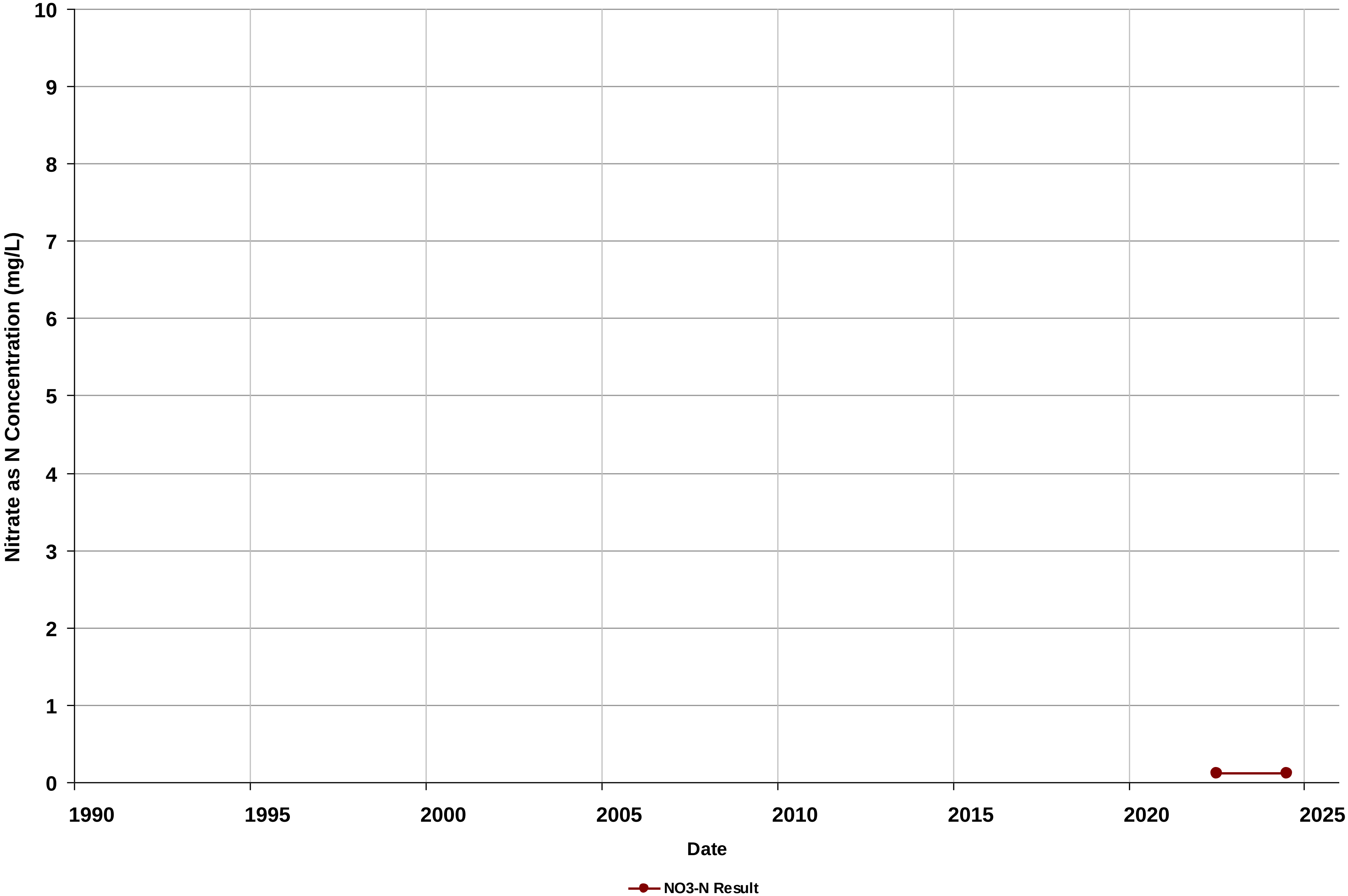
Total Depth (ft bgs): 880
Perf. Top (ft bgs): 790
Perf. Bottom (ft bgs): 870



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB11C
Subbasin: Madera
Well Type: Observation

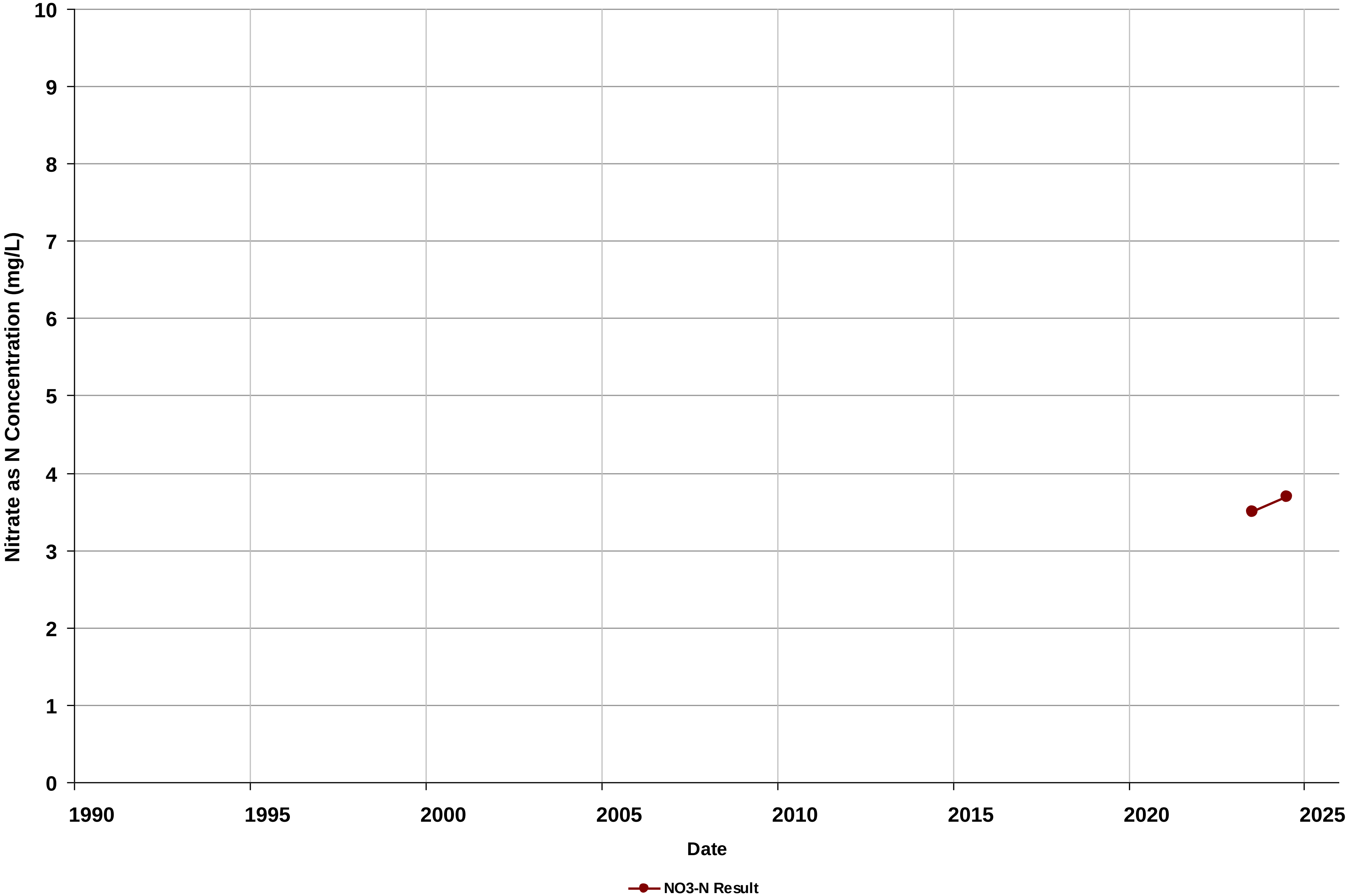
Total Depth (ft bgs): 880
Perf. Top (ft bgs): 775
Perf. Bottom (ft bgs): 870



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB13B
Subbasin: Madera
Well Type: Monitoring

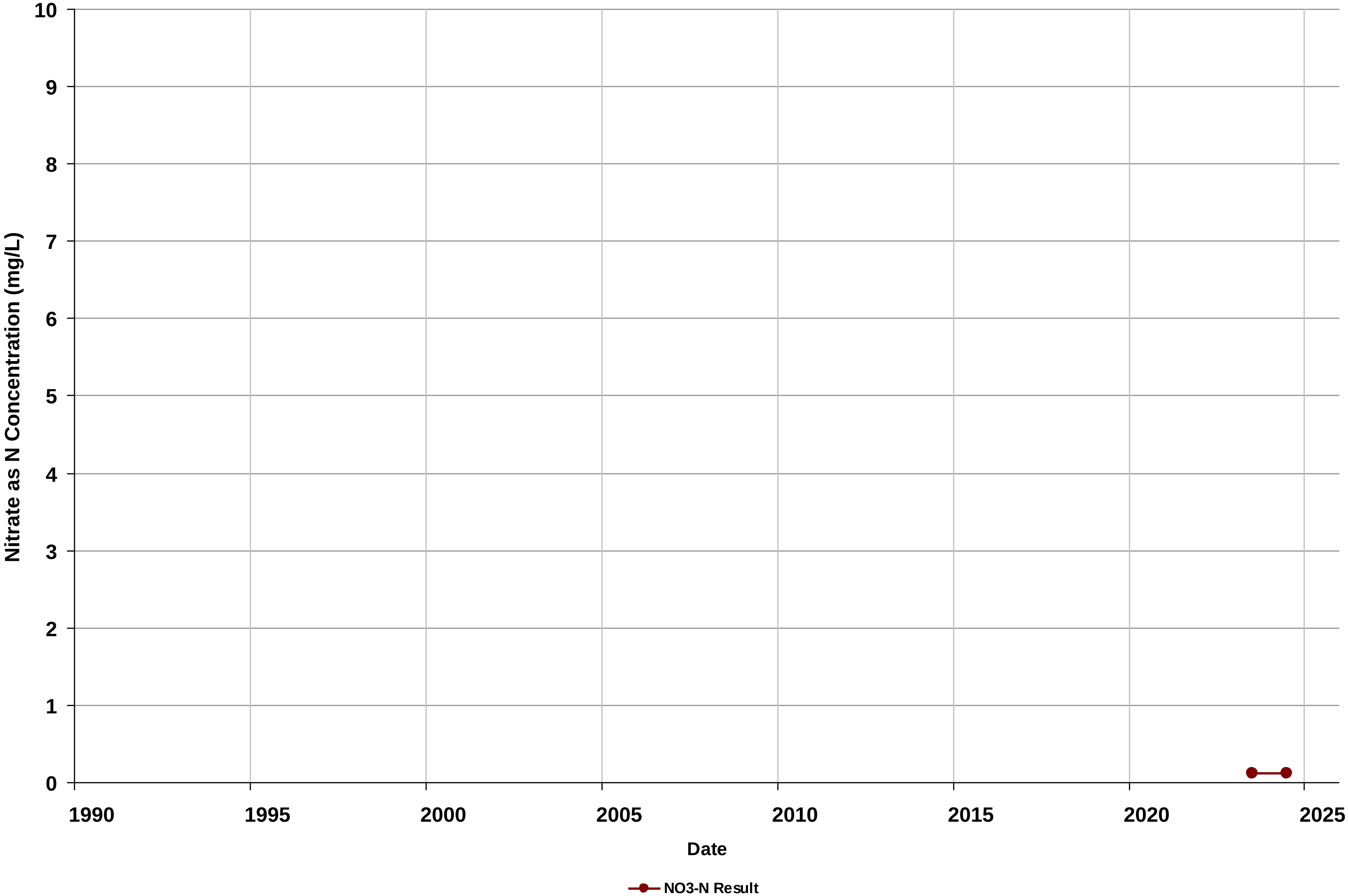
Total Depth (ft bgs): 446
Perf. Top (ft bgs): 396
Perf. Bottom (ft bgs): 436



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB13C
Subbasin: Madera
Well Type: Monitoring

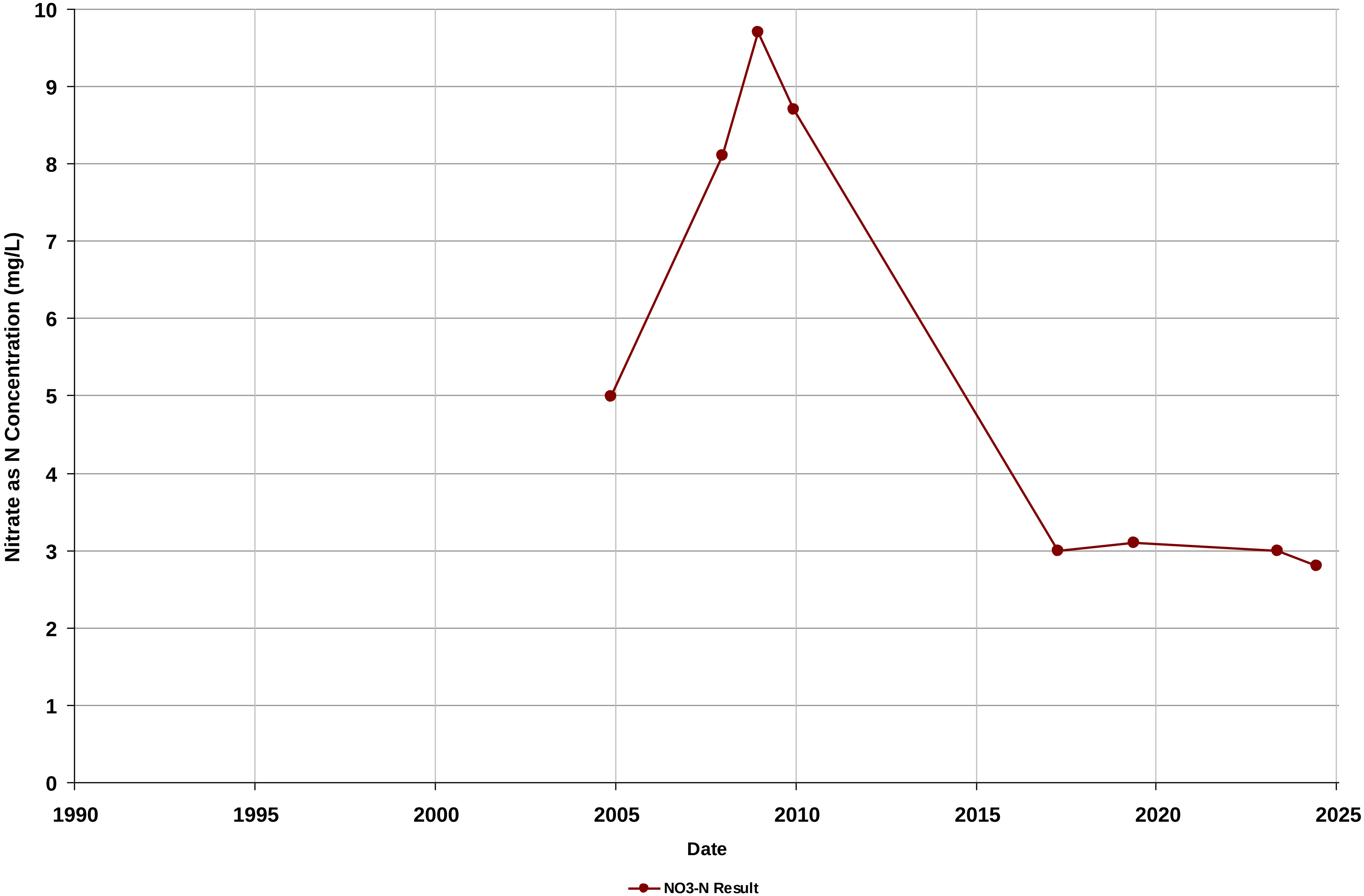
Total Depth (ft bgs): 532
Perf. Top (ft bgs): 522
Perf. Bottom (ft bgs): 532



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2000507-001
Subbasin: Madera
Well Type: Public Supply

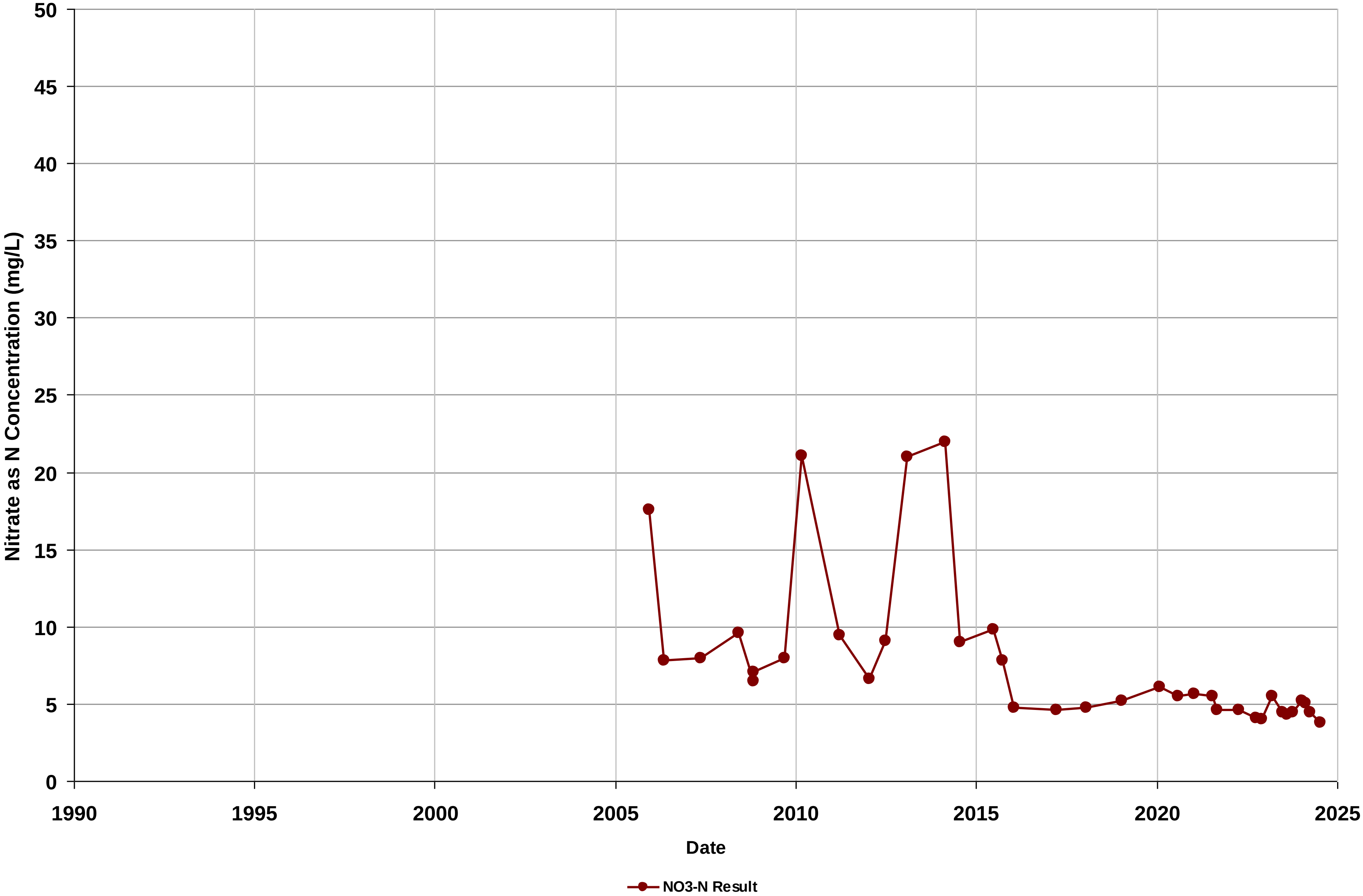
Total Depth (ft bgs):
Perf. Top (ft bgs): 372
Perf. Bottom (ft bgs): 372



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2000553-001
Subbasin: Madera
Well Type: Public Supply

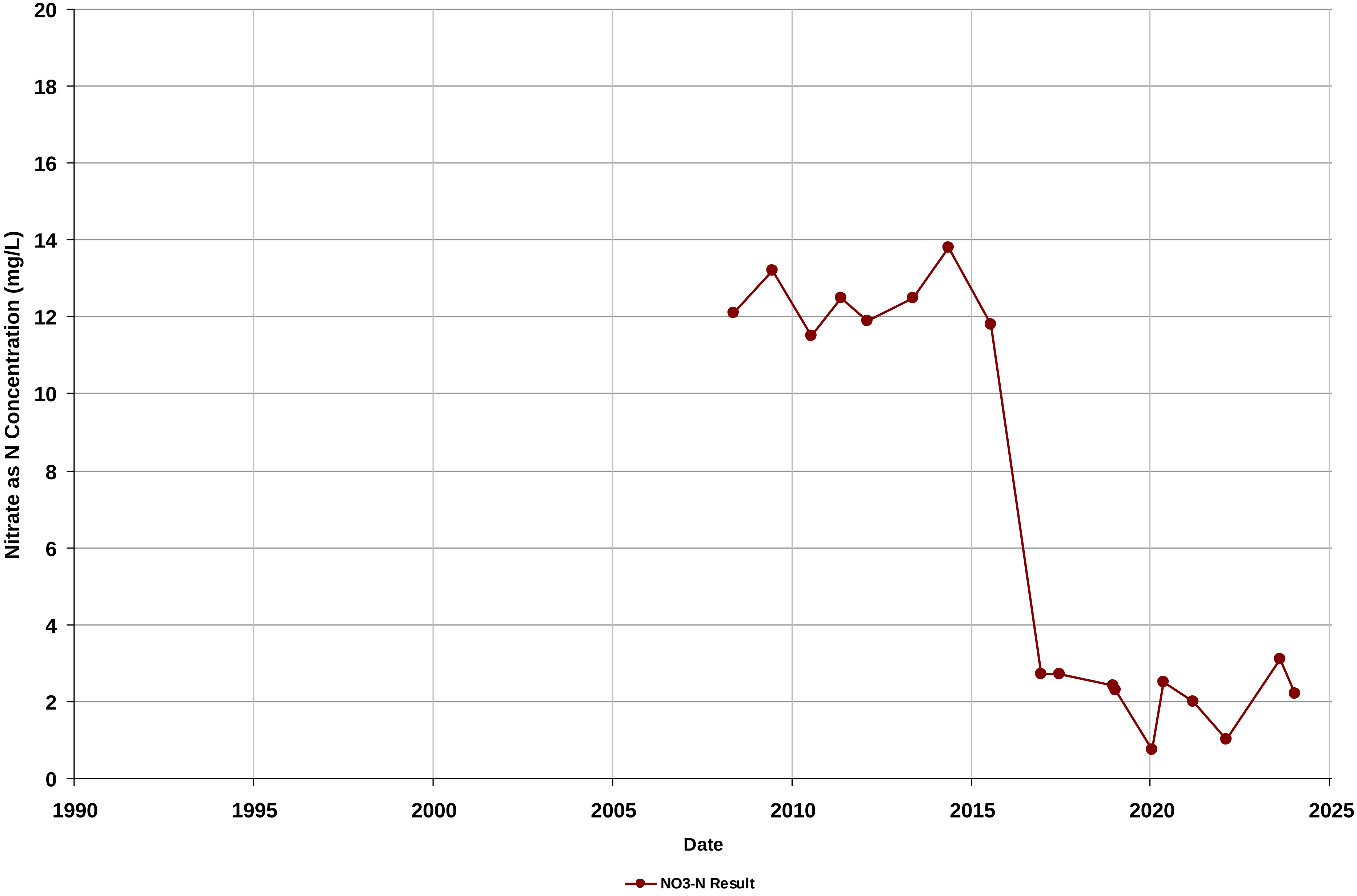
Total Depth (ft bgs):
Perf. Top (ft bgs): 450
Perf. Bottom (ft bgs): 500



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2000682-002
Subbasin: Madera
Well Type: Public Supply

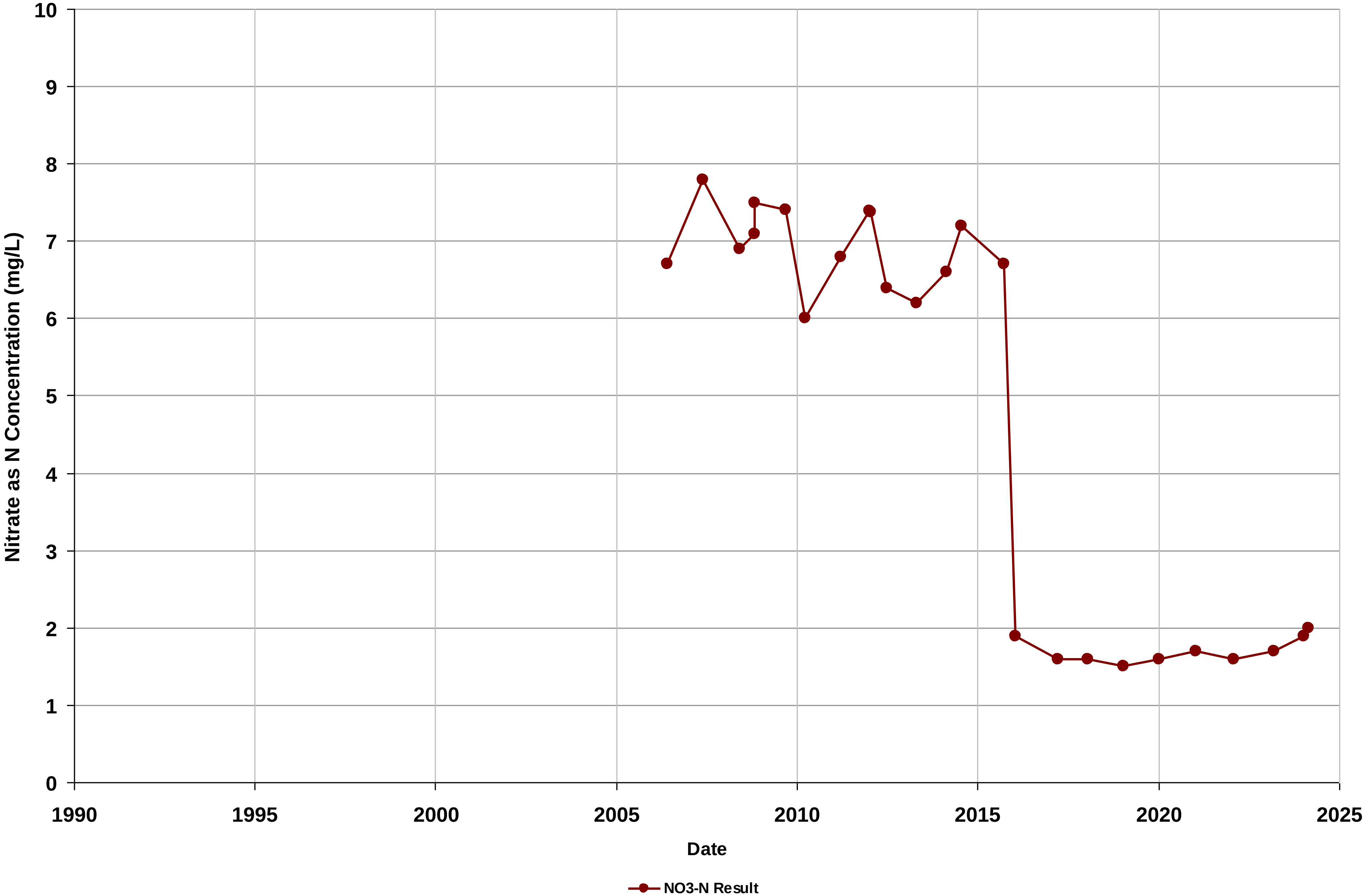
Total Depth (ft bgs):
Perf. Top (ft bgs): 295
Perf. Bottom (ft bgs): 420



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2000727-001
Subbasin: Madera
Well Type: Public Supply

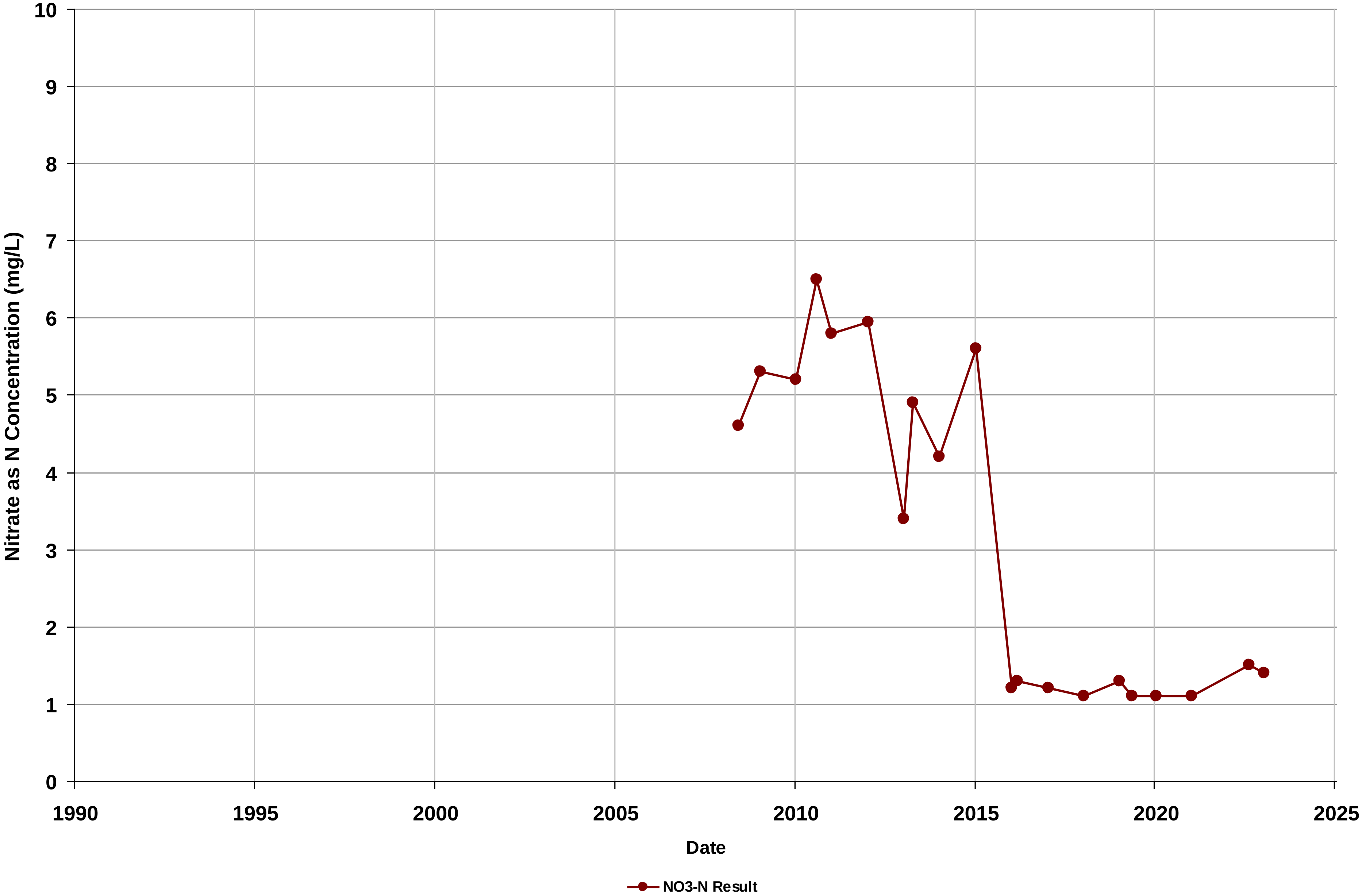
Total Depth (ft bgs):
Perf. Top (ft bgs): 280
Perf. Bottom (ft bgs): 360



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2000938-001
Subbasin: Madera
Well Type: Public Supply

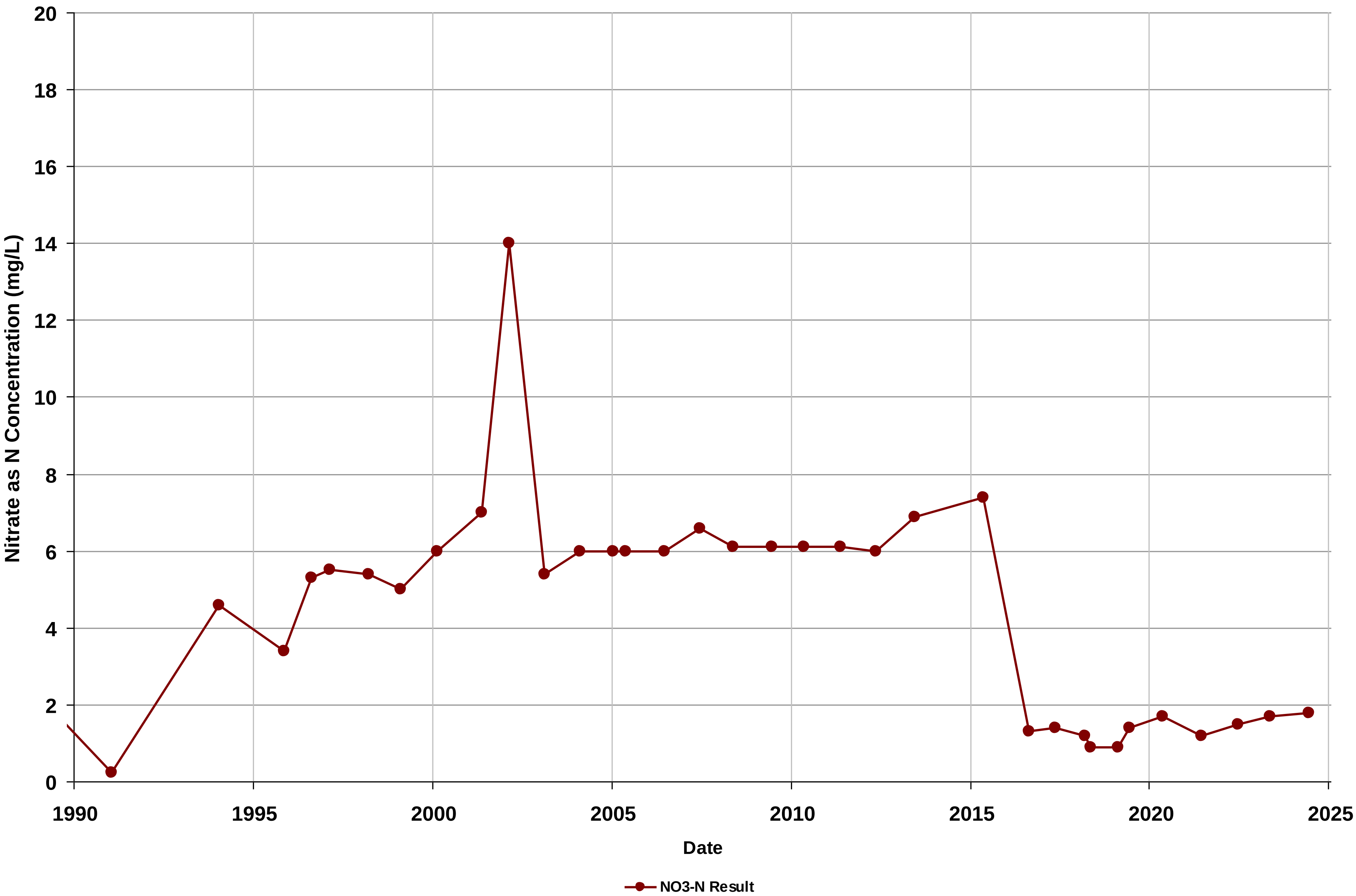
Total Depth (ft bgs):
Perf. Top (ft bgs): 420
Perf. Bottom (ft bgs): 560



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010002-014
Subbasin: Madera
Well Type: Public Supply

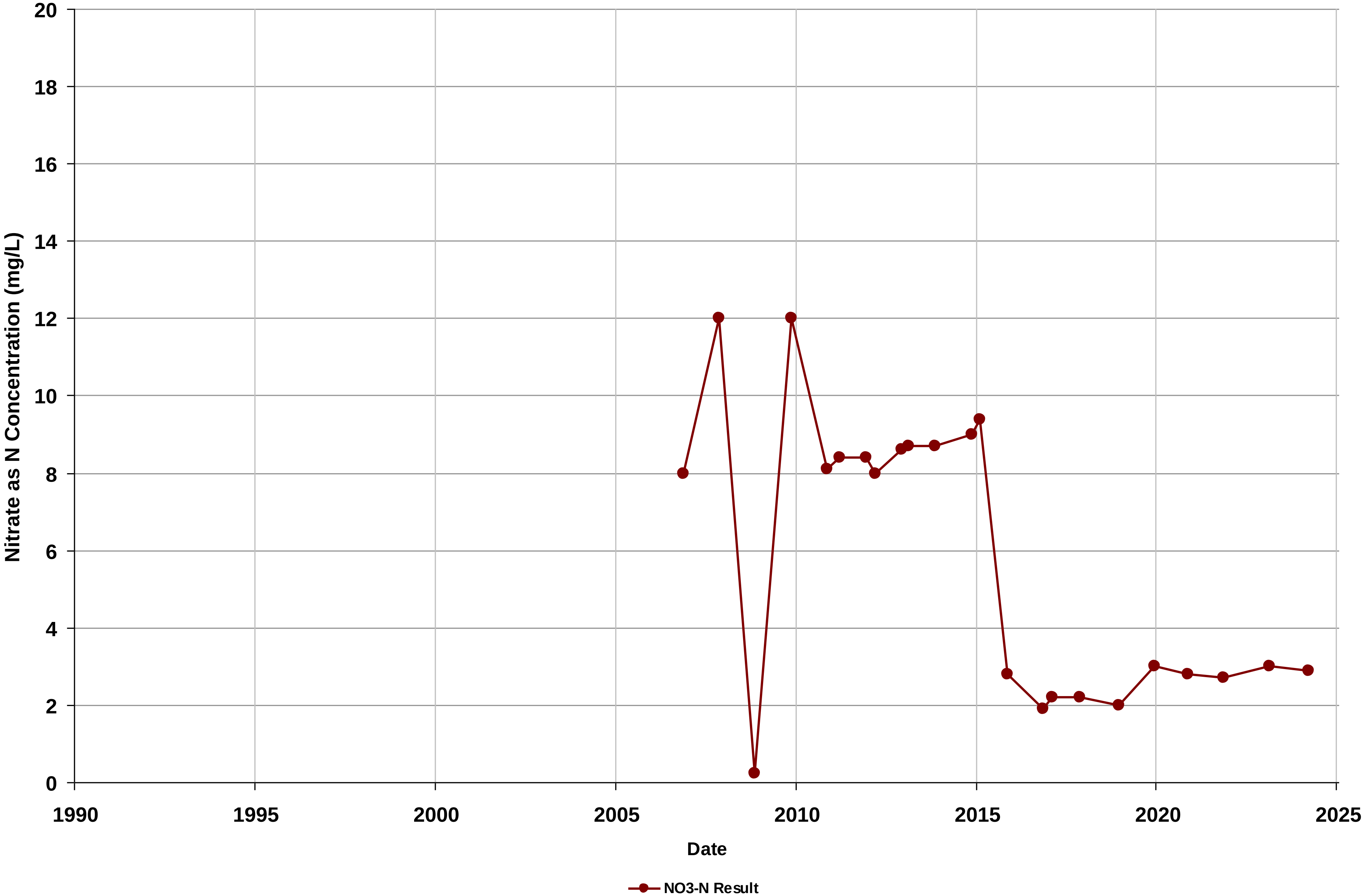
Total Depth (ft bgs):
Perf. Top (ft bgs): 280
Perf. Bottom (ft bgs): 610



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010002-032
Subbasin: Madera
Well Type: Public Supply

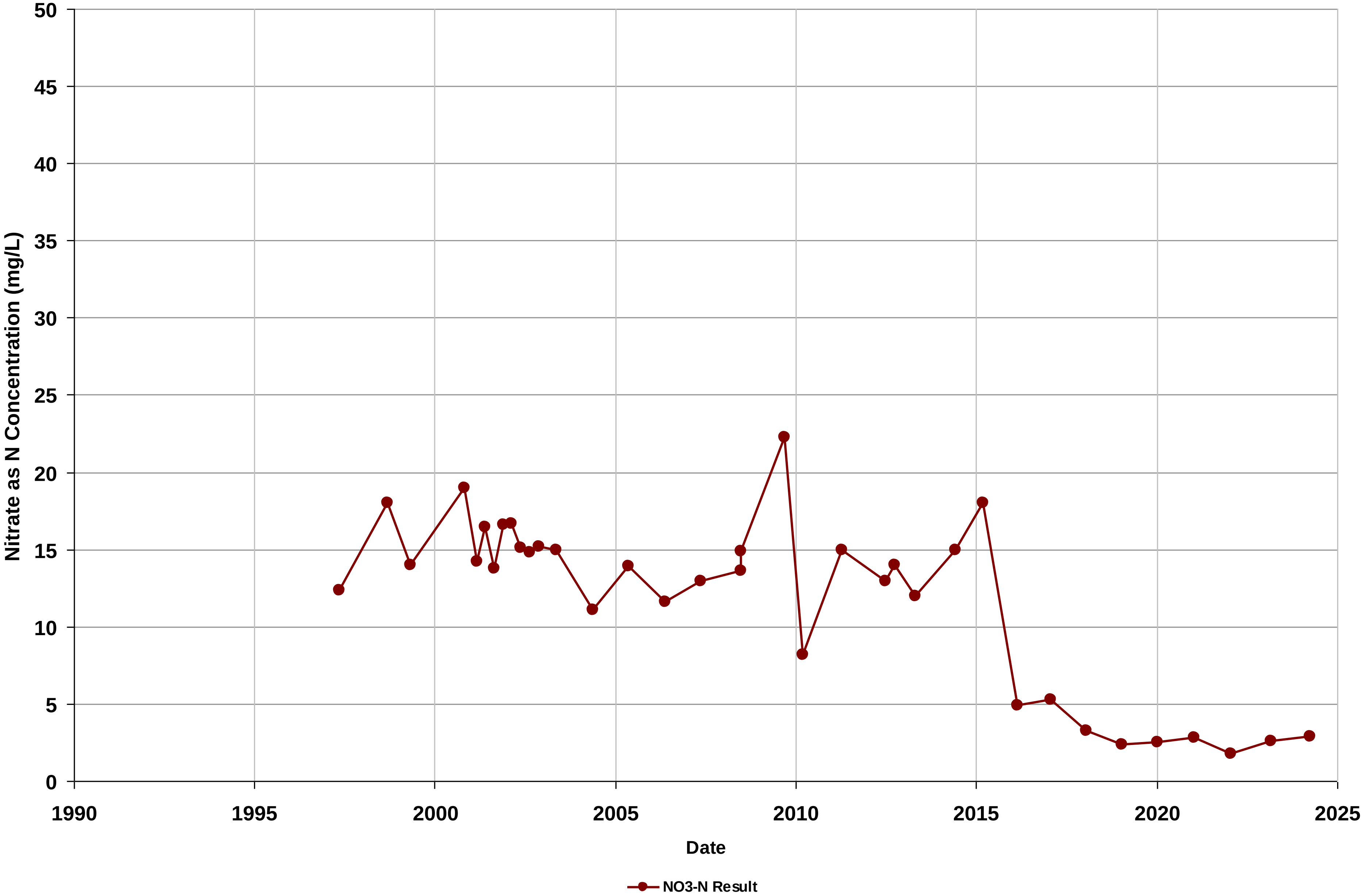
Total Depth (ft bgs):
Perf. Top (ft bgs): 310
Perf. Bottom (ft bgs): 600



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010008-005
Subbasin: Madera
Well Type: Public Supply

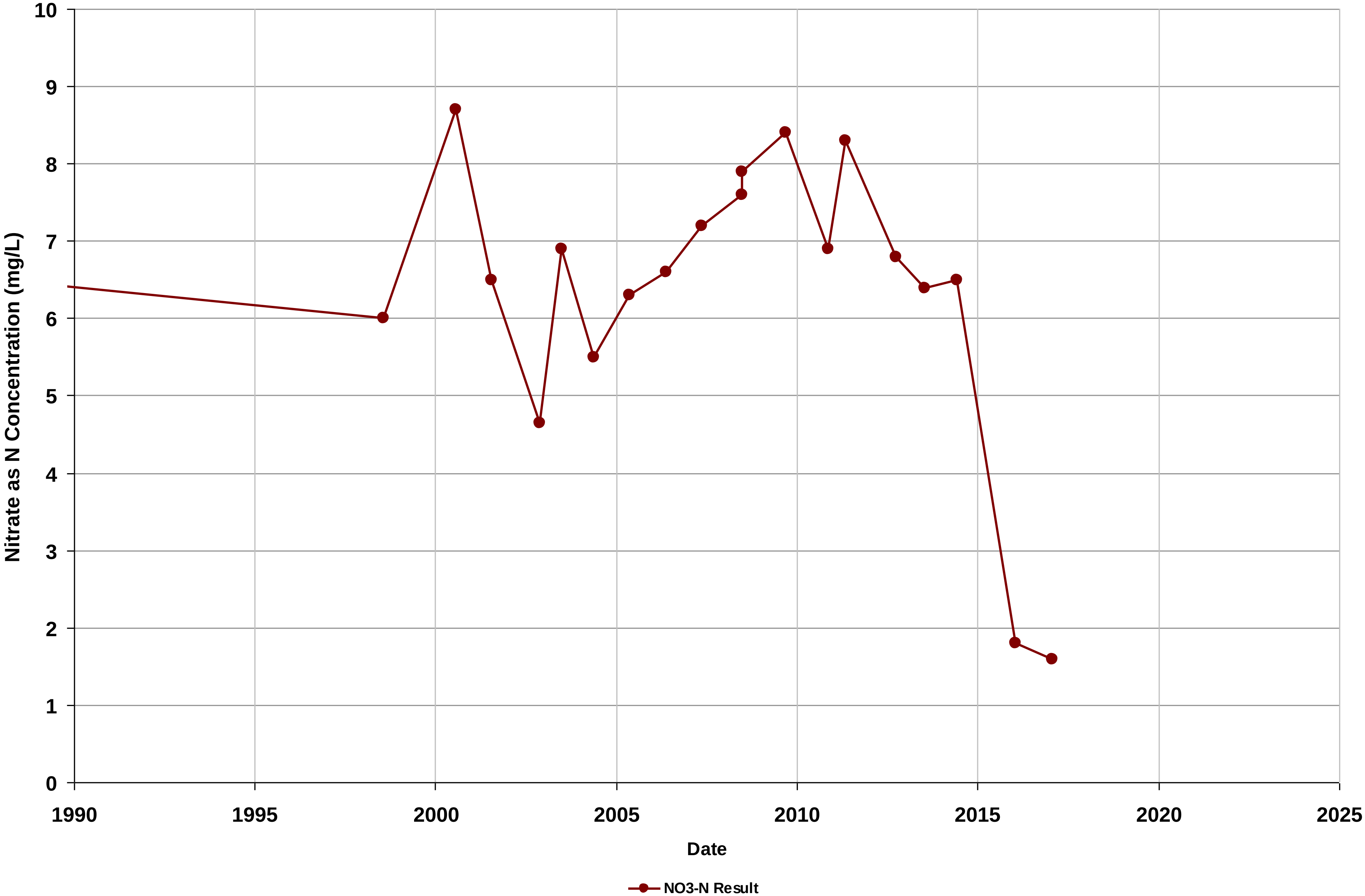
Total Depth (ft bgs):
Perf. Top (ft bgs): 250
Perf. Bottom (ft bgs): 465



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010009-002
Subbasin: Madera
Well Type: Public Supply

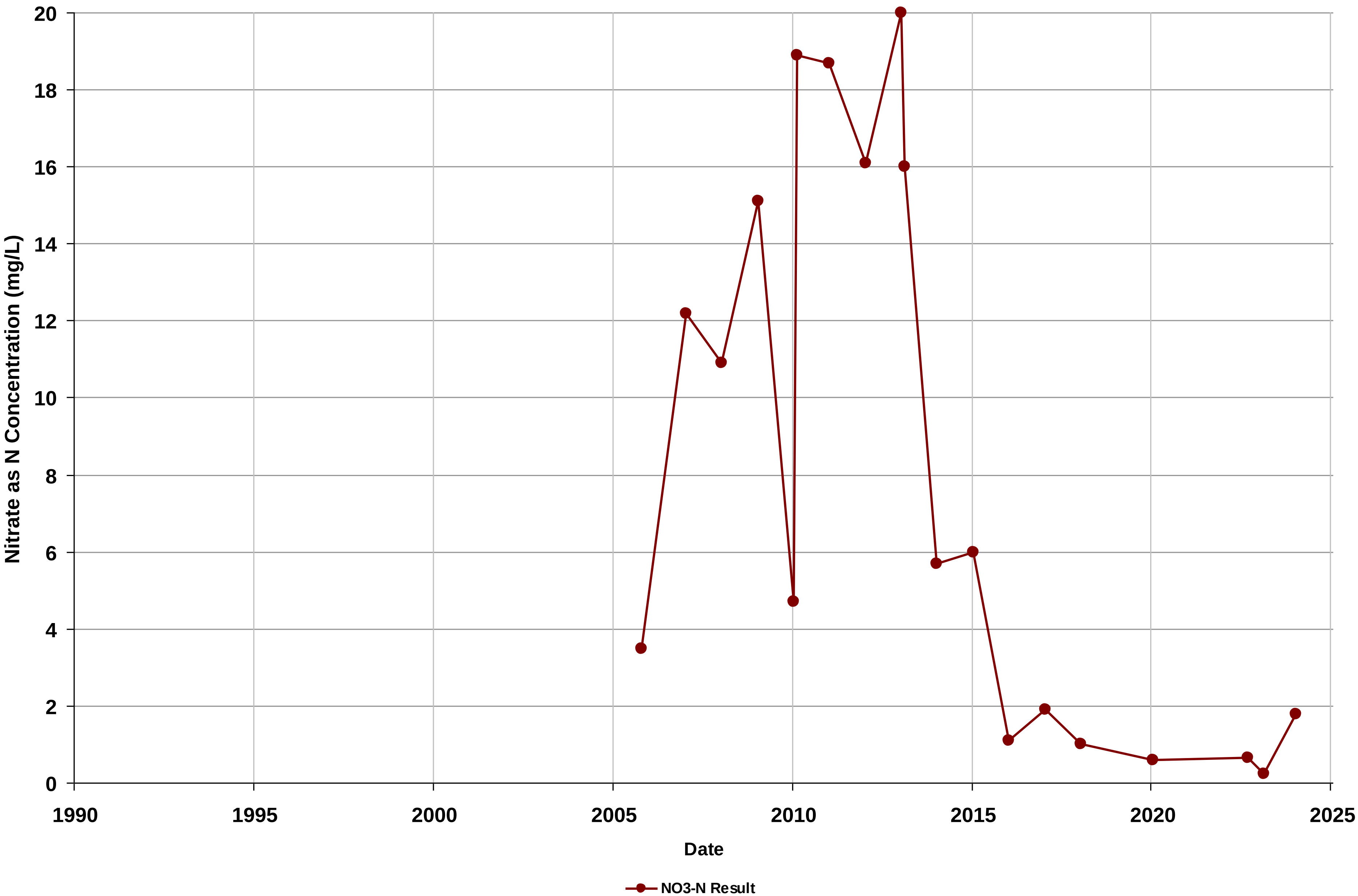
Total Depth (ft bgs):
Perf. Top (ft bgs): 324
Perf. Bottom (ft bgs): 369



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010010-007
Subbasin: Madera
Well Type: Public Supply

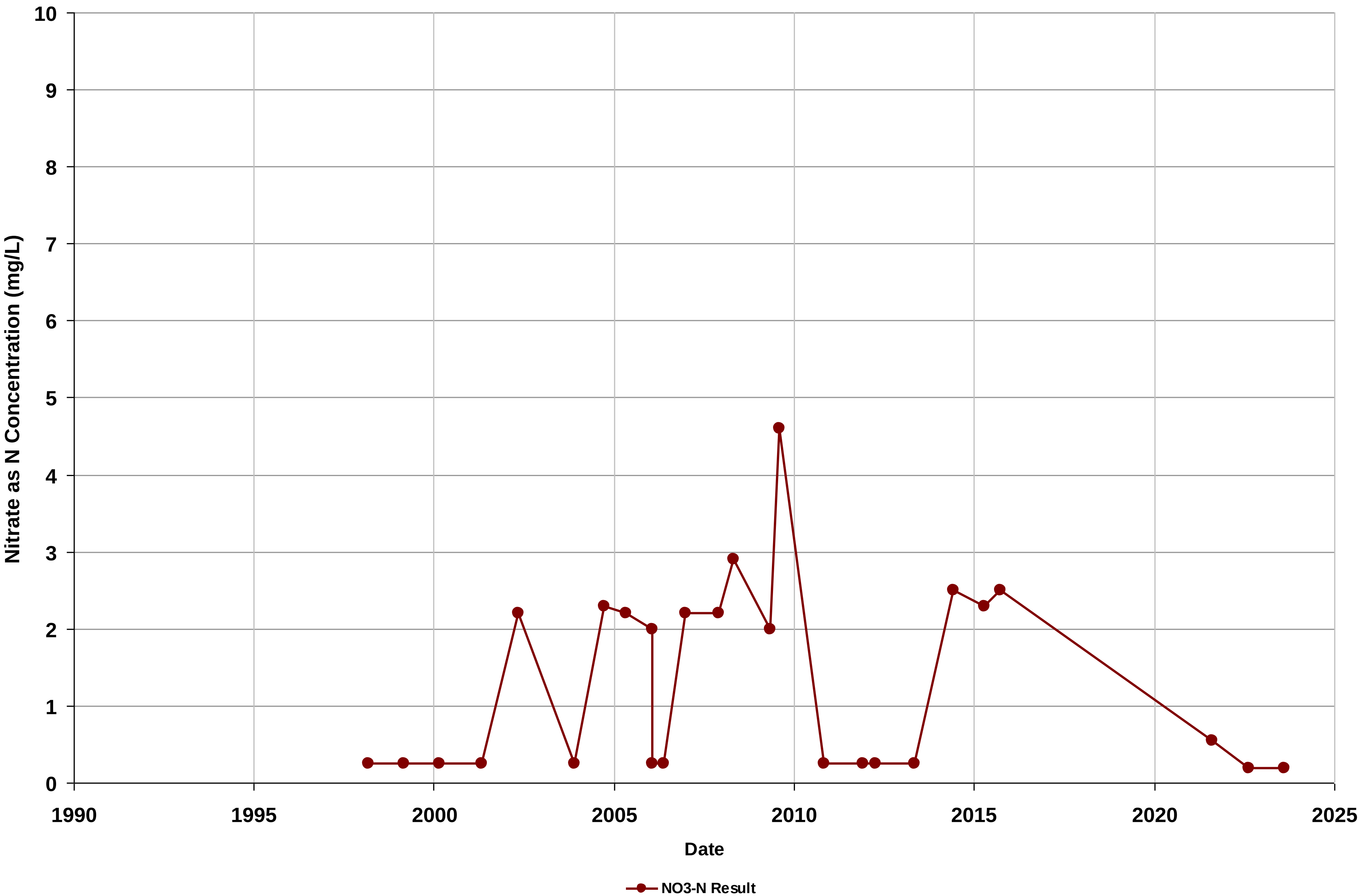
Total Depth (ft bgs):
Perf. Top (ft bgs): 242
Perf. Bottom (ft bgs): 374



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010801-001
Subbasin: Madera
Well Type: Public Supply

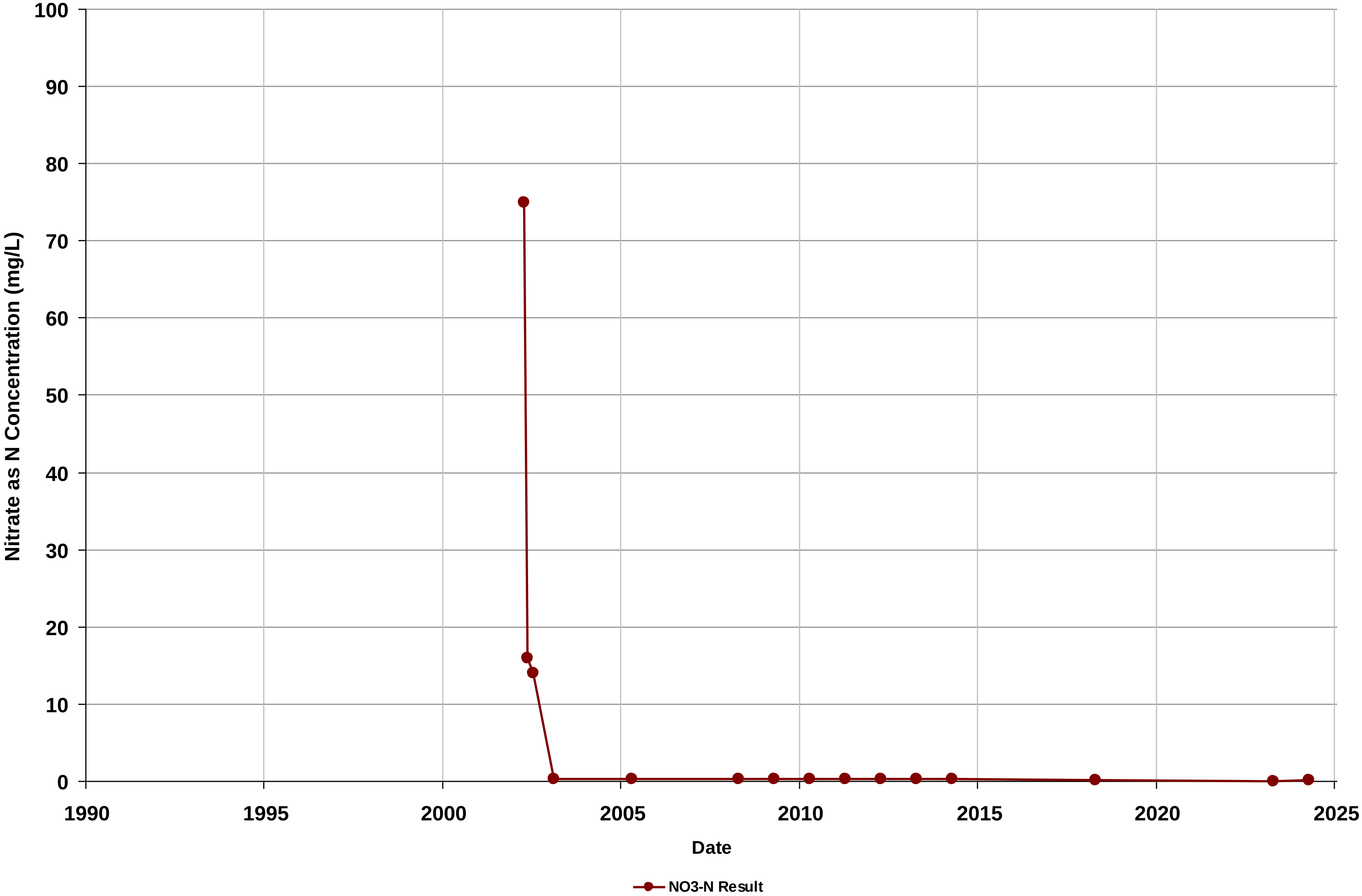
Total Depth (ft bgs):
Perf. Top (ft bgs): 375
Perf. Bottom (ft bgs): 760



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2801077-001
Subbasin: Madera
Well Type: Public Supply

Total Depth (ft bgs):
Perf. Top (ft bgs): 60
Perf. Bottom (ft bgs): 500

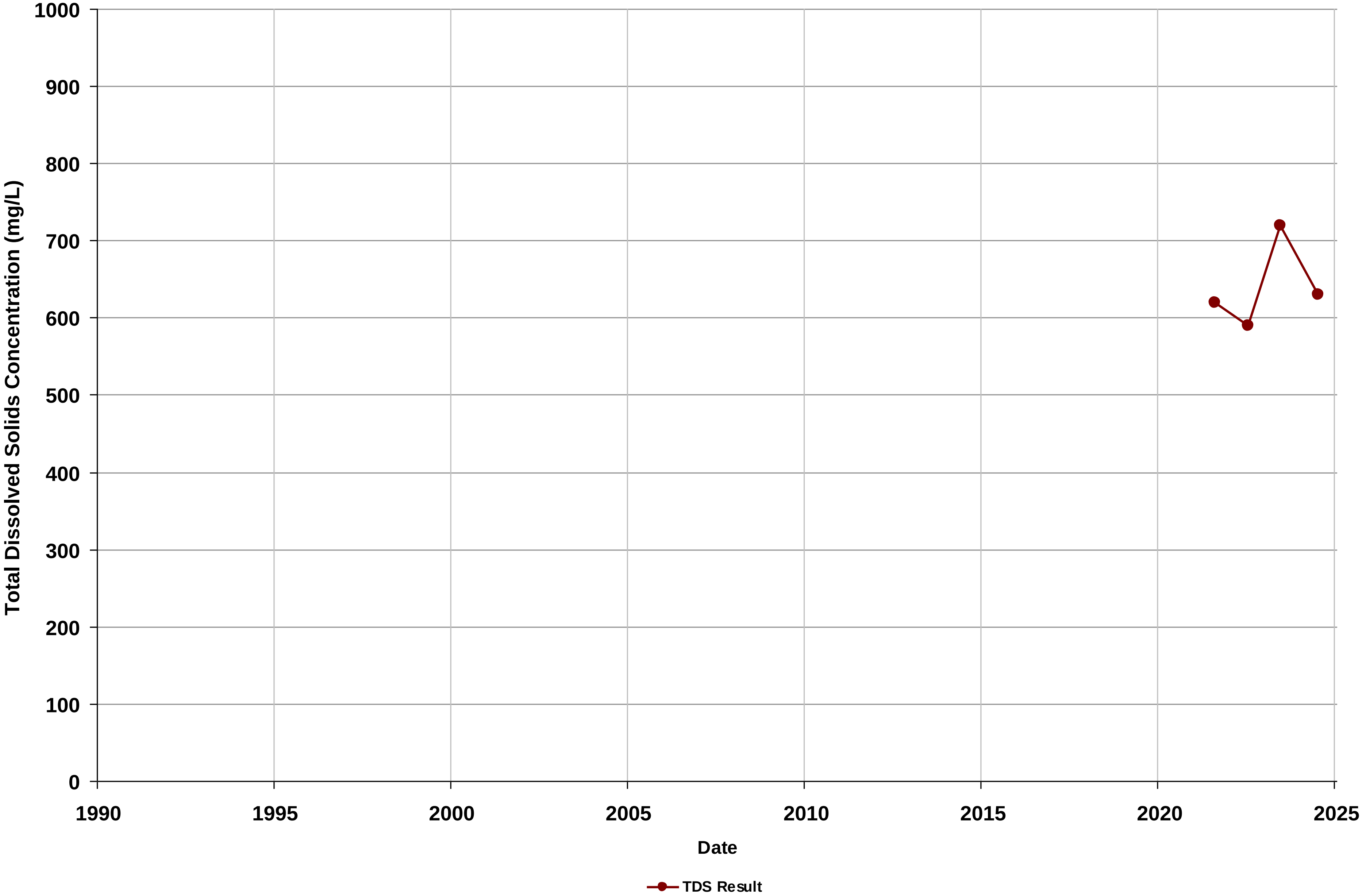


NOTE: Non-Detect results shown as half the reporting limit.

Total Dissolved Solids Hydrographs for Groundwater Quality RMS Wells

Well Name: MCE RMS-3
Subbasin: Madera
Well Type: Unknown

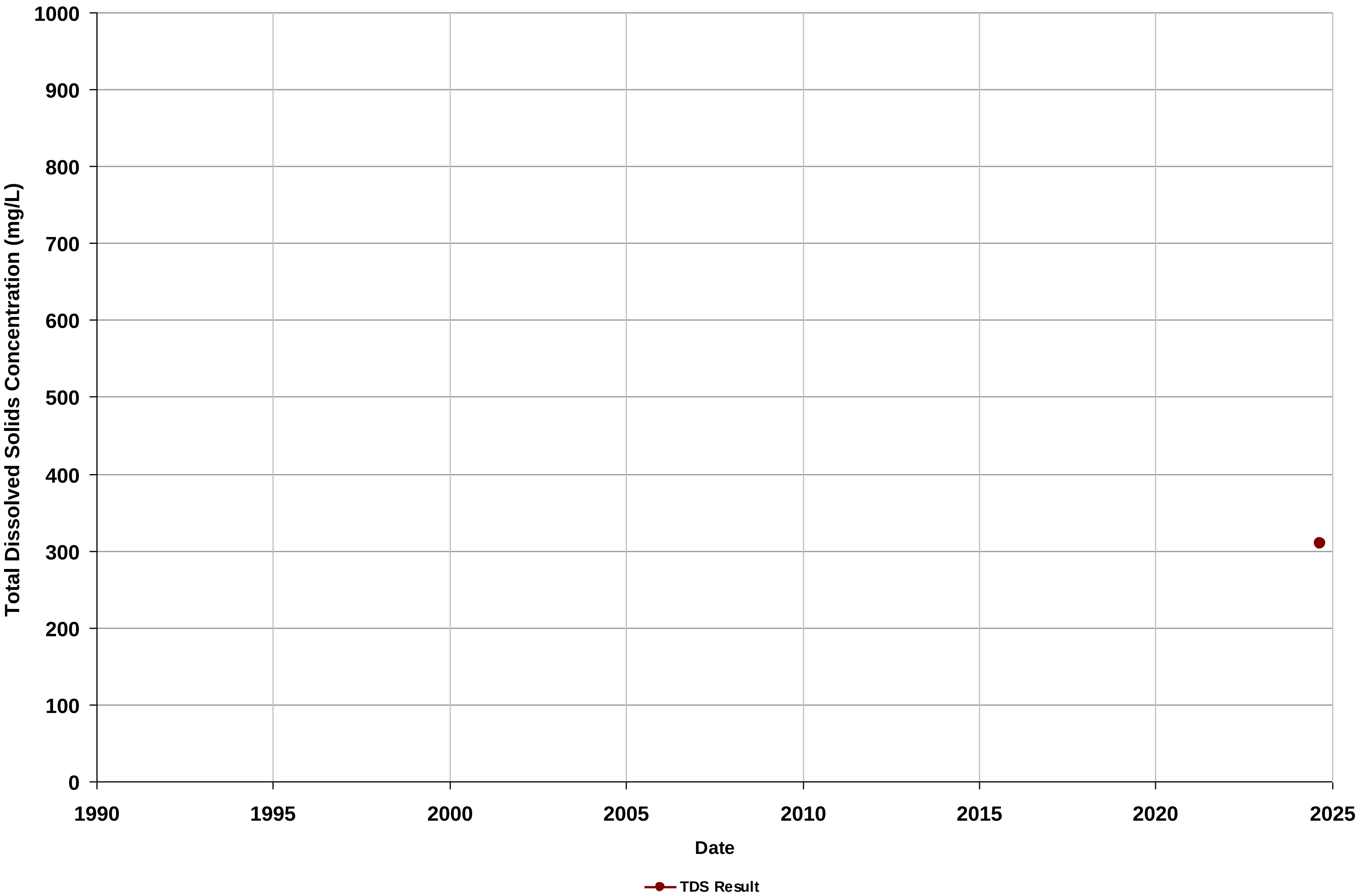
Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MID RMS-4
Subbasin: Madera
Well Type: Irrigation

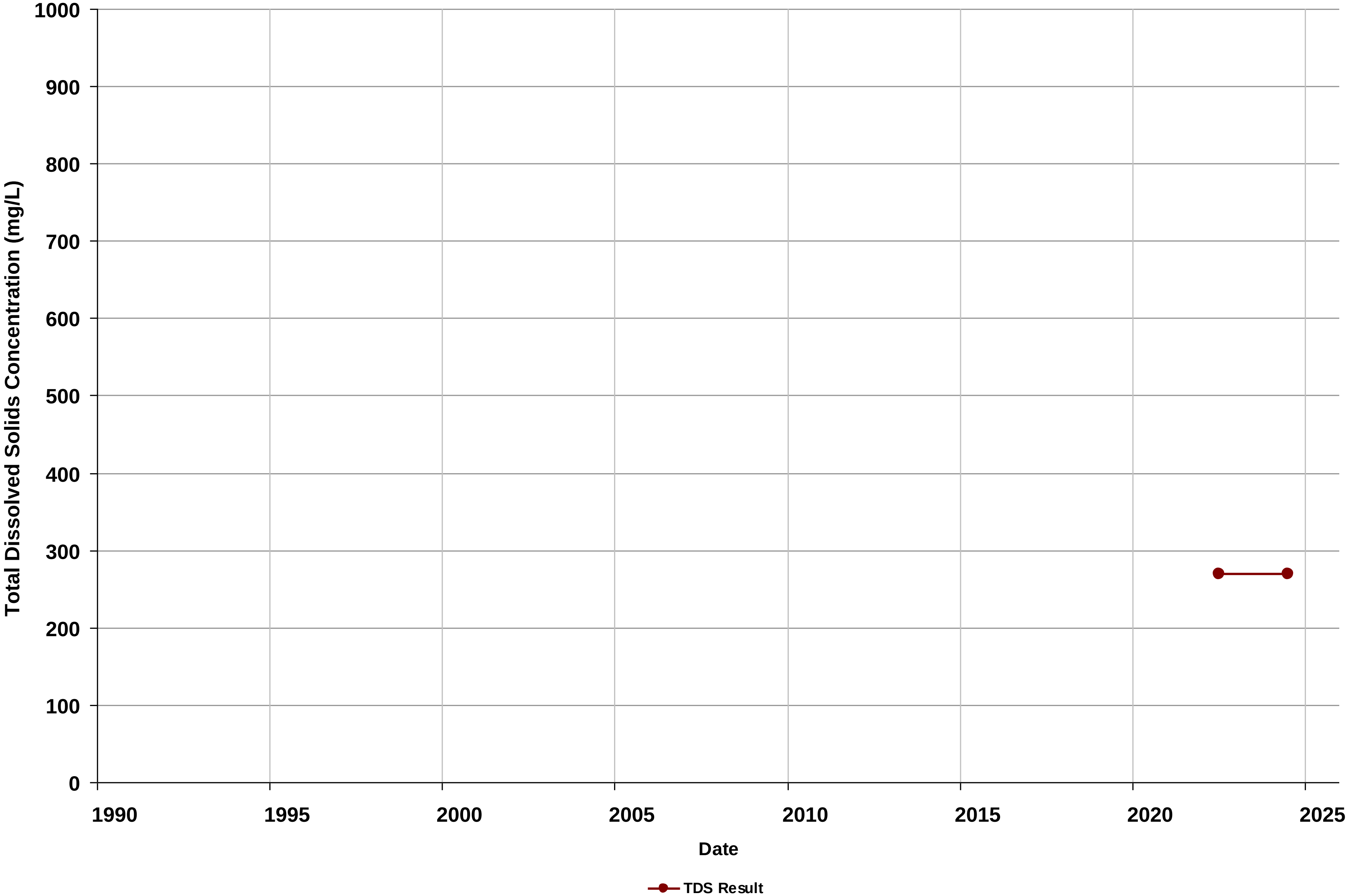
Total Depth (ft bgs): 698
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 667



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MID RMS-6
Subbasin: Madera
Well Type: Industrial

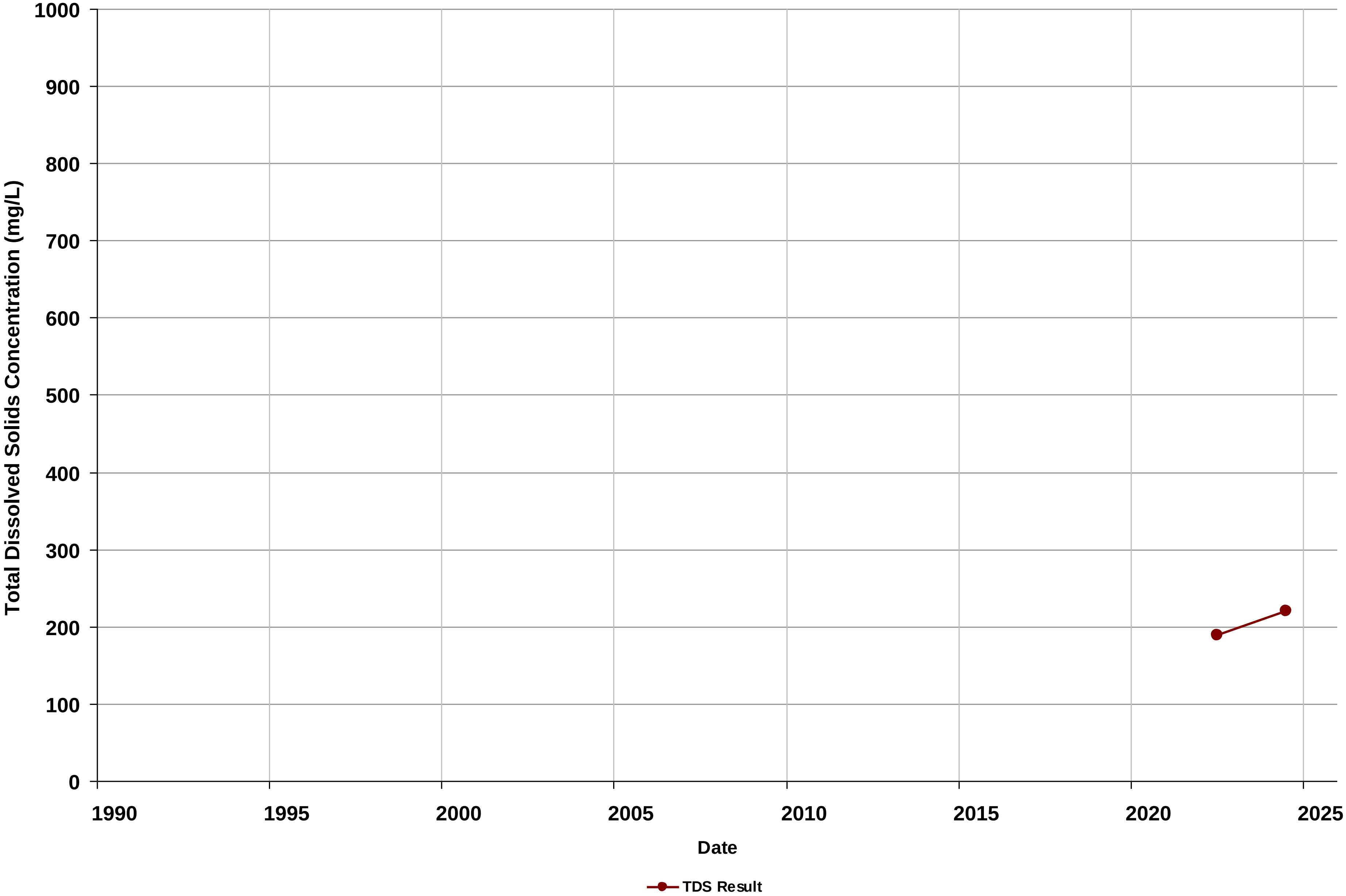
Total Depth (ft bgs): 680
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 680



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MID RMS-7
Subbasin: Madera
Well Type: Irrigation

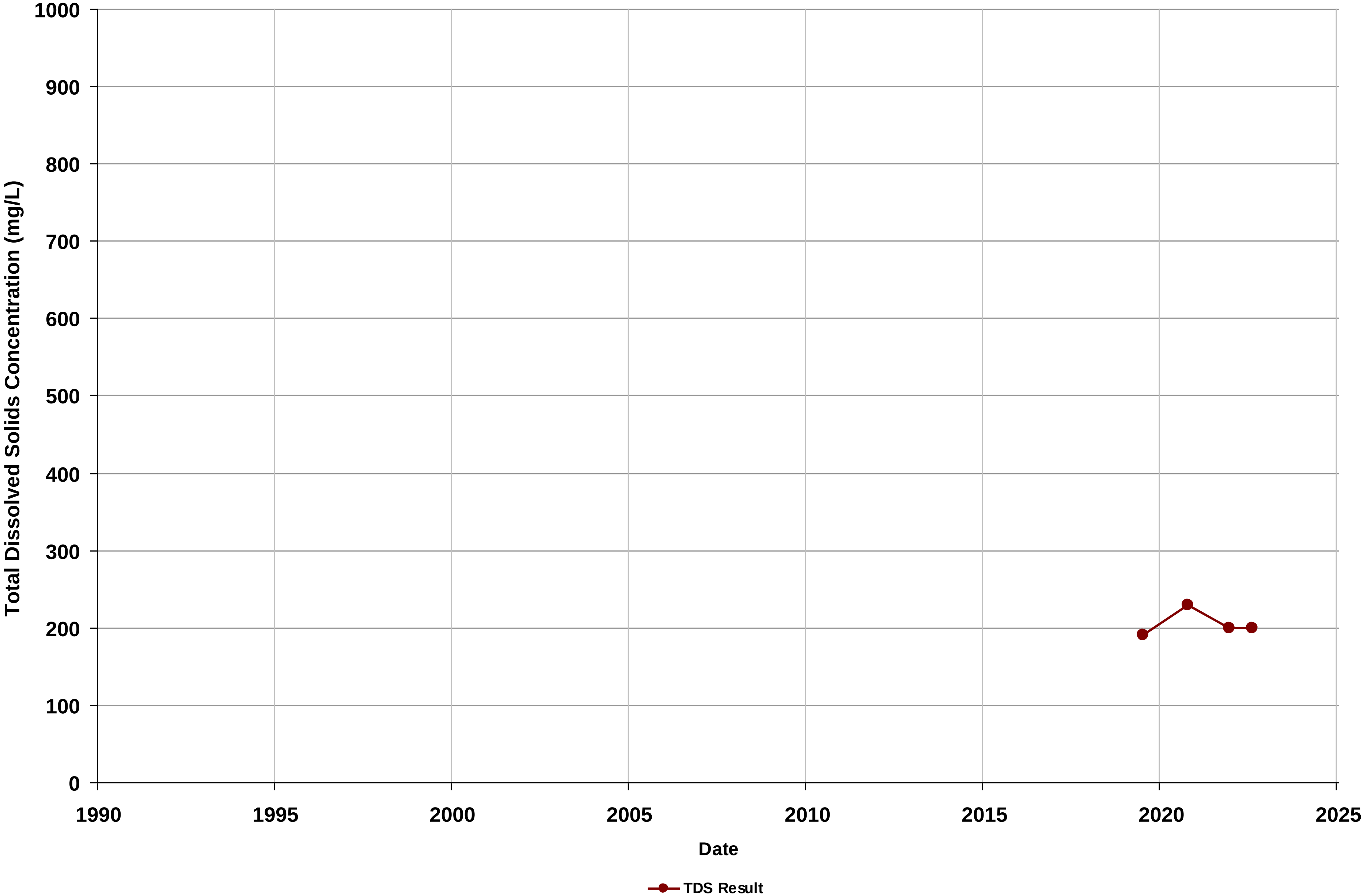
Total Depth (ft bgs): 656
Perf. Top (ft bgs): 290
Perf. Bottom (ft bgs): 635



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MWD RMS-1
Subbasin: Madera
Well Type: Irrigation

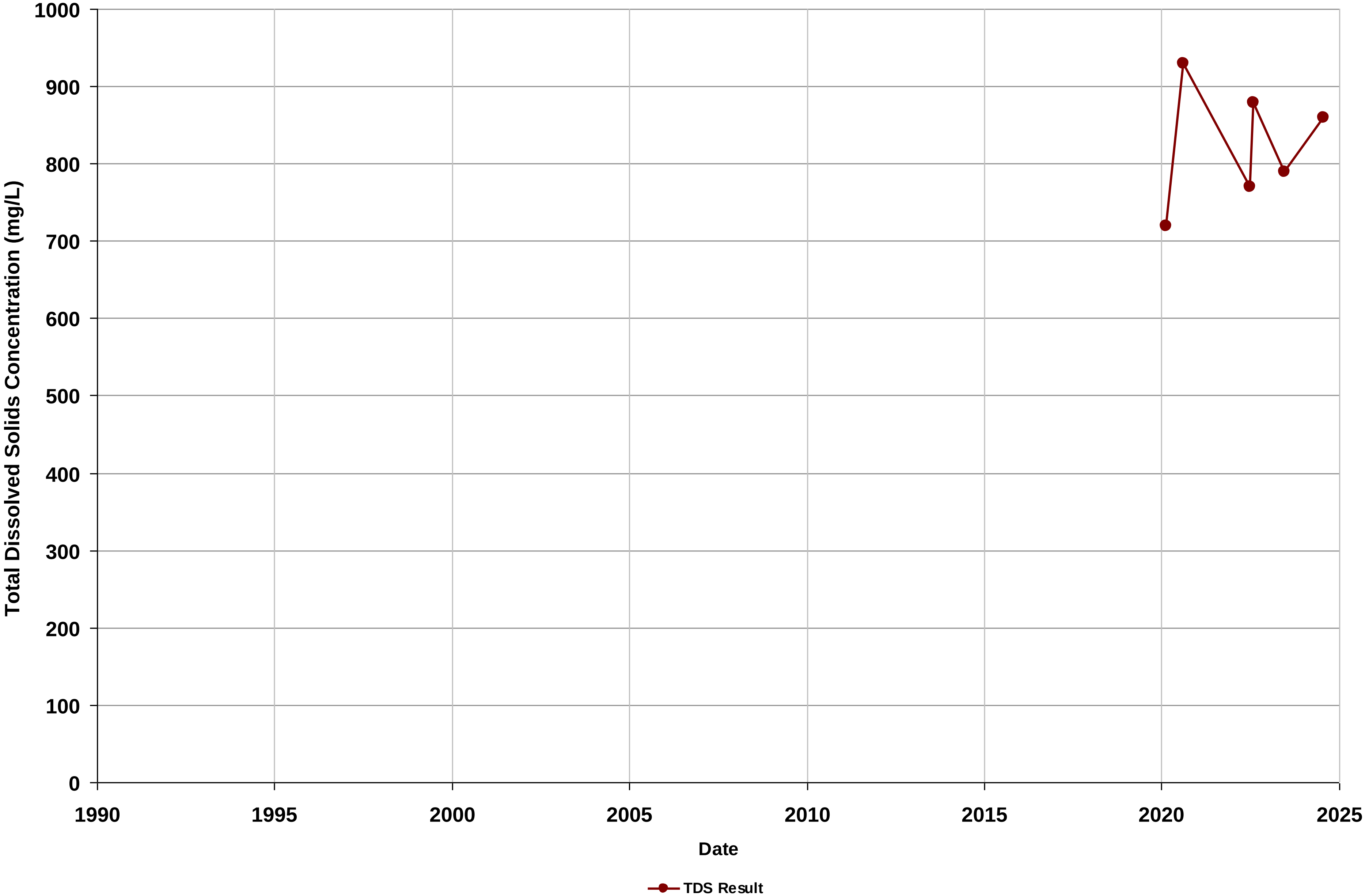
Total Depth (ft bgs): 504
Perf. Top (ft bgs): 200
Perf. Bottom (ft bgs): 500



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB03A
Subbasin: Madera
Well Type: Observation

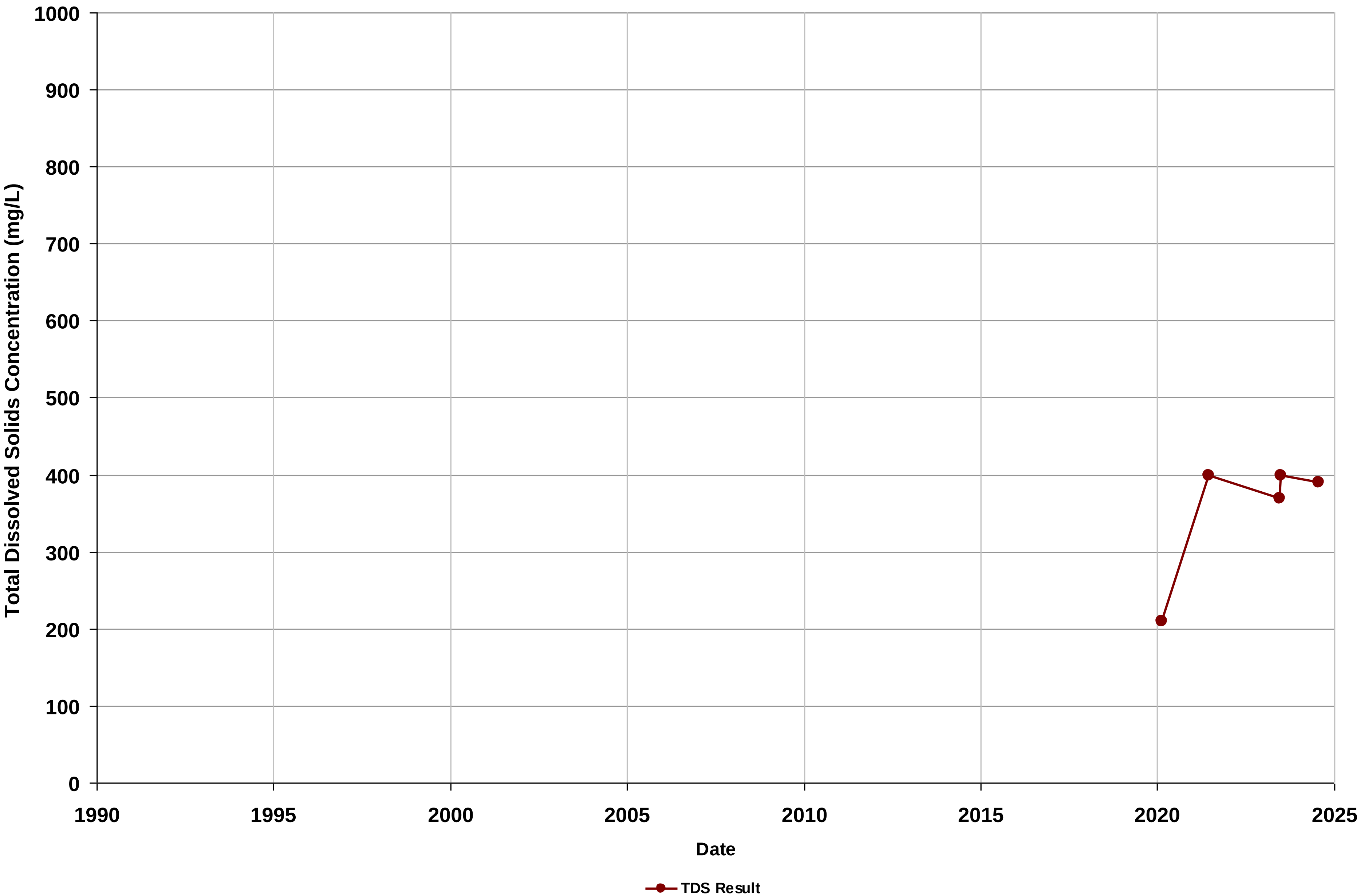
Total Depth (ft bgs): 139
Perf. Top (ft bgs): 74
Perf. Bottom (ft bgs): 134



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB03B
Subbasin: Madera
Well Type: Observation

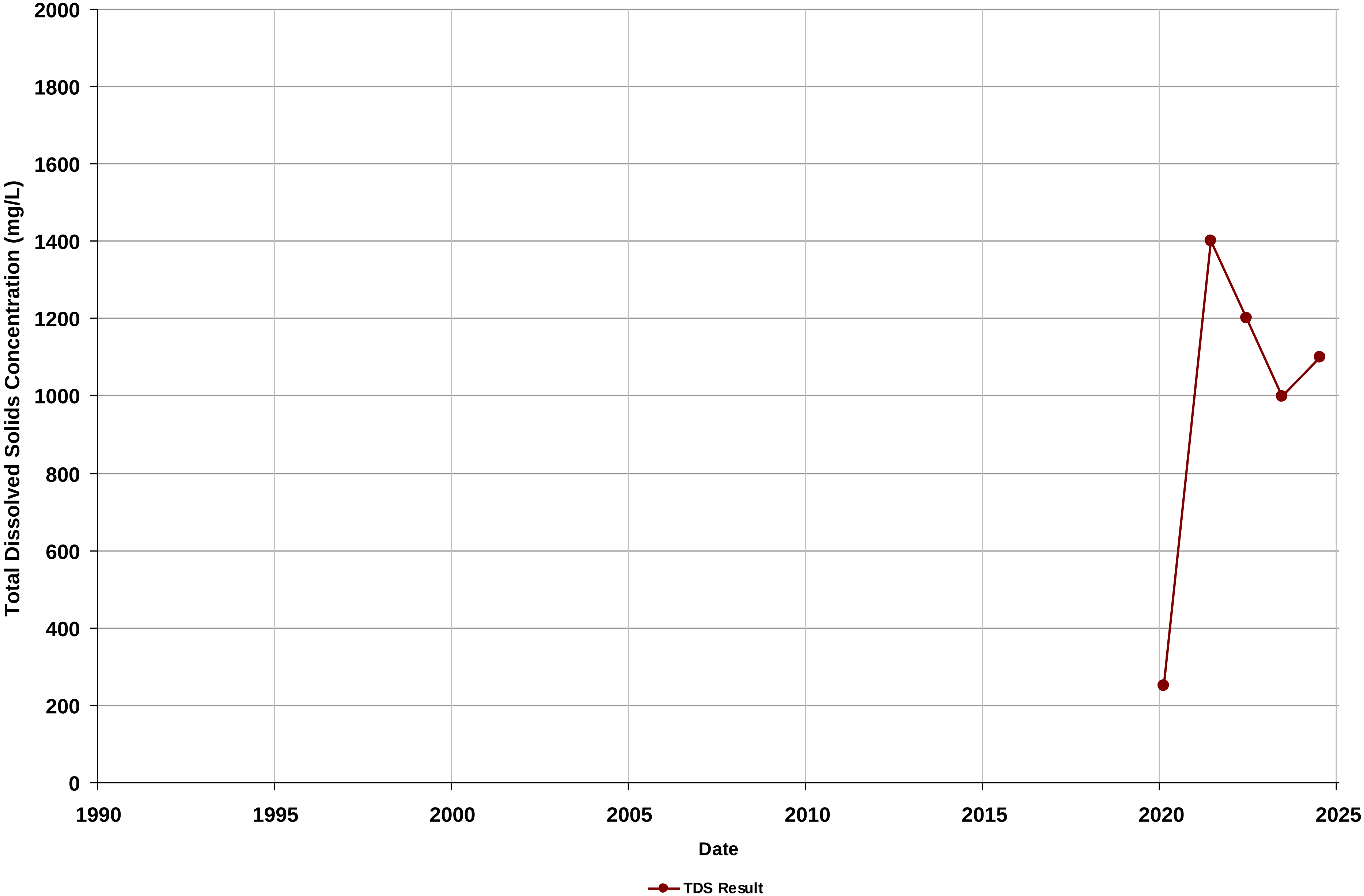
Total Depth (ft bgs): 295
Perf. Top (ft bgs): 215
Perf. Bottom (ft bgs): 285



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB03C
Subbasin: Madera
Well Type: Observation

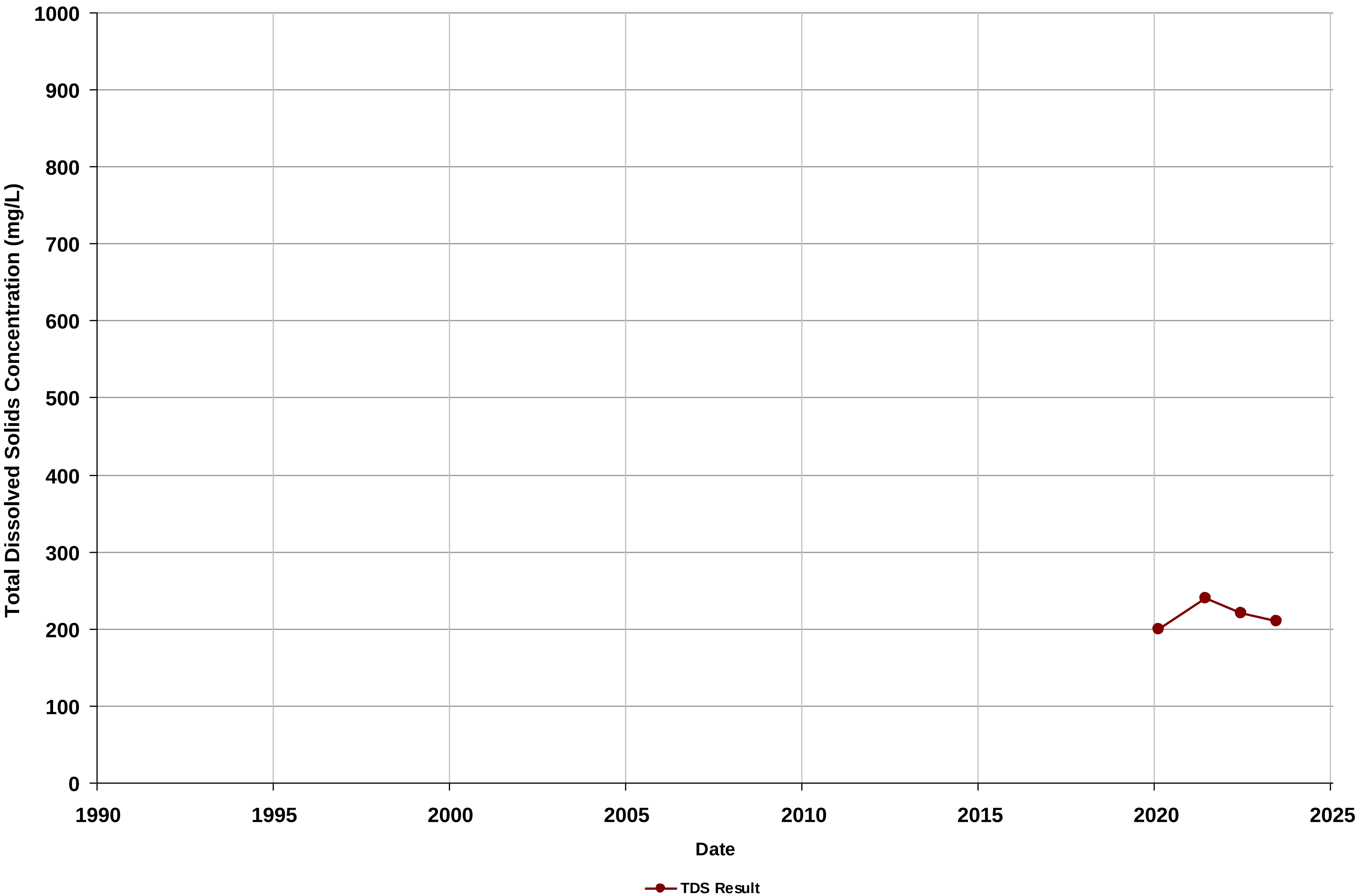
Total Depth (ft bgs): 430
Perf. Top (ft bgs): 355
Perf. Bottom (ft bgs): 420



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB04A
Subbasin: Madera
Well Type: Observation

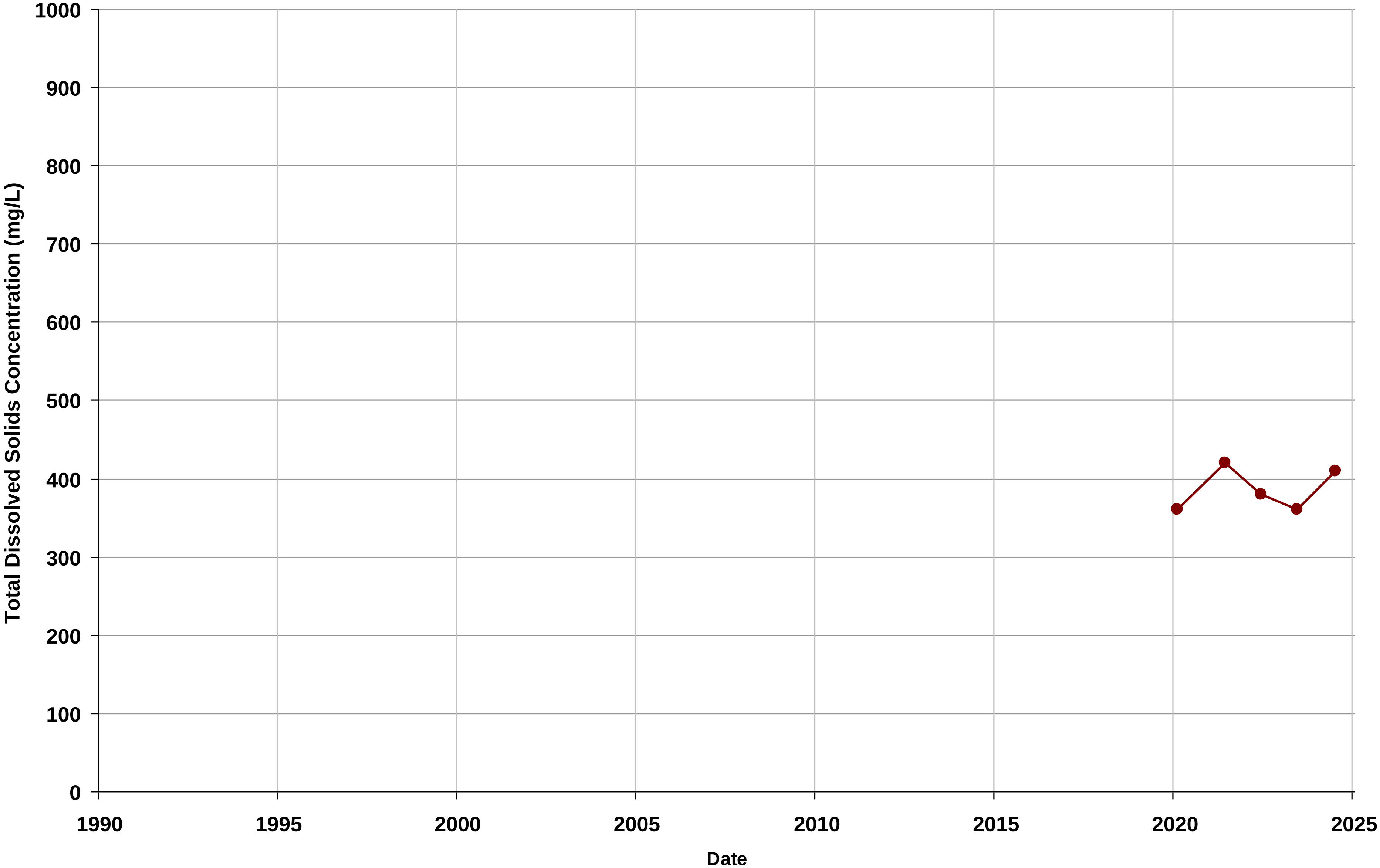
Total Depth (ft bgs): 375
Perf. Top (ft bgs): 180
Perf. Bottom (ft bgs): 365



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB04B
Subbasin: Madera
Well Type: Observation

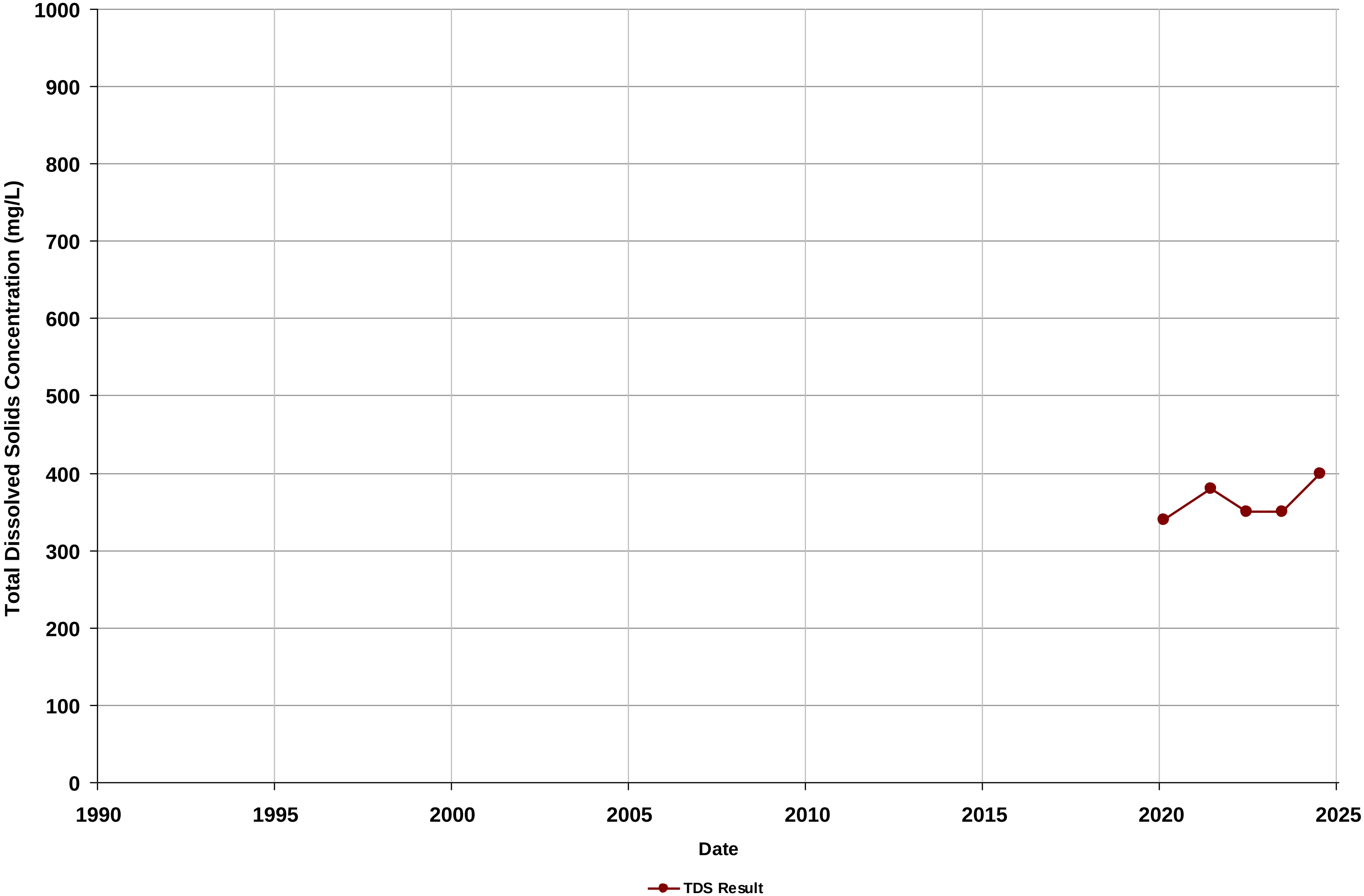
Total Depth (ft bgs): 695
Perf. Top (ft bgs): 530
Perf. Bottom (ft bgs): 685



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB04C
Subbasin: Madera
Well Type: Observation

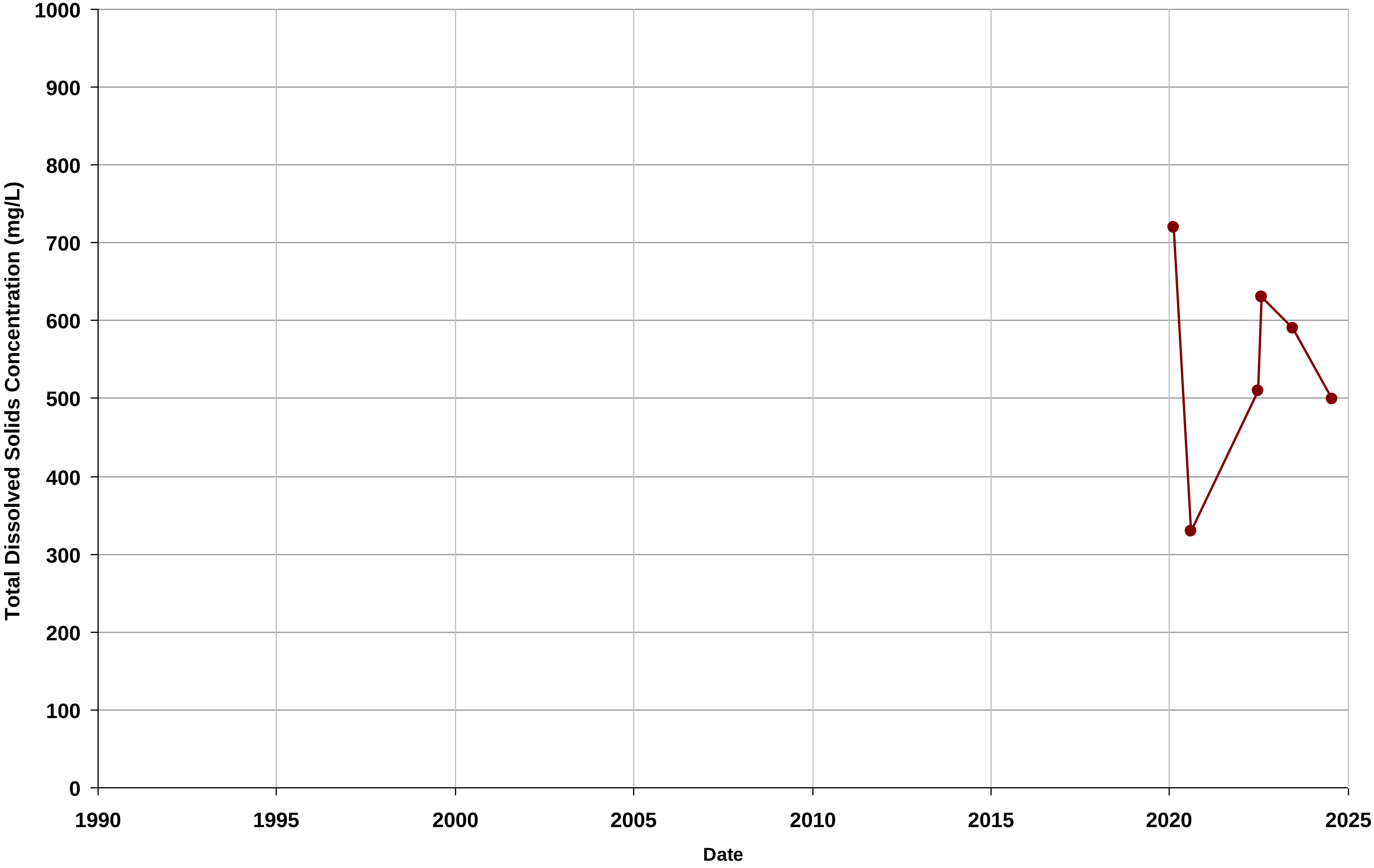
Total Depth (ft bgs): 905
Perf. Top (ft bgs): 750
Perf. Bottom (ft bgs): 895



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB05A
Subbasin: Madera
Well Type: Observation

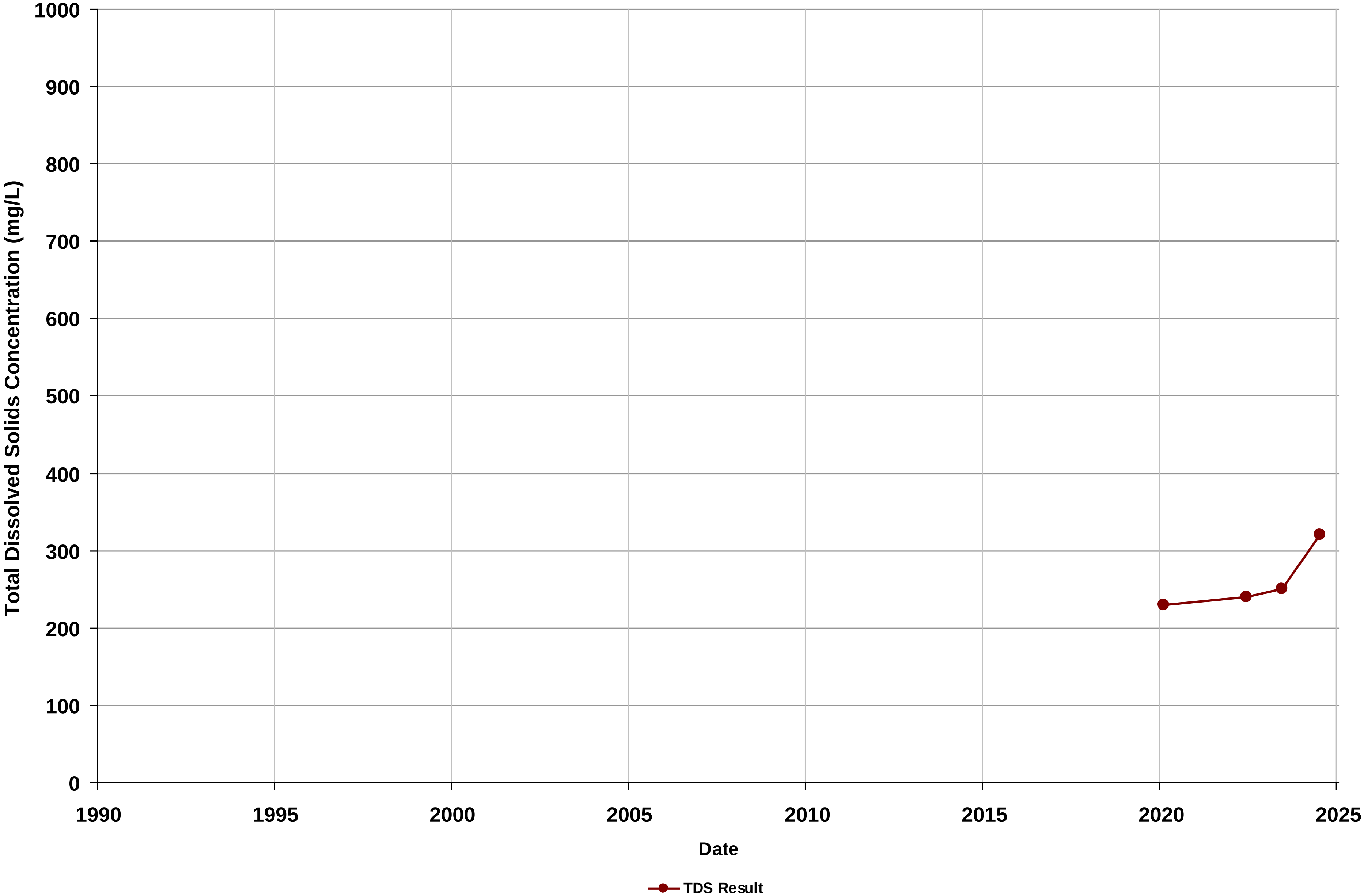
Total Depth (ft bgs): 210
Perf. Top (ft bgs): 140
Perf. Bottom (ft bgs): 200



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB05B
Subbasin: Madera
Well Type: Observation

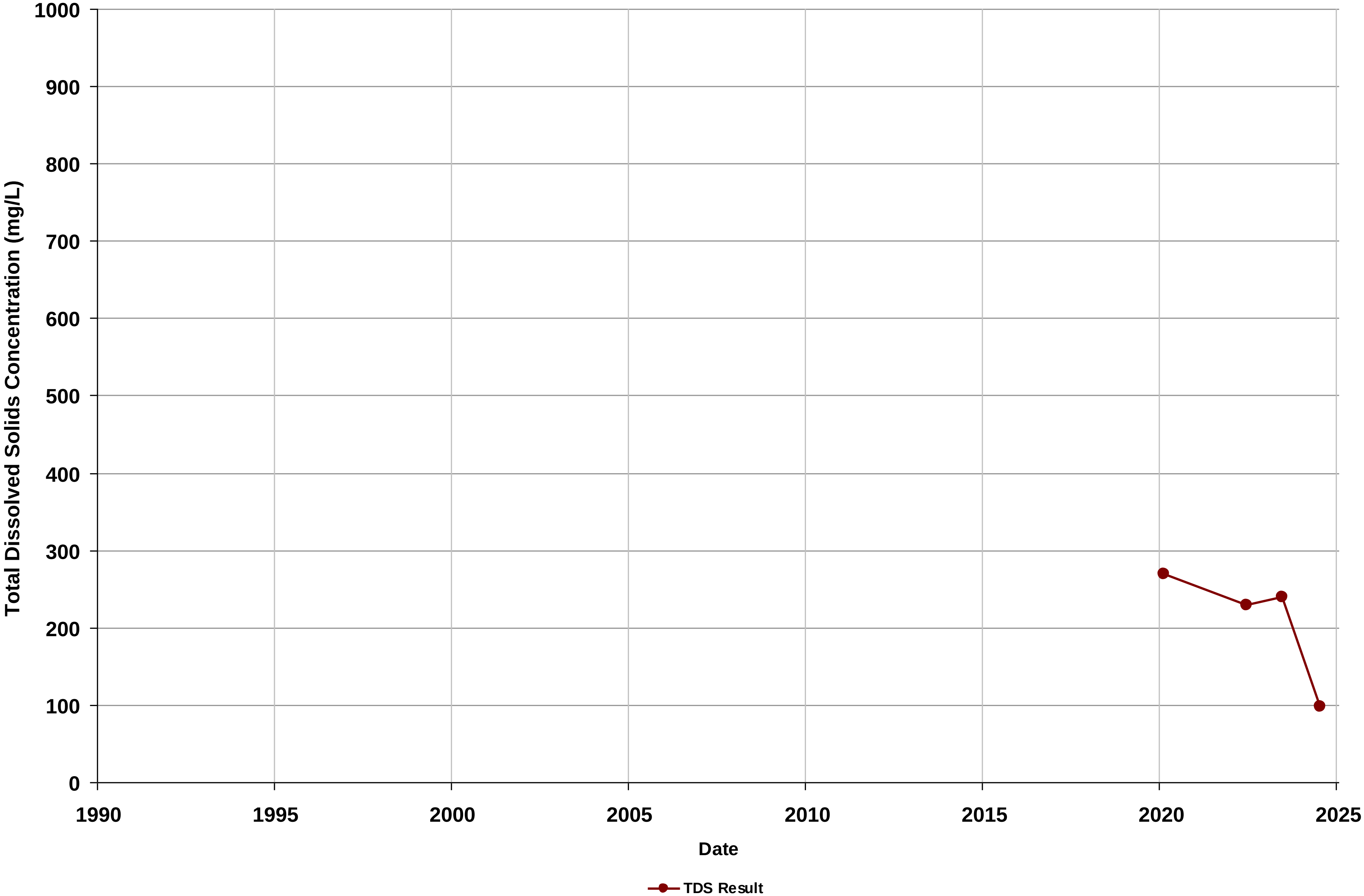
Total Depth (ft bgs): 375
Perf. Top (ft bgs): 240
Perf. Bottom (ft bgs): 365



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB05C
Subbasin: Madera
Well Type: Observation

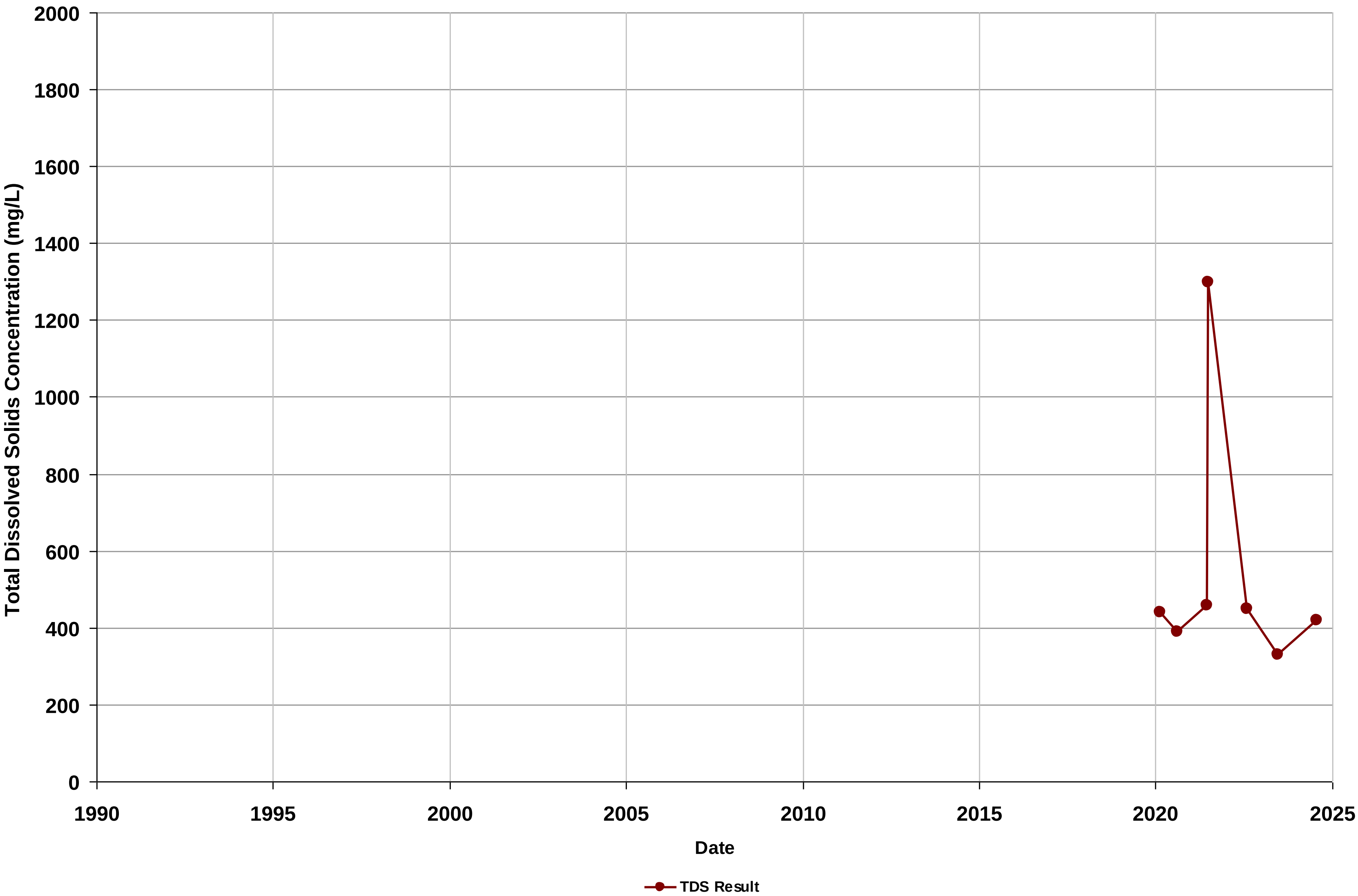
Total Depth (ft bgs): 585
Perf. Top (ft bgs): 420
Perf. Bottom (ft bgs): 585



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB06A
Subbasin: Madera
Well Type: Observation

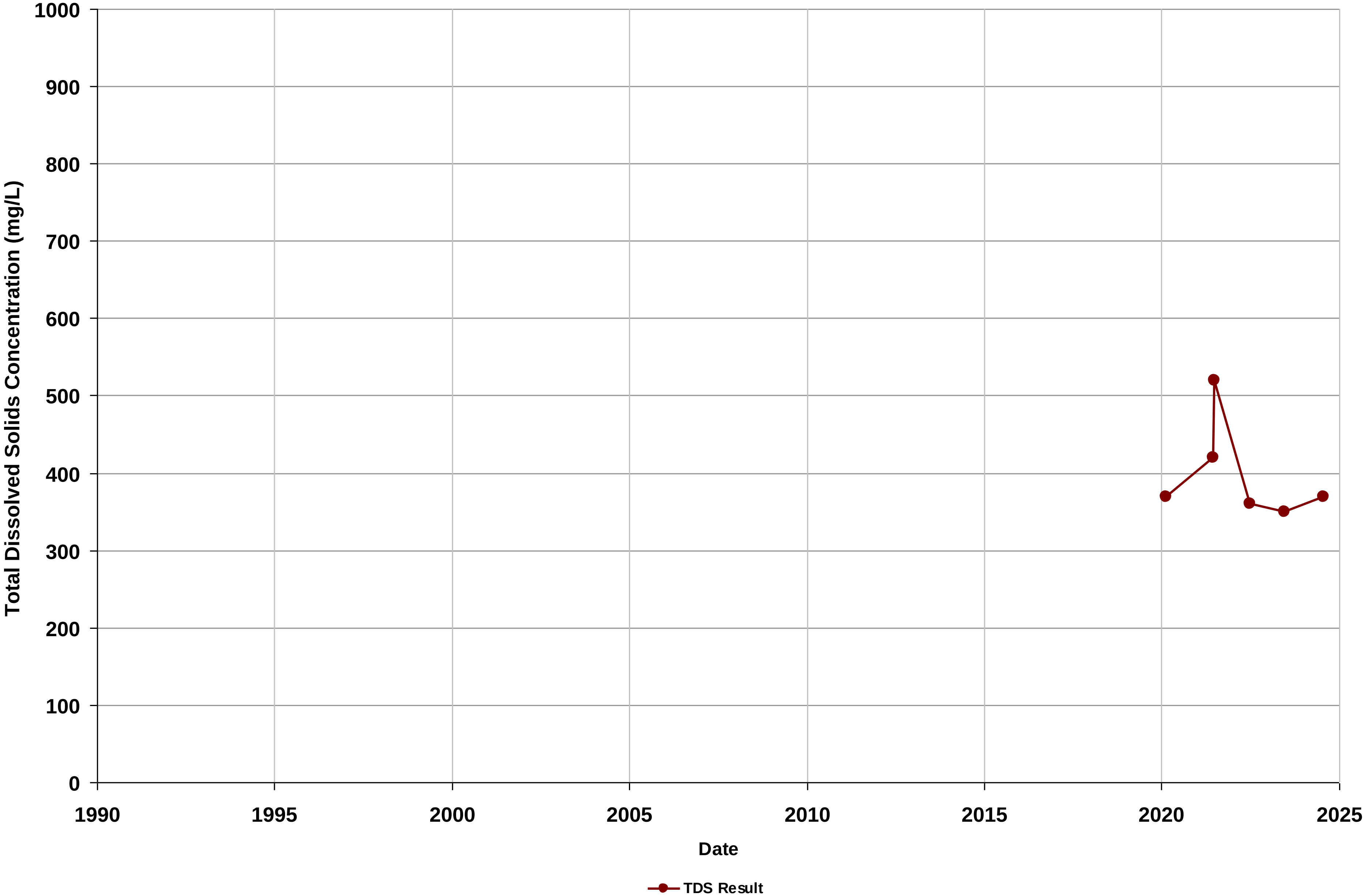
Total Depth (ft bgs): 350
Perf. Top (ft bgs): 135
Perf. Bottom (ft bgs): 340



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB06B
Subbasin: Madera
Well Type: Observation

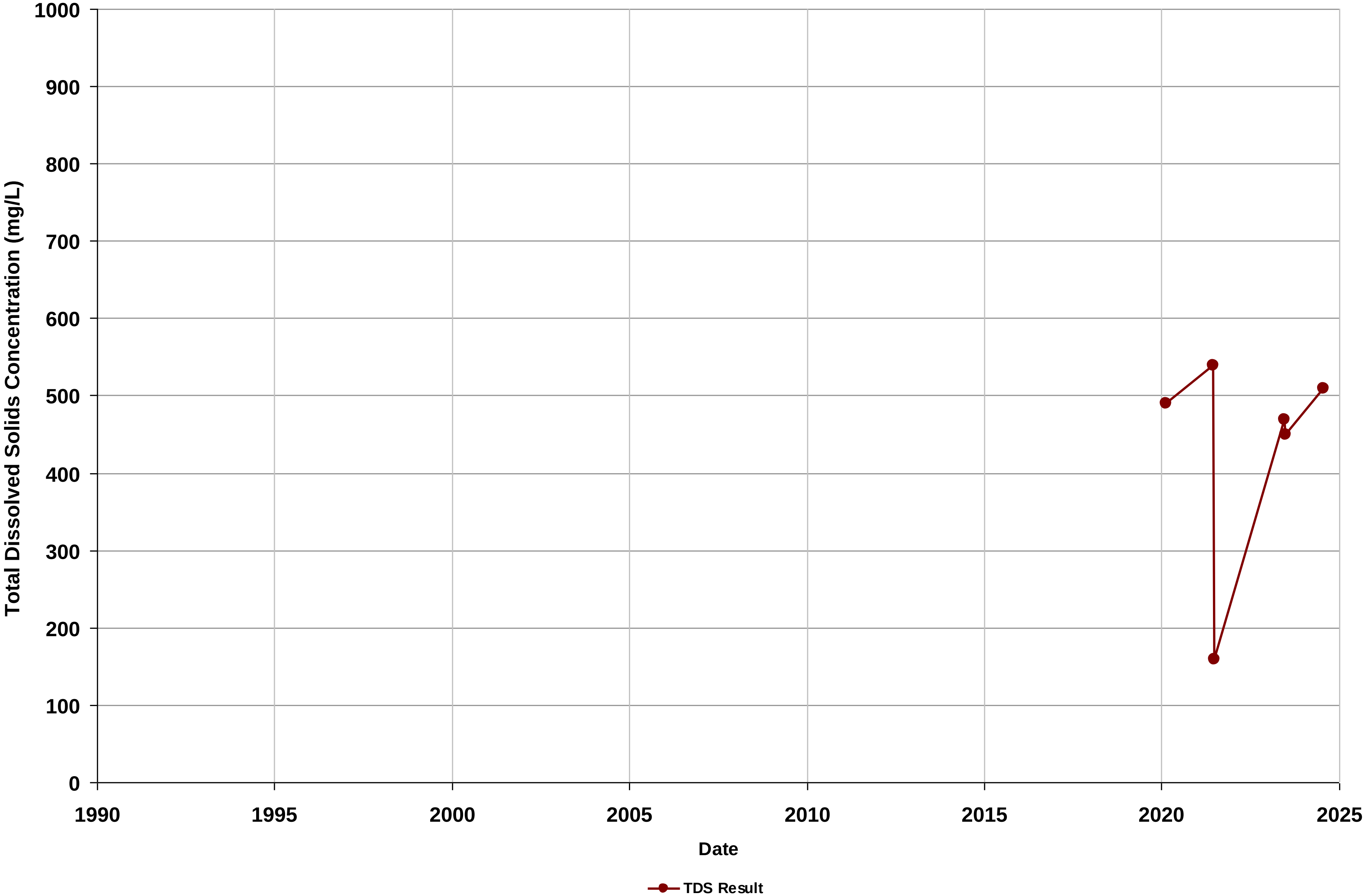
Total Depth (ft bgs): 520
Perf. Top (ft bgs): 425
Perf. Bottom (ft bgs): 510



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB06C
Subbasin: Madera
Well Type: Observation

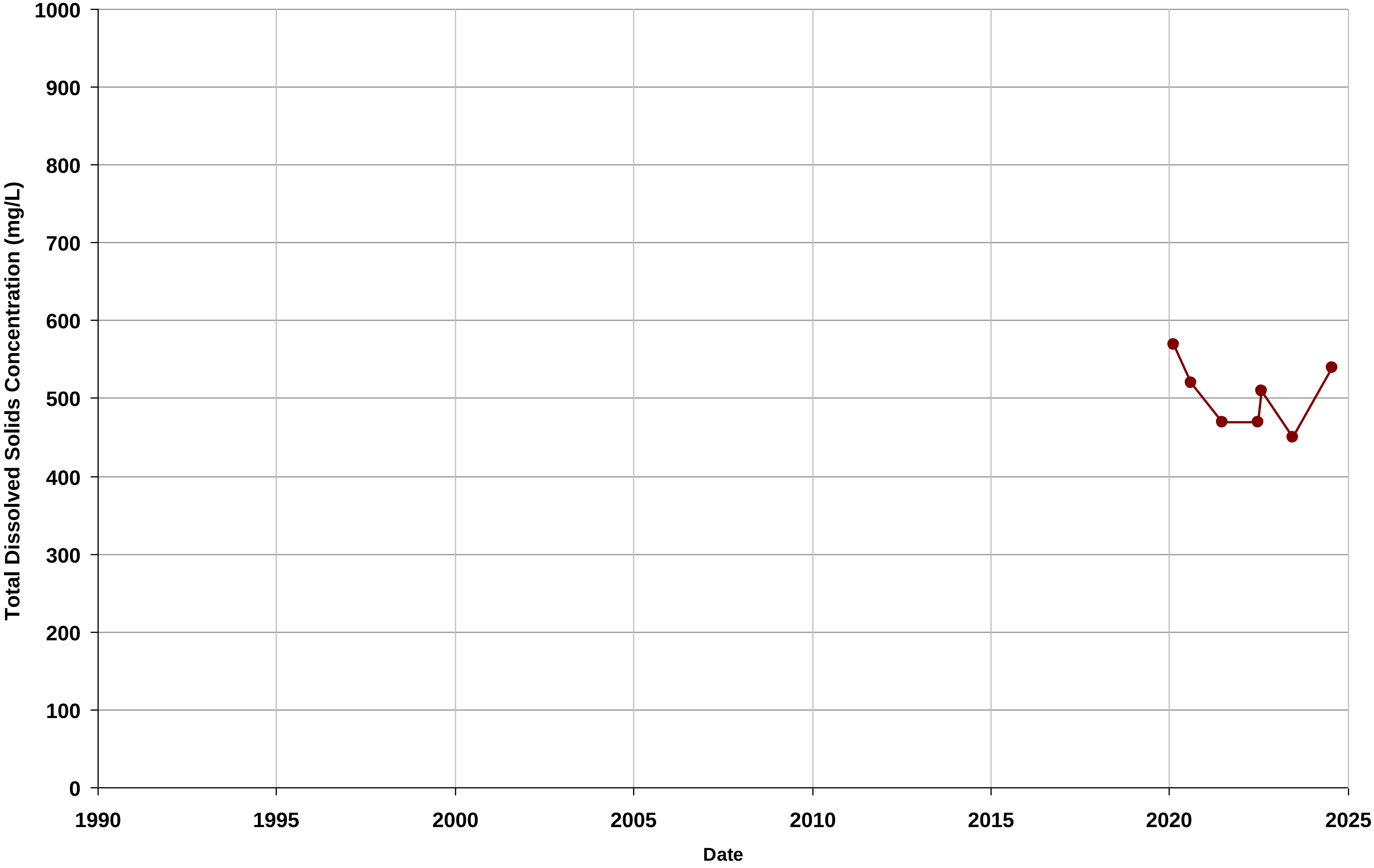
Total Depth (ft bgs): 715
Perf. Top (ft bgs): 630
Perf. Bottom (ft bgs): 705



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB09A
Subbasin: Madera
Well Type: Observation

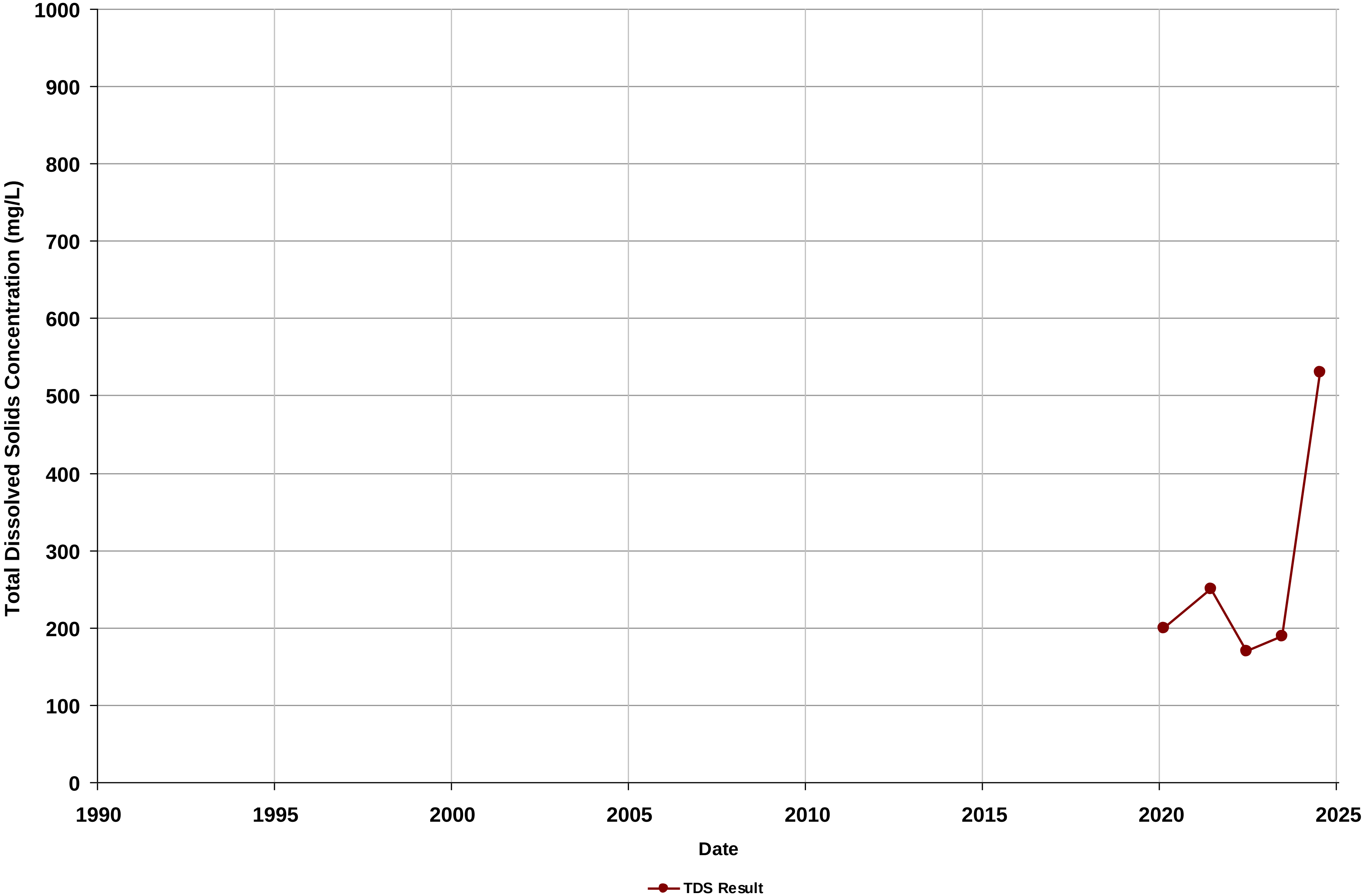
Total Depth (ft bgs): 320
Perf. Top (ft bgs): 200
Perf. Bottom (ft bgs): 310



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB09B
Subbasin: Madera
Well Type: Observation

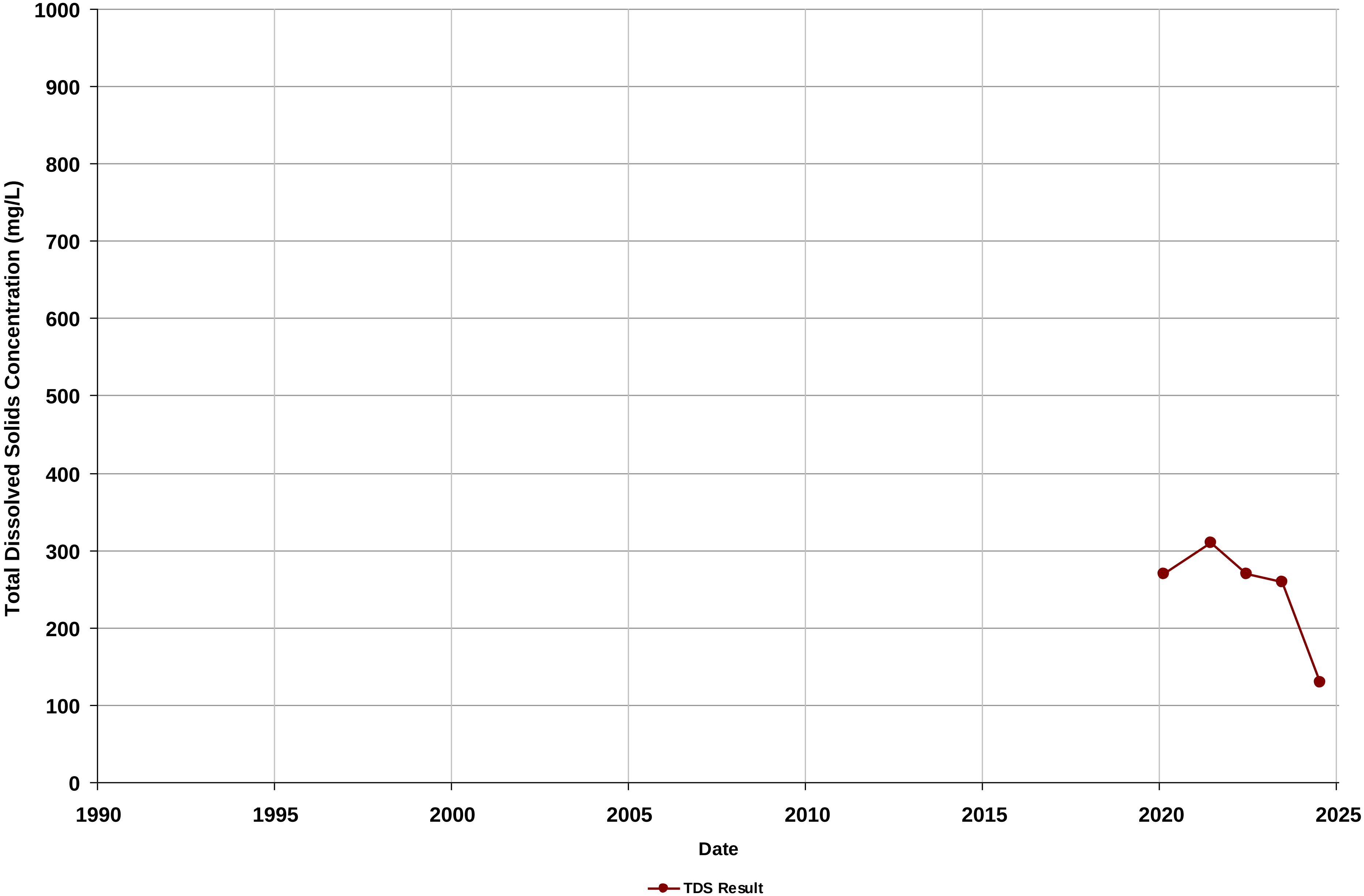
Total Depth (ft bgs): 725
Perf. Top (ft bgs): 520
Perf. Bottom (ft bgs): 715



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB09C
Subbasin: Madera
Well Type: Observation

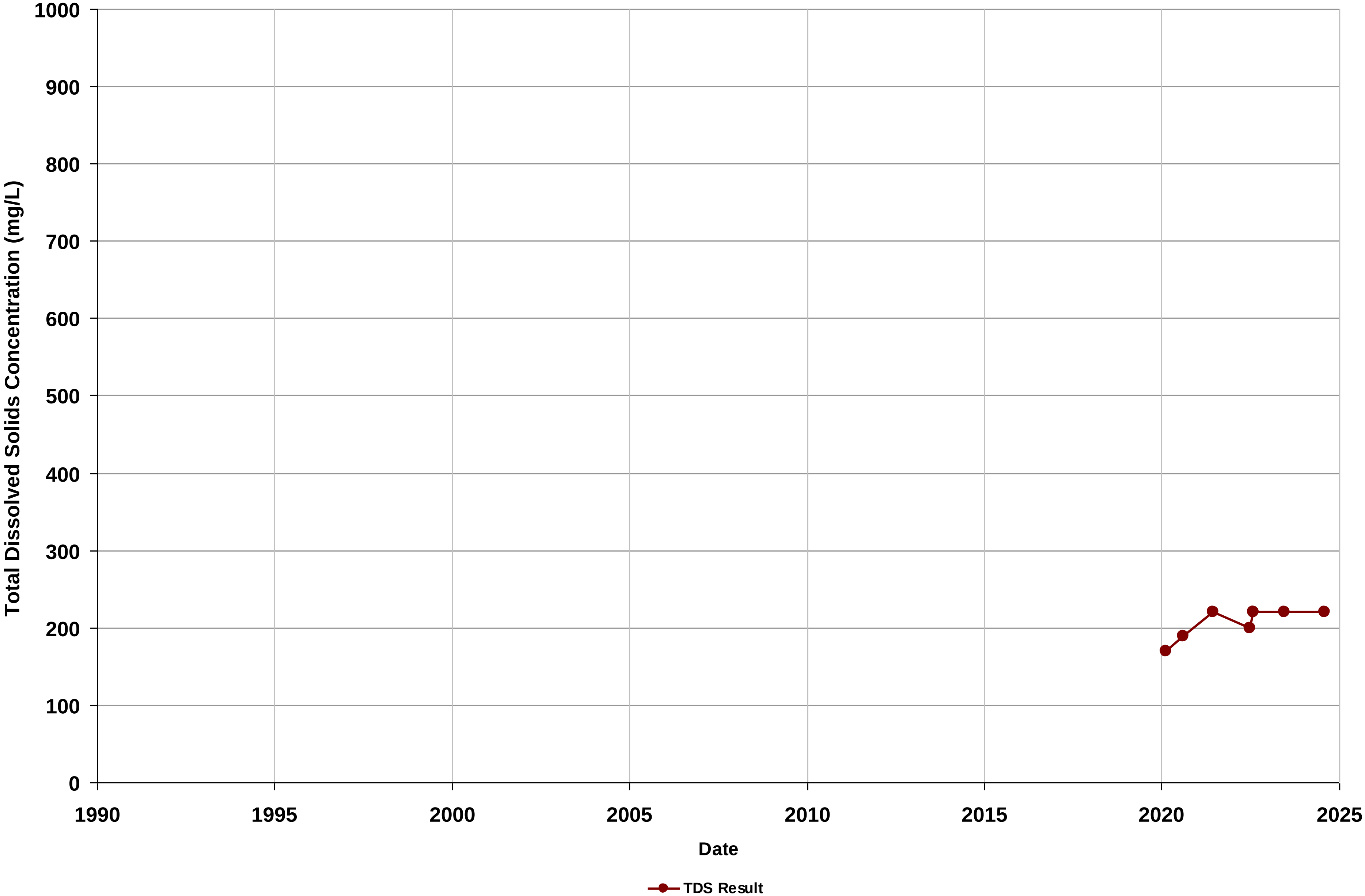
Total Depth (ft bgs): 955
Perf. Top (ft bgs): 880
Perf. Bottom (ft bgs): 945



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB10B
Subbasin: Madera
Well Type: Observation

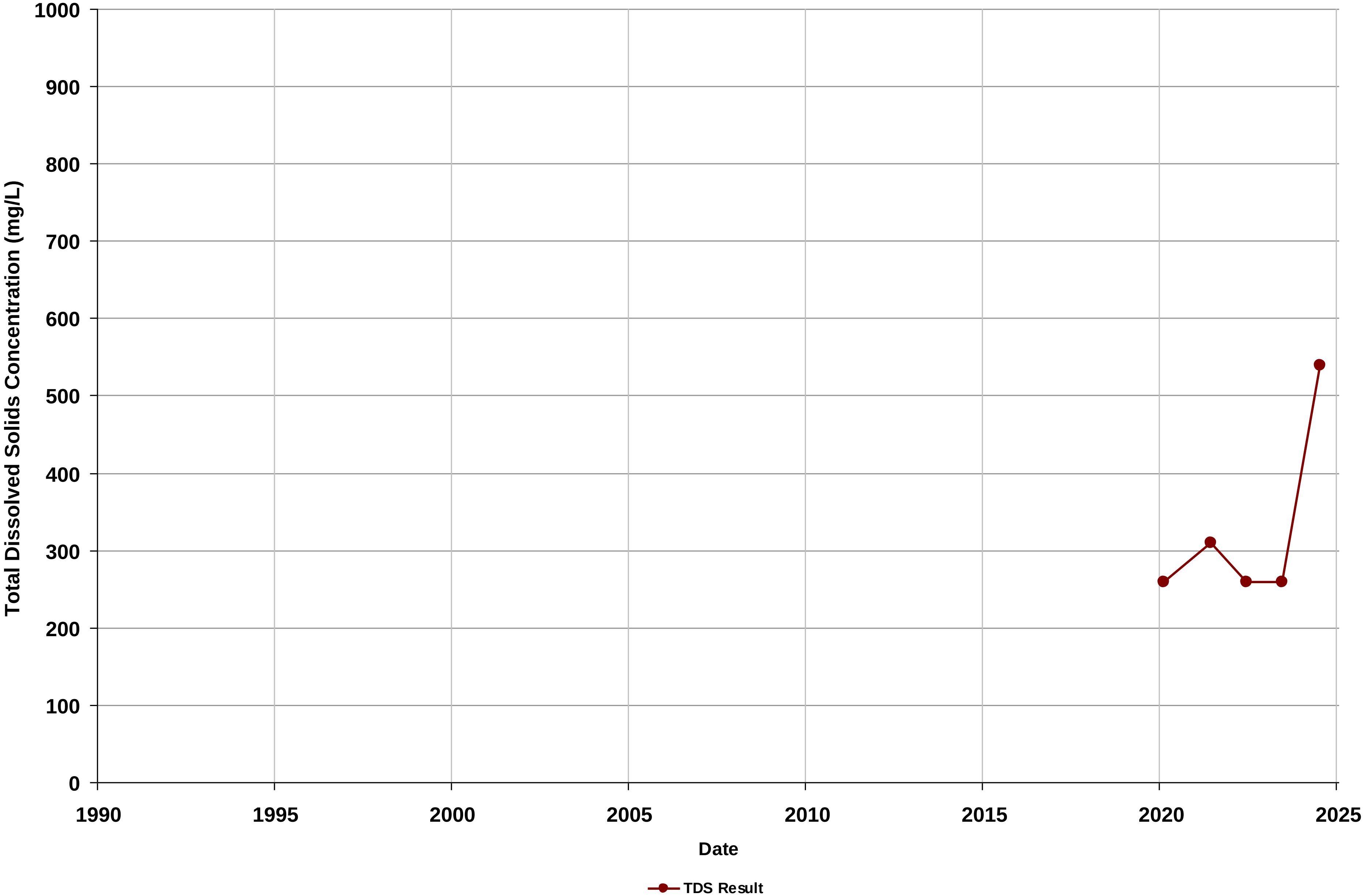
Total Depth (ft bgs): 510
Perf. Top (ft bgs): 400
Perf. Bottom (ft bgs): 500



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB10C
Subbasin: Madera
Well Type: Observation

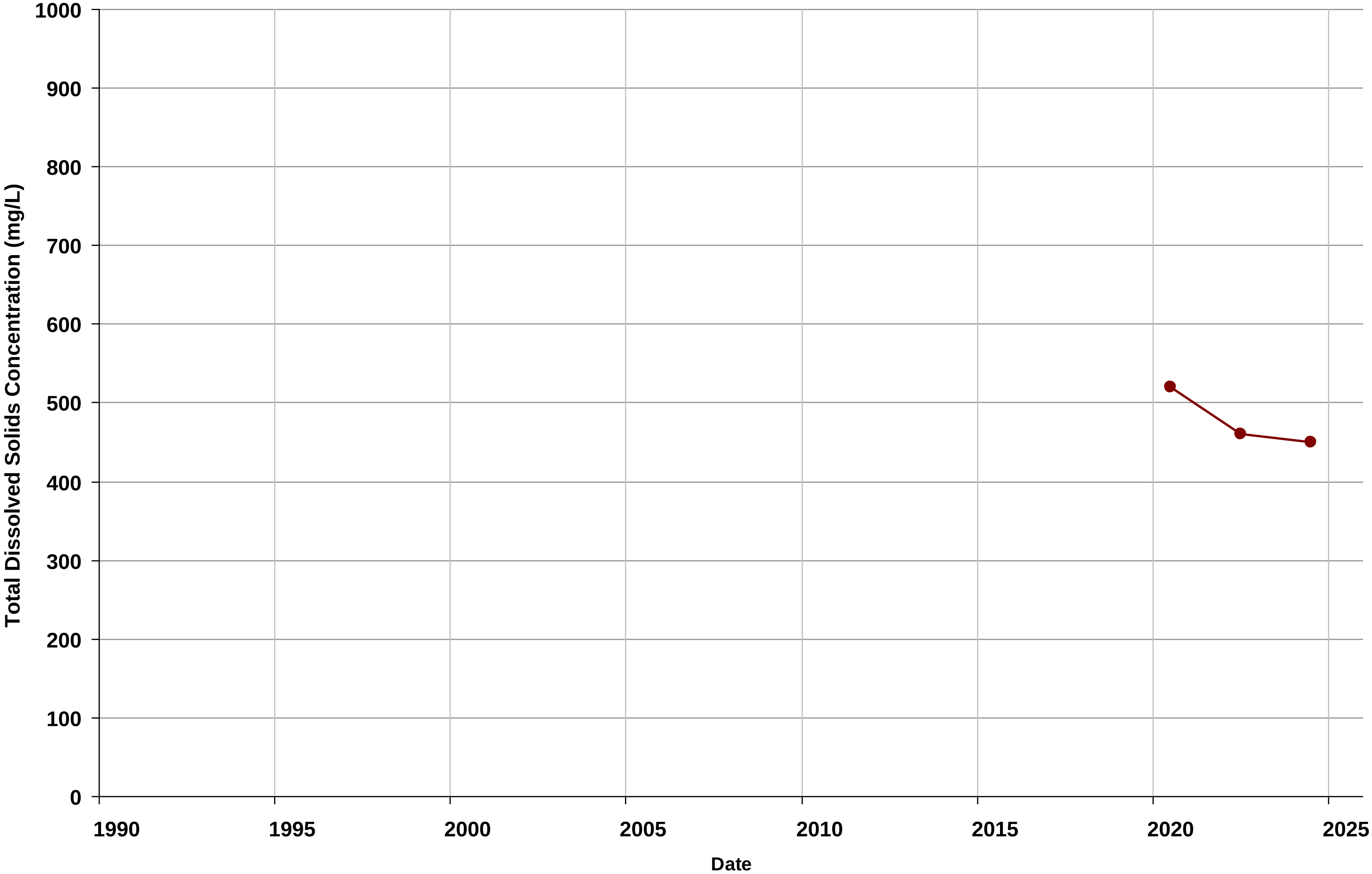
Total Depth (ft bgs): 880
Perf. Top (ft bgs): 790
Perf. Bottom (ft bgs): 870



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB11C
Subbasin: Madera
Well Type: Observation

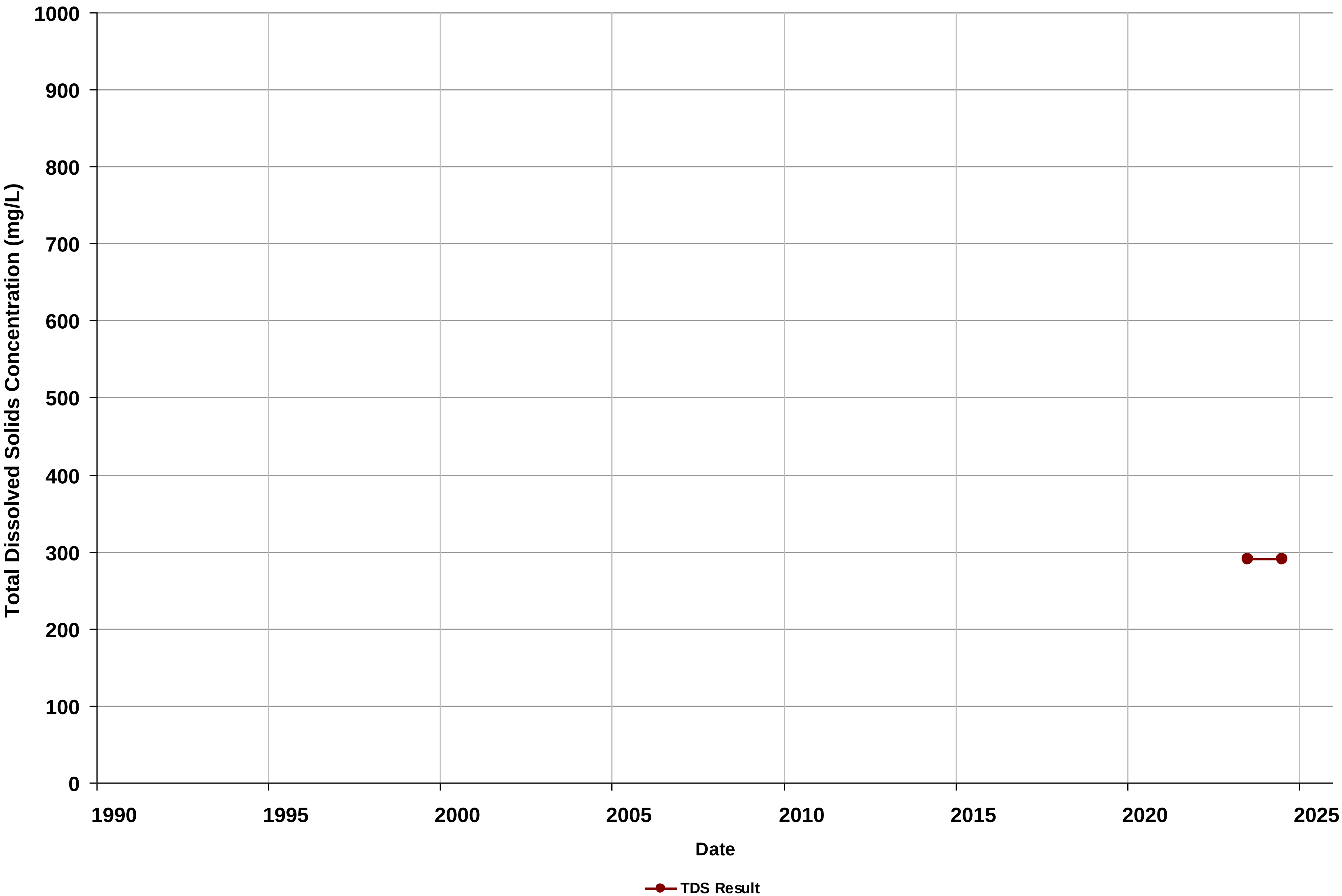
Total Depth (ft bgs): 880
Perf. Top (ft bgs): 775
Perf. Bottom (ft bgs): 870



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB13B
Subbasin: Madera
Well Type: Monitoring

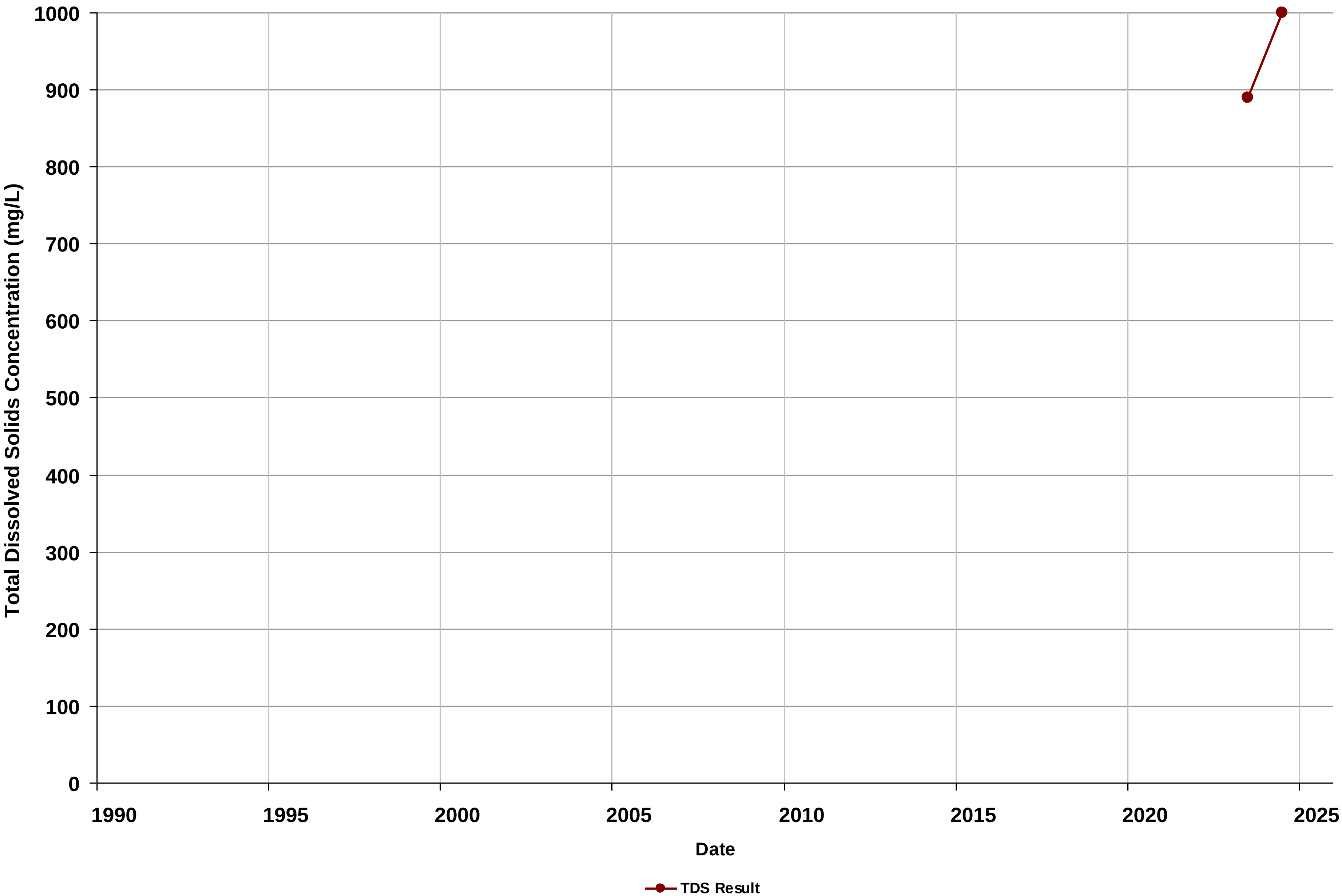
Total Depth (ft bgs): 446
Perf. Top (ft bgs): 396
Perf. Bottom (ft bgs): 436



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: MSB13C
Subbasin: Madera
Well Type: Monitoring

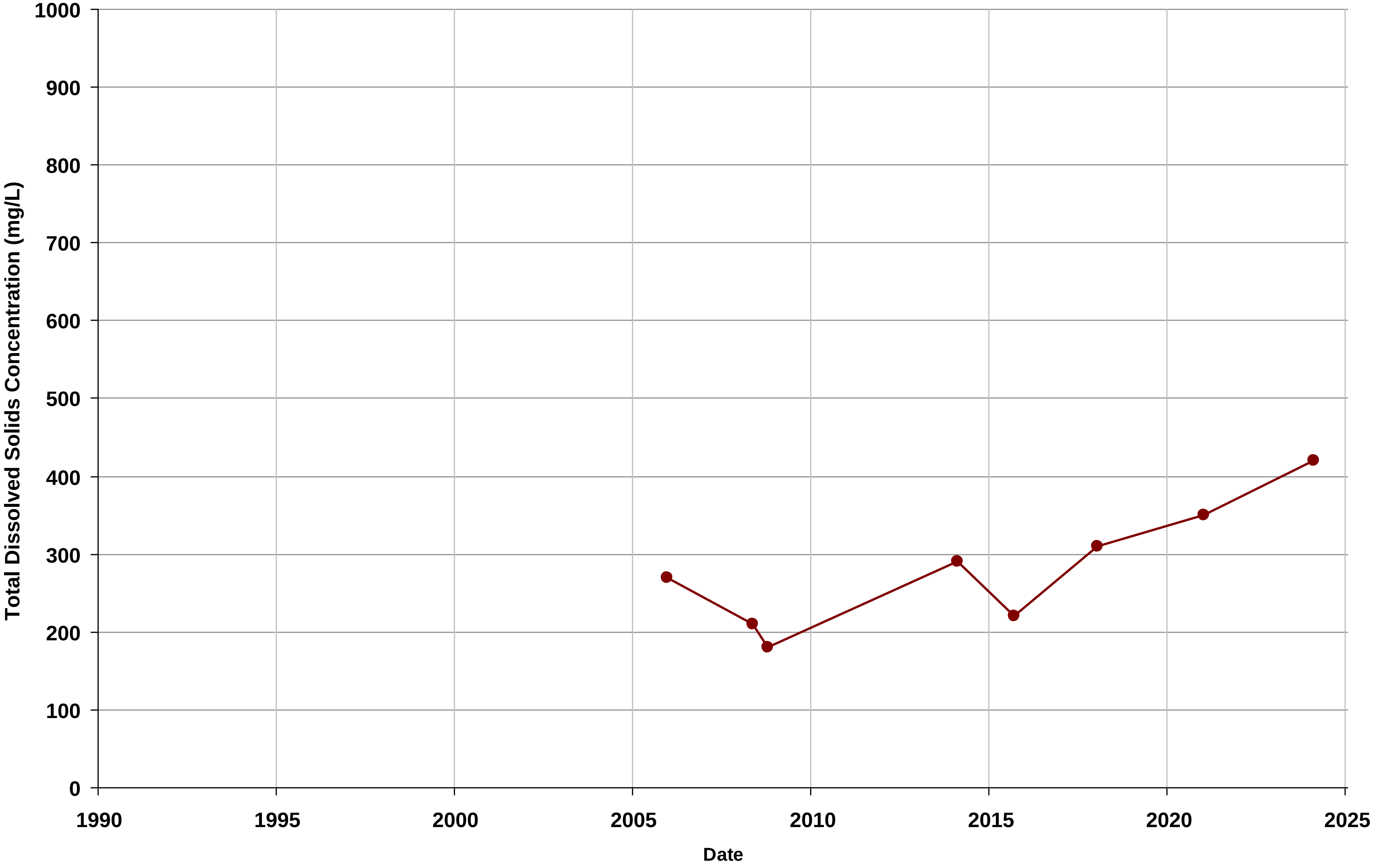
Total Depth (ft bgs): 532
Perf. Top (ft bgs): 522
Perf. Bottom (ft bgs): 532



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2000553-001
Subbasin: Madera
Well Type: Public Supply

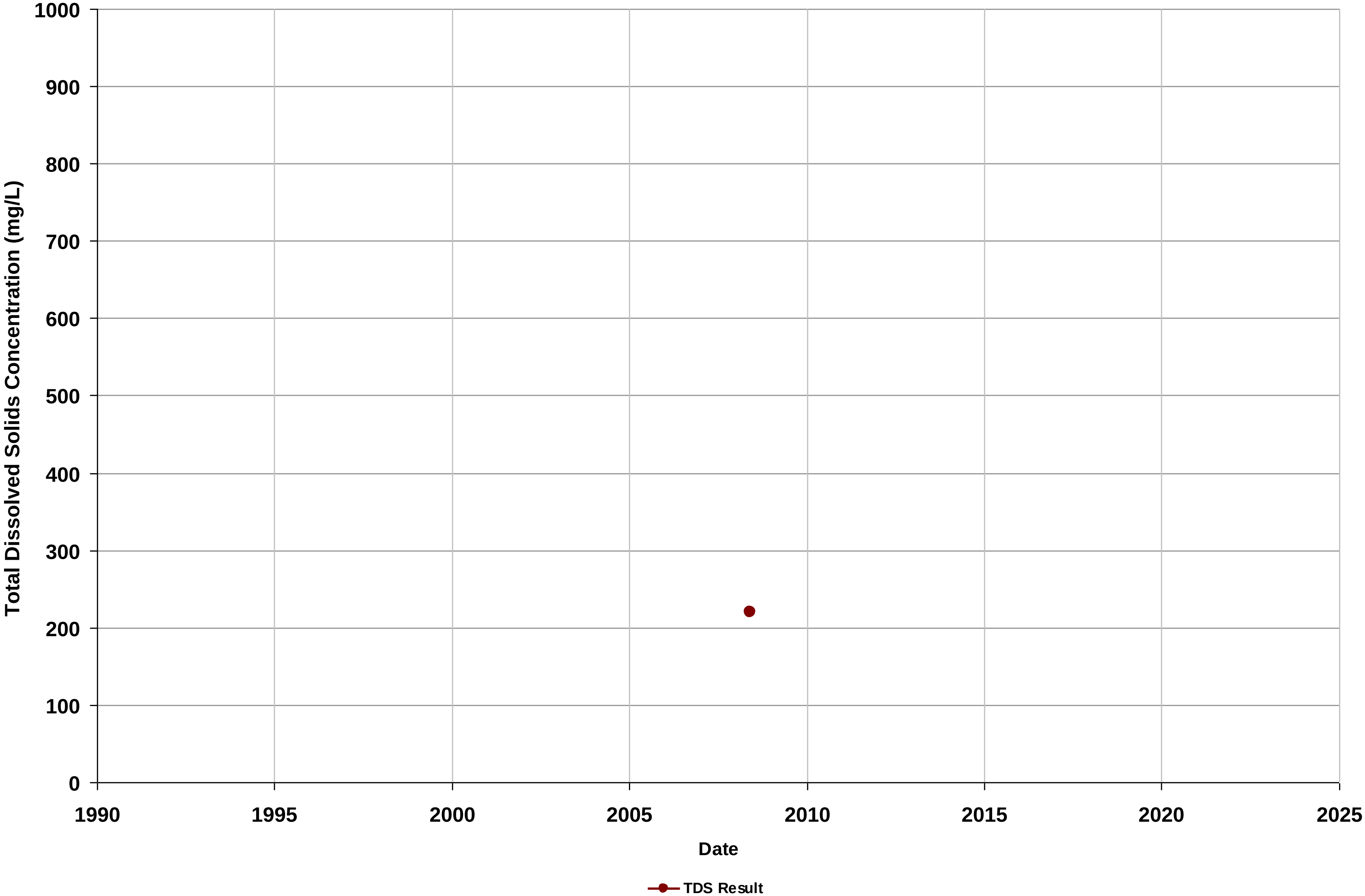
Total Depth (ft bgs):
Perf. Top (ft bgs): 450
Perf. Bottom (ft bgs): 500



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2000682-002
Subbasin: Madera
Well Type: Public Supply

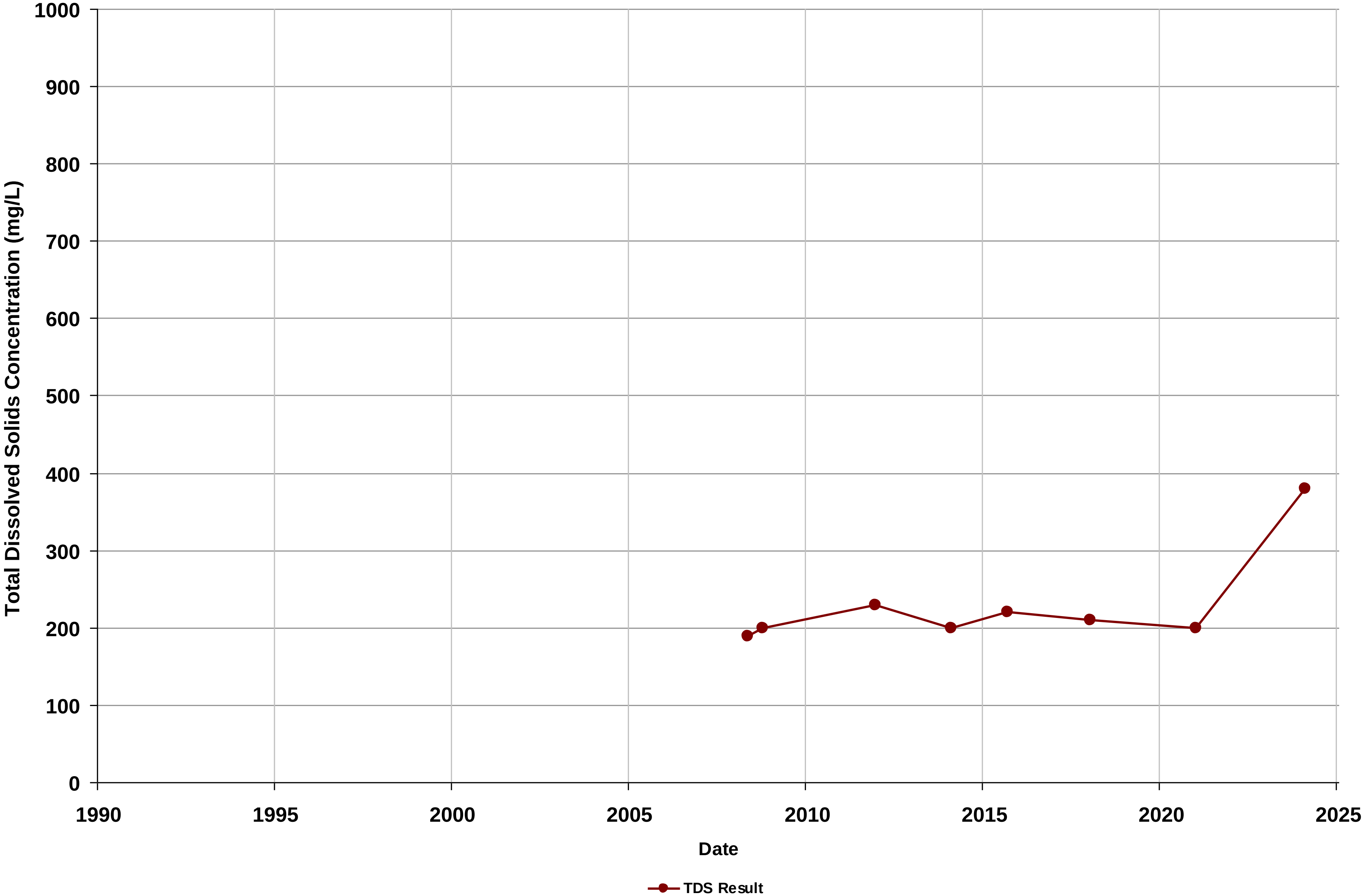
Total Depth (ft bgs):
Perf. Top (ft bgs): 295
Perf. Bottom (ft bgs): 420



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2000727-001
Subbasin: Madera
Well Type: Public Supply

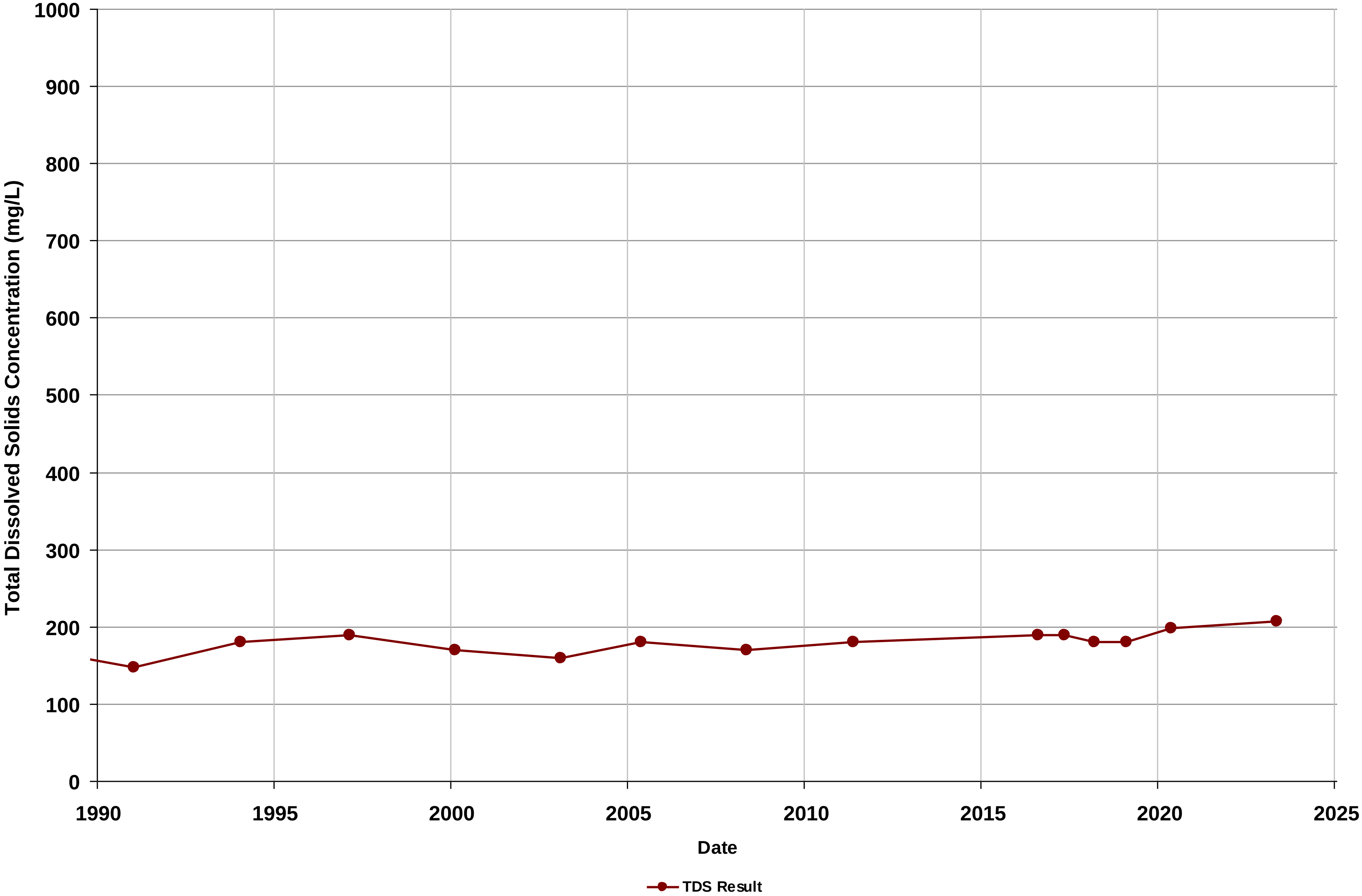
Total Depth (ft bgs):
Perf. Top (ft bgs): 280
Perf. Bottom (ft bgs): 360



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010002-014
Subbasin: Madera
Well Type: Public Supply

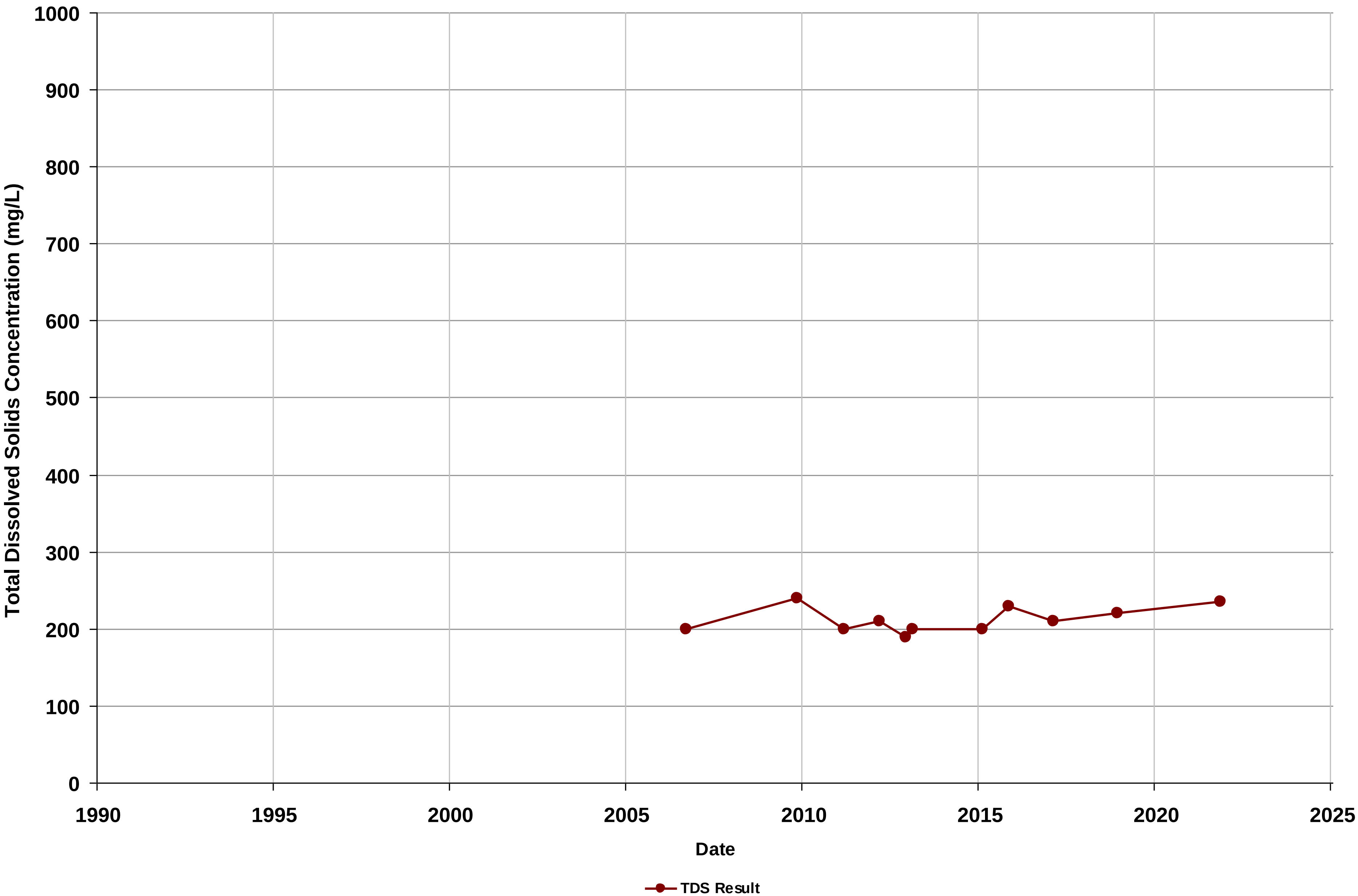
Total Depth (ft bgs):
Perf. Top (ft bgs): 280
Perf. Bottom (ft bgs): 610



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010002-032
Subbasin: Madera
Well Type: Public Supply

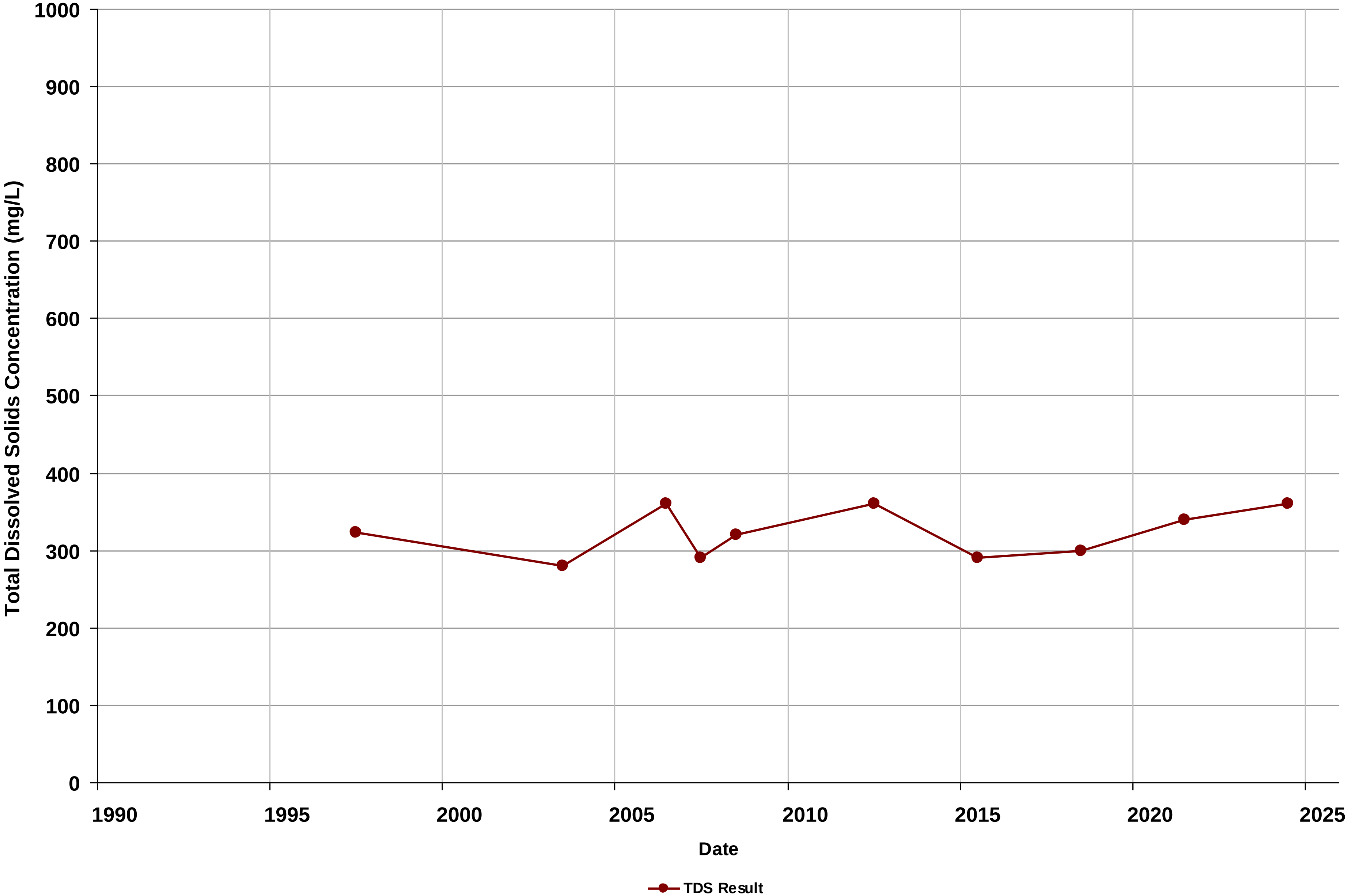
Total Depth (ft bgs):
Perf. Top (ft bgs): 310
Perf. Bottom (ft bgs): 600



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010008-005
Subbasin: Madera
Well Type: Public Supply

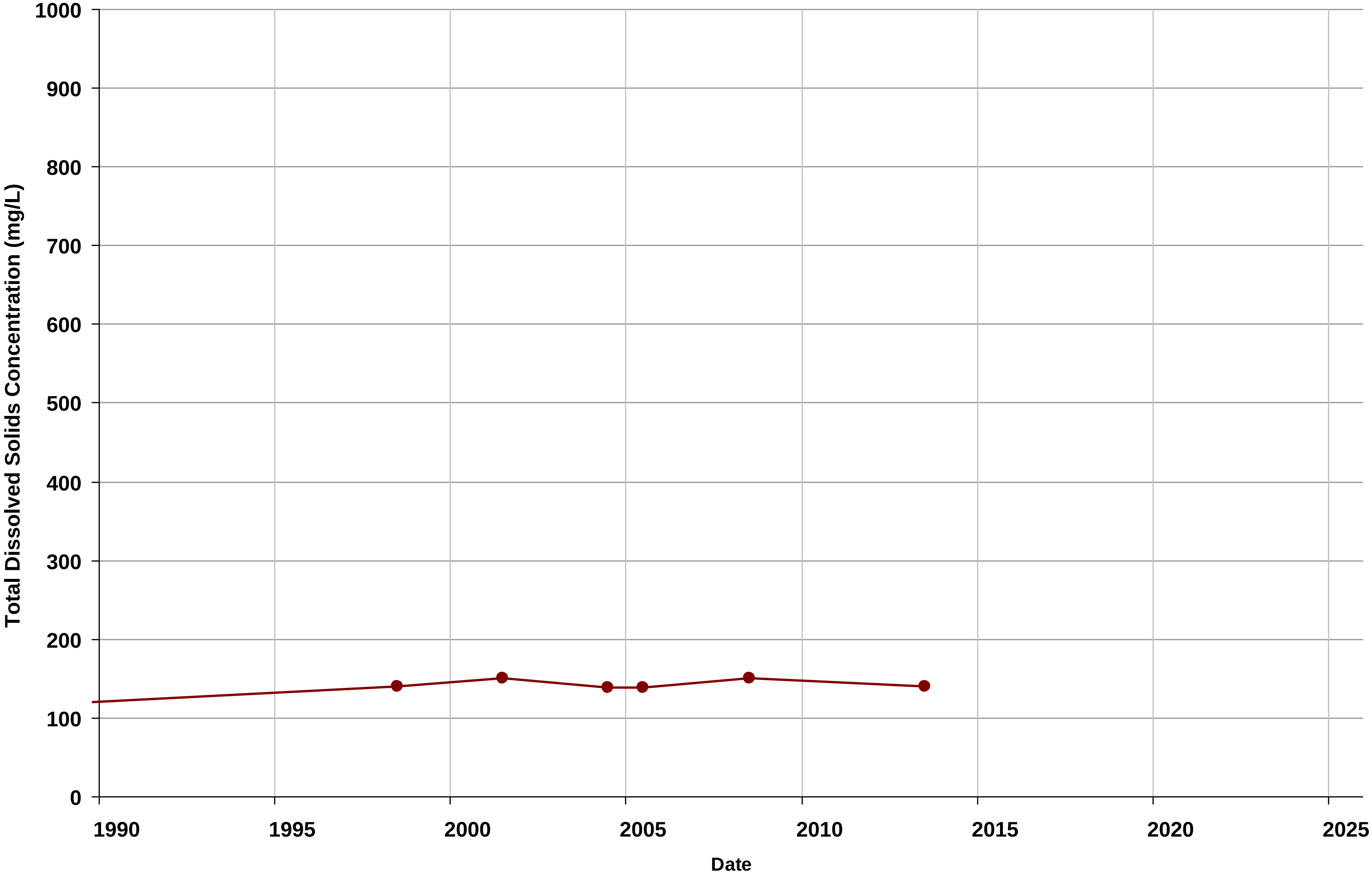
Total Depth (ft bgs):
Perf. Top (ft bgs): 250
Perf. Bottom (ft bgs): 465



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010009-002
Subbasin: Madera
Well Type: Public Supply

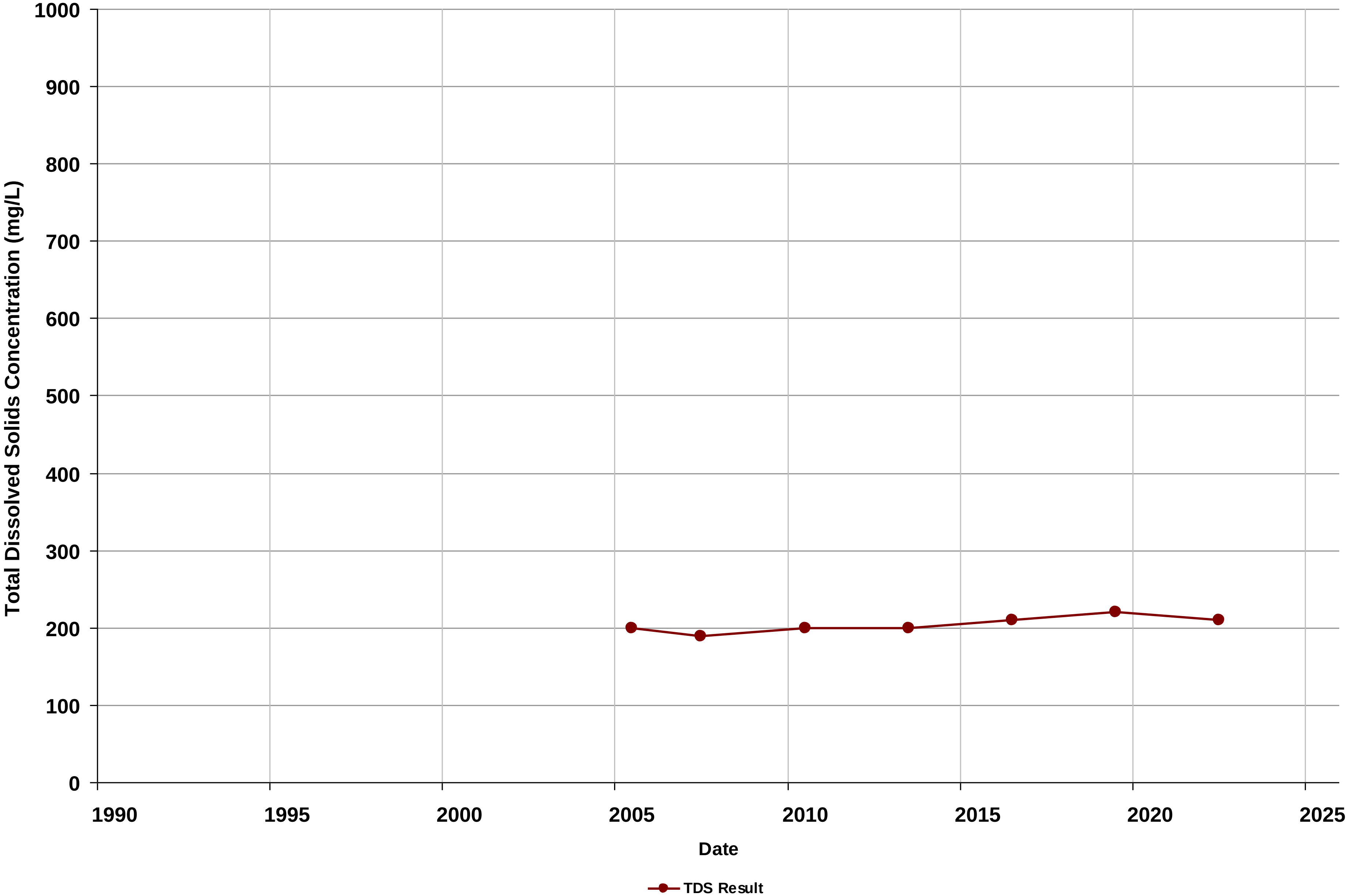
Total Depth (ft bgs):
Perf. Top (ft bgs): 324
Perf. Bottom (ft bgs): 369



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010010-007
Subbasin: Madera
Well Type: Public Supply

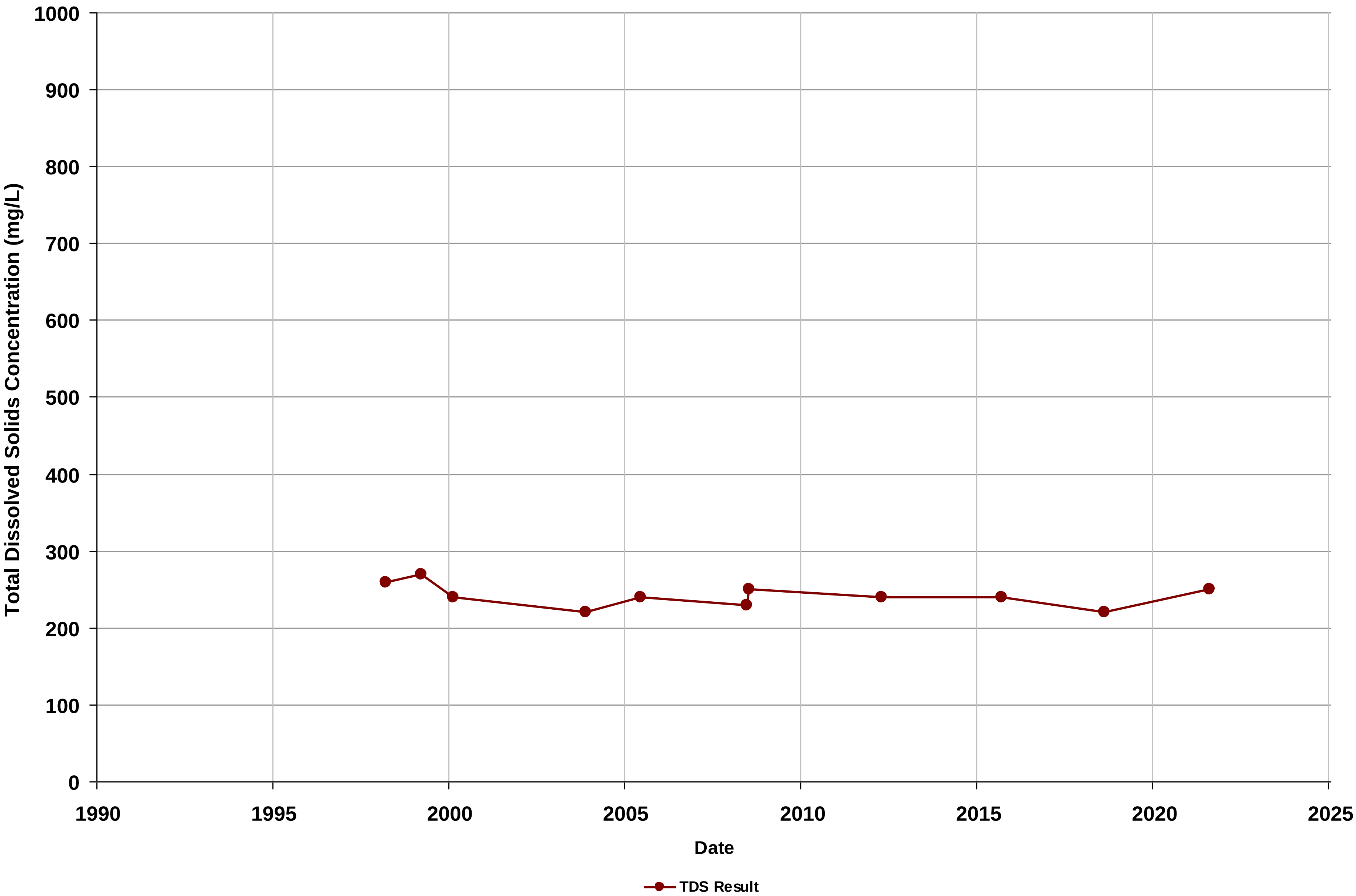
Total Depth (ft bgs):
Perf. Top (ft bgs): 242
Perf. Bottom (ft bgs): 374



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: 2010801-001
Subbasin: Madera
Well Type: Public Supply

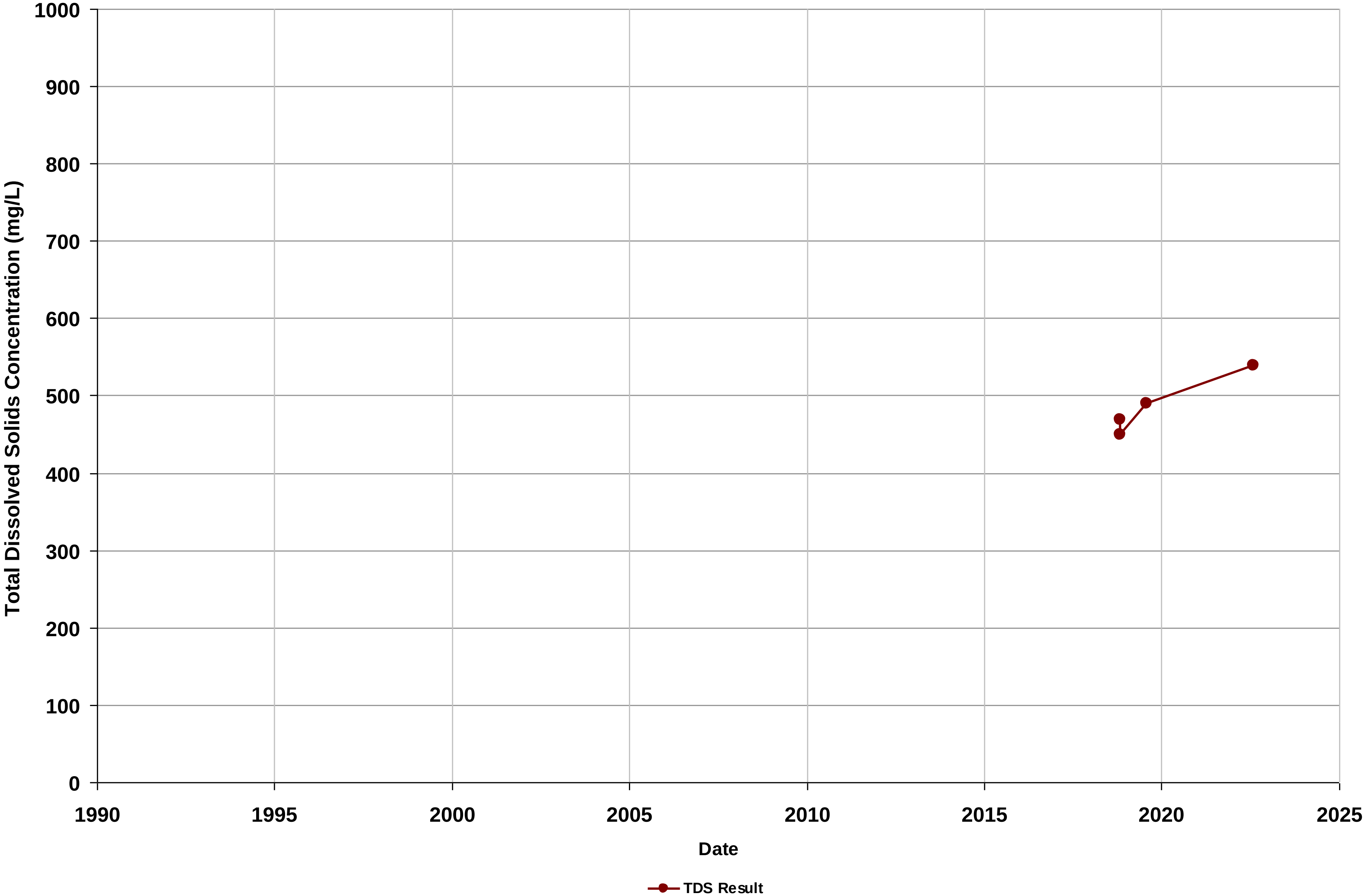
Total Depth (ft bgs):
Perf. Top (ft bgs): 375
Perf. Bottom (ft bgs): 760



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: ESJ12
Subbasin: Madera
Well Type: Domestic

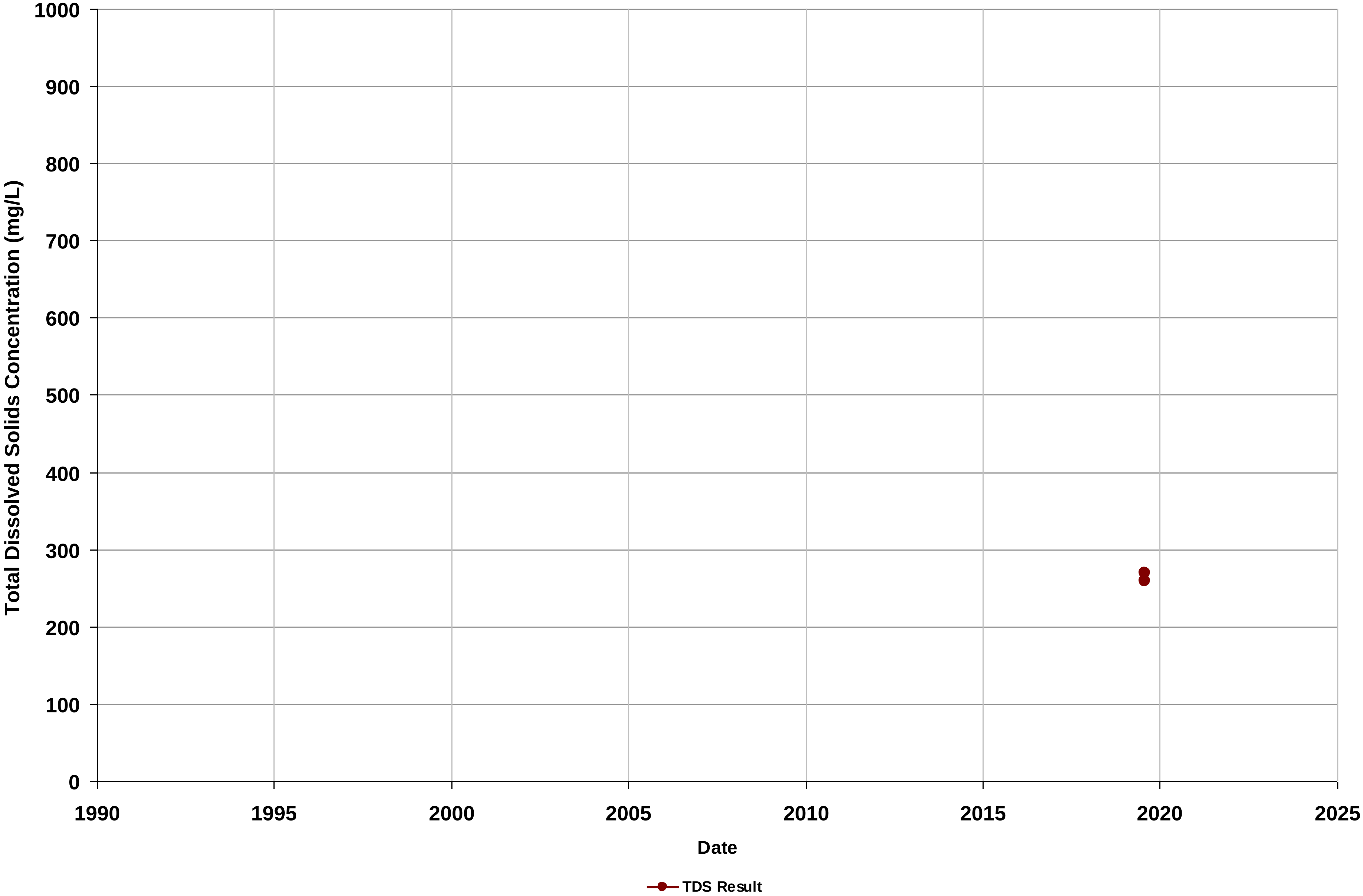
Total Depth (ft bgs): 276
Perf. Top (ft bgs): 160
Perf. Bottom (ft bgs): 172



NOTE: Non-Detect results shown as half the reporting limit.

Well Name: ESJ17
Subbasin: Madera
Well Type: Domestic

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):



NOTE: Non-Detect results shown as half the reporting limit.

Appendix 3. Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) – First Model Update Report

Report | January 2025

Madera County

Sustainable Groundwater Management Act

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) – First Model Update Report

Prepared For

Chowchilla Subbasin Coordination Committee
Madera Subbasin Coordination Committee

Prepared by

Davids Engineering, Inc.
Luhdorff & Scalmanini

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APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
3D	Three-Dimensional
AF	Acre-Feet
AN	Above Normal
BMP	Best Management Practice
BN	Below Normal
C	Critical
C2VSim	California Central Valley Groundwater-Surface Water Simulation Model
C2VSim-CG	California Central Valley Groundwater-Surface Water Simulation Model – Coarse Grid
C2VSim-FG Beta2	California Central Valley Groundwater-Surface Water Simulation Model – Fine Grid
CDEC	California Data Exchange Center
CIMIS	California Irrigation Management Information System
CVHM	Central Valley Hydrologic Model
CVP	Central Valley Project
CWD	Chowchilla Water District
D	Dry
DWR	California Department of Water Resources
ET	Evapotranspiration
ET_a	Actual ET
ET_c	Crop ET
ET_o	Grass Reference ET
ET_r	Alfalfa Reference ET
ET_{ref}	Reference Crop Evapotranspiration
eWRIMS	SWRCB Electronic Water Rights Information Management System
ft/d	Feet Per Day
GDE	Groundwater Dependent Ecosystem
GFWD	Gravelly Ford Water District
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWS	Groundwater System
HCM	Hydrogeologic Conceptual Model
IDC	Integrated Water Flow Model Demand Calculator
IWFM	Integrated Water Flow Model
Kh	Horizontal Hydraulic Conductivity
Kv	Vertical Hydraulic Conductivity
MA	Management Area
MC	Madera County
MCSim	Madera-Chowchilla Groundwater-Surface Water Simulation Model

Acronym	Meaning
MID	Madera Irrigation District
Model	Numerical Groundwater Flow Model
MWD	Madera Water District
NOAA NCEI	National Oceanic and Atmospheric Administration National Centers for Environmental Information
NRCS	United States Department of Agriculture Natural Resources Conservation Service
PM	Penman-Monteith
PRISM	Parameter Elevation Regression on Independent Slopes Model
RCWD	Root Creek Water District
SEBAL	Surface Energy Balance Algorithm for Land
SGMA	Sustainable Groundwater Management Act of 2014
SJRRP	San Joaquin River Restoration Program
SLDMWA	San Luis & Delta-Mendota Water Authority
SS	Specific Storage
SVMWC	Sierra Vista Mutual Water Company
SWP	State Water Project
SWRCB	State Water Resources Control Board
SWS	Surface Water System
Sy	Specific Yield
T-ProGS	Transition Probability Geostatistical Software
TTWD	Triangle T Water District
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
W	Wet
WCR	Well Completion Report

1. INTRODUCTION

This report documents the first model update and re-calibration of the Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim), a numerical groundwater flow model developed for the Madera and Chowchilla Subbasin areas to support preparation of Groundwater Sustainability Plans (GSPs) for both subbasins along with other future potential groundwater management and planning needs. This report includes a summary of the model platform, data sources, model development and calibration, and calibration results.

1.1. Background

To support preparation of GSPs for the Madera and Chowchilla Subbasins, four Groundwater Sustainability Agencies (GSAs) in the Madera Subbasin (Madera County, Madera Irrigation District, Madera Water District and City of Madera) and all GSAs in the Chowchilla Subbasin (Chowchilla Water District, Madera County, Triangle T Water District, and Sierra Vista Mutual Water Company) elected to pursue development of a numerical groundwater flow model to be able to satisfy GSP regulations requiring use of a numerical groundwater model, or equally effective approach, to evaluate projected water budget conditions and potential impacts to groundwater conditions and users from the GSP implementation. The development of the MCSim is intended to support groundwater resources management activities associated with GSP development and implementation. MCSim utilizes data and the hydrogeologic conceptualization that are presented and described in the GSPs for the Madera and Chowchilla Subbasins and also incorporates data assembled as part of Data Collection and Analysis Reports prepared for both subbasins (DE & LSCE, 2017a; and DE & LSCE, 2017b) to improve the understanding of hydrologic processes and their relationship to key sustainability metrics within the Chowchilla and Madera Subbasins. MCSim provides a platform to evaluate potential outcomes and impacts from future management actions, projects, and adaptive management strategies through predictive modeling scenarios.

1.2. Objectives and Approach

Numerical groundwater models are structured tools developed to represent the physical basin setting and simulate groundwater flow processes by integrating a multitude of data (e.g., lithology, groundwater levels, surface water features, groundwater pumping, etc.) that compose the conceptualization of the natural geologic and hydrogeologic environment. MCSim was developed in a manner consistent with the Modeling Best Management Practices (BMP) guidance document prepared by the California Department of Water Resources (DWR) (DWR, 2016). The objective of MCSim is to simulate hydrologic processes and effectively estimate historical and projected future hydrologic conditions in the Chowchilla and Madera Subbasins related to groundwater dependent ecosystems (GDEs) and SGMA sustainability indicators relevant to the Chowchilla and Madera Subbasins including:

1. Lowering of Groundwater Levels
2. Reduction of Groundwater Storage
3. Depletion of Interconnected Surface Water

The development of MCSim involved starting with and evaluating the beta version (released 5/1/2018) of DWR's fine-grid version of the California C[entral Valley Groundwater-Surface Water Flow Model (C2VSim-

FG Beta2) and eventually carving out a local model domain and conducting local refinements to the model structure (e.g., nodes, elements) and modifying or replacing inputs as needed to sufficiently and accurately simulate local conditions in the Madera and Chowchilla Subbasin areas within the model domain. C2VSim-FG Beta2 utilizes the most current version of the Integrated Water Flow Model (IWFM) code available at the time of the MCSim development. IWFM and C2VSim-FG Beta2 were selected as the modeling platform due to the versatility in simulating crop-water demands in the predominantly agricultural setting of the subbasins, groundwater surface-water interaction, the existing hydrologic inputs existing in the model for the time period through the end of water year 2015, and the ability to customize the existing C2VSim-FG Beta2 model to be more representative of local conditions in the area of the Madera and Chowchilla Subbasins. MCSim was refined from C2VSim-FG Beta2 and calibrated to a diverse set of available historical data using industry standard techniques. The version of the IWFM model code available at the time of initial MCSim development did not have the capability of directly simulating land subsidence or solute transport (groundwater quality), which are two additional sustainability indicators relevant to the Madera and Chowchilla Subbasins.

As part of the first Plan Amendment to the Madera Subbasin Joint GSP, MCSim was updated utilizing additional data gathered during GSP implementation and re-calibrated. The updated model, referred herein as MCSim_v2, utilizes the most up to date version of the IWFM code available at the time and now includes simulation of land subsidence. MCSim_v2 will be used to further the understanding of hydrologic processes in the Subbasins and evaluate and refine Sustainable Management Criteria (SMC) as needed.

1.3. Report Organization

This report is organized into the following sections:

- Section 2: Model Code and Platform
- Section 3: Groundwater Flow Model Development
- Section 4: Groundwater Flow Model Results
- Section 5: Sensitivity Analysis and Model Uncertainty
- Section 6: Conclusions and Recommendations
- Section 7: References

2. MODEL CODE AND PLATFORM

The modeling code and platform utilized for MCSim are described below. As required by GSP regulations, the selected model code is in the public domain. The decision to select the model codes for the MCSim was based on providing Madera County with a modeling tool that can be used for GSP development with sufficient representation of local conditions, while utilizing to the extent possible, previous modeling tools available, including regional models. With this objective in mind, the model tools and platforms described below were determined to be most suitable for adaptation for use in GSP analyses.

2.1. Integrated Water Flow Model

IWFM is a quasi-three-dimensional finite element modeling software that simulates groundwater, surface water, groundwater-surface water interaction, as well as other components of the hydrologic system (Dogrul et al., 2017). MCSim was developed using the IWFM Version 2015 (IWFM-2015) code, which couples a three-dimensional finite element groundwater simulation process with one-dimensional land surface, river, lake, unsaturated zone, and small-stream watershed processes (Brush et al., 2016). A key feature of IWFM-2015 is its capability to simulate the water demand as a function of different land use and crop types and compare it to the historical or projected amount of water supply (Dogrul et al., 2017). IWFM uses a model layering structure in which model layers represent aquifer zones that are assigned aquifer properties relating to both horizontal and vertical groundwater movement (e.g., horizontal and vertical hydraulic conductivity) and storage characteristics (e.g., specific yield, specific storage) with the option to associate an aquitard to each layer, although represented aquitards are assigned a more limited set of properties relating primarily to their role in vertical flow (e.g., vertical hydraulic conductivity).

MCSim_v2 utilizes version IWFM-2015.2.1443 of the IWFM-2015 source code. The IWFM-2015 source code and additional information and documentation relating to the IWFM-2015 code is available from DWR at the link below:

https://data.cnra.ca.gov/dataset/iwfm-integrated-water-flow-model/resource/311462d8-6cb5-4259-bd2c-c1e36a5475be

2.1.1. IWFM Demand Calculator

IWFM includes a stand-alone Integrated Water Flow Model Demand Calculator (IDC) that calculates water demands. Agricultural water demands are calculated in the IDC based on climate, land use, soil properties, and irrigation method whereas urban demands are calculated based on population and per-capita water use. MCSim utilizes IDC to simulate root zone processes and water demands. DWR developed and maintains the physically based IDC version 4.11.

2.2. C2VSim-Fine Grid

The C2VSim-FG Beta2 model utilizes the IWFM-2015 code and represents a refinement of the previous C2VSim-Coarse Grid (C2VSim-CG) model. Refinements made in the development of C2VSim-FG Beta2 include a finer horizontal discretization, an updated aquifer layering scheme, updated precipitation data, and an extended simulation period through water year 2015 (DWR, 2018). C2VSim-CG had an average element size of approximately 15 square miles, and the average element size for C2VSim-FG Beta2 was about 0.6 square miles. The C2VSim-FG Beta2 version available from DWR at the time of the initiation of modeling efforts to support GSP preparation in the Madera and Chowchilla, was not a calibrated model version. As of the date of the initial version of MCSim (August 2019), a calibrated version of C2VSim-FG was not available.

3. GROUNDWATER FLOW MODEL DEVELOPMENT

This section describes the spatial and temporal (time-series) structure of the model and the input data that was utilized for model development. The initial model development process utilized data and information that was available at the time of initial model development and is described in greater detail in the GSP and previous Data Collection and Analysis reports (DE & LSCE, 2017a for Chowchilla, and DE & LSCE, 2017b for Madera). The development of the updated version of the model (MCSim_v2) included additional data that had been developed and collected during GSP implementation.

3.1. MCSim_v2 – Historical Model

The initial version of the MCSim historical model simulated the period from October 1985 through September 2015 at a monthly time step, with a calibration period of October 1988 through September 2015. This simulation period was extended and calibrated through September 2023 as part of the MCSim_v2 update. The MCSim_v2 historical model simulates the period from October 1985 through September 2023 at a monthly time step, with a calibration period of October 1988 through September 2023. Annual model time periods are based on water years defined as October 1 through September 30. The historical calibration model period extends from water year 1989 through 2023. Water years 1986 through 1988 are not included as part of the historical calibration period but are simulated to allow the model some time to adjust to the specified initial conditions and spin-up prior to the calibration period starting in October 1988.

3.1.1. Model Configuration

The MCSim grid was carved out of the regional C2VSim-FG Beta2 model domain. While MCSim focuses on the Chowchilla and Madera Subbasins, the model domain was extended outside the two subbasins to incorporate a buffer zone an including area within the Merced, Delta-Mendota, and Kings Subbasins. The extent of the buffer zone was determined, using the C2VSim-FG Beta2 regional model, by simulating pumping wells along the boundary of the Chowchilla and Madera Subbasins to determine the distance to a one-foot drawdown of groundwater levels. This MCSim domain was delineated with consideration of these drawdown distances (typically 5-10 miles from Chowchilla and Madera Subbasin boundaries). The MCSim domain, shown in **Figure 3-1**, encompasses a total of 847,624 acres. All C2VSim-FG Beta2 model features (e.g., nodes, elements, streams, layers) within this domain were initially included in MCSim with subsequent modifications and refinements made within MCSim to these model components, as described in this report.

Nodes and Elements

The MCSim grid contains 2,458 nodes and 2,632 elements (**Figure 3-1**). The X-Y coordinates for node locations are presented in the UTM Zone 10N, NAD83 (meters) projected coordinate system. While the number of nodes and elements within the MCSim domain were not altered from C2VSim-FG Beta2, the locations of some nodes and elements were modified to more accurately align with subbasin boundaries and streams. **Figure 3-2** highlights the modified nodes and elements in MCSim. **Table 3-1** presents MCSim grid characteristics.

Table 3-1. MCSim Grid Characteristics	
Nodes	2,458
Elements	2,632
Average Element Size (acres)	322
Minimum Element Size (acres)	10
Maximum Element Size (acres)	1,486
Subregions	16
Aquifer Layers	7
Aquitard Layers	3

Model Subregions

Model elements are grouped into subregions to assist in the summarization of model results and development of water budgets. MCSim includes 16 subregions (listed in **Table 3-2**). Subregions were delineated by subbasin and also by GSA within the Chowchilla and Madera Subbasins. While subregions are used as the basis for summarizing model results, the model simulates hydrologic processes and conditions at the resolution of elements or nodes. **Figure 3-3** shows the delineation of subregions included within MCSim.

Table 3-2. Model Subregions within MCSim

Subregion	Subbasin	GSA
1	Chowchilla	Chowchilla Water District
2	Chowchilla	Madera County - East
3	Chowchilla	Madera County - West
4	Chowchilla	Sierra Vista MWC - Madera County
5	Chowchilla	Sierra Vista MWC - Merced County
6	Chowchilla	Triangle T Water District
7	Madera	City of Madera
8	Madera	Madera County
9	Madera	Gravelly Ford Water District
10	Madera	Madera Irrigation District
11	Madera	Madera Water District
12	Madera	New Stone Water District
13	Madera	Root Creek Water District
14	Merced	
15	Delta-Mendota	
16	Kings	

Streams

MCSim includes 35 stream reaches composed of 657 stream nodes. Streams that were adapted from existing streams simulated in C2VSim-FG Beta2 include Chowchilla River, Deadman's Creek, Eastside Bypass/Chowchilla Bypass, Fresno River, Fresno Slough, and San Joaquin River. Some of the stream nodes were shifted to better align with the actual stream configuration. Streams added to MCSim that were not included in C2VSim-FG Beta2 include Ash Slough, Berenda Creek, Berenda Slough, Cottonwood Creek, Dry Creek, Dutchman Creek, and Madera Canal. The stream network included in MCSim is shown in **Figure 34**.

Model Layers

A major modification in the adaptation of the C2VSim-FG Beta2 model for MCSim purposes was to refine the representation of the aquifer system through model layering. Within the MCSim domain, C2VSim-FG Beta2 delineates three aquifer layers and one aquitard layer; MCSim was refined to include seven aquifer layers and three aquitard layers corresponding with key hydrogeologic features identified in the Hydrogeologic Conceptual Model (HCM) for the subbasins. The aquifer system within MCSim is broken down into the Upper Aquifer (layers 1 through 3), the Lower Aquifer (layers 4 through 6), and a buffer layer (layer 7). The E-Clay unit (Corcoran Clay) of the Tulare Formation separates the Upper and Lower Aquifers, where present. Other less extensive clay units (e.g., A-Clay, C-Clay) of the Tulare Formation also exist in the area and were explicitly incorporated into the model as discrete model features (aquitard layers) or implicitly through assignment of hydraulic properties based on sediment texture as described below in **section 3.1.4.1**. **Table 3-3** presents the average thickness of each model layer in MCSim_v2.

The Upper Aquifer is generally unconfined, except where the A-Clay and/or C-Clay are present. The top of the aquifer system is defined by the land surface. In general, Layer 1 extends approximately 50 feet below ground surface, or to the top of the A-Clay, where present. The A-Clay is included as the Layer 2 aquitard overlying the Layer 2 aquifer. The Layer 2 aquifer extends from the base of the A-Clay, where present, to the top of the C-Clay (or other comparable shallow clays), where present. The C-Clay is included as the Layer 3 aquitard overlying the Layer 3 aquifer. The Layer 3 aquifer extends from the base of the C-Clay, where present, to the top of the E-Clay (Corcoran Clay), where present. Where aquitard(s) are not present in the Upper Aquifer, the remaining Upper Aquifer thickness below Layer 1 is divided evenly between Layers 2 and 3.

The Corcoran Clay is modeled as the Layer 4 aquitard. This aquitard layer separates the Upper Aquifer from the Lower Aquifer. The depth, thickness, and extent of the Corcoran Clay were refined as part of the MCSim_v2 update. During drilling of nested monitoring wells as part of the GSP implementation, the Corcoran Clay was observed in well CSB09, located outside of the Page (1986) extent. As a result, an effort was made to refine the extent of the Corcoran Clay within the Chowchilla and Madera subbasins.

In order to refine the Corcoran Clay extent, well completion reports (WCRs) in the surrounding area were reviewed for possible Corcoran Clay occurrences. A review of the CSB09 WCR and e-log shows the presence of the Corcoran Clay occurring from 135 to 160 feet below ground surface. Additionally, Mitten et al. (1970) describes the Corcoran Clay in the Madera area as “mostly clay, silty clay, or silt” and “gray, greenish gray, or bluish gray” and “plastic to friable.” WCRs were reviewed for clays described similarly to the description provided by Mitten et al. (1970) and within a similar depth zone (+/- approximately 50 feet) of the CSB09 observance.

WCRs with a possible Corcoran Clay observance were ranked based on the confidence of the WCR. This ranking was based on professional judgment, and included evaluation of the completeness of the WCR, the level of detail included in the geologic logging, and the drilling method used. WCRs that were ranked as High and Medium confidence were selected to refine the extent, depth, and thickness of the Corcoran Clay.

The WCRs identified as part of the refined Corcoran Clay extent were plotted in ArcGIS and surfaces were interpolated between these points to represent the refined extent, depth, and thickness of the Corcoran Clay.

The refined extent depth, and thickness of the Corcoran Clay was implemented within the MCSim_v2 model. Where the Corcoran Clay is not present, the below ground surface to the nearest occurrence of the Corcoran Clay was used to delineate the Upper and Lower aquifers.

The Lower Aquifer is confined where the Corcoran Clay is present and is considered semi-confined outside of the Corcoran Clay extent. The thicknesses of the Layer 4 aquifer and Layers 5, and 6 are delineated as equal percentages (approximately 33 percent) of the total Lower Aquifer thickness to the base of freshwater. The base of the Lower Aquifer was generally kept consistent with the base of the Lower Aquifer in C2VSim-FG Beta2 model, but some modifications were made in MCSim to better align the base of the Lower Aquifer with the base of freshwater (Page, 1973).

Layer 7 extends from the base of freshwater to the base of continental deposits (Williamson et al., 1989) and is considered a buffer layer. Though included in MCSim, Layer 7, although simulated in the model, is treated as a low-conductivity zone below the base of freshwater and below the zone of any groundwater pumping. Layer 7 was preserved in MCSim, with an overall model thickness equal to that of C2VSim-FG Beta2.

Table 3-3. Average Thickness of MCSim_v2 Layers

Model Layers	Average Thickness (feet)
Layer 1	49
A-Clay (where present)	15
Layer 2	99
C-Clay (where present)	13
Layer 3	90
Corcoran Clay (where present)	49
Layer 4	249
Layer 5	249
Layer 6	248
Layer 7	1,863

Elevations and thicknesses of MCSim aquifer and aquitard layers are shown in **Figures 3-5** through **3-25**.

3.1.2. Land Surface System

The IWFM Land Surface Process, which includes the IDC, calculates a water budget for four land use categories: non-ponded agricultural crops, ponded agricultural crops (i.e., rice), native and riparian vegetation, and urban areas. The Land Surface Process calculates water demand at the surface, allocates water to meet demands, and routes excess water through the root zone (Brush et al., 2016). The development of land surface system input files to simulate the Land Surface Process is explained in this section.

During initial MCSim development, a daily IDC application was first developed to calculate historical crop ET (ETc) and other water budget components in the Land Surface Process. A daily root zone water budget is a generally accepted and widely used method for land surface water budget development (ASCE, 2016 and ASABE, 2007). The daily IDC application was then adapted and calibrated to create the monthly IDC application within MCSim. The monthly IDC application within MCSim calculates various water budget components, including:

- ET of applied water
- ET of precipitation
- Infiltration of applied water
- Infiltration of precipitation
- Runoff of precipitation
- Change in root zone storage

Certain key MCSim inputs related to the Land Surface System are described below. Additional details regarding the development of the daily IDC application, including major inputs, are provided in GSP Appendix 2.F.

Precipitation

Monthly precipitation time series data was extracted from C2VSim-FG Beta2 (for water years 1922 through 2015) or directly from the Parameter Elevation Regression on Independent Slopes Model (PRISM; for water years 2016 through 2023), which was developed by the PRISM Climate Group at Oregon State University (PRISM Climate Group, 2024). Precipitation data within C2VSim-FG Beta2 is also based on PRISM data. PRISM quantifies spatial precipitation estimates, among other climate parameters, at a spatial resolution of four kilometers based on available weather station data and modeled spatial relationships with topography and other factors influencing weather and climate.

Monthly precipitation rates were downloaded for the coordinates nearest the centroid of each element and small watershed in MCSim. The monthly data sets were quality controlled and provided as model inputs for the nearest corresponding element or small watershed.

Evapotranspiration

Monthly evapotranspiration (ET) time series data was developed through the following processes, depending on available data during the historical period:

- For water years 1973 through 2015: ET rates were developed based on available weather data, reference crop ET (ET_{ref}), and crop coefficients.
- For water years 2016 through 2023: ET rates were developed using satellite-based remote sensing analyses and data available from OpenET.

These data sources and processes are described below. ET rates were developed for individual crop types and were refined based on available observation data, to the extent available.

Weather Data

Weather data was obtained from the California Irrigation Management Information System (CIMIS) and National Oceanic and Atmospheric Administration National Centers for Environmental Information (NOAA NCEI). **Table 3-4** lists the stations and periods of record used for each station through water year 2015. ET rates after water year 2015 are based on OpenET data, described below.

Table 3-4. Weather Data Time Series Summary

Weather Station	Station Type	Start Date	End Date	Comment
Fresno State	CIMIS	Oct. 2, 1988	May 12, 1998	Used before Madera CIMIS station was installed.
Madera	CIMIS	May 13, 1998	Apr. 2, 2013	Moved eastward 2 miles in 2013 and renamed “Madera II.”
Madera II	CIMIS	Apr. 3, 2013	Dec. 31, 2015	
Madera	NOAA NCEI	Jan. 1, 1928	Dec. 31, 2017	Used for developing ET_{ref} timeseries for water budget period when data gaps occurred, and before CIMIS station data was available.

Daily time series data was evaluated following the quality control procedures described in GSP Appendix 2.F. to develop daily reference crop evapotranspiration (ET_{ref}) for both the Chowchilla and Madera Subbasins during the historical and projected water budget periods.

Reference Evapotranspiration Development

Daily ET_{ref} was determined from available weather data (described above) following the widely accepted standardized Penman-Monteith (PM) method, as described by the ASCE Task Committee Report on the Standardized Reference Evapotranspiration Equation (ASCE-EWRI, 2005). The Task Committee Report standardizes the ASCE PM method for application to a full-cover alfalfa reference (ET_r) and to a clipped cool season grass reference (ET_o). ET_o is widely used throughout California and was selected as ET_{ref} for this application. Daily ET_o values were calculated and used to develop ET inputs for simulating crop consumptive use requirements through water year 2015. ET rates after water year 2015 are based on OpenET data, described below.

ET Development

Historical ET through water year 2015 was quantified for each land use in MCSim using the widely accepted reference ET-crop coefficient method (ASCE, 2016). In this method, ET_o is adjusted to estimate ET of other crops (ET_c) using a crop coefficient unique to the individual crop type, growth characteristics, health, and other local conditions. Crop coefficients for the MCSim domain were derived from actual ET (ET_a) estimated by the Surface Energy Balance Algorithm for Land (SEBAL) from available data in 2009. Remotely sensed energy balance ET results account for soil salinity, deficit irrigation, disease, poor plant stands, and other stress factors that affect crop ET. Studies by Bastiaanssen et al. (2005), Allen et al. (2007 and 2011), Thoreson et al. (2009) and others have found that when performed by an expert analyst, seasonal ET_a estimates produced by SEBAL are within plus or minus five percent of actual crop ET. Historical ET was computed through water year 2015 using the quality controlled ET_{ref} (described above) and these local, remote sensing derived crop coefficients.

For water years 2016 through 2023, ET inputs were developed for all land uses in MCSim using satellite-based remote sensing analyses available from OpenET. OpenET is a multi-agency web-based GIS utility that quantifies ET over time with a spatial resolution of 30 meters (m) x 30 m, or approximately 0.22 acres (OpenET Team, 2024). While OpenET is a new utility, the underlying methodologies to quantify ET apply a variety of well-established modeling approaches that are widely used in government and research applications. The OpenET modeling approaches are also similar to the SEBAL approach used to quantify ET through water year 2015 (described above). OpenET information was summarized from monthly raster coverages of the Chowchilla and Madera Subbasins in 2016 through 2023. ET inputs were then quantified on a monthly timestep as the average ET summarized for each land use in the MCSim domain (see below for information on how land use inputs were developed). ET inputs updated with OpenET information were compared with ET inputs estimated following the process used through water year 2015 to ensure their general consistency (within 5% difference for the primary irrigated agricultural crops in MCSim).

For all years, IDC parsed these ET estimates into the ET of applied water and ET of precipitation estimates used in the Chowchilla Subbasin and Madera Subbasin water budgets.

Land Use

Land use areas in the Chowchilla and Madera Subbasins were identified using the most recent and reliable spatial land use data in the region, depending on the time period. Data sources include:

- DWR county land use surveys for Madera County (1995, 2001, and 2011) and Merced County (1995, 2002, and 2012)
- Statewide crop mapping, available from the California Department of Water Resources through analyses by LandIQ (DWR) (DWR, 2024)
- CropScape Cropland Data Layer coverage, available from the United States Department of Agriculture (USDA, 2024).

For the historical period through 2015, land use areas were developed primarily from DWR county land use surveys statewide crop mapping in 2014, following the processes described in GSP Appendix 2.A.

For water years 2016 through 2023, land use areas were developed from DWR statewide crop mapping data and USDA CropScape data. Land use data from these sources were compiled into 30 m x 30 m annual coverages of the Chowchilla and Madera Subbasins. To prepare the MCSim inputs, DWR statewide crop mapping data (which includes extensive ground-truthing review of results) was preferentially used to identify agricultural land (including irrigated and non-irrigated lands) and urban areas, and then USDA CropScape data was utilized to back-fill gaps of non-irrigated, idle, and non-developed land. Local refinements were also applied, as needed, to account for local land use information, such as district crop reports. Comparisons were made to evaluate the consistency of the datasets with earlier land uses analyses through 2015 and found generally good correspondence for the major land use classes found in the Subbasin.

In addition to their application as MCSim inputs, land use areas were used together with ET-related information to develop crop coefficients and ET inputs for different land uses in MCSim (described above).

3.1.3. Surface Water System

The IWFM Surface Water System Process calculates a water budget along each stream reach between inflows and outflows, including stream-groundwater interactions (Brush et al., 2016). Time series inputs were developed to simulate Surface Water System processes during the historical model calibration period beginning October 1988. A steady-state average was used during earlier years of the MCSim simulation period to allow the model some time to adjust to the specified initial conditions and spin-up during water years 1985-1988, prior to the calibration period. Additional detail on the development of the Surface Water System model inputs is included in GSP Appendix 2.F.

Stream Characteristics

Stream bed parameters were taken from C2VSim-FG Beta2 for those stream nodes extracted from the C2VSim-FG Beta2 regional model. For additional stream nodes in MCSim, stream bed parameters were developed through review of soil properties and stream characteristics. Stream bed parameters, particularly stream bed conductivity and wetted perimeter, were further refined during the calibration process.

Inflows

Surface water inflows into the model domain are specified in MCSim for 10 stream reaches. Stream inflow locations are shown in **Figure 3-26**. Deadman’s Creek inflows were adapted from C2VSim-FG Beta2 inflow data. Fresno Slough inflows were generated in C2VSim-FG Beta2 by placing a stream flow hydrograph at the MCSim inflow node and using the resulting time series data for inflows to MCSim. Berenda Creek, Cottonwood Creek, Dry Creek, and Dutchman Creek inflows were based on available district data, including Madera Irrigation District (MID) Recorder data. and Chowchilla Water District (CWD) records. Chowchilla River, Fresno River, Madera Canal, and San Joaquin River inflows were based off of available records from the United States Army Corps of Engineers (USACE), United States Geological Survey (USGS) gage data, and district data, where applicable. More information regarding the development of surface inflow volumes is presented in **Table 3-5**.

Table 3-5. Summary of Historical Surface Water Inflows Development		
Waterway	**Calculation/Estimation Technique**	**Information Sources**
Berenda Creek	Calculated from MID recorder measurements adjusted upstream to the subbasin boundary for estimated seepage and evaporation	MID Recorder 13, USDA Natural Resources Conservation Service (NRCS) soil survey, Fresno State/Madera/Madera II CIMIS Stations
Chowchilla River	Reported Buchanan Dam irrigation and flood releases	United States Army Corps of Engineers (USACE) records, CWD records
Cottonwood Creek	Calculated from MID recorder measurements adjusted upstream to the subbasin boundary for estimated seepage and evaporation	MID Recorder 14, NRCS soil survey, Fresno State/Madera/Madera II CIMIS Stations
Deadman's Creek	n/a	From C2VSim-FG Beta2
Dry Creek	Estimated as equal to Berenda Creek recorder measurements adjusted upstream to the subbasin boundary for estimated seepage and evaporation	MID Recorder 13, NRCS soil survey, Fresno State/Madera/Madera II CIMIS Stations
Dutchman Creek	Estimated as equal to Received Legrand water reported by CWD	CWD monthly water supply reports
Fresno River	Estimated as equal to USGS measurement site along Fresno River below Hidden Dam	USGS Site 11258000 (FRESNO R BL HIDDEN DAM NR DAULTON CA)
Fresno Slough	Extracted streamflow hydrograph at inflow point from C2VSim-FG Beta2 regional model	From C2VSim-FG Beta2
Madera Canal	Estimated as equal to USGS measurement site along Madera Canal near Friant	USGS Site 11249500 (MADERA CN A FRIANT CA)
San Joaquin River	Estimated as equal to USGS measurement site along San Joaquin River below Friant Dam	USGS Site 11251000 (SAN JOAQUIN R BL FRIANT CA)

Surface Water Diversions and Deliveries

Surface water diversions and deliveries are simulated in the model as diversions from a stream node with an assigned delivery destination (element group). A total of 77 surface water diversions are included in the MCSim_v2 historical model, with 18 diversions adapted from C2VSim-FG Beta2 (primarily outside the Chowchilla and Madera Subbasins) and the remaining diversions added to MCSim. Diversions added to MCSim are used primarily to simulate agricultural diversions to districts and agricultural water users, riparian diversions to water users, and recharge efforts through water year 2023. Diversion locations are shown in **Figure 3-27**. Diversion volumes adapted from C2VSim-FG Beta2 were adjusted fractionally based on the percentage of the original C2VSim-FG Beta2 delivery location included within the MCSim domain. These diversions occur primarily outside of the Chowchilla and Madera Subbasins, but within the MCSim domain. Diversion volumes for the additional MCSim diversions were based on available data, including diversions reported from the United States Bureau of Reclamation (USBR), the State Water Resources Control Board (SWRCB), local district and GSA data sources. More information regarding the development of diversion volumes is presented in **Table 3-6**.

Losses associated with surface water deliveries are defined as fractions of each surface water diversion within MCSim and remain constant throughout the simulation period. Recoverable losses occur as seepage of water from the delivery system prior to arrival at the delivery destination. Accordingly, the fraction of recoverable loss represents water that recharges to the GWS from conveyance losses associated with surface water deliveries. Non-recoverable losses occur from evaporation associated with surface water deliveries. The fraction of non-recoverable loss represents water that does not recharge and occurs as an output from the SWS. The remaining percentage of surface water diversions (after subtraction of recoverable and non-recoverable losses) is considered the delivery fraction. The initial loss fractions used in the model were determined based on analyses of the average conveyance losses and evaporation associated with surface water deliveries within each GSA, as calculated in the SWS water budgets (GSP Appendix 2.F) performed outside the groundwater model. Fractional losses and deliveries were further refined during the calibration process.

In MCSim, surface water diversions are assigned to groups of elements for water delivery and recharge. Surface water delivery and recharge element groups were either adapted from C2VSim-FG Beta2 inputs or were defined to represent areas where surface water deliveries and/or recharge is known or expected to occur. The configuration and inputs associated with delivery and recharge groups adapted from C2VSim-FG Beta2 were not altered in MCSim. For refined surface water diversions and deliveries added into MCSim, delivery and recharge volumes were assigned to the entirety of the GSA receiving water, unless more specific data was available. Delivery groups for additional MCSim diversions were refined in CWD and MID based on delivery zone data provided for each GSA. Recharge groups were refined in CWD, GFWD, and MID based on locations of delivery conveyance systems. If a canal was present in a given element, recharge water was assigned to that element. Delivery locations for surface water deliveries are shown in **Appendix A**, **Figures A-1 through A-77** of this model report.

Table 3-6. Summary of Historical Surface Water Diversions Development

Diversion Number	Detailed Component	Calculation/Estimation Technique	Information Sources
DIV_1 - DIV_4, DIV_6 - DIV_19	C2VSim-FG Beta2 diversions data file	n/a	From C2VSim-FG Beta2
DIV_5	Diversions to RCWD	Reported by MID	MID delivery database

Table 3-6. Summary of Historical Surface Water Diversions Development

Diversion Number	Detailed Component	Calculation/Estimation Technique	Information Sources
DIV_20 - DIV_23	Chowchilla River and Berenda Slough Diversions to CWD	Sum of Buchanan Dam and Madera Canal irrigation releases diverted by CWD, plus additional flood releases diverted to meet reported CWD deliveries; apportioned to each waterway based on CWD delivery records, GIS analysis, and historical operations (18% from Chowchilla River, 82% from Berenda Slough)	USBR Central Valley Project (CVP) delivery records, USACE records, CWD delivery database, CWD monthly water supply reports
DIV_24	Flood Diversions to CWD for managed recharge	Reported deliveries during flood releases prior to the start of the irrigation season	CWD delivery database
DIV_25 - DIV_28	Diversions to GFWD	Reported by GFWD	Gravelly Ford WD reports
DIV_29, DIV_66	Dry Creek Diversions to MWD	Measured by MID, MWD	MID delivery database, MWD delivery records
DIV_30	Fresno River Diversions to MID	Closure of Fresno River Balance	USGS Site 11258000 (FRESNO R BL HIDDEN DAM NR DAULTON CA), USACE data, USBR CVP delivery records, IDC root zone water budget, NRCS soils characteristics, CIMIS precipitation data, MID recorders, and riparian deliveries.
DIV_31 - DIV_43	Madera Canal Diversions to MID	Reported in USBR CVP delivery records at Madera Canal Miles 6.1, 13.06, 22.23, 22.95, 24.1, 26.8, 27.5, 28.38, 28.39, 28.64, 30.4, 30.5, 32.2	USBR CVP delivery records
DIV_44 - DIV_59	Riparian Deliveries to MID, MC, and RCWD	Reported by historical water rights and statements of diversion, estimated from streamflow and crop ET when records not available	SWRCB Electronic Water Rights Information Management System (eWRIMS), Holding Contracts

Table 3-6. Summary of Historical Surface Water Diversions Development			
Diversion Number	**Detailed Component**	**Calculation/Estimation Technique**	**Information Sources**
DIV_60 - DIV_65	Water Rights Deliveries[1]	Reported riparian/appropriative/prescriptive water rights deliveries during flood releases and/or natural flood flows; estimated from streamflow and crop ET when records not available	CWD delivery records, eWRIMS, Fresno State/Madera/Madera II CIMIS Stations, land use data
DIV_67 - DIV_68	Purchased Water and Managed Recharge in TTWD	Reported by TTWD	TTWD reports
DIV_69 - DIV_77	Managed Recharge and Surface Water Diversions in MC, MID, and SVMWC	Reported diversions for recharge projects and additional surface water diversions (e.g., under the provisions of Executive Order N-4-23 in 2023)	District and county reports

[1] Includes riparian, appropriative, and prescriptive water rights deliveries during flood releases and/or natural flood flows along subbasin waterways.

Surface Water Bypasses

Surface water bypasses defined in the model simulate the movement of surface water between different waterways based on specified volumes or fractions. These bypasses can be used to simulate flood bypasses or water system operations. A total of eight surface water bypasses were included in MCSim. Two bypasses associated with moving surface water flows from the San Joaquin River into the Chowchilla Bypass and moving flows from the Chowchilla River into the Eastside Bypass were initially adapted from C2VSim-FG Beta2. Six additional bypasses were added to MCSim as a means to simulate the operations of MID and CWD surface water distribution systems. More information regarding the development of bypass volumes is presented in **Table 3-7**. Bypass locations are shown in **Figure 3-28**.

Table 3-7. Summary of Historical Surface Water Bypasses Develop			
Bypass Number	**Detailed Component**	**Calculation/Estimation Technique**	**Information Sources**
BYP_1	Chowchilla Bypass	Calculated from San Luis & Delta-Mendota Water Authority (SLDMWA) CBP station measurements adjusted downstream to the subbasin boundary for estimated seepage and evaporation	SLDMWA CBP station, NRCS soil survey, Fresno State/Madera/ Madera II CIMIS Stations

Table 3-7. Summary of Historical Surface Water Bypasses Develop			
Bypass Number	Detailed Component	Calculation/Estimation Technique	Information Sources
BYP_2	C2VSim-FG Beta2 diversions data file	N/A	From C2VSim-FG Beta2
BYP_3 - BYP_4	Madera Canal Diversions to CWD	Reported in USBR CVP delivery records at Madera Canal Miles 33.6 and 35.6	USBR CVP delivery records
BYP_5	MID Deliveries to CWD	Measured by MID, CWD	MID delivery database
BYP_6 - BYP_7	Chowchilla River and Berenda Slough Diversions to CWD	Sum of Buchanan Dam and Madera Canal irrigation releases diverted by CWD, plus additional flood releases diverted to meet reported CWD deliveries; apportioned to each waterway based on CWD delivery records, GIS analysis, and historical operations (18% from Chowchilla River, 82% from Berenda Slough)	USBR CVP delivery records, USACE records, CWD delivery database, CWD monthly water supply reports
BYP_8	Madera Canal Mile 18.8 Diversions to MID, Fresno River	Reported in USBR CVP delivery records at Madera Canal Mile 18.8	USBR CVP delivery records

[1] Includes riparian, appropriative, and prescriptive water rights deliveries during flood releases and/or natural flood flows along subbasin waterways.

3.1.4. Groundwater System

The IFWM Groundwater Flow Process balances subsurface inflows and outflows and manages groundwater storage within each element and layer (Brush et al., 2016). The development of groundwater system input files is explained in this section.

Aquifer Parameters

Because C2VSim-FG Beta2 was not a calibrated model and the basis for determining aquifer parameters in previous versions of C2VSim-CG were not characterized, aquifer parameters were defined in MCSim through subsurface lithologic textural analysis in conjunction with calibration of parameters based on texture. Aquifer parameters in MCSim are assigned to each node for each model layer and were developed to represent subsurface hydrogeologic characteristics.

Lithologic Texture Data

A significant refinement within MCSim_v2 was the implementation of a new textural model. A lithologic texture model was developed using borehole lithology data for 2,683 data points from DWR Airborne Electromagnetic Survey (AEM) data (Survey Area 5 and Survey Area 9 for Basin Characterization Pilot Study, available at https://data.cnra.ca.gov/dataset/aem) and an additional 120 Well Completion Reports (WCRs) located within the model domain. Lithology and texture data from the textural dataset developed for the US Geological Survey (USGS) Central Valley Hydrologic Model (CVHM) was used to fill spatial (lateral and vertical) gaps in the AEM and WCR textural dataset. For each dataset, the original texture description was simplified into a general texture class (gravel, sand, silt, clay). A binary percent coarse value was then assigned to each general texture classes, consistent with the methodology used by USGS in the development of the CVHM model (https://ca.water.usgs.gov/projects/central-valley/cvhm-texture-model.html). Gravels and sands were assigned a 1 while silts and clays were assigned a 0.

Translating the point textural dataset to a continuous textural model for use in MCSim_v2 was done by assigning values for the percent coarse at each textural borehole datapoint to each model layer penetrated by the borehole and then interpolating percent coarse by layer across the entire model domain. In this process, the intervals of fine and coarse-grained, textured sediments were calculated for model layers at each WCR location and the thickness-weighted percentage of coarse-grained materials within each model layer were estimated. Using values for percent coarse-grained materials by model layer at each borehole point, spatially continuous datasets representing the percentage of coarse-grained materials were developed for each model layer through point interpolation methods. Interpolation was performed using ordinary kriging interpolation tool in the ESRI ArcGIS software package, which applies a semivariogram approach. An appropriate semivariogram model was selected through exploration of the data. The resulting kriged spatial distribution of percent coarse by model layer is shown in **Figures 3-29 through 3-35**. During model development and calibration, aquifer parameters were assigned to model nodes and layers using parameter values specified for both the fine and coarse end members and relating these to the percent coarse values developed from the textural model. The process used to assign and calibrate aquifer parameters in the model based on the percent coarse values are described in the discussions of model calibration in Section 3.2 of this document.

Aquifer Parameter Zones

To better represent the geology within the MCSim domain, a set of aquifer parameter zones were developed to enable for more refined assignment of aquifer parameters based on the lithologic texture values, especially recognizing that aquifer properties for similar-textured materials (based on the textural model) may differ by geologic formation. Four zones (within Corcoran Clay (confined), within Corcoran Clay (semi-confined), outside Corcoran Clay/West of Highway 99, and East of Highway 99 were delineated for using multipliers applied to parameter values derived from the textural data. Depth decay factors are also applied to the multipliers within these zones, to represent the increased consolidation and induration that is believed to exist in older geologic units that are at greater depth and have undergone compression and compaction because of the geostatic load at greater depth.

A very low depth decay factor was applied to Layer 7 consistent with the greater depth of the layer and because the layer is below the depth at which groundwater pumping occurs in the area. Few or no wells penetrate to depths below the top of Layer 7 because it is below the base of freshwater. As a result, no groundwater pumping occurs at such great depths and little lithologic information is available so Layer 7 was represented with low aquifer properties to reduce any effect the layer may have on simulated conditions within the upper model layers where groundwater is actively used. Layer 7 was not considered in water budget estimates developed using the model.

A parameter overwrite was used to represent the occurrence of low-permeability materials associated with the basement complex within the MCSim model domain. Although the base of Layer 7 in the model was delineated to align with the base of continental deposits in many parts of the basin, because the contact between continental deposits and basement becomes steep along the eastern edge of the mode domain, in such areas MCSim simulated this contact through assignment of different aquifer parameters instead of through explicitly delineating this contact in the configuration of model layering. To achieve this, if a model layer was more than 50 percent below the mapped top of basement at a given model node, the node in that layer was designated as a basement complex node. Nodes designated as basement complex were assigned aquifer parameters associated with basement materials.

The discussion of the calibration of aquifer parameters using the parameter zones described above, and the results of the model calibration, are presented in **Sections 3.2 and 4.7** below.

Boundary Conditions

MCSim utilizes time-varying general head boundary conditions to simulate groundwater levels and fluxes at the extent of the model domain. A map of nodes where general head boundary conditions were specified in the model is presented in **Figure 3-36**. In specifying general head boundary conditions, hydraulic conductance was estimated at each boundary node by layer based on average horizontal hydraulic conductivity (Kh), cross-sectional area associated with each boundary node (product of distance between nodes and saturated layer thickness), and the distance from the model boundary (set as 1,000 feet). Transient historical water level boundary conditions were refined in MCSim_v2 by using the interpreted initial head conditions in 1985 and applying relative changes based on simulated water levels derived from the C2VSim-FG model for each model time step for the period 1985 to 2023. Some additional refinements were made to the boundary conditions after comparing modeled water levels to observed data.

Groundwater Pumping

Pumping within MCSim is determined by element based on land use characteristics and simulated demand and is calculated internally by the IDC to meet both agricultural and urban demands after available surface water deliveries have been accounted for. The vertical distribution of pumping by layer in MCSim was modified based on review of well construction information in DWR's database of Well Completion Reports (WCR) for wells within the model domain. Agricultural and urban pumping were distributed vertically based on well construction information data in DWR's WCR database for respective well types. The vertical distribution of pumping does not change over the historical simulation period. Maps of the vertical distribution of agricultural pumping by layer are presented in **Figures 3-37 through 3-43** and for urban pumping by layer in **Figures 3-44 through 3-50**.

3.1.5. Small Watersheds

A total of 44 small watersheds were included in MCSim from C2VSim-FG Beta2 (**Figure 3-51**). **Table 3-8** summarizes the contributions of small watersheds to modeled streams. Modifications were made to C2VSim-FG Beta2 small watersheds to properly route water through the additional streams modeled in MCSim. Additionally, minor edits to the contributing acreage of small watersheds were made to adjust to modifications of elements along model boundary.

Table 3-8. Summary of Small Watersheds		
Stream fed by Small Watersheds	**Count of Contributing Watersheds**	**Total Contributing Watershed Acreage**
Berenda Creek	3	4,694
Cottonwood Creek	3	12,710
Deadman's Creek	4	17,131
Dry Creek	3	15,820
Dutchman Creek	2	3,335
Fresno River	3	2,174
Madera Canal	16	31,814
San Joaquin River	10	42,899
TOTAL	**44**	**130,577**

3.1.6. Initial Conditions

Initial conditions were refined for MCSim_v2 and generated from mapped groundwater conditions based on observed groundwater levels and contour interpretation. Available historical groundwater level data were used to interpret groundwater elevations across the domain in Fall 1985 for use in the representation of initial model water level (head) conditions. Layers 1 through 3 were assigned initial head conditions representative of the Upper Aquifer and Layers 4 through 7 were assigned initial head conditions representative of the Lower Aquifer. Initial water level conditions used in the historical MCSim runs are shown in **Figures 3-52 through 3-58**.

Initial conditions for the unsaturated zone and small watersheds were defined from simulated C2VSim-FG Beta2 conditions.

3.2. Model Calibration

MCSim_v2 was calibrated using a trial and error approach in conjunction with utilization of automated calibration and parameter estimation techniques involving application of UCODE-2014, an inverse modeling computer code developed by the US Geological Survey. Automated techniques were used at stages during the calibration to explore model sensitivity and inform the trial and error calibration efforts. The calibration process focused on adjusting key model parameter values to improve the fit of simulated historical groundwater levels and subsidence to observed (measured) data. The key model parameters included in calibration were aquifer properties and subsidence properties.

Aquifer parameters were developed by assigning texture end member values to the percent coarse-grained materials in the textural model described in **Section 3.1.5.1.1** of this report. Texture end member values are the aquifer parameter values at the two ends of the percent coarse spectrum, either 100% (coarse) or 0% (fine). Aquifer parameters adjusted during calibration included horizontal hydraulic conductivity (Kh), vertical hydraulic conductivity (Kv), specific storage (Ss), specific yield (Sy), which were specified for aquifer parameter zones. The equations used to calculate the aquifer parameter values for each node and layer from the specified end-member values are presented below. For aquifer parameter zones where a multiplier was included in the calibration, the multiplier was applied to the parameter values resulting from calculations using these equations. The equations used for estimating aquifer parameters from textural model information are consistent with the methods used and described in development of the hydrogeologic conceptual model and model parameterization for C2VSim-FG (DWR, 2021).

Horizontal hydraulic conductivity (Kh) at each node and layer is calculated using the following equation:

$$Kh = (PCT * ({Kh_{C0}}^{pKh}) + (1 - PCT) * ({Kh_{F0}}^{pKh}))^{\frac{1}{pKh}}$$

Where: PCT is the percent coarse

Kh_{C0} is the Kh end member of coarse materials

Kh_{F0} is the Kh end member of fine materials

pKh is the power law empirical parameter for Kh

The vertical hydraulic conductivity (Kv) end member values are calculated through application of an anisotropy ratio (Kv / Kh) to the Kh endmember values. The Kv value at each node and layer is then calculated using the following equation:

$$Kv = (PCT * ({Kv_{C0}}^{pKv}) + (1 - PCT) * ({Kv_{F0}}^{pKv}))^{\frac{1}{pKv}}$$

Where: PCT is the percent coarse

Kv_{C0} is the Kv end member of coarse materials

Kv_{F0} is the Kv end member of fine materials

pKv is the power law empirical parameter for Kv

Specific storage (Ss) is calculated using the following equation:

$$SS = PCT * Ss_C + (1 - PCT) * Ss_F$$

Where: PCT is the percent coarse

Ss_C is the Ss end member of coarse materials

Ss_F is the Ss end member of fine materials

Specific yield (Sy) is calculated using the following equation:

$$Sy = PCT * Sy_C + (1 - PCT) * Sy_F$$

Where: PCT is the percent coarse

Sy_C is the Sy end member of coarse materials

Sy_F is the Sy end member of fine materials

Calibrated end member values are presented in **Section 4.2** of this report.

Observations used in the calibration of aquifer parameters included approximately 39,100 groundwater level observations from 401 wells across the model domain selected based on historical data record, well construction, and spatial representation (lateral and vertical distribution) (**Figure 3-59**).

Subsidence properties adjusted during the calibration included elastic specific storage (SCE), inelastic specific storage (SCI), and interbed vertical hydraulic conductivity (Kvi). SCE and SCI were assigned by applying a multiplier to the calculated SS value at each node for each layer. Multipliers were assigned using the same aquifer parameter zones described in **Section 3.1.5.1.2**. Kvi was initially assigned as the Kv value at each node and was subsequently adjusted during the calibration process.

Observations used in the calibration of the subsidence parameters included approximately 10,300 subsidence measurements from 37 subsidence monitoring stations (**Figure 3-60**).

The results of the model calibration are presented and discussed in **Section 4.1** below.

3.3. MCSim – Projected Model

The projected model simulations are intended to evaluate the effects of anticipated future conditions of hydrology, water supply availability, water demand, and projects and management actions within the Madera and Chowchilla Subbasins. The projected simulation period runs from WY 2024 through 2090 beginning on October 1, 2023, and ending September 30, 2090, at a monthly time step. Two distinct time periods exist in the future projected modeling: the implementation period (2024-2039), during which projects and management actions are enacted to bring the basin into sustainability, and the sustainability period (2040-2090), after which projects and management actions have been fully implemented. The projected model scenarios use hydrologic conditions representative of the most recent 50 years of hydrology in the Subbasins, with adjustments applied in scenarios for evaluating the water budget under climate change and/or altered water supply and demand conditions. The development of the projected future scenarios in MCSim is described in this section.

3.3.1. Projected Hydrology

Establishing a sequence of projected hydrology is key to the development of the projected model scenarios. Projected hydrology model inputs were developed based on review and consideration of the recent 50 years of hydrology for 1973-2023 and utilization of a hydrologic sequence that replicates the hydrologic patterns and trends over this period. During the implementation period, an average climatic period was simulated by repeating the observed average climatic period from 1999-2013 for the 2025 to 2039 period. During the sustainability period, the 50-year climatic period from 1973-2023 is repeated. The projected water year type and assigned surrogate water years for use developing the projected hydrology are shown in **Table 3-9**.

Table 3-9. Summary of Projected Water Years

WY	WY Type	WY Index
1989	C	1.96
1990	C	1.51
1991	C	1.96
1992	C	1.56
1993	W	4.20
1994	C	2.05
1995	W	5.95
1996	W	4.12
1997	W	4.13
1998	W	5.65
1999	AN	3.59
2000	AN	3.38
2001	D	2.20
2002	D	2.34
2003	BN	2.81
2004	D	2.21
2005	W	4.75
2006	W	5.90
2007	C	1.97
2008	C	2.06
2009	BN	2.72
2010	AN	3.55
2011	W	5.58
2012	D	2.18
2013	C	1.71
2014	C	1.16
2015	C	0.81
2016	D	2.35
2017	W	6.46
2018	BN	3.03

WY	Surrogate WY	WY Type	WY Index
2024	2018	BN	3.03
2025	1999	AN	3.59
2026	2000	AN	3.38
2027	2001	D	2.20
2028	2002	D	2.34
2029	2003	BN	2.81
2030	2004	D	2.21
2031	2005	W	4.75
2032	2006	W	5.90
2033	2007	C	1.97
2034	2008	C	2.06
2035	2009	BN	2.72
2036	2010	AN	3.55
2037	2011	W	5.58
2038	2012	D	2.18
2039	2013	C	1.71
2040	1973	AN	3.50
2041	1974	W	3.90
2042	1975	W	3.85
2043	1976	C	1.57
2044	1977	C	0.84
2045	1978	W	4.58
2046	1979	AN	3.67
2047	1980	W	4.73
2048	1981	D	2.44
2049	1982	W	5.45
2050	1983	W	7.22
2051	1984	AN	3.69
2052	1985	D	2.40
2053	1986	W	4.31

WY	Surrogate WY	WY Type	WY Index
2059	1992	C	1.56
2060	1993	W	4.20
2061	1994	C	2.05
2062	1995	W	5.95
2063	1996	W	4.12
2064	1997	W	4.13
2065	1998	W	5.65
2066	1999	AN	3.59
2067	2000	AN	3.38
2068	2001	D	2.20
2069	2002	D	2.34
2070	2003	BN	2.81
2071	2004	D	2.21
2072	2005	W	4.75
2073	2006	W	5.90
2074	2007	C	1.97
2075	2008	C	2.06
2076	2009	BN	2.72
2077	2010	AN	3.55
2078	2011	W	5.58
2079	2012	D	2.18
2080	2013	C	1.71
2081	2014	C	1.16
2082	2015	C	0.81
2083	2016	D	2.35
2084	2017	W	6.46
2085	2018	BN	3.03
2086	2019	W	4.94
2087	2020	D	2.35
2088	2021	C	1.32

Table 3-9. Summary of Projected Water Years

WY	WY Type	WY Index
2019	W	4.94
2020	D	2.35
2021	C	1.32
2022	C	1.56
2023	W	6.40

WY	Surrogate WY	WY Type	WY Index
2054	1987	C	1.86
2055	1988	C	1.48
2056	1989	C	1.96
2057	1990	C	1.51
2058	1991	C	1.96

WY	Surrogate WY	WY Type	WY Index
2089	2022	C	1.56
2090	2023	W	6.40

Note: Water Year Type is based on the San Joaquin Valley Water Year Index and is classified into five types:
W = Wet; AN = Above Normal; BN = Below Normal; D = Dry; C = Critical

Climate Change Adjustments

Climate change adjustments were also included in selected projected future scenarios to evaluate the potential influence of climate change on future conditions. The climate change factors applied to applicable MCSim inputs are from the DWR CalSim II simulated volume projections based on State Water Project (SWP) and Central Valley Project (CVP) operations under the 2030 mean climate change scenario (SGMA Data Viewer). For precipitation, evapotranspiration, and surface inflows for unimpaired waterways, historical data was adjusted by the CalSim II 2030 monthly streamflow change factors by water year type. For surface inflows for impaired waterways, the CalSim II projected reservoir outflows (assuming 2030 climate change) was used when available (1965-2003), or inflows were estimated as the average monthly CalSim II projected volume by water year type in other years (2004 and thereafter). For inflows to the San Joaquin River and other waterways stemming from it (i.e., Madera Canal), inflows were either derived from projected flows from a report on future supplies by the Friant Water Authority (Friant Water Authority, 2018), considering San Joaquin River Restoration Program (SJRRP) implementation and the CalSim II 2030 climate change projections (1965-2003), or inflows were estimated based on the average monthly projected volume by water year type (2004 and thereafter) included in the Friant Water Authority Report (Friant Water Authority, 2018). Additional information about climate change adjustments used in projected future scenarios is included in **Table 3-11** and **Table 3-13**.

3.3.2. Overview of Projected Scenarios

Four projected future scenarios were simulated to compare possible outcomes and evaluate the future sustainability of the Subbasins. These scenarios include: a Projected (No Action) scenario, a Projected (No Action) with Climate Change scenario, a Projected with Projects scenario, and a Projected with Projects and with Climate Change scenario. All four scenarios are simulated using the projected hydrology described in **Section 3.3.1** as a baseline. **Table 3-10** outlines the different model scenarios evaluated. The Projected (No Action) and Projected (No Action) with Climate Change scenarios use no flow boundary conditions, under which no subsurface flow is assumed to enter or exit the model domain along the model boundary. The Projected with Projects and Projected with Projects and with Climate Change scenarios use boundary conditions that assume adjacent basins are also implementing projects. The Projected with Climate Change and Projected with Projects and with Climate Change scenarios incorporate the 2030 mean climate change scenario adjustment for precipitation, ET, stream inflows, and surface water diversion volumes. All other model inputs are held constant across projected future scenarios.

The Projected with Projects scenario was chosen as the baseline future projected scenario. The Projected with Projects and with Climate Change, Projected (No Action), and Projected (No Action) with Climate Change model runs were chosen as sensitivity analysis scenarios.

Table 3-10. Summary of Projected Future Scenarios

Model Scenario Name/Description	Time Period (Water Years)	Boundary Conditions	Climate Change Adjustment	Projects and Management Actions
Projected with Projects	2024-2090	Adjacent Basins Implementing Projects	None	Yes
Projected with Projects and with Climate Change	2024-2090	Adjacent Basins Implementing Projects	2030 CT	Yes
Projected (No Action)	2024-2090	No Flow Assumed	None	No
Projected (No Action) with Climate Change	2024-2090	No Flow Assumed	2030 CT	No

3.3.3. Land Surface System

The development of land surface system datasets for projected future scenarios is described below.

Precipitation

For the projected scenarios, historical precipitation inputs from the appropriate surrogate water year were mapped to each projected water year through 2090 (**Table 3-9**). For scenarios with climate change adjustments, the historical precipitation inputs were adjusted using the appropriate CalSim II 2030 mean climate change scenario monthly water year type multiplier (see Section 3.3.1.1). Additional information about the development of projected precipitation rates is included in **Table 3-11**.

Table 3-11. Development of Projected Future Land Surface Process Components

Water Budget Component	Without Climate Change Adjustments		With Climate Change Adjustments	
	Implementation Period	Sustainability Period	Implementation Period	Sustainability Period
	(2024[1]-2039)	(2040-2090)	(2024[1]-2039)	(2040-2090)
Precipitation	2018, 1999-2013 historical data (2024 and 2025-2039)	1973-2023 historical data (2040-2090)	2018, 1999-2013 historical data (2024 and 2025-2039) adjusted by CalSim II 2030 monthly change factors by water year type	1973-2023 historical data (2040-2090) adjusted by CalSim II 2030 monthly change factors by water year type
Evapotranspiration	2018, 1999-2013 historical data (2024 and 2025-2039), assuming 2023 land use adjusted for projected urban area growth from 2024-2039	1973-2023 historical data (2040-2090), assuming 2023 land use adjusted for projected urban area growth from 2024-2070 (urban area constant from 2071-2090)	2018, 1999-2013 historical data (2024 and 2025-2039) adjusted by CalSim II 2030 monthly change factors by water year type, assuming 2023 land use adjusted for projected urban area growth from 2024-2039	1973-2023 historical data (2040-2090) adjusted by CalSim II 2030 monthly change factors by water year type, assuming 2023 land use adjusted for projected urban area growth from 2024-2070 (urban area constant from 2071-2090)

[1] Implementation period is from 2020-2039, although projected future MCSim updates have been refined to begin in 2024, following historical MCSim updates through 2023.

Evapotranspiration

ET inputs were also projected into the future by mapping historical ET inputs from the appropriate surrogate water year to each projected water year through 2090 (**Table 3-9**), with consideration of applicable projected changes in land use (described in **Section 3.3.3.3**). Additional information about the development of projected ET rates is included in **Table 3-11**.

Land Use

For all projected future scenarios, land use areas in the MCSim domain were adjusted starting from a baseline land use in 2023 (see Section 3.1.2.3). Specific land use area adjustments in each projected future scenario are summarized below.

No Action (Without Projects) Scenarios

Except in areas with urban growth, projected land use in the Projected No Action scenarios was based on the 2023 land use from the historical MCSim inputs. In areas with projected urban growth, simulated urban land use was gradually expanded over the 2024-2070 period, accompanied by commensurate decreases in agricultural and native vegetation land uses. Urban growth rates were developed through an analysis of urban growth trends from 1989 through 2023. These urban growth trends were also verified for general consistency with available urban water planning documents in the City of Madera, including the 2020 Urban Water Management Plan. Starting from 2023, urban land use was increased through 2070 using these urban growth percentages in elements where non-urban land was available for conversion. Any remaining non-urban land was distributed among the other land uses in the element based on each non-urban land use's percentage of total non-urban area in the element in 2023. After 2070, urban acreage was held constant through 2090.

In addition to urban land use expansion, projected urban population in the Projected No Action scenarios was developed based on review of observed population growth during water years 1989-2023. Projected urban population growth in the City of Chowchilla was estimated based on average 10-year population growth and projections for 2000-2040 from the City of Chowchilla Sphere of Influence Expansion & Municipal Service Review (Land Use Associates, 2011). Projected urban population growth in the City of Madera was estimated based on average 5-year population growth and review of the Madera Area Municipal Service Review and Sphere of Influence Update (Quad Knopf, 2018). Estimated urban population in water years 2071-2090 was held constant at the estimated population in 2070. The monthly projected urban per capita water use between water years 2024 and 2090 was estimated to be the same as water year 2018, a recent average year.

With Projects Scenarios

Land use in the Projected with Projects scenarios is based on land use in the Projected No Action scenarios, with modification to incorporate land use changes estimated to occur in association with projects and management actions (**Table 3-12**).

Madera County GSA is implementing a demand management program in both the Madera and Chowchilla Subbasins, which is expected to result in demand reduction to reach the sustainable yield for the Madera County GSA in each subbasin by 2040 (approximately 22,500 AFY in the Chowchilla Subbasin, and approximately 90,000 AFY in the Madera Subbasin), consistent with current planning efforts. Starting in water year 2024, irrigated agricultural land uses were gradually converted to fallow land uses in the Madera County GSA in each subbasin in order to meet anticipated annual demand reduction targets through 2040. Simulation of the demand management program is based on current plans for the program, although future updates may be warranted to the extent that program implementation or other assumptions change before 2040.

Land use was also modified to simulate gradual conversion of certain currently irrigated agricultural parcels to dedicated recharge basins within the MID GSA. Parcels anticipated to be converted in the future were transitioned from irrigated agriculture to recharge basins in MCSim according to their proposed extent and timeline (**Table 3-12**). These changes in land use and associated benefits to recharge in the

Subbasin may occur prior to 2040, depending on the MID GSA's implementation of projects and management actions.

Table 3-12. Land Use Changes in the Projected with Projects Scenarios

Subbasin	GSA	Change Year(s)	Project or Management Action	Land Use Changes
Chowchilla	Madera County	2024-2040	Demand management program	Annual conversion of irrigated agricultural land to fallow land in order to reach the GSA sustainable yield by 2040 (22,500 AFY), beginning with 10% reduction of transitional water in 2024-2025 and gradual reduction of remaining transitional water through 2040.
Madera	Madera County	2024-2040	Demand management program	Annual conversion of irrigated agricultural land to fallow land in order to reach the GSA sustainable yield by 2040 (90,000 AFY), beginning with 10% reduction of transitional water in 2024-2025 and gradual reduction of remaining transitional water through 2040.
Madera	Madera ID	2024-2028	Additional recharge basin conversions	Gradual conversion of 260 acres of irrigated agricultural land (as of 2023) to recharge basins (assuming orchards are converted).

3.3.4. Surface Water System

The development of surface water system datasets for projected future scenarios is described below.

Stream Inflows

For the projected scenarios, historical stream inflows from the appropriate surrogate water year were mapped to each projected water year through 2090 (**Table 3-9**), with the exception of inflows to the San Joaquin River and waterways stemming from the San Joaquin River (Madera Canal and Chowchilla Bypass), which were estimated from a report on future supplies by the Friant Water Authority (Friant Water Authority, 2018). For scenarios with climate change, a climate change adjustment was incorporated into the projections as described in Section 3.3.1.1. Additional information about the development of projected stream inflows is included in **Table 3-13**.

Table 3-13. Development of Projected Future Surface Water System Components				
Water Budget Component	Without Climate Change Adjustments		With Climate Change Adjustments	
	Implementation Period (2024[1]-2039)	Sustainability Period (2040-2090)	Implementation Period (2024[1]-2039)	Sustainability Period (2040-2090)
Surface Water Inflow - Unimpaired Streams	2018, 1999-2013 historical data (2024 and 2025-2039)	1973-2023 historical data (2040-2090)	2018, 1999-2013 historical data (2024 and 2025-2039) adjusted by CalSim II 2030 monthly streamflow change factors by water year type	1973-2023 historical data (2040-2090) adjusted by CalSim II 2030 monthly streamflow change factors by water year type
Surface Water Inflow - Chowchilla River (Buchanan Dam Releases)	2018, 1999-2013 historical data (2024 and 2025-2039)	1973-2023 historical data (2040-2090)	2018, 1999-2013 historical data (2024 and 2025-2039): 1999-2003 historical data adjusted by CalSim II 2030 climate change projections for Eastman Lake; 2004-2013 data estimated as the historical volume adjusted by the average monthly climate-adjusted volume by water year type	1973-2003 historical data (2040-2070) adjusted by CalSim II 2030 climate change projections for Eastman Lake; 2004-2023 data (2071-2090) estimated as the historical volume adjusted by the average monthly climate-adjusted volume by water year type
Surface Water Inflow - Fresno River (Hidden Dam Releases)	2018, 1999-2013 historical data (2024 and 2025-2039)	1973-2023 historical data (2040-2090)	2018, 1999-2013 historical data (2024 and 2025-2039): 1999-2003 historical data adjusted by CalSim II 2030 climate change projections for Hensley Lake; 2004-2013 data estimated as the historical volume adjusted by the average monthly climate-adjusted volume by water year type	1973-2003 historical data (2040-2070) adjusted by CalSim II 2030 climate change projections for Hensley Lake; 2004-2023 data (2071-2090) estimated as the historical volume adjusted by the average monthly climate-adjusted volume by water year type

Table 3-13. Development of Projected Future Surface Water System Components				
Water Budget Component	Without Climate Change Adjustments		With Climate Change Adjustments	
	Implementation Period (2024[1]-2039)	Sustainability Period (2040-2090)	Implementation Period (2024[1]-2039)	Sustainability Period (2040-2090)
Surface Water Inflow - San Joaquin River (Friant Dam Releases)	Estimated based on the Friant Water Authority Report* (same as implementation period with climate change adjustments**, see right)	Estimated based on the Friant Water Authority Report* (same as implementation period with climate change adjustments**, see right)	2018, 1999-2013 historical data (2024 and 2025-2039): 1999-2003 data provided by Friant Water Authority Report*, considering the CalSim II 2030 climate change projections and implementation of the SJRRP; 2004-2013 data estimated as the historical volume adjusted by the average Friant Report volume by month and water year type	1973-2003 data (2040-2070) provided by Friant Water Authority Report*, considering the CalSim II 2030 climate change projections and implementation of the SJRRP; 2004-2023 data (2071-2090) estimated as the historical volume adjusted by the average Friant Report volume by month and water year type
Surface Water Inflow - Chowchilla Bypass	Estimated based on the historical monthly ratio of Chowchilla Bypass (CBP) and San Joaquin River (SJR) flows, with projected SJR inflow data provided by the Friant Water Authority Report* (same as the implementation period with climate change adjustments**, see right)	Estimated based on the historical monthly ratio of CBP and SJR flows, with projected SJR inflow data provided by the Friant Water Authority Report* (same as the implementation period with climate change adjustments**, see right)	2018, 1999-2013 historical data (2024 and 2025-2039): 1999-2003: estimated based on the historical monthly ratio of CBP and SJR flows by water year type, with projected SJR inflow data provided by the Friant Water Authority Report*, considering the CalSim II 2030 climate change projections and implementation of the SJRRP; 2004-2013: estimated based on the historical monthly ratio of CBP to SJR flows by water year	1973-2003 (2040-2070): estimated based on the historical monthly ratio of CBP to SJR flows by water year type, with projected SJR inflow data provided by the Friant Water Authority Report*, considering the CalSim II 2030 climate change projections and implementation of the SJRRP; 2004-2023 (2071-2090): estimated based on the historical monthly ratio of CBP to SJR flows by water year type, with

Table 3-13. Development of Projected Future Surface Water System Components				
Water Budget Component	Without Climate Change Adjustments		With Climate Change Adjustments	
	Implementation Period (2024[1]-2039)	Sustainability Period (2040-2090)	Implementation Period (2024[1]-2039)	Sustainability Period (2040-2090)
			type, with average projected SJR inflows calculated from 1921-2003 by month and water year type	average projected SJR inflows calculated by month and water year type
Diversions from Madera Canal	Estimated based on the Friant Water Authority Report* (same as implementation period with climate change adjustments**, see right)	Estimated based on the Friant Water Authority Report* (same as the implementation period with climate change adjustments**, see right)	2018, 1999-2013 historical data (2024 and 2025-2039): 1999-2003 data provided by Friant Water Authority Report*, considering the CalSim II 2030 climate change projections and implementation of the SJRRP; 2004-2013 data estimated as the historical volume adjusted by the average Friant Report climate change volume by month and water year type	1973-2003 data (2040-2070) provided by Friant Water Authority Report*, considering the CalSim II 2030 climate change projections and implementation of the SJRRP; 2004-2023 data (2071-2090) estimated as the historical volume adjusted by the average Friant Report climate change volume by month and water year type
Other Diversions/ Bypasses	2018, 1999-2013 historical data (2024 and 2025-2039)	1973-2023 historical data (2040-2090)	2018, 1999-2013 historical data (2024 and 2025-2039)***	1973-2023 historical data (2040-2090)***

[1] Implementation period is from 2020-2039, although projected future MCSim updates have been refined to begin in 2024, following historical MCSim updates through 2023.

* "Estimate of Future Friant Division Supplies for use in Groundwater Sustainability Plans, California," Friant Water Authority, 2018.

** Although the Friant Water Authority Report (or Friant Report) accounts for climate change, it is considered the best available estimate of projected Madera Canal deliveries under SJRRP. For comparison, projected Madera Canal deliveries under SJRRP were also estimated without account for climate change from the Steiner Report Kondolf Hydrograph (Steiner, 2005). These estimates were approximately equal to the Friant Report 2030 climate change adjusted deliveries. Thus, the Friant Report projections were used instead to maintain consistent assumptions in estimating Madera Canal deliveries across all projected simulations.

*** Historical volumes specified in the model to ensure that GSAs can use as much surface water as is available in a given time step up to the maximum historical surface water used.

Diversions

Surface water diversion volumes were projected into the future based on historical surface water diversions from the corresponding assigned water year (**Table 3-9**), with the exception of diversions from the Madera Canal which were estimated from a report on future supplies by the Friant Water Authority (Friant Water Authority, 2018). For scenarios with climate change, a climate change adjustment was incorporated into the projections as described in Section 3.3.1.1. Additional information on the development of projected surface water diversions is included in **Table 3-13**.

Projects

Three main types of projects or management actions were simulated in MCSim: direct recharge projects (e.g., projects that deliver flood water to recharge basins or fields to increase groundwater recharge); in-lieu recharge projects (e.g., projects that reduce groundwater pumping by encouraging growers to use surface water rather than groundwater, or by purchasing and importing additional surface water); and projects or management actions that lead to land use changes (e.g., demand management; simulated through land use changes, see Section 3.3.3.3). Estimates of direct and in-lieu recharge project configurations and recharge were developed in close collaboration with each GSA, as reported in the GSPs. The objective of the projects (and demand management in the case of the Madera County GSA) is to increase recharge or reduce groundwater pumping a sufficient volume so groundwater pumping does not exceed the sustainable yield. A summary of projected projects simulated in each GSA is presented in **Table 3-14**.

For recharge projects (e.g., recharge basins and flood managed aquifer recharge (flood-MAR) projects), diversion volumes were developed based on estimated project recharge benefits and typical anticipated project operations and water availability by water year type and month, consistent with project plans reported in the GSP. For in-lieu recharge projects (e.g., projects that purchase and import additional surface water), estimated diversion volumes were specified consistent with project plans reported in the GSP.

For recharge projects using flood water, diversions were specified in the model as the maximum volumes that could be diverted and used by the projects during years when flood water is anticipated to occur. This ensured that projects could take as much water as was available in a given time step up to the maximum capacity of each project. Because maximum volumes were specified for each project, no climate change adjustment was applied to projects in the Projected with Projects with Climate Change scenario.

Project diversion locations are provided in **Figure 3-61.**

Diversion points were located downstream of historical diversions in order to prioritize historical diversions over project diversions. Project diversions were delivered to the entirety of the appropriate GSA, unless more detailed delivery information was available for the project. Delivery locations for projects are shown in **Figures A-78 through A-158** of **Appendix A**.

Bypasses

Bypass volumes were generally projected into the future based on historical bypass flows from the corresponding assigned water year (**Table 3-9**). The inflows to the Chowchilla Bypass from the San Joaquin River were estimated based on the historical monthly ratio of Chowchilla Bypass USGS stream gage (CBP) and projected San Joaquin River flows provided by a report on future supplies by the Friant Water Authority (Friant Water Authority, 2018). For scenarios with climate change, a climate change adjustment was incorporated into the projections. Additional information about the development of projected bypass volumes is included in **Table 3-13**.

Table 3-14. Summary of Projected Projects by GSA											
Div ID	Subbasin	GSA/ Sub-region[1]	Project Description	Project Start	Simulated Benefits by WY Type (AFY)					Months with Benefits	Notes
					W	AN	BN	D	C		
67-68	Chowchilla	CWD	Road 13 Groundwater Recharge Basin (East and West)	2024	3,000	3,000	0	0	0	Jan-Apr	Average benefits (Road 13 East and West) distributed across typical months with recharge (based on 2023)
69	Chowchilla	CWD	City Groundwater Recharge Basin	2024	3,500	3,500	0	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023)
70	Chowchilla	CWD	Road 19 Groundwater Recharge Basin	2024	600	600	0	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023)
71	Chowchilla	CWD	Acconero Groundwater Recharge Basin	2024	1,900	1,900	0	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023)
72-73	Chowchilla	CWD	Wood Groundwater Recharge Basin (East and West)	2024	1,000	1,000	0	0	0	Jan-Apr	Average benefits (Wood East and West) distributed across typical months with recharge (based on 2023)
74	Chowchilla	CWD	Flood-MAR (Winter Recharge)	2024	15,000	8,000	0	0	0	Dec-Mar	Average benefits distributed across typical Flood-MAR period
75	Chowchilla	CWD	Additional Groundwater Recharge Basins	2028	25,000	6,000	0	0	0	Jan-Apr	Average anticipated benefits from GSP distributed across typical months with recharge at other CWD recharge basins

Table 3-14. Summary of Projected Projects by GSA

Div ID	Subbasin	GSA/ Sub-region[1]	Project Description	Project Start	Simulated Benefits by WY Type (AFY)					Months with Benefits	Notes
					W	AN	BN	D	C		
76	Chowchilla	CWD	Madera Canal Capacity Increase	N/A	0	0	0	0	0	N/A	No estimated benefits; project proposed in 2020 Initial GSP, but no longer considered as of 2024
77	Chowchilla	CWD	Merced-Chowchilla Intertie	2035	15,000	15,000	0	0	0	May-Aug	Average anticipated benefits from GSP distributed across typical peak irrigation season
78	Chowchilla	CWD	Buchanan Dam Capacity Increase	2040	24,800	0	0	0	0	May-Aug	Average anticipated benefits from GSP distributed across typical peak irrigation season
79	Chowchilla	CWD	Enhanced Management of Flood Releases for Recharge	2024	28,000	3,500	0	0	0	Dec-Mar	Average benefits distributed across typical flood release periods
80	Chowchilla	MC	Madera County East: Water Purchase	N/A	0	0	0	0	0	N/A	No estimated benefits; project proposed in 2020 Initial GSP, but funding for project is not currently available
81	Chowchilla	MC	Madera County East: Flood Flow Recharge	2024	1,400	0	0	0	0	Dec-Mar	Average anticipated recharge associated with SB122, based on benefits in 2023 distributed across typical flood water periods (assuming benefits increase by 5% in first three W years, then same benefits in all future W years)

Table 3-14. Summary of Projected Projects by GSA											
Div ID	Subbasin	GSA/ Sub-region[1]	Project Description	Project Start	Simulated Benefits by WY Type (AFY)					Months with Benefits	Notes
					W	AN	BN	D	C		
82	Chowchilla	MC	Madera County East: Additional Water Rights Diversions for Ag	2024	400	0	0	0	0	May-Aug	Average anticipated diversions associated with SB122 and water rights use, based on benefits in 2023 distributed across typical peak irrigation season during flood water years
83	Chowchilla	MC	Madera County West: Chowchilla Bypass Flood Flow Recharge Phase 1	2026	8,300	0	0	0	0	Dec-Mar	Average anticipated recharge associated with Chowchilla Bypass Flood Flow Recharge Phase 1 (Project 1 in Chowchilla Subbasin), assuming construction finishes in 2025 and benefits are distributed across typical flood water periods
84	Chowchilla	MC	Madera County West: Chowchilla Bypass Flood Flow Recharge Phase 2	2026	4,000	0	0	0	0	Dec-Mar	Average anticipated recharge associated with Chowchilla Bypass Flood Flow Recharge Phase 2 (Project 2 in Chowchilla Subbasin, with refined location/design), assuming construction finishes in 2025 and benefits are distributed across typical flood water periods
85	Chowchilla	MC	Madera County West: Flood Flow Recharge	2024	33,000	0	0	0	0	Dec-Mar	Average anticipated recharge associated with SB122, based on benefits in 2023 distributed across typical flood water periods (assuming benefits increase by 5% in first three W years, then same benefits in all future W years)

Table 3-14. Summary of Projected Projects by GSA											
Div ID	Subbasin	GSA/ Sub-region[1]	Project Description	Project Start	Simulated Benefits by WY Type (AFY)					Months with Benefits	Notes
					W	AN	BN	D	C		
N/A	Chowchilla	MC	Demand Management	2024	--	--	--	--	--	--	Simulated through land use changes.
86	Chowchilla	MC	Madera County West: Additional Water Rights Diversions for Ag	2024	800	0	0	0	0	May-Aug	Average anticipated diversions associated with SB122 and water rights use, based on benefits in 2023 distributed across typical peak irrigation season during flood water years
87	Chowchilla	MC	Millerton Flood Release Imports	N/A	0	0	0	0	0	N/A	No estimated benefits; project proposed in 2020 Initial GSP, but funding for project is not currently available
88	Chowchilla	MC	Water Imports Purchase	N/A	0	0	0	0	0	N/A	No estimated benefits; project proposed in 2020 Initial GSP, but funding for project is not currently available
89	Chowchilla	SVMWC	SVMWC recharge basin	2024	5,000	3,000	0	0	0	Dec-Mar	Average anticipated benefits distributed across typical flood water periods; first year estimated from WY 2023 Annual Report
90	Chowchilla	SVMWC	Additional Water Rights Diversions for Ag	2024	2,200	0	0	0	0	May-Aug	Average anticipated diversions associated with SB122 and water rights use, based on benefits in 2023 distributed across typical peak irrigation season during flood water years

Table 3-14. Summary of Projected Projects by GSA

Div ID	Subbasin	GSA/ Sub-region[1]	Project Description	Project Start	Simulated Benefits by WY Type (AFY)					Months with Benefits	Notes
					W	AN	BN	D	C		
91	Chowchilla	TTWD	Poso Canal Pipeline and Columbia Canal Company Pipeline Projects	2024	8,000	8,000	8,000	7,500	7,000	May-Aug	Average additional water supply based on GSP and reported benefits through 2023, distributed across typical peak irrigation season
92	Chowchilla	TTWD	Poso Canal Pipeline Extension Project	2024	4,000	4,000	4,000	4,000	4,000	May-Aug	Average anticipated benefits distributed across typical peak irrigation season; first year estimated from WY 2023 Annual Report
93	Chowchilla	TTWD	Utilize Existing Recharge Basin	2024	14,000	4,000	0	0	0	Dec-Apr	Average recharge benefits based on GSP and reported benefits through 2023, distributed across typical flood water periods
94-95	Chowchilla	TTWD	Additional Recharge Basins to Capture Floodwater	2028	70,000	15,000	0	0	0	Dec-Apr	Average anticipated recharge based on GSP and distributed across typical flood water periods
96	Madera	CM	Berry Basin (with MID)	2024	221	30	10	0	0	Jan-Apr	Average benefits distributed across typical months with recharge; Partial benefit shown (50%, remainder of benefit assigned to MID)

Table 3-14. Summary of Projected Projects by GSA											
Div ID	Subbasin	GSA/ Sub-region[1]	Project Description	Project Start	Simulated Benefits by WY Type (AFY)					Months with Benefits	Notes
					W	AN	BN	D	C		
97	Madera	CM	Additional Recharge Basins with MID (Golf Course)	2024	51	25	0	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023); Partial benefit shown (50%, remainder of benefit assigned to MID)
98	Madera	CM	Additional Recharge Basins with MID (Absire)	2024	240	120	0	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023); Partial benefit shown (50%, remainder of benefit assigned to MID)
99	Madera	CM	Additional Recharge Basins with MID (Stadium)	2024	164	82	0	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023); Partial benefit shown (50%, remainder of benefit assigned to MID)
100	Madera	CM	Additional Recharge Basins with MID (Mitchell)	2024	88	44	0	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023); Partial benefit shown (50%, remainder of benefit assigned to MID)
101	Madera	CM	Additional Recharge Basins with MID (Mosesian)	2024	88	44	0	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023); Partial benefit shown (50%, remainder of benefit assigned to MID)

Table 3-14. Summary of Projected Projects by GSA											
Div ID	Subbasin	GSA/ Sub-region[1]	Project Description	Project Start	Simulated Benefits by WY Type (AFY)					Months with Benefits	Notes
					W	AN	BN	D	C		
102	Madera	CM	Meters and Volumetric Pricing	2024	3,350	3,350	3,350	3,350	3,350	Jan-Dec	Average benefits based on GSP
103	Madera	MC	Ellis Basin (with MID)	2024	275	150	150	0	0	Jan-Apr	Average benefits distributed across typical months with recharge; Partial benefit shown (50%, remainder of benefit assigned to MID)
104	Madera	MC	Water Imports Purchase	2025	0	5,000	7,000	9,000	2,500	May-Aug	Average anticipated benefits based on GSP and distributed across typical peak irrigation season; first year estimated from WY 2023 Annual Report
105	Madera	MC	Millerton Flood Release Imports	2025	22,000	0	0	0	0	Dec-Mar	Average anticipated benefits based on GSP and distributed across typical flood release periods; first year estimated from WY 2023 Annual Report
106	Madera	MC	Chowchilla Bypass Flood Flow Recharge Phase 1	2027	11,200	0	0	0	0	Dec-Mar	Average anticipated recharge associated with Chowchilla Bypass Flood Flow Recharge Phase 1 (Project 1, Option C in Madera Subbasin), assuming construction finishes in spring 2026 and benefits are distributed across typical flood water periods

Table 3-14. Summary of Projected Projects by GSA											
Div ID	Subbasin	GSA/ Sub-region[1]	Project Description	Project Start	Simulated Benefits by WY Type (AFY)					Months with Benefits	Notes
					W	AN	BN	D	C		
107	Madera	MC	Chowchilla Bypass Flood Flow Recharge Phase 2	2030	49,600	0	0	0	0	Dec-Mar	Average anticipated recharge associated with Chowchilla Bypass Flood Flow Recharge Phase 2 (Projects 2-5, Option C in Madera Subbasin), assuming construction finishes by 2030 and benefits are distributed across typical flood water periods
108	Madera	MC	Flood Flow Recharge	2024	22,500	0	0	0	0	Dec-Mar	Average anticipated recharge associated with SB122, based on benefits in 2023 distributed across typical flood water periods (assuming benefits increase by 5% in first three W years, then same benefits in all future W years)
109	Madera	MC	Additional Water Rights Diversions for Ag	2024	19,600	0	0	0	0	May-Aug	Average anticipated diversions associated with SB122 and water rights use, based on benefits in 2023 distributed across typical peak irrigation season during flood water years
N/A	Chowchilla	MC	Demand Management	2024	--	--	--	--	--	--	Simulated through land use changes.
110	Madera	MID	Ellis Basin (with MC)	2024	275	150	150	0	0	Jan-Apr	Average benefits distributed across typical months with recharge; Partial benefit shown (50%, remainder of benefit assigned to MC)

Table 3-14. Summary of Projected Projects by GSA											
Div ID	Subbasin	GSA/ Sub-region[1]	Project Description	Project Start	Simulated Benefits by WY Type (AFY)					Months with Benefits	Notes
					W	AN	BN	D	C		
111	Madera	MID	Berry Basin (with CM)	2024	221	30	10	0	0	Jan-Apr	Average benefits distributed across typical months with recharge; Partial benefit shown (50%, remainder of benefit assigned to CM)
112	Madera	MID	Allende Basin	2024	5,000	1,300	400	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023)
113	Madera	MID	Additional Recharge Basins with CM (Golf Course)	2024	51	25	0	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023); Partial benefit shown (50%, remainder of benefit assigned to MID)
114	Madera	MID	Additional Recharge Basins with CM (Absire)	2024	240	120	0	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023); Partial benefit shown (50%, remainder of benefit assigned to MID)
115	Madera	MID	Additional Recharge Basins with CM (Stadium)	2024	164	82	0	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023); Partial benefit shown (50%, remainder of benefit assigned to MID)
116	Madera	MID	Additional Recharge Basins with CM (Mitchell)	2024	88	44	0	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023); Partial benefit shown (50%, remainder of benefit assigned to MID)

Table 3-14. Summary of Projected Projects by GSA											
Div ID	Subbasin	GSA/ Sub-region[1]	Project Description	Project Start	Simulated Benefits by WY Type (AFY)					Months with Benefits	Notes
					W	AN	BN	D	C		
117	Madera	MID	Additional Recharge Basins with CM (Mosesian)	2024	88	44	0	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023); Partial benefit shown (50%, remainder of benefit assigned to MID)
118	Madera	MID	Rehab Recharge Basins (MID Basin #1 - 32.2)	2024	1,560	780	585	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023)
119	Madera	MID	Rehab Recharge Basins (MID Basin #2 - Airport)	2024	4,920	2,460	1,845	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023)
120	Madera	MID	Rehab Recharge Basins (MID Basin #3 - Russell)	2024	2,040	1,020	765	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023)
121	Madera	MID	Rehab Recharge Basins (MID Basin #4 - Burgess)	2024	480	240	180	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023)
122	Madera	MID	Rehab Recharge Basins (MID Basin #5 - Beeman)	2024	2,760	1,380	1,035	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023)

Table 3-14. Summary of Projected Projects by GSA

Div ID	Subbasin	GSA/ Sub-region[1]	Project Description	Project Start	Simulated Benefits by WY Type (AFY)					Months with Benefits	Notes
					W	AN	BN	D	C		
123	Madera	MID	Rehab Recharge Basins (MID Basin #6 - Madera Lake)	2024	240	120	90	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023)
124	Madera	MID	Additional Recharge Basins Phase 1 (MID Basin #8 - Campbell)	2024	7,540	3,770	1,044	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023)
125	Madera	MID	Additional Recharge Basins Phase 1 (MID Basin #9 - Basila)	2024	5,460	2,730	756	0	0	Jan-Apr	Average benefits distributed across typical months with recharge (based on 2023)
126	Madera	MID	Additional Recharge Basins Phase 2 (MID Basin #10)	2025	5,400	2,800	1,000	0	0	Jan-Apr	Average anticipated benefits of Phase 2 recharge basin on acquired parcel distributed across typical months with recharge, assuming recharge begins in 2025
127	Madera	MID	Additional Recharge Basins Phase 2 (Other New)	2035	48,600	25,200	9,000	0	0	Jan-Apr	Average anticipated benefits of remaining Phase 2 recharge basins planned in GSP distributed across typical months with recharge
128	Madera	MID	On-Farm Recharge Phase 1	2024	1,300	500	0	0	0	Dec-Mar	Average benefits distributed across typical on-farm recharge period

Table 3-14. Summary of Projected Projects by GSA

Div ID	Subbasin	GSA/ Sub-region[1]	Project Description	Project Start	Simulated Benefits by WY Type (AFY)					Months with Benefits	Notes
					W	AN	BN	D	C		
129	Madera	MID	On-Farm Recharge Phase 2	2025	4,000	3,000	0	0	0	Dec-Mar	Average anticipated benefits from GSP and distributed across typical on-farm recharge period
130	Madera	MID	MID Pipeline	2024	420	420	420	420	420	May-Aug	Average benefits based on GSP and distributed across typical peak irrigation season
131	Madera	MID	WaterSMART Pipeline	2024	880	880	880	880	880	May-Aug	Average benefits based on GSP and distributed across typical peak irrigation season
132	Madera	MID	WaterSMART SCADA	2024	1,230	1,230	1,230	1,230	1,230	May-Aug	Average benefits based on GSP and distributed across typical peak irrigation season
133	Madera	MID	Water Supply Partnerships	2025	3,990	3,990	3,990	3,990	3,990	May-Aug	Average benefits based on GSP and distributed across typical peak irrigation season
134	Madera	MID	Incentive Program	2024	5,010	5,010	5,010	5,010	5,010	May-Aug	Average benefits based on GSP and distributed across typical peak irrigation season
135	Madera	MWD	Expanded Surface Water Purchase	2024	6,000	6,000	1,500	0	0	May-Aug	Average benefits based on GSP and distributed across typical peak irrigation season; first year estimated from WY 2023 Annual Report
136	Madera	NSWD	Exercise of Appropriative Right	2024	15,700	0	0	0	0	Jan-Jun	Average benefits and timing estimated based on NSWD GSP and input from GSA technical team

Table 3-14. Summary of Projected Projects by GSA											
Div ID	Subbasin	GSA/ Sub-region[1]	Project Description	Project Start	Simulated Benefits by WY Type (AFY)					Months with Benefits	Notes
					W	AN	BN	D	C		
137	Madera	RCWD	1 - North WWTP ponds	2024	1,200	1,200	1,200	1,200	1,200	Jan-Dec	Average benefits and timing estimated based on RCWD GSP and input from GSA technical team
138	Madera	RCWD	2 - South WWTP ponds	2024	100	0	0	0	0	Jan-May	Average benefits and timing estimated based on RCWD GSP and input from GSA technical team
139	Madera	RCWD	3,4 - Flood MAR	2024	120	120	0	0	0	Dec-Mar	Average benefits and timing estimated based on RCWD GSP and input from GSA technical team
140	Madera	RCWD	5 - In-lieu Irrigation System	2024	4,155	4,155	0	0	0	May-Aug	Average benefits and timing estimated based on RCWD GSP and input from GSA technical team
141	Madera	RCWD	6,7,8 - Expanded in-lieu system	2027	1,845	1,845	0	0	0	May-Aug	Average benefits and timing estimated based on RCWD GSP and input from GSA technical team
142	Madera	RCWD	9 - Recharge basin	2030	4,500	4,500	0	0	0	Jan-Apr	Average benefits and timing estimated based on RCWD GSP and input from GSA technical team
143	Madera	RCWD	10 - Root Creek channel	2027	1,000	1,000	1,000	1,000	1,000	Jan-Apr	Average benefits and timing estimated based on RCWD GSP and input from GSA technical team
144	Madera	RCWD	11 - Riverstone Demand Reduction	2024-2035	2,000	2,000	2,000	2,000	2,000	May-Aug	Average benefits and timing estimated based on RCWD GSP and input from GSA technical team

Table 3-14. Summary of Projected Projects by GSA

Div ID	Subbasin	GSA/ Sub-region[1]	Project Description	Project Start	Simulated Benefits by WY Type (AFY)					Months with Benefits	Notes
					W	AN	BN	D	C		
145	Madera	GFWD	Gravelly Ford Canal	2024	4,338	2,892	2,169	0	0	Feb-Jun	Average benefits and timing estimated based on GFWD GSP and input from GSA technical team
146	Madera	GFWD	Gravelly Ford Recharge Basin	2024	2,700	1,800	1,350	0	0	Feb-Jun	Average benefits and timing estimated based on GFWD GSP and input from GSA technical team
147	Madera	GFWD	Cottonwood Creek	2026	3,011	2,007	1,505	0	0	Feb-Jun	Average benefits and timing estimated based on GFWD GSP and input from GSA technical team

[1] CWD = Chowchilla Water District GSA; MC = Madera County GSA; SVMWC = Sierra Vista Mutual water Company GSA; TTWD = Triangle T Water District GSA; CM = City of Madera GSA; MID = Madera Irrigation District GSA; MWD = Madera Water District GSA; NSWD = New Stone Water District GSA; RCWD = Root Creek Water District GSA; GFWD = Gravelly Ford Water District GSA

3.3.5. Groundwater System

The development of groundwater system datasets for projected future scenarios is described below.

Boundary Conditions

Several different boundary head conditions were developed for use in evaluating potential future conditions in the projected future scenarios. Future boundary head conditions scenarios were developed for: 1) no subsurface flow boundary conditions, 2) continuation of the average historical trend in groundwater levels over the period 1989 to 2015, and 3) gradual ramping down of the average historical groundwater level trend over the implementation period (2020-2040) with long-term stable trends in groundwater levels from 2040 to 2070 and 2090. In developing the future groundwater head conditions, head conditions developed over the historical model base period from 1989 to 2015 were substituted based on similar water year types for the projected period. The relative changes in boundary head conditions from the base period were used to represent the appropriate trend in boundary head conditions to be represented at each boundary node. In scenarios in which the historical trend in boundary heads was ramped down over the implementation period and then set as stable for the sustainability period past 2040, adjustments were applied to achieve reductions in trend slopes in intervals of five years from 2020 to 2040 and then an adjustment to represent a zero long-term trend was applied for both the periods 2040 to 2070 and also 2070 to 2090.

In the future simulations, both the Projected (No Action) and Projected (No Action) with Climate Change scenarios assume no flow boundary conditions, under which no subsurface flow enters or exits the model domain along the model boundary. In the No Action scenarios, it is assumed that no subbasin is subject to SGMA, so levels continue to fall in neighboring subbasins also. In this situation, inflows probably remain about the same. To model this, a boundary condition of no subsurface inflow or outflow at the model boundary is assumed (approximately 5-10 miles outside Chowchilla and Madera Subbasin boundaries. The Projected with Projects and Projected with Projects and with Climate Change scenarios utilize general head boundary conditions with the assumption that adjacent basins are also implementing projects and experience ramping down of historical groundwater level trends with generally stable water level conditions after 2040. The same conductance values from the Historical simulation period are also used for the projected future general head boundary conditions.

Groundwater Pumping

The pumping specifications used for the historical simulation period were retained for the duration of all projected simulations (2024-2090) except in the Western Management Area (MA) of Chowchilla Subbasin. Due to the general need to reduce pumping from the Lower Aquifer in many parts of the Western MA to mitigate for potential subsidence impacts, in projected scenarios much of the pumping that occurred from the Lower Aquifer in the Western MA under the historical simulations was shifted into the Upper Aquifer model layers for the projected simulations. As a result, in the Western MA approximately 90 percent of projected pumping occurs in the Upper Aquifer and 10 percent is in the Lower Aquifer. Maps of the vertical distribution of projected agricultural pumping by layer are presented in **Figures 3-62 through 3-68** and for projected urban pumping by layer in **Figures 3-69 through 3-75**.

3.3.6. Initial Conditions

Initial conditions used for projected future simulations in 2024 utilized the final conditions from the historical simulation at the end of 2023. The initial conditions included used of the final conditions of the historical simulation period for the unsaturated zone, root zone, small watersheds, and groundwater levels. Initial groundwater levels are shown in **Figures 3-76 through 3-82**.

4. GROUNDWATER FLOW MODEL RESULTS

This section presents the results from simulations conducted with MCSim_v2. Results presented in this section include the results from model calibration, including calibrated aquifer parameters, and simulated Subbasin water budgets for various scenarios. The water budget results presented in this section are rounded to two significant digits consistent with the typical uncertainty associated with the methods and sources used in the analysis. Water budget component results may not sum to the totals presented because of rounding.

4.1. Model Calibration Results

Model calibration was achieved through comparison of observed groundwater levels and subsidence to model results. Observations used to constrain aquifer parameter values included approximately 39,100 groundwater level observations from 401 wells. Observations used to constrain subsidence parameters included approximately 10,300 subsidence measurements from 37 subsidence monitoring stations.

Calibration quality quantifies the ability of the groundwater model to simulate observed groundwater levels. These results are evaluated with respect to fit statistics outlined by Anderson and Woessner (2002). More qualitative measures of model fit are also commonly used to evaluate model calibration quality and included in the model results.

4.1.1. Statistical Measures of Model Fit

Model calibration was evaluated through five common residual error statistics used to characterize model fit. These include the mean of residual error (ME), mean of absolute residual error (MAE), root mean of squared residual error ($RMSE$), Normalized RMSE ($NRMSE$), and linear correlation coefficient (R). The residual error here is calculated by subtracting the observed value from the simulated value at a specific physical location and time.

The mean of residual error (ME) is a measure of the general model tendency to overestimate (+) or underestimate (-) measured values. In general, it is a quantification of the model bias given by:

$$ME = \frac{1}{N}\sum_{i=1}^{N}(y_i - \hat{y}_i)$$

Where: N is the total number of observations

y_i is the ith observed value

$\hat{y}_i$ is the ith simulated value of a model dependent variable

The mean absolute residual errors (MAE) is more robust to represent the goodness of fit as no individual errors will be canceled in the estimation as ME. The MAE estimates the average magnitude of the error between modeled and observed values and is defined as:

$$MAE = \frac{1}{N}\sum_{i=1}^{N}|(y_i - \hat{y}_i)|$$

The root mean of squared residual error ($RMSE$) is defined as the square root of the second moment of the differences between observed and simulated error. Since the error between each observed and simulated value is squared, larger errors tend to have a greater impact on the value of the $RMSE$, therefore RMSE is generally more sensitive to outliers than the MAE.

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(y_i - \hat{y}_i)^{2}}$$

The normalized root mean squared error ($NRMSE$) is calculated to account for the scale dependency of the $RMSE$ and is a measure of the $RMSE$ divided by the range of observations (Anderson and Woessner, 2002).

The linear correlation coefficient (R) is defined in the following equations:

$$R = \frac{COV(y, \hat{y})}{\sigma_y . \sigma_{\hat{y}}}$$

Where: $COV(y, \hat{y}_i)$ is the covariance between the observed (y) and simulated ($\hat{y}$) values

σ_y is the standard deviation of the observed values

$\sigma_{\hat{y}}$ is the standard deviation of the simulated values

The value of R lies between 1 (perfect linear correlation) and -1 (perfect linear correlation in the opposite direction). Usually, simulated and observed quantity is plotted in a scatter diagram to represent the model calibration results graphically with associated linear correlation coefficient R.

There are no uniform calibration standards used to determine an acceptable calibration of a groundwater flow model (Anderson and Woessner, 2002; Anderson et al., 2015). Summary statistics, such as those discussed in this section, should be used to evaluate the fit of simulated values to observed data and to minimize the error between these values (Murray-Darling Basin Commission, 2001; ASTM, 2008). For the purposes of calibrating MCSim_v2, calibration targets were set to minimize the model error to within 10% of the range of observed values.

4.1.2. Groundwater Level Calibration

A subset of the approximately 2,400 wells that have observed groundwater levels in the study area was selected for model calibration. Wells were selected to provide a broad representation of the model domain based on the spatial distribution, availability of associated well construction information, depth zone of well completion, and period of record of available water level data. A total of 401 wells were selected to be used in calibration of MCSim_v2 with a total of 39,103 water level observations during the calibration period. Simulated and observed groundwater elevations were compared over the WY 1989 through 2023 calibration period.

Groundwater level calibration statistics are presented in **Table 4-1**. As stated in **Section 4.1.1**, the calibration targets for MCSim_v2 were set to minimize the model error to within 10% of the range of observed values. Observed groundwater level measurements used for calibration range from -183 to 339 feet, therefore an acceptable *RMSE* for MCSim_v2 would be 52.2 feet. The final calibrated *RMSE* was 25.6 feet, resulting in a *NRMSE* of 5%, well within acceptable limits (**Figure 4-1**). The calculated *ME* (-8.2 feet) and *MAE (*16.2 feet*)* indicate that the model tends to simulate higher groundwater levels than observed (over-predict). The relation between observed and simulated groundwater elevations is shown by layer in **Figure 4-2**. Points plotting above 1-to-1 correlation line represent observations where MCSim_v2 is simulating higher than observed groundwater elevations, while points plotting below the 1-to-1 correlation line represent observations where MCSim_v2 is simulating lower than observed groundwater elevations. In general, while points are plotting close to the 1-to-1 correlation line (R = 0.90), the model tends to over simulate water levels at lower observed groundwater elevations. The greatest residuals are generally observed in the Lower Aquifer, likely because of the thickness of layers 4, 5, and 6. Because the model can only produce one water level per model layer, it is hard to capture the nuance of water levels within a thicker model layers. The spatial distribution of residual errors in the simulated levels by well are presented in **Figure 4-3**. MCSim_v2 is generally well calibrated. Residuals tend to be randomly distributed, indicating no clear bias in the model.

Groundwater hydrographs of simulated and observed groundwater elevations used for model calibration are included in **Appendix B.**

Table 4-1. Groundwater Level Calibration Statistics

Calibration Statistic	Result	Target
Mean of Residual Error (ME)	-8.2 feet	-
Mean Absolute Residual Error (MAE)	16.2 feet	-
Root Mean of Squared Residual Error (RMSE)	25.6 feet	52.2 feet
Normalized Root Mean of Squared Residual Error (NRMSE)	5%	10%
Linear Correlation Coefficient (R)	0.90	1

4.1.3. Subsidence Calibration

Observed calibration measurements are generally unavailable during the early portion of the historical simulation period, with more subsidence monitoring beginning primarily in 2011. Observed subsidence measurements were compared to simulated compaction at 37 monitoring stations. Hydrographs of observed versus simulated subsidence are available in **Appendix C**. The spatial distribution of residual errors in the simulated subsidence by station are presented in **Figure 4-4**. In general, simulated subsidence is slightly greater than observed, but trends and rates generally match observed data where available.

4.2. Aquifer Parameters

Initial end member values assigned for each aquifer parameter were based on reported literature values. These values were further refined and adjusted during the calibration process. Final calibrated end member values for each of the aquifer parameters are presented in **Table 4**-2 and zone multipliers used to calculate aquifer parameters are presented in **Table 4-3**. These values were used to calculate aquifer parameter values for each model node in each model layer. The process for calculating aquifer parameters was previously described in **Section 3.1.4.1**.

Table 4-2. Summary of Aquifer Parameters End Member Values

Parameter	End Member Value
pKh (power law empirical parameter for Kh)	0.6
pKv (power law empirical parameter for KV)	-0.82
Kh_{C0} (Kh end member of coarse materials)	350
Kh_{F0} (Kh end member of fine materials)	0.5
VKA (Kv / Kh anisotropy ratio)	0.08
Ss_C (Ss end member of coarse materials)	1.00E-06
Ss_F (Ss end member of fine materials)	7.77E-06
Sy_C (Sy end member of coarse materials)	0.2393
Sy_F (Sy end member of fine materials)	0.03

Table 4-3. Summary of Zone Multipliers used to Calculate Aquifer Parameters

		Zone Multipliers			
	Layer	Horizontal Hydraulic Conductivity	Vertical Hydraulic Conductivity	Specific Yield	Specific Storage
Within Corcoran Clay (Confined)	1-3	1	1.1	1	1
	4	0.15	0.3	0.2	0.2
	5	0.25	0.6	0.2	0.2
	6	0.4	0.6	0.3	0.3
Within Corcoran Clay (Semi-unconfined)	1-3	1	1.1	1	1
	4	0.15	0.3	0.2	0.2
	5	0.35	0.6	0.2	0.2
	6	0.4	0.6	0.3	0.3
Outside of Corcoran Clay - West of Highway 99	1	0.25	0.5	1	1
	2	0.5	0.2	1	1
	3	0.7	0.7	1	1
	4	0.5	0.7	0.4	0.4

Table 4-3. Summary of Zone Multipliers used to Calculate Aquifer Parameters					
	Layer	Zone Multipliers			
		Horizontal Hydraulic Conductivity	Vertical Hydraulic Conductivity	Specific Yield	Specific Storage
	5	0.1	0.8	0.3	0.4
	6	0.3	0.4	0.6	0.6
Outside of Corcoran Clay - East of Highway 99	1	0.25	0.5	0.8	0.8
	2	0.35	0.35	0.8	0.8
	3	0.08	0.05	0.8	0.8
	4	0.05	0.3	0.3	0.4
	5	0.01	0.35	0.3	0.4
	6	0.6	0.6	0.65	0.6
Shallow Bedrock Zone	1	0.075	0.1	0.6	0.6
	2	0.085	0.085	0.6	0.6
	3	0.008	0.005	0.6	0.6
	4	0.005	0.03	0.1	0.2
	5	0.001	0.035	0.1	0.2
	6	0.06	0.06	0.45	0.4
Buffer Layer	7	0.001	0.001	0.001	0.001

4.2.1. Hydraulic Conductivity

The calibrated horizontal hydraulic conductivity (Kh) averages by layer are presented in **Table 4-4**. In the Chowchilla Subbasin, average Kh values range from 9.11 feet per day (ft/d) in layer 4 to 95.42 ft/d in layer 2. In the Madera Subbasin, average Kh values range from 7.78 ft/d in layer 5 to 68.30 ft/d in layer 2. Across the entire MCSim_v2 domain, average Kh values range from 10.30 ft/d in layer 5 to 87.92 ft/d in layer 2. The calibrated Kh values in MCSim_v2 are shown by model layer in **Figures 4-5 through 4-11**.

The calibrated vertical hydraulic conductivity (Kv) averages by layer are presented in **Table 4-4**. In the Chowchilla Subbasin, average Kv values range from 0.0206 ft/d in layer 4 to 0.0885 ft/d in layer 2. In the Madera Subbasin, average Kv values range from 0.0234 ft/d in layer 4 to 0.0585 ft/d in layer 1. Across the entire MCSim_v2 domain, average Kv values range from 0.0236 ft/d in layer 4 to 0.0797 ft/d in layer 1. The calibrated aquitard Kv averages by layer are also presented in **Table 4-4**. The aquitard layers simulated in the model (see **Section 3.1.1.4**) include the A-Clay (Layer 2), C-Clay (Layer 3), and E-Clay, or Corcoran Clay (Layer 4). The calibrated Kv values in MCSim_v2 are shown by model layer in **Figures 4-12 through 4-21**.

Table 4-4. Summary of MCSim_v2 Calibrated Hydraulic Conductivity			
Model Layer	AQUIFER PARAMETERS		
	Horizontal Hydraulic Conductivity (feet/day)	Vertical Hydraulic Conductivity (feet/day)	Aquitard Vertical Hydraulic Conductivity (feet/day)
CHOWCHILLA SUBBASIN			
1	82.19	0.0837	-
2	95.42	0.0885	0.0016
3	73.41	0.0742	0.0016
4	9.11	0.0206	0.0047
5	16.92	0.0379	-
6	11.11	0.0300	-
7	0.05	0.0001	-
Upper Aquifer	83.67	0.0821	-
Lower Aquifer	12.38	0.0295	-
MADERA SUBBASIN			
1	48.48	0.0585	-
2	68.30	0.0547	0.0034
3	55.68	0.0487	0.0034
4	11.31	0.0234	0.0030
5	7.78	0.0312	-
6	21.90	0.0273	-
7	0.01	0.0005	-
Upper Aquifer	57.49	0.0540	-
Lower Aquifer	13.66	0.0273	-
ENTIRE MODEL DOMAIN			
1	77.05	0.0797	-
2	87.92	0.0758	0.0024
3	71.96	0.0680	0.0024
4	11.95	0.0236	0.0039
5	10.30	0.0346	-
6	17.85	0.0298	-
7	0.04	0.0002	-
Upper Aquifer	78.98	0.0745	-
Lower Aquifer	13.37	0.0293	-

Note: Layers 1-3 are considered the Upper Aquifer, Layer 4-6 are considered the Lower Aquifer, and Layer 7 is considered a buffer layer.

4.2.2. Storage Coefficients

The calibrated specific storage (SS) averages by layer are presented in **Table 4-5**. In the Chowchilla Subbasin, average SS values range from 1.23E-06 $feet^{-1}$ in layer 4 to 4.82E-06 $feet^{-1}$ in layer 3. In the Madera Subbasin, average SS values range from 1.83E-06 $feet^{-1}$ in layer 4 to 3.84E-06 $feet^{-1}$ in layer 1. Across the entire MCSim_v2 domain, average SS values range from 1.51E-06 $feet^{-1}$ in layer 4 to 4.23E-06 $feet^{-1}$ in layer 3. The calibrated SS values in MCSim_v2 are shown by model layer in **Figures 4-22 through 4-28**.

The calibrated specific yield (Sy) averages by layer are presented in **Table 4-5**. In the Chowchilla Subbasin, average Sy values range from 0.02 in layers 4-6 to 0.13 in layer 2. In the Madera Subbasin, average Sy values range from 0.03 in layers 4-5 to 0.12 in layer 2. Across the entire MCSim_v2 domain, average Sy values range from 0.02 in layer 5 to 0.13 in layer 2. The calibrated Sy values in MCSim_v2 are shown by model layer in **Figures 4-29 through 4-35**.

Table 4-5. Summary of MCSim_v2 Calibrated Storage Coefficients

Model Layer	AQUIFER PARAMETERS	
	Specific Storage ($feet^{-1}$)	Specifc Yield (-)
CHOWCHILLA SUBBASIN		
1	4.67E-06	0.12
2	4.45E-06	0.13
3	4.82E-06	0.11
4	1.23E-06	0.02
5	1.26E-06	0.02
6	2.13E-06	0.02
7	1.69E-07	1.73E-03
Upper Aquifer	4.65E-06	0.12
Lower Aquifer	1.54E-06	0.02
MADERA SUBBASIN		
1	3.84E-06	0.11
2	3.46E-06	0.12
3	3.64E-06	0.11
4	1.83E-06	0.03
5	1.84E-06	0.03
6	2.67E-06	0.04
7	2.44E-06	2.44E-02
Upper Aquifer	3.65E-06	0.11
Lower Aquifer	2.11E-06	0.03

Table 4-5. Summary of MCSim_v2 Calibrated Storage Coefficients		
Model Layer	AQUIFER PARAMETERS	
	Specific Storage (feet^{-1})	Specifc Yield (-)
ENTIRE MODEL DOMAIN		
1	4.11E-06	0.12
2	3.94E-06	0.13
3	4.23E-06	0.12
4	1.51E-06	0.03
5	1.55E-06	0.02
6	2.32E-06	0.04
7	9.55E-07	9.58E-03
Upper Aquifer	4.09E-06	0.12
Lower Aquifer	1.79E-06	0.03

Note: Layers 1-3 are considered the Upper Aquifer, Layer 4-6 are considered the Lower Aquifer, and Layer 7 is considered a buffer layer.

4.2.3. Subsidence Parameters

The calibrated inelastic specific storage (SCI) averages by layer are presented in **Table 4-6**. In the Chowchilla Subbasin, average SCI values range from 2.29E-05 feet^{-1} in layer 2 to 3.09E-05 feet^{-1} in layer 6. In the Madera Subbasin, average SCI values range from 1.85E-05 feet^{-1} in layer 2 to 2.28E-05 feet^{-1} in layer 6. Across the entire MCSim_v2 domain, average SCI values range from 2.00E-05 feet^{-1} in layer 2 to 2.62E-05 feet^{-1} in layer 6. The calibrated SCI values in MCSim_v2 are shown by model layer in **Figures 4-36 through 4-42**.

The calibrated elastic specific storage (SCE) averages by layer are presented in **Table 4-6**. In the Chowchilla Subbasin, average SCE values range from 1.56E-04 feet^{-1} in layer 2 to 2.23E-04 feet^{-1} in layer 6. In the Madera Subbasin, average SCE values range from 7.55E-05 feet^{-1} in layer 2 to 1.11E-04 feet^{-1} in layer 6. Across the entire MCSim_v2 domain, average SCE values range from 1.34E-04 feet^{-1} in layer 1 to 1.93E-04 feet^{-1} in layer 6. The calibrated SCE values in MCSim_v2 are shown by model layer in **Figures 4-43 through 4-49**.

The calibrated interbed vertical hydraulic conductivity (interbed Kv) averages by layer are presented in **Table 4-4**. In the Chowchilla Subbasin, average interbed Kv values range from 0.0234 ft/d in layer 4 to 0.1087 ft/d in layer 2. In the Madera Subbasin, average interbed Kv values range from 0.0257 ft/d in layer 4 to 0.0700 ft/d in layer 1. Across the entire MCSim_v2 domain, average interbed Kv values range from 0.0276 ft/d in layer 4 to 0.1013 ft/d in layer 1. The calibrated interbed Kv values in MCSim_v2 are shown by model layer in **Figures 4-50 through 4-56**.

Table 4-6. Summary of MCSim_v2 Calibrated Subsidence Parameters			
Model Layer	SUBSIDENCE PARAMETERS		
	Inelastic Specific Storage (feet^{-1})	Elastic Specific Storage (feet^{-1})	Interbed Vertical Hydraulic Conductivity (feet/day)
CHOWCHILLA SUBBASIN			
1	2.40E-05	1.64E-04	0.1012
2	2.29E-05	1.56E-04	0.1087
3	2.48E-05	1.71E-04	0.0880
4	2.67E-05	1.84E-04	0.0234
5	2.70E-05	1.89E-04	0.0431
6	3.09E-05	2.23E-04	0.0317
7	2.77E-05	2.77E-04	0.0001
Upper Aquifer	2.39E-05	1.64E-04	0.0993
Lower Aquifer	2.82E-05	1.99E-04	0.0327
MADERA SUBBASIN			
1	2.06E-05	7.75E-05	0.0700
2	1.85E-05	7.55E-05	0.0685
3	1.97E-05	7.80E-05	0.0611
4	2.22E-05	9.53E-05	0.0257
5	2.11E-05	9.83E-05	0.0351
6	2.28E-05	1.11E-04	0.0293
7	1.29E-05	1.29E-04	0.0005
Upper Aquifer	1.96E-05	7.70E-05	0.0665
Lower Aquifer	2.20E-05	1.02E-04	0.0300
ENTIRE MODEL DOMAIN			
1	2.09E-05	1.34E-04	0.1013
2	2.00E-05	1.35E-04	0.0978
3	2.16E-05	1.46E-04	0.0859
4	2.45E-05	1.71E-04	0.0276
5	2.46E-05	1.78E-04	0.0395
6	2.62E-05	1.93E-04	0.0328
7	2.16E-05	2.16E-04	0.0002
Upper Aquifer	2.09E-05	1.38E-04	0.0950
Lower Aquifer	2.51E-05	1.81E-04	0.0333

Note: Layers 1-3 are considered the Upper Aquifer, Layer 4-6 are considered the Lower Aquifer, and Layer 7 is considered a buffer layer.

4.3. Chowchilla Subbasin Model Results

The following section summarizes the analyses and results for the Chowchilla Subbasin. Water budget results presented below reflect the complete groundwater system water budget. The surface water system water budget, as presented in the GSP, excludes subsurface flows and presents net recharge to groundwater using the net seepage, deep percolation, and groundwater pumping components.

4.3.1. Historical Period, WY 1989-2023

The water budget during the historical period simulation was calculated for the 1989-2023 water years spanning three different sub-time periods: the GSP historical period (WY 1989-2015), a transitional period (WY 2016-2019), and the GSP implementation period (WY 2020-2023). The water budgets presented in this section summarize results for the GSP historical period (WY 1989-2015) and the entire calibrated historical period (WY 1989-2023).

GSP Historical Period (WY 1989-2015)

Summarized results for major components of the GSP historical period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-7**. The positive net seepage values (on average 53,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 120,000 AF per year. The positive net subsurface flows (on average 18,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 42,000 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -260,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 27-year historic period indicates a cumulative change in groundwater storage of about -770,000 AF, which equals an average annual change in groundwater storage of about -28,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -5.27 AF per acre on average over the 27 years and an annual decrease of about -0.20 AF per acre across the entire Subbasin (approximately 146,000 acres).

Detailed results for each of the individual water budget components in the historical water budget are presented in **Appendix D.1**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.1**, and simulated subsidence hydrographs are presented in **Appendix F.1**.

Table 4-7. Chowchilla Subbasin GSP Historical Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (WY 1989-2015)
Net Stream Seepage	53,000
Deep Percolation	120,000
Groundwater Extractions	-260,000
Subsidence	42,000

Net Subsurface Flows	18,000
Annual Change in Groundwater Storage	**-28,000**

Calibrated Historical Period (WY 1989-2023)

Summarized results for major components of the calibrated historical period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-8**. The positive net seepage values (on average 59,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 120,000 AF per year. The positive net subsurface flows (on average 21,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 42,000 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -270,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 35-year historic period indicates a cumulative change in groundwater storage of about -700,000 AF, which equals an average annual change in groundwater storage of about -20,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -4.81 AF per acre on average over the 35 years and an annual decrease of about -0.14 AF per acre across the entire Subbasin (approximately 146,000 acres).

Detailed results for each of the individual water budget components in the historical water budget are presented in **Appendix D.1**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.1**, and simulated subsidence hydrographs are presented in **Appendix F.1**.

Table 4-8. Chowchilla Subbasin Calibrated Historical Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (WY 1989-2023)
Net Stream Seepage	59,000
Deep Percolation	120,000
Groundwater Extractions	-270,000
Subsidence	42,000
Net Subsurface Flows	21,000
Annual Change in Groundwater Storage	**-20,000**

4.3.2. Projected Scenarios, WY 2024-2090

The water budget during the projected scenarios was calculated for the 2024-2090 water years spanning two different sub-time periods: the GSP implementation period (WY 2024-2039) and the GSP sustainability period (WY 2040-2090).

Projected with Projects

Implementation Period, WY 2024-2039

Summarized results for major components of the Projected with Projects Implementation Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-9**. The positive net seepage values (on average 80,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 95,000 AF per year. The positive net subsurface flows (on average 24,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 8,600 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -220,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 16-year implementation period indicates a cumulative change in groundwater storage of about -200,000 AF, which equals an average annual change in groundwater storage of about -12,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -1.36 AF per acre on average over the 16 years and an annual decrease of about -0.09 AF per acre across the entire Subbasin (approximately 146,000 acres).

Detailed results for each of the individual water budget components in the Projected with Projects water budget are presented in **Appendix D.1**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.1**, and simulated subsidence hydrographs are presented in **Appendix F.1**.

Table 4-9. Chowchilla Subbasin Projected with Projects Implementation Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (2024-2039)
Net Stream Seepage	80,000
Deep Percolation	95,000
Groundwater Extractions	-220,000
Subsidence	8,600
Net Subsurface Flows	24,000
Annual Change in Groundwater Storage	**-12,000**

Sustainability Period, WY 2040-2090

Summarized results for major components of the Projected with Projects Sustainability Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-10**. The positive net seepage values (on average 90,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 98,000 AF per year. The positive net subsurface flows (on average 2,400 AF per year) represent the combined subsurface flows into the

Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 310 AF per year), while an inflow to the GWS water budget, represents a small amount of active compaction within the Subbasin. Groundwater pumping (on average -190,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 51-year historic period indicates a cumulative change in groundwater storage of about 300,000 AF, which equals an average annual change in groundwater storage of about 6,000 AF per year. These change in storage estimates equate to total increases in storage in the Subbasin of about 2.09 AF per acre on average over the 51 years and an annual increase of about 0.04 AF per acre across the entire Subbasin (approximately 146,000 acres).

Detailed results for each of the individual water budget components in the Projected with Projects water budget are presented in **Appendix D.1**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.1**, and simulated subsidence hydrographs are presented in **Appendix F.1**.

Table 4-10. Chowchilla Subbasin Projected with Projects Sustainability Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (2040-2090)
Net Stream Seepage	90,000
Deep Percolation	98,000
Groundwater Extractions	-190,000
Subsidence	310
Net Subsurface Flows	2,400
Annual Change in Groundwater Storage	**6,000**

Projects with Projects and with Climate Change

Implementation Period, WY 2024-2039

Summarized results for major components of the Projected with Projects and with Climate Change Implementation Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-11**. The positive net seepage values (on average 69,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 90,000 AF per year. The positive net subsurface flows (on average 34,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 22,000 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -240,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 16-year implementation period indicates a cumulative change in groundwater storage of about -370,000 AF, which equals an average annual change in groundwater storage of about -23,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -2.55 AF per acre on average over the 16 years and an annual decrease of about -0.16 AF per acre across the entire Subbasin (approximately 146,000 acres).

Detailed results for each of the individual water budget components in the Projected with Projects and with Climate Change water budget are presented in **Appendix D.1**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.1**, and simulated subsidence hydrographs are presented in **Appendix F.1**.

Table 4-11. Chowchilla Subbasin Projected with Projects and with Climate Change Implementation Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (2024-2039)
Net Stream Seepage	69,000
Deep Percolation	90,000
Groundwater Extractions	-240,000
Subsidence	22,000
Net Subsurface Flows	34,000
Annual Change in Groundwater Storage	**-23,000**

Sustainability Period, WY 2040-2090

Summarized results for major components of the Projected with Projects and with Climate Change Sustainability Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-12**. The positive net seepage values (on average 84,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 94,000 AF per year. The positive net subsurface flows (on average 20,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 4,700 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -200,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 51-year historic period indicates a cumulative change in groundwater storage of about 85,000 AF, which equals an average annual change in groundwater storage of about 1,700 AF per year. These change in storage estimates equate to total increase in storage in the Subbasin of about 0.58 AF per acre on average over the 51 years and an annual increase of about 0.01 AF per acre across the entire Subbasin (approximately 146,000 acres).

Detailed results for each of the individual water budget components in the Projected with Projects and with Climate Change water budget are presented in **Appendix D.1**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.1**, and simulated subsidence hydrographs are presented in **Appendix F.1**.

Table 4-12. Chowchilla Subbasin Projected with Projects and with Climate Change Sustainability Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (2040-2090)
Net Stream Seepage	84,000
Deep Percolation	94,000
Groundwater Extractions	-200,000
Subsidence	4,700
Net Subsurface Flows	20,000
Annual Change in Groundwater Storage	**1,700**

Projected (No Action)

Implementation Period, WY 2024-2039

Summarized results for major components of the Projected (No Action) Implementation Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-13**. The positive net seepage values (on average 72,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 97,000 AF per year. The positive net subsurface flows (on average 32,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 20,000 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -250,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 16-year implementation period indicates a cumulative change in groundwater storage of about -490,000 AF, which equals an average annual change in groundwater storage of about -31,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -3.37 AF per acre on average over the 16 years and an annual decrease of about -0.21 AF per acre across the entire Subbasin (approximately 146,000 acres).

Detailed results for each of the individual water budget components in the Projected (No Action) water budget are presented in **Appendix D.1**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.1**, and simulated subsidence hydrographs are presented in **Appendix F.1**.

Table 4-13. Chowchilla Subbasin Projected (No Action) Implementation Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (2024-2039)
Net Stream Seepage	72,000

Deep Percolation	97,000
Groundwater Extractions	-250,000
Subsidence	20,000
Net Subsurface Flows	32,000
Annual Change in Groundwater Storage	**-31,000**

Sustainability Period, WY 2040-2090

Summarized results for major components of the Projected (No Action) Sustainability Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-14**. The positive net seepage values (on average 77,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 110,000 AF per year. The positive net subsurface flows (on average 38,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 27,000 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -260,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 51-year historic period indicates a cumulative change in groundwater storage of about -620,000 AF, which equals an average annual change in groundwater storage of about -12,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -4.28 AF per acre on average over the 51 years and an annual decrease of about -0.08 AF per acre across the entire Subbasin (approximately 146,000 acres).

Detailed results for each of the individual water budget components in the Projected (No Action) water budget are presented in **Appendix D.1**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.1**, and simulated subsidence hydrographs are presented in **Appendix F.1**.

Table 4-14. Chowchilla Subbasin Projected (No Action) Sustainability Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (2040-2090)
Net Stream Seepage	77,000
Deep Percolation	110,000
Groundwater Extractions	-260,000
Subsidence	27,000
Net Subsurface Flows	38,000
Annual Change in Groundwater Storage	**-12,000**

Projected (No Action) with Climate Change

Implementation Period, WY 2024-2039

Summarized results for major components of the Projected (No Action) with Climate Change Implementation Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-15**. The positive net seepage values (on average 64,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 97,000 AF per year. The positive net subsurface flows (on average 47,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 36,000 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -290,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 16-year implementation period indicates a cumulative change in groundwater storage of about -670,000 AF, which equals an average annual change in groundwater storage of about -42,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -4.59 AF per acre on average over the 16 years and an annual decrease of about -0.29 AF per acre across the entire Subbasin (approximately 146,000 acres).

Detailed results for each of the individual water budget components in the Projected (No Action) with Climate Change water budget are presented in **Appendix D.1**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.1**, and simulated subsidence hydrographs are presented in **Appendix F.1**.

Table 4-15. Chowchilla Subbasin Projected (No Action) with Climate Change Implementation Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (2024-2039)
Net Stream Seepage	64,000
Deep Percolation	97,000
Groundwater Extractions	-290,000
Subsidence	36,000
Net Subsurface Flows	47,000
Annual Change in Groundwater Storage	**-42,000**

Sustainability Period, WY 2040-2090

Summarized results for major components of the Projected (No Action) with Climate Change Sustainability Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-16**. The positive net seepage values (on average 75,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 110,000 AF per year. The positive net subsurface flows (on average 56,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 33,000 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -290,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 51-year historic period indicates a cumulative change in groundwater storage of about -720,000 AF, which equals an average annual change in groundwater storage of about -14,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -4.97 AF per acre on average over the 51 years and an annual decrease of about -0.10 AF per acre across the entire Subbasin (approximately 146,000 acres).

Detailed results for each of the individual water budget components in the Projected (No Action) with Climate Change water budget are presented in **Appendix D.1**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.1**, and simulated subsidence hydrographs are presented in **Appendix F.1**.

Table 4-16. Chowchilla Subbasin Projected (No Action) with Climate Change Sustainability Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (2040-2090)
Net Stream Seepage	75,000
Deep Percolation	110,000
Groundwater Extractions	-290,000
Subsidence	33,000
Net Subsurface Flows	56,000
Annual Change in Groundwater Storage	**-14,000**

4.4. Madera Subbasin Model Results

The following section summarizes the analyses and results for the Madera Subbasin. Water budget results presented below reflect the complete groundwater system water budget. The surface water system water budget, as presented in the GSP, excludes subsurface flows and presents net recharge to groundwater using the net seepage, deep percolation, and groundwater pumping components.

4.4.1. Historical Period, WY 1989-2023

The water budget during the historical period simulation was calculated for the 1989-2023 water years spanning three different sub-time periods: the GSP historical period (WY 1989-2015), a transitional period (WY 2016-2019), and the GSP implementation period (WY 2020-2023). The water budgets presented in this section summarize results for the GSP historical period (WY 1989-2015) and the entire calibrated historical period (WY 1989-2023).

GSP Historical Period (WY 1989-2015)

Summarized results for major components of the GSP historical period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-17**. The positive net seepage values (on average 130,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 230,000 AF per year. The positive net subsurface flows (on average 54,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 31,000 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -490,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 27-year historic period indicates a cumulative change in groundwater storage of about -1,200,000 AF, which equals an average annual change in groundwater storage of about -43,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -3.33 AF per acre on average over the 27 years and an annual decrease of about -0.12 AF per acre across the entire Subbasin (approximately 349,000 acres).

Detailed results for each of the individual water budget components in the historical water budget are presented in **Appendix D.2**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.2**, and simulated subsidence hydrographs are presented in **Appendix F.2**.

Table 4-17. Madera Subbasin GSP Historical Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (WY 1989-2015)
Net Stream Seepage	130,000
Deep Percolation	230,000
Groundwater Extractions	-490,000
Subsidence	31,000
Net Subsurface Flows	54,000
Annual Change in Groundwater Storage	**-43,000**

Calibrated Historical Period (WY 1989-2023)

Summarized results for major components of the calibrated historical period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-18**. The positive net seepage values (on average 140,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 230,000 AF per year. The positive net subsurface flows (on average 59,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 34,000 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -500,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 35-year historic period indicates a cumulative change in groundwater storage of about -1,200,000 AF, which equals an average annual change in groundwater storage of about -36,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -3.57 AF per acre on average over the 35 years and an annual decrease of about -0.10 AF per acre across the entire Subbasin (approximately 349,000 acres).

Detailed results for each of the individual water budget components in the historical water budget are presented in **Appendix D.2**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.2**, and simulated subsidence hydrographs are presented in **Appendix F.2**.

Table 4-18. Madera Subbasin Calibrated Historical Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (WY 1989-2023)
Net Stream Seepage	140,000
Deep Percolation	230,000
Groundwater Extractions	-500,000
Subsidence	34,000
Net Subsurface Flows	59,000
Annual Change in Groundwater Storage	**-36,000**

4.4.2. Projected Scenarios, WY 2024-2090

The water budget during the projected scenarios was calculated for the 2024-2090 water years spanning two different sub-time periods: the GSP implementation period (WY 2024-2039) and the GSP sustainability period (WY 2040-2090).

Projected with Projects

Implementation Period, WY 2024-2039

Summarized results for major components of the Projected with Projects Implementation Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-19**. The positive net seepage values (on average 190,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 180,000 AF per year. The positive net subsurface flows (on average 64,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 7,300 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -450,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 16-year implementation period indicates a cumulative change in groundwater storage of about -120,000 AF, which equals an average annual change in groundwater storage of about -7,700 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -0.36 AF per acre on average over the 16 years and an annual decrease of about -0.02 AF per acre across the entire Subbasin (approximately 349,000 acres).

Detailed results for each of the individual water budget components in the Projected with Projects water budget are presented in **Appendix D.2**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.2**, and simulated subsidence hydrographs are presented in **Appendix F.2**.

Table 4-19. Madera Subbasin Projected with Projects Implementation Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (2024-2039)
Net Stream Seepage	190,000
Deep Percolation	180,000
Groundwater Extractions	-450,000
Subsidence	7,300
Net Subsurface Flows	64,000
Annual Change in Groundwater Storage	**-7,700**

Sustainability Period, WY 2040-2090

Summarized results for major components of the Projected with Projects Sustainability Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-20**. The positive net seepage values (on average 230,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 200,000 AF per year. The negative net subsurface flows (on average -5,600 AF per year) represent the combined subsurface flows out of the Subbasin to adjacent subbasins and into the Subbasin from upland areas. The negative subsidence value (on average -2,700 AF per year), while an outflow from the GWS water budget, represents a stop of active compaction within the Subbasin. Groundwater pumping (on average -390,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 51-year historic period indicates a cumulative change in groundwater storage of about 1,200,000 AF, which equals an average annual change in groundwater storage of about 24,000 AF per year. These change in storage estimates equate to total increases in storage in the Subbasin of about 3.49 AF per acre on average over the 51 years and an annual increase of about 0.07 AF per acre across the entire Subbasin (approximately 349,000 acres).

Detailed results for each of the individual water budget components in the Projected with Projects water budget are presented in **Appendix D.2**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.2**, and simulated subsidence hydrographs are presented in **Appendix F.2**.

Table 4-20. Madera Subbasin Projected with Projects Sustainability Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (2040-2090)
Net Stream Seepage	230,000
Deep Percolation	200,000
Groundwater Extractions	-390,000
Subsidence	-2,700
Net Subsurface Flows	-5,600
Annual Change in Groundwater Storage	**24,000**

Projects with Projects and with Climate Change

Implementation Period, WY 2024-2039

Summarized results for major components of the Projected with Projects and with Climate Change Implementation Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-21**. The positive net seepage values (on average 160,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 180,000 AF per year. The positive net subsurface flows (on average 75,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 19,000 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -480,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 16-year implementation period indicates a cumulative change in groundwater storage of about -760,000 AF, which equals an average annual change in groundwater storage of about -47,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -2.17 AF per acre on average over the 16 years and an annual decrease of about -0.14 AF per acre across the entire Subbasin (approximately 349,000 acres).

Detailed results for each of the individual water budget components in the Projected with Projects and with Climate Change water budget are presented in **Appendix D.2**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.2**, and simulated subsidence hydrographs are presented in **Appendix F.2**.

Table 4-21. Madera Subbasin Projected with Projects and with Climate Change Implementation Period Groundwater System Annual Water Budget Summary (acre-feet)	
Water Budget Component	Average Annual (2024-2039)
Net Stream Seepage	160,000
Deep Percolation	180,000
Groundwater Extractions	-480,000
Subsidence	19,000
Net Subsurface Flows	75,000
Annual Change in Groundwater Storage	**-47,000**

Sustainability Period, WY 2040-2090

Summarized results for major components of the Projected with Projects and with Climate Change Sustainability Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-22**. The positive net seepage values (on average 180,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 200,000 AF per year. The positive net subsurface flows (on average 42,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 2,200 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -420,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 51-year historic period indicates a cumulative change in groundwater storage of about 480,000 AF, which equals an average annual change in groundwater storage of about 9,500 AF per year. These change in storage estimates equate to total increases in storage in the Subbasin of about 1.38 AF per acre on average over the 51 years and an annual increase of about 0.03 AF per acre across the entire Subbasin (approximately 349,000 acres).

Detailed results for each of the individual water budget components in the Projected with Projects and with Climate Change water budget are presented in **Appendix D.2**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.2**, and simulated subsidence hydrographs are presented in **Appendix F.2**.

Table 4-22. Madera Subbasin Projected with Projects and with Climate Change Sustainability Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (2040-2090)
Net Stream Seepage	180,000
Deep Percolation	200,000
Groundwater Extractions	-420,000
Subsidence	2,200
Net Subsurface Flows	42,000
Annual Change in Groundwater Storage	**9,500**

Projected (No Action)

Implementation Period, WY 2024-2039

Summarized results for major components of the Projected (No Action) Implementation Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-23**. The positive net seepage values (on average 140,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 190,000 AF per year. The positive net subsurface flows (on average 89,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 28,000 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -520,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 16-year implementation period indicates a cumulative change in groundwater storage of about -1,100,000 AF, which equals an average annual change in groundwater storage of about -69,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -3.16 AF per acre on average over the 16 years and an annual decrease of about -0.20 AF per acre across the entire Subbasin (approximately 349,000 acres).

Detailed results for each of the individual water budget components in the Projected (No Action) water budget are presented in **Appendix D.2**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.2**, and simulated subsidence hydrographs are presented in **Appendix F.2**.

Table 4-23. Madera Subbasin Projected (No Action) Implementation Period Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual (2024-2039)
Net Stream Seepage	140,000
Deep Percolation	190,000
Groundwater Extractions	-520,000
Subsidence	28,000
Net Subsurface Flows	89,000
Annual Change in Groundwater Storage	**-69,000**

Sustainability Period, WY 2040-2090

Summarized results for major components of the Projected (No Action) Sustainability Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-24**. The positive net seepage values (on average 160,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 220,000 AF per year. The positive net subsurface flows (on average 100,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 26,000 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -540,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 51-year historic period indicates a cumulative change in groundwater storage of about -1,500,000 AF, which equals an average annual change in groundwater storage of about -29,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -4.18 AF per acre on average over the 51 years and an annual decrease of about -0.08 AF per acre across the entire Subbasin (approximately 349,000 acres).

Detailed results for each of the individual water budget components in the Projected (No Action) water budget are presented in **Appendix D.2**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.2**, and simulated subsidence hydrographs are presented in **Appendix F.2**.

Table 4-24. Madera Subbasin Projected (No Action) Sustainability Period Groundwater System Annual Water Budget Summary (acre-feet)	
Water Budget Component	**Average Annual (2040-2090)**
Net Stream Seepage	160,000
Deep Percolation	220,000
Groundwater Extractions	-540,000
Subsidence	26,000
Net Subsurface Flows	100,000
Annual Change in Groundwater Storage	**-29,000**

Projected (No Action) with Climate Change

Implementation Period, WY 2024-2039

Summarized results for major components of the Projected (No Action) with Climate Change Implementation Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-25**. The positive net seepage values (on average 130,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 190,000 AF per year. The positive net subsurface flows (on average 94,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 41,000 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -550,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 16-year implementation period indicates a cumulative change in groundwater storage of about -1,500,000 AF, which equals an average annual change in groundwater storage of about -96,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -4.41 AF per acre on average over the 16 years and an annual decrease of about -0.28 AF per acre across the entire Subbasin (approximately 349,000 acres).

Detailed results for each of the individual water budget components in the Projected (No Action) with Climate Change water budget are presented in **Appendix D.2**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.2**, and simulated subsidence hydrographs are presented in **Appendix F.2**.

Table 4-25. Madera Subbasin Projected (No Action) with Climate Change Implementation Period Groundwater System Annual Water Budget Summary (acre-feet)	
Water Budget Component	**Average Annual (2024-2039)**
Net Stream Seepage	130,000
Deep Percolation	190,000
Groundwater Extractions	-550,000
Subsidence	41,000
Net Subsurface Flows	94,000
Annual Change in Groundwater Storage	**-96,000**

Sustainability Period, WY 2040-2090

Summarized results for major components of the Projected (No Action) with Climate Change Sustainability Period water budget as they relate to the groundwater system (GWS) are presented in **Table 4-26**. The positive net seepage values (on average 150,000 AF per year) represent net stream seepage to groundwater. Deep percolation represents another large net inflow averaging about 220,000 AF per year. The positive net subsurface flows (on average 130,000 AF per year) represent the combined subsurface flows into the Subbasin from adjacent subbasins and upland areas. The positive subsidence value (on average 32,000 AF per year), while an inflow to the GWS water budget, represents active compaction within the Subbasin. Groundwater pumping (on average -560,000 AF per year) is a large outflow from the GWS. Overall, the water budget results for the 51-year historic period indicates a cumulative change in groundwater storage of about -1,700,000 AF, which equals an average annual change in groundwater storage of about -34,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -4.96 AF per acre on average over the 51 years and an annual decrease of about -0.10 AF per acre across the entire Subbasin (approximately 349,000 acres).

Detailed results for each of the individual water budget components in the Projected (No Action) with Climate Change water budget are presented in **Appendix D.2**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.2**, and simulated subsidence hydrographs are presented in **Appendix F.2**.

Table 4-26. Madera Subbasin Projected (No Action) with Climate Change Sustainability Period Groundwater System Annual Water Budget Summary (acre-feet)	
Water Budget Component	**Average Annual (2040-2090)**
Net Stream Seepage	150,000
Deep Percolation	220,000
Groundwater Extractions	-560,000
Subsidence	32,000
Net Subsurface Flows	130,000
Annual Change in Groundwater Storage	**-34,000**

4.5. Model Results by GSA Area

The following section summarizes the water budgets for the individual GSAs within Chowchilla and Madera Subbasins. Water budget results presented below reflect the complete groundwater system water budget. The surface water system water budget, as presented in the GSP, excludes subsurface flows and presents net recharge to groundwater using the net seepage, deep percolation, and groundwater pumping components.

4.5.1. Chowchilla Subbasin GSAs

There are five different GSAs within Chowchilla Subbasin: Chowchilla Water District GSA, Madera County GSA – East, Madera County GSA – West, Triangle T Water District GSA, and Sierra Vista Mutual Water Company GSA.

Chowchilla Water District GSA

The following section summarizes the analyses and results relating to the Chowchilla Water District GSA within Chowchilla Subbasin. Detailed results for each of the individual water budget components for each scenario are presented in **Appendix D.1.a**.

<u>Historical</u>

Summarized results for major components of the historical water budget as they relate to the GWS are presented in **Table 4-27**.

For the GSP historical period, inflows to the GWS include net stream seepage (on average 38,000 AF per year), deep percolation (on average 72,000 AF per year), and subsidence (on average 24,000 AF per year). Outflows from the GWS include groundwater extraction (on average -140,000 AF per year) and net subsurface flows (on average -17,000 AF per year). Overall, the water budget results for the 27-year historical period indicates a cumulative change in groundwater storage of about -580,000 AF, which equals an average annual change in groundwater storage of about -21,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -6.73 AF per acre on average over the 27 years and an annual decrease of -0.24 AF per acre across the entire GSA (approximately 86,000 acres).

For the calibrated historical period, inflows to the GWS include net stream seepage (on average 38,000 AF per year), deep percolation (on average 71,000 AF per year), and subsidence (on average 24,000 AF per year). Outflows from the GWS include groundwater extraction (on average -140,000 AF per year) and net subsurface flows (on average -13,000 AF per year). Overall, the water budget results for the 35-year historical period indicates a cumulative change in groundwater storage of about -610,000 AF, which equals an average annual change in groundwater storage of about -18,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -7.13 AF per acre on average over the 35 years and an annual decrease of -0.20 AF per acre across the entire GSA (approximately 86,000 acres).

Table 4-27. Chowchilla Water District GSA Historical Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual GSP Historical Period (WY 1989-2015)	Average Annual Calibrated Historical Period (WY 1989-2023)
Net Stream Seepage	38,000	38,000
Deep Percolation	72,000	71,000
Groundwater Extractions	-140,000	-140,000
Subsidence	24,000	24,000
Net Subsurface Flows	-17,000	-13,000
Annual Change in Groundwater Storage	**-21,000**	**-18,000**

Projected with Projects

Summarized results for major components of the Projected with Projects water budget as they relate to the GWS are presented in **Table 4-28**.

For the Projected with Projects Implementation period, inflows to the GWS include net stream seepage (on average 50,000 AF per year), deep percolation (on average 59,000 AF per year), and subsidence (on average 7,000 AF per year). Outflows from the GWS include groundwater extraction (on average -120,000 AF per year) and net subsurface flows (on average -2,900 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -91,000 AF, which equals an average annual change in groundwater storage of about -5,700 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -1.06 AF per acre on average over the 16 years and an annual decrease of -0.07 AF per acre across the entire GSA (approximately 86,000 acres).

For the Projected with Projects Sustainability period, inflows to the GWS include net stream seepage (on average 56,000 AF per year), deep percolation (on average 64,000 AF per year), subsidence (on average 550 AF per year), and net subsurface flows (on average 6,100 AF per year). Outflows from the GWS include groundwater extraction (on average -120,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 120,000 AF, which equals an average annual change in groundwater storage of about 2,400 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 1.40 AF per acre on average over the 51 years and an annual increase of 0.03 AF per acre across the entire GSA (approximately 86,000 acres).

Table 4-28. Chowchilla Water District GSA Projected with Projects Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	50,000	56,000
Deep Percolation	59,000	64,000
Groundwater Extractions	-120,000	-120,000
Subsidence	7,000	550
Net Subsurface Flows	-2,900	6,100
Annual Change in Groundwater Storage	**-5,700**	**2,400**

Summarized results for major components of the Projected with Projects and with Climate Change water budget as they relate to the GWS are presented in **Table 4-29**.

For the Projected with Projects and with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 39,000 AF per year), deep percolation (on average 58,000 AF per year), subsidence (on average 18,000 AF per year), and net subsurface flows (on average 20,000 AF per year). Outflows from the GWS include groundwater extraction (on average -150,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -220,000 AF, which equals an average annual change in groundwater storage of about -14,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.56 AF per acre on average over the 16 years and an annual decrease of -0.16 AF per acre across the entire GSA (approximately 86,000 acres).

For the Projected with Projects and with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 45,000 AF per year), deep percolation (on average 64,000 AF per year), subsidence (on average 4,100 AF per year), and net subsurface flows (on average 41,000 AF per year). Outflows from the GWS include groundwater extraction (on average -160,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -33,000 AF, which equals an average annual change in groundwater storage of about -650 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -0.38 AF per acre on average over the 51 years and an annual decrease of -0.01 AF per acre across the entire GSA (approximately 86,000 acres).

Table 4-29. Chowchilla Water District GSA Projected with Projects and with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	39,000	45,000
Deep Percolation	58,000	64,000
Groundwater Extractions	-150,000	-160,000
Subsidence	18,000	4,100
Net Subsurface Flows	20,000	41,000
Annual Change in Groundwater Storage	**-14,000**	**-650**

Projected (No Action)

Summarized results for major components of the Projected (No Action) water budget as they relate to the GWS are presented in **Table 4-30**.

For the Projected (No Action) Implementation period, inflows to the GWS include net stream seepage (on average 43,000 AF per year), deep percolation (on average 59,000 AF per year), and subsidence (on average 13,000 AF per year). Outflows from the GWS include groundwater extraction (on average -120,000 AF per year) and net subsurface flows (on average -10,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -230,000 AF, which equals an average annual change in groundwater storage of about -14,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.65 AF per acre on average over the 16 years and an annual decrease of -0.17 AF per acre across the entire GSA (approximately 86,000 acres).

For the Projected (No Action) Sustainability period, inflows to the GWS include net stream seepage (on average 38,000 AF per year), deep percolation (on average 64,000 AF per year), subsidence (on average 18,000 AF per year), and net subsurface flows (on average 5,400 AF per year). Outflows from the GWS include groundwater extraction (on average -130,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -440,000 AF, which equals an average annual change in groundwater storage of about -8,600 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.07 AF per acre on average over the 51 years and an annual decrease of -0.10 AF per acre across the entire GSA (approximately 86,000 acres).

Table 4-30. Chowchilla Water District GSA Projected (No Action) Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	43,000	38,000
Deep Percolation	59,000	64,000
Groundwater Extractions	-120,000	-130,000
Subsidence	13,000	18,000
Net Subsurface Flows	-10,000	5,400
Annual Change in Groundwater Storage	**-14,000**	**-8,600**

Summarized results for major components of the Projected (No Action) with Climate Change water budget as they relate to the GWS are presented in **Table 4-31**.

For the Projected (No Action) with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 33,000 AF per year), deep percolation (on average 59,000 AF per year), subsidence (on average 25,000 AF per year), and net subsurface flows (on average 10,000 AF per year). Outflows from the GWS include groundwater extraction (on average -150,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -340,000 AF, which equals an average annual change in groundwater storage of about -21,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -3.99 AF per acre on average over the 16 years and an annual decrease of -0.25 AF per acre across the entire GSA (approximately 86,000 acres).

For the Projected (No Action) with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 32,000 AF per year), deep percolation (on average 64,000 AF per year), subsidence (on average 21,000 AF per year), and net subsurface flows (on average 29,000 AF per year). Outflows from the GWS include groundwater extraction (on average -160,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -500,000 AF, which equals an average annual change in groundwater storage of about -9,800 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.79 AF per acre on average over the 51 years and an annual decrease of -0.11 AF per acre across the entire GSA (approximately 86,000 acres).

Table 4-31. Chowchilla Water District GSA Projected (No Action) with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	33,000	32,000
Deep Percolation	59,000	64,000
Groundwater Extractions	-150,000	-160,000
Subsidence	25,000	21,000
Net Subsurface Flows	10,000	29,000
Annual Change in Groundwater Storage	**-21,000**	**-9,800**

Madera County GSA – East

The following section summarizes the analyses and results relating to the Madera County GSA – East within Chowchilla. Detailed results for each of the individual water budget components for each scenario are presented in **Appendix D.1.b**.

Historical

Summarized results for major components of the historical water budget as they relate to the GWS are presented in **Table 4-32**.

For the GSP historical period, inflows to the GWS include net stream seepage (on average 1,800 AF per year), deep percolation (on average 5,300 AF per year), subsidence (on average 2,500 AF per year), and net subsurface flows (on average 5,100 AF per year). Outflows from the GWS include groundwater extraction (on average -16,000 AF per year). Overall, the water budget results for the 27-year historical period indicates a cumulative change in groundwater storage of about -45,000 AF, which equals an average annual change in groundwater storage of about -1,700 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.35 AF per acre on average over the 27 years and an annual decrease of -0.16 AF per acre across the entire GSA (approximately 10,000 acres).

For the calibrated historical period, inflows to the GWS include net stream seepage (on average 1,900 AF per year), deep percolation (on average 5,300 AF per year), subsidence (on average 2,600 AF per year), and net subsurface flows (on average 5,600 AF per year). Outflows from the GWS include groundwater extraction (on average -17,000 AF per year). Overall, the water budget results for the 35-year historical period indicates a cumulative change in groundwater storage of about -54,000 AF, which equals an average annual change in groundwater storage of about -1,500 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.29 AF per acre on average over the 35 years and an annual increase of -0.15 AF per acre across the entire GSA (approximately 10,000 acres).

Table 4-32. Madera County - East GSA Historical Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual GSP Historical Period (WY 1989-2015)**	**Average Annual Calibrated Historical Period (WY 1989-2023)**
Net Stream Seepage	1,800	1,900
Deep Percolation	5,300	5,300
Groundwater Extractions	-16,000	-17,000
Subsidence	2,500	2,600
Net Subsurface Flows	5,100	5,600
Annual Change in Groundwater Storage	**-1,700**	**-1,500**

Projected with Projects

Summarized results for major components of the Projected with Projects water budget as they relate to the GWS are presented in **Table 4-33**.

For the Projected with Projects Implementation period, inflows to the GWS include net stream seepage (on average 2,200 AF per year), deep percolation (on average 4,300 AF per year), subsidence (on average 980 AF per year), and net subsurface flows (on average 6,700 AF per year). Outflows from the GWS include groundwater extraction (on average -15,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -19,000 AF, which equals an average annual change in groundwater storage of about -1,200 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -1.83 AF per acre on average over the 16 years and an annual decrease of -0.11 AF per acre across the entire GSA (approximately 10,000 acres).

For the Projected with Projects Sustainability period, inflows to the GWS include net stream seepage (on average 2,200 AF per year), deep percolation (on average 3,400 AF per year), and net subsurface flows (on average 1,200 AF per year). Outflows from the GWS include groundwater extraction (on average -6,300 AF per year) and subsidence (on average -55 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 21,000 AF, which equals an average annual change in groundwater storage of about 420 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 2.07 AF per acre on average over the 51 years and an annual increase of 0.04 AF per acre across the entire GSA (approximately 10,000 acres).

Table 4-33. Madera County - East GSA Projected with Projects Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	2,200	2,200
Deep Percolation	4,300	3,400
Groundwater Extractions	-15,000	-6,300
Subsidence	980	-55
Net Subsurface Flows	6,700	1,200
Annual Change in Groundwater Storage	**-1,200**	**420**

Summarized results for major components of the Projected with Projects and with Climate Change water budget as they relate to the GWS are presented in **Table 4-34**.

For the Projected with Projects and with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 2,100 AF per year), deep percolation (on average 3,800 AF per year), subsidence (on average 1,300 AF per year), and net subsurface flows (on average 2,600 AF per year). Outflows from the GWS include groundwater extraction (on average -11,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -23,000 AF, which equals an average annual change in groundwater storage of about -1,500 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.27 AF per acre on average over the 16 years and an annual decrease of -0.14 AF per acre across the entire GSA (approximately 10,000 acres).

For the Projected with Projects and with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 2,500 AF per year), deep percolation (on average 2,700 AF per year), and subsidence (on average 230 AF per year). Outflows from the GWS include groundwater extraction (on average -1,300 AF per year) and net subsurface flows (on average 4,100 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 2,600 AF, which equals an average annual change in groundwater storage of about 52 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 0.26 AF per acre on average over the 51 years and an annual increase of 0.01 AF per acre across the entire GSA (approximately 10,000 acres).

Table 4-34. Madera County - East GSA Projected with Projects and with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	2,100	2,500
Deep Percolation	3,800	2,700
Groundwater Extractions	-11,000	-1,300
Subsidence	1,300	230
Net Subsurface Flows	2,600	-4,100
Annual Change in Groundwater Storage	**-1,500**	**52**

Projected (No Action)

Summarized results for major components of the Projected (No Action) water budget as they relate to the GWS are presented in **Table 4-35**.

For the Projected (No Action) Implementation period, inflows to the GWS include net stream seepage (on average 2,200 AF per year), deep percolation (on average 4,800 AF per year), subsidence (on average 4,800 AF per year), and net subsurface flows (on average 9,000 AF per year). Outflows from the GWS include groundwater extraction (on average -20,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -39,000 AF, which equals an average annual change in groundwater storage of about -2,500 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -3.84 AF per acre on average over the 16 years and an annual decrease of -0.24 AF per acre across the entire GSA (approximately 10,000 acres).

For the Projected (No Action) Sustainability period, inflows to the GWS include net stream seepage (on average 2,100 AF per year), deep percolation (on average 4,800 AF per year), subsidence (on average 1,500 AF per year), and net subsurface flows (on average 9,500 AF per year). Outflows from the GWS include groundwater extraction (on average -19,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -67,000 AF, which equals an average annual change in groundwater storage of about -1,300 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -6.57 AF per acre on average over the 51 years and an annual decrease of -0.13 AF per acre across the entire GSA (approximately 10,000 acres).

Table 4-35. Madera County - East GSA Projected (No Action) Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	2,200	2,100
Deep Percolation	4,800	4,800
Groundwater Extractions	-20,000	-19,000
Subsidence	4,800	1,500
Net Subsurface Flows	9,000	9,500
Annual Change in Groundwater Storage	**-2,500**	**-1,300**

Summarized results for major components of the Projected (No Action) with Climate Change water budget as they relate to the GWS are presented in **Table 4-36**.

For the Projected (No Action) with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 1,900 AF per year), deep percolation (on average 4,700 AF per year), subsidence (on average 2,400 AF per year), and net subsurface flows (on average 8,500 AF per year). Outflows from the GWS include groundwater extraction (on average -21,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -51,000 AF, which equals an average annual change in groundwater storage of about -3,200 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.94 AF per acre on average over the 16 years and an annual decrease of -0.31 AF per acre across the entire GSA (approximately 10,000 acres).

For the Projected (No Action) with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 2,100 AF per year), deep percolation (on average 4,800 AF per year), subsidence (on average 1,700 AF per year), and net subsurface flows (on average 9,200 AF per year). Outflows from the GWS include groundwater extraction (on average -19,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -84,000 AF, which equals an average annual change in groundwater storage of about -1,600 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -8.21 AF per acre on average over the 51 years and an annual decrease of -0.16 AF per acre across the entire GSA (approximately 10,000 acres).

Table 4-36. Madera County - East GSA Projected (No Action) with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	1,900	2,100
Deep Percolation	4,700	4,800
Groundwater Extractions	-21,000	-19,000
Subsidence	2,400	1,700
Net Subsurface Flows	8,500	9,200
Annual Change in Groundwater Storage	**-3,200**	**-1,600**

Madera County GSA – West

The following section summarizes the analyses and results relating to the Madera County GSA – West within Chowchilla Subbasin. Detailed results for each of the individual water budget components for each scenario are presented in **Appendix D.1.c**.

Historical

Summarized results for major components of the historical water budget as they relate to the GWS are presented in **Table 4-37**.

For the GSP historical period, inflows to the GWS include net stream seepage (on average 12,000 AF per year), deep percolation (on average 29,000 AF per year), subsidence (on average 9,900 AF per year), and net subsurface flows (on average 22,000 AF per year). Outflows from the GWS include groundwater extraction (on average -77,000 AF per year). Overall, the water budget results for the 27-year historical period indicates a cumulative change in groundwater storage of about -90,000 AF, which equals an average annual change in groundwater storage of about -3,300 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.94 AF per acre on average over the 27 years and an annual decrease of -0.11 AF per acre across the entire GSA (approximately 31,000 acres).

For the calibrated historical period, inflows to the GWS include net stream seepage (on average 16,000 AF per year), deep percolation (on average 30,000 AF per year), subsidence (on average 9,400 AF per year), and net subsurface flows (on average 20,000 AF per year). Outflows from the GWS include groundwater extraction (on average -76,000 AF per year). Overall, the water budget results for the 35-year historical period indicates a cumulative change in groundwater storage of about -38,000 AF, which equals an average annual change in groundwater storage of about -1,100 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -1.23 AF per acre on average over the 35 years and an annual decrease of -0.04 AF per acre across the entire GSA (approximately 31,000 acres).

Table 4-37. Madera County - West GSA Historical Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual GSP Historical Period (WY 1989-2015)	Average Annual Calibrated Historical Period (WY 1989-2023)
Net Stream Seepage	12,000	16,000
Deep Percolation	29,000	30,000
Groundwater Extractions	-77,000	-76,000
Subsidence	9,900	9,400
Net Subsurface Flows	22,000	20,000
Annual Change in Groundwater Storage	**-3,300**	**-1,100**

Projected with Projects

Summarized results for major components of the Projected with Projects water budget as they relate to the GWS are presented in **Table 4-38**.

For the Projected with Projects Implementation period, inflows to the GWS include net stream seepage (on average 24,000 AF per year), deep percolation (on average 18,000 AF per year), subsidence (on average 140 AF per year), and net subsurface flows (on average 4,600 AF per year). Outflows from the GWS include groundwater extraction (on average -49,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -42,000 AF, which equals an average annual change in groundwater storage of about -2,600 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -1.36 AF per acre on average over the 16 years and an annual decrease of -0.09 AF per acre across the entire GSA (approximately 31,000 acres).

For the Projected with Projects Sustainability period, inflows to the GWS include net stream seepage (on average 26,000 AF per year) and deep percolation (on average 13,000 AF per year. Outflows from the GWS include groundwater extraction (on average -20,000 AF per year), subsidence (on average -170 AF per year), and net subsurface flows (on average -17,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 110,000 AF, which equals an average annual change in groundwater storage of about 2,100 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 3.57 AF per acre on average over the 51 years and an annual increase of 0.07 AF per acre across the entire GSA (approximately 31,000 acres).

Table 4-38. Madera County - West GSA Projected with Projects Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	24,000	26,000
Deep Percolation	18,000	13,000
Groundwater Extractions	-49,000	-20,000
Subsidence	140	-170
Net Subsurface Flows	4,600	-17,000
Annual Change in Groundwater Storage	**-2,600**	**2,100**

Summarized results for major components of the Projected with Projects and with Climate Change water budget as they relate to the GWS are presented in **Table 4-39**.

For the Projected with Projects and with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 25,000 AF per year), deep percolation (on average 14,000 AF per year), and subsidence (on average 1,200 AF per year). Outflows from the GWS include groundwater extraction (on average -36,000 AF per year) and net subsurface flows (on average -9,100 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -68,000 AF, which equals an average annual change in groundwater storage of about -4,300 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.24 AF per acre on average over the 16 years and an annual decrease of -0.14 AF per acre across the entire GSA (approximately 31,000 acres).

For the Projected with Projects and with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 32,000 AF per year), deep percolation (on average 10,000 AF per year), and subsidence (on average 110 AF per year). Outflows from the GWS include groundwater extraction (on average -4,100 AF per year) and net subsurface flows (on average -36,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 76,000 AF, which equals an average annual change in groundwater storage of about 1,500 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 2.49 AF per acre on average over the 51 years and an annual increase of 0.05 AF per acre across the entire GSA (approximately 31,000 acres).

Table 4-39. Madera County - West GSA Projected with Projects and with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	25,000	32,000
Deep Percolation	14,000	10,000
Groundwater Extractions	-36,000	-4,100
Subsidence	1,200	110
Net Subsurface Flows	-9,100	-36,000
Annual Change in Groundwater Storage	**-4,300**	**1,500**

Projected (No Action)

Summarized results for major components of the Projected (No Action) water budget as they relate to the GWS are presented in **Table 4-40**.

For the Projected (No Action) Implementation period, inflows to the GWS include net stream seepage (on average 25,000 AF per year), deep percolation (on average 20,000 AF per year), subsidence (on average 2,600 AF per year), and net subsurface flows (on average 8,100 AF per year). Outflows from the GWS include groundwater extraction (on average -64,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -140,000 AF, which equals an average annual change in groundwater storage of about -8,700 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.56 AF per acre on average over the 16 years and an annual decrease of -0.29 AF per acre across the entire GSA (approximately 31,000 acres).

For the Projected (No Action) Sustainability period, inflows to the GWS include net stream seepage (on average 34,000 AF per year), deep percolation (on average 23,000 AF per year), and subsidence (on average 5,400 AF per year). Outflows from the GWS include groundwater extraction (on average -64,000 AF per year) and net subsurface flows (on average -430 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -89,000 AF, which equals an average annual change in groundwater storage of about -1,800 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.92 AF per acre on average over the 51 years and an annual decrease of -0.06 AF per acre across the entire GSA (approximately 31,000 acres).

Table 4-40. Madera County - West GSA Projected (No Action) Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	25,000	34,000
Deep Percolation	20,000	23,000
Groundwater Extractions	-64,000	-64,000
Subsidence	2,600	5,400
Net Subsurface Flows	8,100	-430
Annual Change in Groundwater Storage	**-8,700**	**-1,800**

Summarized results for major components of the Projected (No Action) with Climate Change water budget as they relate to the GWS are presented in **Table 4-41**.

For the Projected (No Action) with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 27,000 AF per year), deep percolation (on average 20,000 AF per year), subsidence (on average 5,200 AF per year), and net subsurface flows (on average 3,000 AF per year). Outflows from the GWS include groundwater extraction (on average -66,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -180,000 AF, which equals an average annual change in groundwater storage of about -11,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.88 AF per acre on average over the 16 years and an annual decrease of -0.37 AF per acre across the entire GSA (approximately 31,000 acres).

For the Projected (No Action) with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 38,000 AF per year), deep percolation (on average 23,000 AF per year), and subsidence (on average 7,500 AF per year). Outflows from the GWS include groundwater extraction (on average -66,000 AF per year) and net subsurface flows (on average -5,200 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -99,000 AF, which equals an average annual change in groundwater storage of about -1,900 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -3.25 AF per acre on average over the 51 years and an annual decrease of -0.06 AF per acre across the entire GSA (approximately 31,000 acres).

Table 4-41. Madera County - West GSA Projected (No Action) with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	27,000	38,000
Deep Percolation	20,000	23,000
Groundwater Extractions	-66,000	-66,000
Subsidence	5,200	7,500
Net Subsurface Flows	3,000	-5,200
Annual Change in Groundwater Storage	**-11,000**	**-1,900**

Triangle T Water District GSA

The following section summarizes the analyses and results relating to the Triangle T Water District GSA (TTWD) within Chowchilla Subbasin. Detailed results for each of the individual water budget components for each scenario are presented in **Appendix D.1.d**.

Historical

Summarized results for major components of the historical water budget as they relate to the GWS are presented in **Table 4-42**.

For the GSP historical period, inflows to the GWS include net stream seepage (on average 680 AF per year), deep percolation (on average 10,000 AF per year), subsidence (on average 4,400 AF per year), and net subsurface flows (on average 4,000 AF per year). Outflows from the GWS include groundwater extraction (on average -21,000 AF per year). Overall, the water budget results for the 27-year historical period indicate a cumulative change in groundwater storage of about -42,000 AF, which equals an average annual change in groundwater storage of about -1,600 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.84 AF per acre on average over the 27 years and an annual decrease of -0.11 AF per acre across the entire GSA (approximately 15,000 acres).

For the calibrated historical period, inflows to the GWS include net stream seepage (on average 2,300 AF per year), deep percolation (on average 12,000 AF per year), subsidence (on average 4,200 AF per year), and net subsurface flows (on average 4,800 AF per year). Outflows from the GWS include groundwater extraction (on average -23,000 AF per year). Overall, the water budget results for the 35-year historical period indicates a cumulative change in groundwater storage of about 16,000 AF, which equals an average annual change in groundwater storage of about 460 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 1.09 AF per acre on average over the 35 years and an annual increase of 0.03 AF per acre across the entire GSA (approximately 15,000 acres).

Table 4-42. Triangle T Water District GSA Historical Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual GSP Historical Period (WY 1989-2015)	Average Annual Calibrated Historical Period (WY 1989-2023)
Net Stream Seepage	680	2,300
Deep Percolation	10,000	12,000
Groundwater Extractions	-21,000	-23,000
Subsidence	4,400	4,200
Net Subsurface Flows	4,000	4,800
Annual Change in Groundwater Storage	**-1,600**	**460**

Projected with Projects

Summarized results for major components of the Projected with Projects water budget as they relate to the GWS are presented in **Table 4-43**.

For the Projected with Projects Implementation period, inflows to the GWS include net stream seepage (on average 3,100 AF per year), deep percolation (on average 9,500 AF per year), subsidence (on average 32 AF per year), and net subsurface flows (on average 13,000 AF per year). Outflows from the GWS include groundwater extraction (on average -28,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -44,000 AF, which equals an average annual change in groundwater storage of about -2,700 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.94 AF per acre on average over the 16 years and an annual decrease of -0.18 AF per acre across the entire GSA (approximately 15,000 acres).

For the Projected with Projects Sustainability period, inflows to the GWS include net stream seepage (on average 5,300 AF per year), deep percolation (on average 13,000 AF per year), and net subsurface flows (on average 8,900 AF per year). Outflows from the GWS include groundwater extraction (on average -26,000 AF per year) and subsidence (on average -70 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 49,000 AF, which equals an average annual change in groundwater storage of about 970 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 3.32 AF per acre on average over the 51 years and an annual increase of 0.07 AF per acre across the entire GSA (approximately 15,000 acres).

Table 4-43. Triangle T Water District GSA Projected with Projects Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	3,100	5,300
Deep Percolation	9,500	13,000
Groundwater Extractions	-28,000	-26,000
Subsidence	32	-70
Net Subsurface Flows	13,000	8,900
Annual Change in Groundwater Storage	**-2,700**	**970**

Summarized results for major components of the Projected with Projects and with Climate Change water budget as they relate to the GWS are presented in **Table 4-44**.

For the Projected with Projects and with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 2,600 AF per year), deep percolation (on average 9,100 AF per year), subsidence (on average 380 AF per year), and net subsurface flows (on average 18,000 AF per year). Outflows from the GWS include groundwater extraction (on average -33,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -54,000 AF, which equals an average annual change in groundwater storage of about -3,400 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -3.61 AF per acre on average over the 16 years and an annual decrease of -0.23 AF per acre across the entire GSA (approximately 15,000 acres).

For the Projected with Projects and with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 4,600 AF per year), deep percolation (on average 13,000 AF per year), and net subsurface flows (on average 15,000 AF per year). Outflows from the GWS include groundwater extraction (on average -32,000 AF per year) and subsidence (on average -20 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 41,000 AF, which equals an average annual change in groundwater storage of about 810 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 2.79 AF per acre on average over the 51 years and an annual increase of 0.05 AF per acre across the entire GSA (approximately 15,000 acres).

Table 4-44. Triangle T Water District GSA Projected with Projects and with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	2,600	4,600
Deep Percolation	9,100	13,000
Groundwater Extractions	-33,000	-32,000
Subsidence	380	-20
Net Subsurface Flows	18,000	15,000
Annual Change in Groundwater Storage	**-3,400**	**810**

Projected (No Action)

Summarized results for major components of the Projected (No Action) water budget as they relate to the GWS are presented in **Table 4-45**.

For the Projected (No Action) Implementation period, inflows to the GWS include net stream seepage (on average 1,700 AF per year), deep percolation (on average 8,800 AF per year), subsidence (on average 1,300 AF per year), and net subsurface flows (on average 22,000 AF per year). Outflows from the GWS include groundwater extraction (on average -39,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -78,000 AF, which equals an average annual change in groundwater storage of about -4,900 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.28 AF per acre on average over the 16 years and an annual decrease of -0.33 AF per acre across the entire GSA (approximately 15,000 acres).

For the Projected (No Action) Sustainability period, inflows to the GWS include net stream seepage (on average 2,400 AF per year), deep percolation (on average 13,000 AF per year), subsidence (on average 1,800 AF per year), and net subsurface flows (on average 20,000 AF per year). Outflows from the GWS include groundwater extraction (on average -37,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -14,000 AF, which equals an average annual change in groundwater storage of about -270 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -0.93 AF per acre on average over the 51 years and an annual decrease of -0.02 AF per acre across the entire GSA (approximately 15,000 acres).

Table 4-45. Triangle T Water District GSA Projected (No Action) Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	1,700	2,400
Deep Percolation	8,800	13,000
Groundwater Extractions	-39,000	-37,000
Subsidence	1,300	1,800
Net Subsurface Flows	22,000	20,000
Annual Change in Groundwater Storage	**-4,900**	**-270**

Summarized results for major components of the Projected (No Action) with Climate Change water budget as they relate to the GWS are presented in **Table 4-46**.

For the Projected (No Action) with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 2,000 AF per year), deep percolation (on average 8,700 AF per year), subsidence (on average 2,100 AF per year), and net subsurface flows (on average 22,000 AF per year). Outflows from the GWS include groundwater extraction (on average -41,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -87,000 AF, which equals an average annual change in groundwater storage of about -5,400 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.84 AF per acre on average over the 16 years and an annual decrease of -0.36 AF per acre across the entire GSA (approximately 15,000 acres).

For the Projected (No Action) with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 3,000 AF per year), deep percolation (on average 13,000 AF per year), subsidence (on average 2,500 AF per year), and net subsurface flows (on average 20,000 AF per year). Outflows from the GWS include groundwater extraction (on average -39,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -23,000 AF, which equals an average annual change in groundwater storage of about -450 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -1.55 AF per acre on average over the 51 years and an annual decrease of -0.03 AF per acre across the entire GSA (approximately 15,000 acres).

Table 4-46. Triangle T Water District GSA Projected (No Action) with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	2,000	3,000
Deep Percolation	8,700	13,000
Groundwater Extractions	-41,000	-39,000
Subsidence	2,100	2,500
Net Subsurface Flows	22,000	20,000
Annual Change in Groundwater Storage	**-5,400**	**-450**

Sierra Vista Mutual Water Company GSA

The following section summarizes the analyses and results relating to the Sierra Vista Mutual Water Company GSA (SVMWC) within Chowchilla Subbasin. Detailed results for each of the individual water budget components for each scenario are presented in **Appendix D.1.e**.

Historical

Summarized results for major components of the historical water budget as they relate to the GWS are presented in **Table 4-47**.

For the GSP historical period, inflows to the GWS include net stream seepage (on average 230 AF per year), deep percolation (on average 5,400 AF per year), subsidence (on average 1,300 AF per year), and net subsurface flows (on average 3,200 AF per year). Outflows from the GWS include groundwater extraction (on average -11,000 AF per year). Overall, the water budget results for the 27-year historical period indicate a cumulative change in groundwater storage of about -11,000 AF, which equals an average annual change in groundwater storage of about -390 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.70 AF per acre on average over the 27 years and an annual decrease of -0.10 AF per acre across the entire GSA (approximately 4,000 acres).

For the calibrated historical period, inflows to the GWS include net stream seepage (on average 220 AF per year), deep percolation (on average 5,400 AF per year), subsidence (on average 1,400 AF per year), and net subsurface flows (on average 3,300 AF per year). Outflows from the GWS include groundwater extraction (on average -11,000 AF per year). Overall, the water budget results for the 35-year historical period indicate a cumulative change in groundwater storage of about -11,000 AF, which equals an average annual change in groundwater storage of about -320 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.83 AF per acre on average over the 35 years and an annual decrease of -0.08 AF per acre across the entire GSA (approximately 4,000 acres).

Table 4-47. Sierra Vista Mutual Water Company GSA Historical Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual GSP Historical Period (WY 1989-2015)	Average Annual Calibrated Historical Period (WY 1989-2023)
Net Stream Seepage	230	220
Deep Percolation	5,400	5,400
Groundwater Extractions	-11,000	-11,000
Subsidence	1,300	1,400
Net Subsurface Flows	3,200	3,300
Annual Change in Groundwater Storage	**-390**	**-320**

Projected with Projects

Summarized results for major components of the Projected with Projects water budget as they relate to the GWS are presented in **Table 4-48**.

For the Projected with Projects Implementation period, inflows to the GWS include net stream seepage (on average 850 AF per year), deep percolation (on average 4,500 AF per year), subsidence (on average 450 AF per year), and net subsurface flows (on average 3,000 AF per year). Outflows from the GWS include groundwater extraction (on average -9,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -2,800 AF, which equals an average annual change in groundwater storage of about -180 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -0.72 AF per acre on average over the 16 years and an annual decrease of -0.05 AF per acre across the entire GSA (approximately 4,000 acres).

For the Projected with Projects Sustainability period, inflows to the GWS include net stream seepage (on average 1,200 AF per year), deep percolation (on average 4,700 AF per year), subsidence (on average 58 AF per year), and net subsurface flows (on average 2,800 AF per year). Outflows from the GWS include groundwater extraction (on average -8,600 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 4,300 AF, which equals an average annual change in groundwater storage of about 84 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 1.10 AF per acre on average over the 51 years and an annual increase of 0.02 AF per acre across the entire GSA (approximately 4,000 acres).

Table 4-48. Sierra Vista Mutual Water Company GSA Projected with Projects Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	850	1,200
Deep Percolation	4,500	4,700
Groundwater Extractions	-9,000	-8,600
Subsidence	450	58
Net Subsurface Flows	3,000	2,800
Annual Change in Groundwater Storage	**-180**	**84**

Summarized results for major components of the Projected with Projects and with Climate Change water budget as they relate to the GWS are presented in **Table 4-49**.

For the Projected with Projects and with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 220 AF per year), deep percolation (on average 4,500 AF per year), subsidence (on average 930 AF per year), and net subsurface flows (on average 3,500 AF per year). Outflows from the GWS include groundwater extraction (on average -9,600 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -6,100 AF, which equals an average annual change in groundwater storage of about -390 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -1.57 AF per acre on average over the 16 years and an annual decrease of -0.10 AF per acre across the entire GSA (approximately 4,000 acres).

For the Projected with Projects and with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 230 AF per year), deep percolation (on average 4,800 AF per year), subsidence (on average 260 AF per year), and net subsurface flows (on average 4,300 AF per year). Outflows from the GWS include groundwater extraction (on average -9,600 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -0.62 AF, which equals an average annual change in groundwater storage of about -48 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -0.62 AF per acre on average over the 51 years and an annual decrease of -0.01 AF per acre across the entire GSA (approximately 4,000 acres).

Table 4-49. Sierra Vista Mutual Water Company GSA Projected with Projects and with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	220	230
Deep Percolation	4,500	4,800
Groundwater Extractions	-9,600	-9,600
Subsidence	930	260
Net Subsurface Flows	3,500	4,300
Annual Change in Groundwater Storage	**-390**	**-48**

Projected (No Action)

Summarized results for major components of the Projected (No Action) water budget as they relate to the GWS are presented in **Table 4-50**.

For the Projected (No Action) Implementation period, inflows to the GWS include net stream seepage (on average 230 AF per year), deep percolation (on average 4,500 AF per year), subsidence (on average 750 AF per year), and net subsurface flows (on average 3,500 AF per year). Outflows from the GWS include groundwater extraction (on average -9,400 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -5,800 AF, which equals an average annual change in groundwater storage of about -370 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -1.49 AF per acre on average over the 16 years and an annual decrease of -0.09 AF per acre across the entire GSA (approximately 4,000 acres).

For the Projected (No Action) Sustainability period, inflows to the GWS include net stream seepage (on average 230 AF per year), deep percolation (on average 4,600 AF per year), subsidence (on average 880 AF per year), and net subsurface flows (on average 3,300 AF per year). Outflows from the GWS include groundwater extraction (on average -9,300 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -16,000 AF, which equals an average annual change in groundwater storage of about -320 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.16 AF per acre on average over the 51 years and an annual decrease of -0.08 AF per acre across the entire GSA (approximately 4,000 acres).

Table 4-50. Sierra Vista Mutual Water Company GSA Projected (No Action) Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	230	230
Deep Percolation	4,500	4,600
Groundwater Extractions	-9,400	-9,300
Subsidence	750	880
Net Subsurface Flows	3,500	3,300
Annual Change in Groundwater Storage	**-370**	**-320**

Summarized results for major components of the Projected (No Action) with Climate Change water budget as they relate to the GWS are presented in **Table 4-51**.

For the Projected (No Action) with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 220 AF per year), deep percolation (on average 4,500 AF per year), subsidence (on average 1,300 AF per year), and net subsurface flows (on average 3,100 AF per year). Outflows from the GWS include groundwater extraction (on average -9,700 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -8,700 AF, which equals an average annual change in groundwater storage of about -540 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.22 AF per acre on average over the 16 years and an annual decrease of -0.14 AF per acre across the entire GSA (approximately 4,000 acres).

For the Projected (No Action) with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 230 AF per year), deep percolation (on average 4,500 AF per year), subsidence (on average 1,000 AF per year), and net subsurface flows (on average 3,300 AF per year). Outflows from the GWS include groundwater extraction (on average -9,500 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -20,000 AF, which equals an average annual change in groundwater storage of about -390 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.13 AF per acre on average over the 51 years and an annual decrease of -0.10 AF per acre across the entire GSA (approximately 4,000 acres).

Table 4-51. Sierra Vista Mutual Water Company GSA Projected (No Action) with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	220	230
Deep Percolation	4,500	4,500
Groundwater Extractions	-9,700	-9,500
Subsidence	1,300	1,000
Net Subsurface Flows	3,100	3,300
Annual Change in Groundwater Storage	**-540**	**-390**

4.5.2. Madera Subbasin GSAs

There are four different GSAs within Madera Subbasin that are part of the Joint GSP: City of Madera GSA, Madera County GSA, Madera Irrigation District GSA, and Madera Water District GSA. There are an additional three GSAs who prepared individual GSPs within Madera Subbasin: Gravelly Ford Water District GSA, New Stone Water District GSA, and Root Creek Water District GSA.

Joint GSP GSAs

City of Madera GSA

The following section summarizes the analyses and results relating to the City of Madera District GSA within Madera Subbasin. Detailed results for each of the individual water budget components for each scenario are presented in **Appendix D.2.a**.

Historical

Summarized results for major components of the historical water budget as they relate to the GWS are presented in **Table 4-52**.

For the GSP historical period, inflows to the GWS include net stream seepage (on average 2,100 AF per year), deep percolation (on average 3,900 AF per year), subsidence (on average 880 AF per year), and net subsurface flows (on average 1,000 AF per year). Outflows from the GWS include groundwater extraction (on average -9,400 AF per year). Overall, the water budget results for the 27-year historical period indicates a cumulative change in groundwater storage of about -40,000 AF, which equals an average annual change in groundwater storage of about -1,500 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.48 AF per acre on average over the 27 years and an annual decrease of -0.17 AF per acre across the entire GSA (approximately 8,900 acres).

For the calibrated historical period, inflows to the GWS include net stream seepage (on average 2,300 AF per year), deep percolation (on average 3,800 AF per year), subsidence (on average 1,100 AF per year), and net subsurface flows (on average 720 AF per year). Outflows from the GWS include groundwater extraction (on average -9,400 AF per year). Overall, the water budget results for the 35-year historical period indicates a cumulative change in groundwater storage of about -54,000 AF, which equals an average annual change in groundwater storage of about -1,500 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -6.07 AF per acre on average over the 35 years and an annual decrease of -0.17 AF per acre across the entire GSA (approximately 8,900 acres).

Table 4-52. City of Madera District GSA Historical Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual GSP Historical Period (WY 1989-2015)	Average Annual Calibrated Historical Period (WY 1989-2023)
Net Stream Seepage	2,100	2,300
Deep Percolation	3,900	3,800
Groundwater Extractions	-9,400	-9,400
Subsidence	880	1,100
Net Subsurface Flows	1,000	720
Annual Change in Groundwater Storage	**-1,500**	**-1,500**

Projected with Projects

Summarized results for major components of the Projected with Projects water budget as they relate to the GWS are presented in **Table 4-53**.

For the Projected with Projects Implementation period, inflows to the GWS include net stream seepage (on average 6,100 AF per year), deep percolation (on average 3,300 AF per year), subsidence (on average 230 AF per year), and net subsurface flows (on average 500 AF per year). Outflows from the GWS include groundwater extraction (on average -9,500 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about 9,800 AF, which equals an average annual change in groundwater storage of about 610 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 1.10 AF per acre on average over the 16 years and an annual increase of 0.07 AF per acre across the entire GSA (approximately 8,900 acres).

For the Projected with Projects Sustainability period, inflows to the GWS include net stream seepage (on average 7,900 AF per year), deep percolation (on average 4,700 AF per year), and net subsurface flows (on average 590 AF per year). Outflows from the GWS include groundwater extraction (on average -12,000 AF per year) and subsidence (on average -100 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 31,000 AF, which equals an average annual change in groundwater storage of about 610 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 3.49 AF per acre on average over the 51 years and an annual increase of 0.07 AF per acre across the entire GSA (approximately 8,900 acres).

Table 4-53. City of Madera District GSA Projected with Projects Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	6,100	7,900
Deep Percolation	3,300	4,700
Groundwater Extractions	-9,500	-12,000
Subsidence	230	-100
Net Subsurface Flows	500	590
Annual Change in Groundwater Storage	**610**	**610**

Summarized results for major components of the Projected with Projects and with Climate Change water budget as they relate to the GWS are presented in **Table 4-54**.

For the Projected with Projects and with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 6,100 AF per year), deep percolation (on average 3,100 AF per year), and subsidence (on average 660 AF per year). Outflows from the GWS include groundwater extraction (on average -9,600 AF per year) and net subsurface flows (on average -850 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -8,300 AF, which equals an average annual change in groundwater storage of about -520 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -0.93 AF per acre on average over the 16 years and an annual decrease of -0.06 AF per acre across the entire GSA (approximately 8,900 acres).

For the Projected with Projects and with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 8,200 AF per year), deep percolation (on average 4,600 AF per year), and subsidence (on average 130 AF per year). Outflows from the GWS include groundwater extraction (on average -12,000 AF per year) and net subsurface flows (on average -260 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 8,400 AF, which equals an average annual change in groundwater storage of about 160 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 0.94 AF per acre on average over the 51 years and an annual increase of 0.02 AF per acre across the entire GSA (approximately 8,900 acres).

Table 4-54. City of Madera District GSA Projected with Projects and with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	6,100	8,200
Deep Percolation	3,100	4,600
Groundwater Extractions	-9,600	-12,000
Subsidence	660	130
Net Subsurface Flows	-850	-260
Annual Change in Groundwater Storage	**-520**	**160**

Projected (No Action)

Summarized results for major components of the Projected (No Action) water budget as they relate to the GWS are presented in **Table 4-55**.

For the Projected (No Action) Implementation period, inflows to the GWS include net stream seepage (on average 1,700 AF per year), deep percolation (on average 3,400 AF per year), subsidence (on average 940 AF per year), and net subsurface flows (on average 2,200 AF per year). Outflows from the GWS include groundwater extraction (on average -10,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -30,000 AF, which equals an average annual change in groundwater storage of about -1,900 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -3.35 AF per acre on average over the 16 years and an annual decrease of -0.21 AF per acre across the entire GSA (approximately 8,900 acres).

For the Projected (No Action) Sustainability period, inflows to the GWS include net stream seepage (on average 2,400 AF per year), deep percolation (on average 6,000 AF per year), subsidence (on average 910 AF per year), and net subsurface flows (on average 5,700 AF per year). Outflows from the GWS include groundwater extraction (on average -16,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -39,000 AF, which equals an average annual change in groundwater storage of about -770 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.42 AF per acre on average over the 51 years and an annual decrease of -0.09 AF per acre across the entire GSA (approximately 8,900 acres).

Table 4-55. City of Madera District GSA Projected (No Action) Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	1,700	2,400
Deep Percolation	3,400	6,000
Groundwater Extractions	-10,000	-16,000
Subsidence	940	910
Net Subsurface Flows	2,200	5,700
Annual Change in Groundwater Storage	**-1,900**	**-770**

Summarized results for major components of the Projected (No Action) with Climate Change water budget as they relate to the GWS are presented in **Table 4-56**.

For the Projected (No Action) with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 1,700 AF per year), deep percolation (on average 3,200 AF per year), subsidence (on average 1,400 AF per year), and net subsurface flows (on average 1,100 AF per year). Outflows from the GWS include groundwater extraction (on average -10,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -44,000 AF, which equals an average annual change in groundwater storage of about -2,800 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.96 AF per acre on average over the 16 years and an annual decrease of -0.31 AF per acre across the entire GSA (approximately 8,900 acres).

For the Projected (No Action) with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 2,600 AF per year), deep percolation (on average 5,900 AF per year), subsidence (on average 1,100 AF per year), and net subsurface flows (on average 5,200 AF per year). Outflows from the GWS include groundwater extraction (on average -16,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -52,000 AF, which equals an average annual change in groundwater storage of about -1,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.85 AF per acre on average over the 51 years and an annual decrease of -0.11 AF per acre across the entire GSA (approximately 8,900 acres).

Table 4-56. City of Madera District GSA Projected (No Action) with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	1,700	2,600
Deep Percolation	3,200	5,900
Groundwater Extractions	-10,000	-16,000
Subsidence	1,400	1,100
Net Subsurface Flows	1,100	5,200
Annual Change in Groundwater Storage	**-2,800**	**-1,000**

Madera County GSA

The following section summarizes the analyses and results relating to the Madera County GSA within Madera Subbasin. Detailed results for each of the individual water budget components for each scenario are presented in **Appendix D.2.b**.

<u>Historical</u>

Summarized results for major components of the historical water budget as they relate to the GWS are presented in **Table 4-57**.

For the GSP historical period, inflows to the GWS include net stream seepage (on average 36,000 AF per year), deep percolation (on average 98,000 AF per year), subsidence (on average 17,000 AF per year), and net subsurface flows (on average 50,000 AF per year). Outflows from the GWS include groundwater extraction (on average -220,000 AF per year). Overall, the water budget results for the 27-year historical period indicates a cumulative change in groundwater storage of about -360,000 AF, which equals an average annual change in groundwater storage of about -13,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.68 AF per acre on average over the 27 years and an annual decrease of -0.10 AF per acre across the entire GSA (approximately 180,000 acres).

For the calibrated historical period, inflows to the GWS include net stream seepage (on average 40,000 AF per year), deep percolation (on average 99,000 AF per year), subsidence (on average 17,000 AF per year), and net subsurface flows (on average 52,000 AF per year). Outflows from the GWS include groundwater extraction (on average -220,000 AF per year). Overall, the water budget results for the 35-year historical period indicates a cumulative change in groundwater storage of about -390,000 AF, which equals an average annual change in groundwater storage of about -11,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.84 AF per acre on average over the 35 years and an annual decrease of -0.08 AF per acre across the entire GSA (approximately 180,000 acres).

Table 4-57. Madera County GSA Historical Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual GSP Historical Period (WY 1989-2015)**	**Average Annual Calibrated Historical Period (WY 1989-2023)**
Net Stream Seepage	36,000	40,000
Deep Percolation	98,000	99,000
Groundwater Extractions	-220,000	-220,000
Subsidence	17,000	17,000
Net Subsurface Flows	50,000	52,000
Annual Change in Groundwater Storage	**-13,000**	**-11,000**

Projected with Projects

Summarized results for major components of the Projected with Projects water budget as they relate to the GWS are presented in **Table 4-58**.

For the Projected with Projects Implementation period, inflows to the GWS include net stream seepage (on average 51,000 AF per year), deep percolation (on average 76,000 AF per year), subsidence (on average 2,900 AF per year), and net subsurface flows (on average 44,000 AF per year). Outflows from the GWS include groundwater extraction (on average -170,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about 13,000 AF, which equals an average annual change in groundwater storage of about 810 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 0.10 AF per acre on average over the 16 years and an annual increase of 0.01 AF per acre across the entire GSA (approximately 180,000 acres).

For the Projected with Projects Sustainability period, inflows to the GWS include net stream seepage (on average 63,000 AF per year) and deep percolation (on average 75,000 AF per year). Outflows from the GWS include groundwater extraction (on average -110,000 AF per year), subsidence (on average -1,500 AF per year), and net subsurface flows (on average -17,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 590,000 AF, which equals an average annual change in groundwater storage of about 12,000 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 4.35 AF per acre on average over the 51 years and an annual increase of 0.09 AF per acre across the entire GSA (approximately 180,000 acres).

Table 4-58. Madera County GSA Projected with Projects Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	51,000	63,000
Deep Percolation	76,000	75,000
Groundwater Extractions	-170,000	-110,000
Subsidence	2,900	-1,500
Net Subsurface Flows	44,000	-17,000
Annual Change in Groundwater Storage	**810**	**12,000**

Summarized results for major components of the Projected with Projects and with Climate Change water budget as they relate to the GWS are presented in **Table 4-59**.

For the Projected with Projects and with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 45,000 AF per year), deep percolation (on average 73,000 AF per year), subsidence (on average 7,800 AF per year), and net subsurface flows (on average 34,000 AF per year). Outflows from the GWS include groundwater extraction (on average -180,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -240,000 AF, which equals an average annual change in groundwater storage of about -15,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -1.73 AF per acre on average over the 16 years and an annual decrease of -0.11 AF per acre across the entire GSA (approximately 180,000 acres).

For the Projected with Projects and with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 57,000 AF per year), deep percolation (on average 75,000 AF per year), and subsidence (on average 590 AF per year). Outflows from the GWS include groundwater extraction (on average -110,000 AF per year) and net subsurface flows (on average -14,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 260,000 AF, which equals an average annual change in groundwater storage of about 5,100 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 1.93 AF per acre on average over the 51 years and an annual increase of 0.04 AF per acre across the entire GSA (approximately 180,000 acres).

Table 4-59. Madera County GSA Projected with Projects and with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	45,000	57,000
Deep Percolation	73,000	75,000
Groundwater Extractions	-180,000	-110,000
Subsidence	7,800	590
Net Subsurface Flows	34,000	-14,000
Annual Change in Groundwater Storage	**-15,000**	**5,100**

Projected (No Action)

Summarized results for major components of the Projected (No Action) water budget as they relate to the GWS are presented in **Table 4-60**.

For the Projected (No Action) Implementation period, inflows to the GWS include net stream seepage (on average 44,000 AF per year), deep percolation (on average 82,000 AF per year), subsidence (on average 14,000 AF per year), and net subsurface flows (on average 68,000 AF per year). Outflows from the GWS include groundwater extraction (on average -240,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -450,000 AF, which equals an average annual change in groundwater storage of about -28,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -3.33 AF per acre on average over the 16 years and an annual decrease of -0.21 AF per acre across the entire GSA (approximately 180,000 acres).

For the Projected (No Action) Sustainability period, inflows to the GWS include net stream seepage (on average 54,000 AF per year), deep percolation (on average 94,000 AF per year), subsidence (on average 12,000 AF per year), and net subsurface flows (on average 69,000 AF per year). Outflows from the GWS include groundwater extraction (on average -240,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -570,000 AF, which equals an average annual change in groundwater storage of about -11,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.18 AF per acre on average over the 51 years and an annual decrease of -0.08 AF per acre across the entire GSA (approximately 180,000 acres).

Table 4-60. Madera County GSA Projected (No Action) Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	44,000	54,000
Deep Percolation	82,000	94,000
Groundwater Extractions	-240,000	-240,000
Subsidence	14,000	12,000
Net Subsurface Flows	68,000	69,000
Annual Change in Groundwater Storage	**-28,000**	**-11,000**

Summarized results for major components of the Projected (No Action) with Climate Change water budget as they relate to the GWS are presented in **Table 4-61**.

For the Projected (No Action) with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 44,000 AF per year), deep percolation (on average 81,000 AF per year), subsidence (on average 20,000 AF per year), and net subsurface flows (on average 60,000 AF per year). Outflows from the GWS include groundwater extraction (on average -240,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -610,000 AF, which equals an average annual change in groundwater storage of about -38,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.49 AF per acre on average over the 16 years and an annual decrease of -0.28 AF per acre across the entire GSA (approximately 180,000 acres).

For the Projected (No Action) with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 55,000 AF per year), deep percolation (on average 95,000 AF per year), subsidence (on average 15,000 AF per year), and net subsurface flows (on average 68,000 AF per year). Outflows from the GWS include groundwater extraction (on average -240,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -670,000 AF, which equals an average annual change in groundwater storage of about -13,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.96 AF per acre on average over the 51 years and an annual decrease of -0.10 AF per acre across the entire GSA (approximately 180,000 acres).

Table 4-61. Madera County GSA Projected (No Action) with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	44,000	55,000
Deep Percolation	81,000	95,000
Groundwater Extractions	-240,000	-240,000
Subsidence	20,000	15,000
Net Subsurface Flows	60,000	68,000
Annual Change in Groundwater Storage	**-38,000**	**-13,000**

Madera Irrigation District GSA

The following section summarizes the analyses and results relating to the Madera Irrigation District GSA (MID) within Madera Subbasin. Detailed results for each of the individual water budget components for each scenario are presented in **Appendix D.2.c**.

Historical

Summarized results for major components of the historical water budget as they relate to the GWS are presented in **Table 4-62**.

For the GSP historical period, inflows to the GWS include net stream seepage (on average 80,000 AF per year), deep percolation (on average 100,000 AF per year), and subsidence (on average 12,000 AF per year). Outflows from the GWS include groundwater extraction (on average -200,000 AF per year) and net subsurface flows (on average -18,000 AF per year). Overall, the water budget results for the 27-year historical period indicates a cumulative change in groundwater storage of about -700,000 AF, which equals an average annual change in groundwater storage of about -26,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.24 AF per acre on average over the 27 years and an annual decrease of -0.19 AF per acre across the entire GSA (approximately 130,000 acres).

For the calibrated historical period, inflows to the GWS include net stream seepage (on average 82,000 AF per year), deep percolation (on average 110,000 AF per year), and subsidence (on average 13,000 AF per year). Outflows from the GWS include groundwater extraction (on average -210,000 AF per year) and net subsurface flows (on average -14,000 AF per year). Overall, the water budget results for the 35-year historical period indicates a cumulative change in groundwater storage of about -760,000 AF, which equals an average annual change in groundwater storage of about -22,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.64 AF per acre on average over the 35 years and an annual decrease of -0.16 AF per acre across the entire GSA (approximately 130,000 acres).

Table 4-62. Madera Irrigation District GSA Historical Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual GSP Historical Period (WY 1989-2015)	Average Annual Calibrated Historical Period (WY 1989-2023)
Net Stream Seepage	80,000	82,000
Deep Percolation	100,000	110,000
Groundwater Extractions	-200,000	-210,000
Subsidence	12,000	13,000
Net Subsurface Flows	-18,000	-14,000
Annual Change in Groundwater Storage	**-26,000**	**-22,000**

Projected with Projects

Summarized results for major components of the Projected with Projects water budget as they relate to the GWS are presented in **Table 4-63**.

For the Projected with Projects Implementation period, inflows to the GWS include net stream seepage (on average 110,000 AF per year), deep percolation (on average 87,000 AF per year), subsidence (on average 3,400 AF per year), and net subsurface flows (on average 9,800 AF per year). Outflows from the GWS include groundwater extraction (on average -220,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -140,000 AF, which equals an average annual change in groundwater storage of about -8,700 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -1.04 AF per acre on average over the 16 years and an annual decrease of -0.06 AF per acre across the entire GSA (approximately 130,000 acres).

For the Projected with Projects Sustainability period, inflows to the GWS include net stream seepage (on average 130,000 AF per year), deep percolation (on average 99,000 AF per year), and net subsurface flows (on average 2,600 AF per year). Outflows from the GWS include groundwater extraction (on average -220,000 AF per year) and subsidence (on average -1,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 500,000 AF, which equals an average annual change in groundwater storage of about 9,800 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 3.70 AF per acre on average over the 51 years and an annual increase of 0.07 AF per acre across the entire GSA (approximately 130,000 acres).

Table 4-63. Madera Irrigation District GSA Projected with Projects Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	110,000	130,000
Deep Percolation	87,000	99,000
Groundwater Extractions	-220,000	-220,000
Subsidence	3,400	-1,000
Net Subsurface Flows	9,800	2,600
Annual Change in Groundwater Storage	**-8,700**	**9,800**

Summarized results for major components of the Projected with Projects and with Climate Change water budget as they relate to the GWS are presented in **Table 4-64**.

For the Projected with Projects and with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 88,000 AF per year), deep percolation (on average 85,000 AF per year), subsidence (on average 9,400 AF per year), and net subsurface flows (on average 29,000 AF per year). Outflows from the GWS include groundwater extraction (on average -240,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -470,000 AF, which equals an average annual change in groundwater storage of about -29,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -3.46 AF per acre on average over the 16 years and an annual decrease of -0.22 AF per acre across the entire GSA (approximately 130,000 acres).

For the Projected with Projects and with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 98,000 AF per year), deep percolation (on average 99,000 AF per year), subsidence (on average 1,400 AF per year), and net subsurface flows (on average 45,000 AF per year). Outflows from the GWS include groundwater extraction (on average -240,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 160,000 AF, which equals an average annual change in groundwater storage of about 3,100 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 1.16 AF per acre on average over the 51 years and an annual increase of 0.02 AF per acre across the entire GSA (approximately 130,000 acres).

Table 4-64. Madera Irrigation District GSA Projected with Projects and with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	88,000	98,000
Deep Percolation	85,000	99,000
Groundwater Extractions	-240,000	-240,000
Subsidence	9,400	1,400
Net Subsurface Flows	29,000	45,000
Annual Change in Groundwater Storage	**-29,000**	**3,100**

Projected (No Action)

Summarized results for major components of the Projected (No Action) water budget as they relate to the GWS are presented in **Table 4-65**.

For the Projected (No Action) Implementation period, inflows to the GWS include net stream seepage (on average 86,000 AF per year), deep percolation (on average 87,000 AF per year), subsidence (on average 11,000 AF per year), and net subsurface flows (on average 3,400 AF per year). Outflows from the GWS include groundwater extraction (on average -220,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -520,000 AF, which equals an average annual change in groundwater storage of about -33,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -3.91 AF per acre on average over the 16 years and an annual decrease of -0.24 AF per acre across the entire GSA (approximately 130,000 acres).

For the Projected (No Action) Sustainability period, inflows to the GWS include net stream seepage (on average 88,000 AF per year), deep percolation (on average 100,000 AF per year), subsidence (on average 11,000 AF per year), and net subsurface flows (on average 14,000 AF per year). Outflows from the GWS include groundwater extraction (on average -230,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -740,000 AF, which equals an average annual change in groundwater storage of about -15,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.53 AF per acre on average over the 51 years and an annual decrease of -0.11 AF per acre across the entire GSA (approximately 130,000 acres).

Table 4-65. Madera Irrigation District GSA Projected (No Action) Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	86,000	88,000
Deep Percolation	87,000	100,000
Groundwater Extractions	-220,000	-230,000
Subsidence	11,000	11,000
Net Subsurface Flows	3,400	14,000
Annual Change in Groundwater Storage	**-33,000**	**-15,000**

Summarized results for major components of the Projected (No Action) with Climate Change water budget as they relate to the GWS are presented in **Table 4-66**.

For the Projected (No Action) with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 74,000 AF per year), deep percolation (on average 85,000 AF per year), subsidence (on average 17,000 AF per year), and net subsurface flows (on average 18,000 AF per year). Outflows from the GWS include groundwater extraction (on average -240,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -770,000 AF, which equals an average annual change in groundwater storage of about -48,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.72 AF per acre on average over the 16 years and an annual decrease of -0.36 AF per acre across the entire GSA (approximately 130,000 acres).

For the Projected (No Action) with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 79,000 AF per year), deep percolation (on average 100,000 AF per year), subsidence (on average 14,000 AF per year), and net subsurface flows (on average 37,000 AF per year). Outflows from the GWS include groundwater extraction (on average -250,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -870,000 AF, which equals an average annual change in groundwater storage of about -17,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -6.47 AF per acre on average over the 51 years and an annual decrease of -0.13 AF per acre across the entire GSA (approximately 130,000 acres).

Table 4-66. Madera Irrigation District GSA Projected (No Action) with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	74,000	79,000
Deep Percolation	85,000	100,000
Groundwater Extractions	-240,000	-250,000
Subsidence	17,000	14,000
Net Subsurface Flows	18,000	37,000
Annual Change in Groundwater Storage	**-48,000**	**-17,000**

Madera Water District GSA

The following section summarizes the analyses and results relating to the Madera Water District GSA (MWD) within Madera Subbasin. Detailed results for each of the individual water budget components for each scenario are presented in **Appendix D.2.d**.

<u>Historical</u>

Summarized results for major components of the historical water budget as they relate to the GWS are presented in **Table 4-67**.

For the GSP historical period, inflows to the GWS include net stream seepage (on average 120 AF per year), deep percolation (on average 3,500 AF per year), subsidence (on average 510 AF per year), and net subsurface flows (on average 3,000 AF per year). Outflows from the GWS include groundwater extraction (on average -7,900 AF per year). Overall, the water budget results for the 27-year historical period indicates a cumulative change in groundwater storage of about -18,000 AF, which equals an average annual change in groundwater storage of about -650 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.23 AF per acre on average over the 27 years and an annual decrease of -0.19 AF per acre across the entire GSA (approximately 3,400 acres).

For the calibrated historical period, inflows to the GWS include net stream seepage (on average 120 AF per year), deep percolation (on average 3,400 AF per year), subsidence (on average 500 AF per year), and net subsurface flows (on average 2,500 AF per year). Outflows from the GWS include groundwater extraction (on average -7,000 AF per year). Overall, the water budget results for the 35-year historical period indicates a cumulative change in groundwater storage of about -18,000 AF, which equals an average annual change in groundwater storage of about -530 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.44 AF per acre on average over the 35 years and an annual decrease of -0.16 AF per acre across the entire GSA (approximately 3,400 acres).

Table 4-67. Madera Water District GSA Historical Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual GSP Historical Period (WY 1989-2015)	Average Annual Calibrated Historical Period (WY 1989-2023)
Net Stream Seepage	120	120
Deep Percolation	3,500	3,400
Groundwater Extractions	-7,900	-7,000
Subsidence	510	500
Net Subsurface Flows	3,000	2,500
Annual Change in Groundwater Storage	**-650**	**-530**

Projected with Projects

Summarized results for major components of the Projected with Projects water budget as they relate to the GWS are presented in **Table 4-68**.

For the Projected with Projects Implementation period, inflows to the GWS include net stream seepage (on average 2,500 AF per year), deep percolation (on average 2,400 AF per year), subsidence (on average 190 AF per year), and net subsurface flows (on average 1,100 AF per year). Outflows from the GWS include groundwater extraction (on average -6,100 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about 2,000 AF, which equals an average annual change in groundwater storage of about 120 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 0.58 AF per acre on average over the 16 years and an annual increase of 0.04 AF per acre across the entire GSA (approximately 3,400 acres).

For the Projected with Projects Sustainability period, inflows to the GWS include net stream seepage (on average 3,100 AF per year), deep percolation (on average 2,700 AF per year), and net subsurface flows (on average 1,100 AF per year). Outflows from the GWS include groundwater extraction (on average -6,400 AF per year) and subsidence (on average -59 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 21,000 AF, which equals an average annual change in groundwater storage of about 410 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 6.19 AF per acre on average over the 51 years and an annual increase of 0.12 AF per acre across the entire GSA (approximately 3,400 acres).

Table 4-68. Madera Water District GSA Projected with Projects Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	2,500	3,100
Deep Percolation	2,400	2,700
Groundwater Extractions	-6,100	-6,400
Subsidence	190	-59
Net Subsurface Flows	1,100	1,100
Annual Change in Groundwater Storage	**120**	**410**

Summarized results for major components of the Projected with Projects and with Climate Change water budget as they relate to the GWS are presented in **Table 4-69**.

For the Projected with Projects and with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 100 AF per year), deep percolation (on average 2,500 AF per year), subsidence (on average 370 AF per year), and net subsurface flows (on average 2,800 AF per year). Outflows from the GWS include groundwater extraction (on average -6,500 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -12,000 AF, which equals an average annual change in groundwater storage of about -760 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -3.59 AF per acre on average over the 16 years and an annual decrease of -0.22 AF per acre across the entire GSA (approximately 3,400 acres).

For the Projected with Projects and with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 170 AF per year), deep percolation (on average 2,700 AF per year), subsidence (on average 55 AF per year), and net subsurface flows (on average 4,000 AF per year). Outflows from the GWS include groundwater extraction (on average -6,700 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 8,400 AF, which equals an average annual change in groundwater storage of about 170 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 2.50 AF per acre on average over the 51 years and an annual increase of 0.05 AF per acre across the entire GSA (approximately 3,400 acres).

Table 4-69. Madera Water District GSA Projected with Projects and with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	100	170
Deep Percolation	2,500	2,700
Groundwater Extractions	-6,500	-6,700
Subsidence	370	55
Net Subsurface Flows	2,800	4,000
Annual Change in Groundwater Storage	**-760**	**170**

Projected (No Action)

Summarized results for major components of the Projected (No Action) water budget as they relate to the GWS are presented in **Table 4-70**.

For the Projected (No Action) Implementation period, inflows to the GWS include net stream seepage (on average 100 AF per year), deep percolation (on average 2,400 AF per year), subsidence (on average 460 AF per year), and net subsurface flows (on average 2,100 AF per year). Outflows from the GWS include groundwater extraction (on average -6,100 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -17,000 AF, which equals an average annual change in groundwater storage of about -1,000 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.90 AF per acre on average over the 16 years and an annual decrease of -0.31 AF per acre across the entire GSA (approximately 3,400 acres).

For the Projected (No Action) Sustainability period, inflows to the GWS include net stream seepage (on average 160 AF per year), deep percolation (on average 2,700 AF per year), subsidence (on average 390 AF per year), and net subsurface flows (on average 2,800 AF per year). Outflows from the GWS include groundwater extraction (on average -6,400 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -23,000 AF, which equals an average annual change in groundwater storage of about -450 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -6.75 AF per acre on average over the 51 years and an annual decrease of -0.13 AF per acre across the entire GSA (approximately 3,400 acres).

Table 4-70. Madera Water District GSA Projected (No Action) Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	100	160
Deep Percolation	2,400	2,700
Groundwater Extractions	-6,100	-6,400
Subsidence	460	390
Net Subsurface Flows	2,100	2,800
Annual Change in Groundwater Storage	**-1,000**	**-450**

Summarized results for major components of the Projected (No Action) with Climate Change water budget as they relate to the GWS are presented in **Table 4-71**.

For the Projected (No Action) with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 100 AF per year), deep percolation (on average 2,500 AF per year), subsidence (on average 580 AF per year), and net subsurface flows (on average 2,000 AF per year). Outflows from the GWS include groundwater extraction (on average -6,500 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -21,000 AF, which equals an average annual change in groundwater storage of about -1,300 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -6.25 AF per acre on average over the 16 years and an annual decrease of -0.39 AF per acre across the entire GSA (approximately 3,400 acres).

For the Projected (No Action) with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 160 AF per year), deep percolation (on average 2,700 AF per year), subsidence (on average 490 AF per year), and net subsurface flows (on average 2,700 AF per year). Outflows from the GWS include groundwater extraction (on average -6,700 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -34,000 AF, which equals an average annual change in groundwater storage of about -670 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -10.14 AF per acre on average over the 51 years and an annual decrease of -0.20 AF per acre across the entire GSA (approximately 3,400 acres).

Table 4-71. Madera Water District GSA Projected (No Action) with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	100	160
Deep Percolation	2,500	2,700
Groundwater Extractions	-6,500	-6,700
Subsidence	580	490
Net Subsurface Flows	2,000	2,700
Annual Change in Groundwater Storage	**-1,300**	**-670**

Other GSP GSAs

Gravelly Ford Water District GSA

The following section summarizes the analyses and results relating to the Gravelly Ford Water District GSA (GFWD) within Madera Subbasin. Detailed results for each of the individual water budget components for each scenario are presented in **Appendix D.2.e**.

<u>Historical</u>

Summarized results for major components of the historical water budget as they relate to the GWS are presented in **Table 4-72**.

For the GSP historical period, inflows to the GWS include net stream seepage (on average 5,800 AF per year), deep percolation (on average 9,100 AF per year), and subsidence (on average 570 AF per year). Outflows from the GWS include groundwater extraction (on average -16,000 AF per year) and net subsurface flows (on average -980 AF per year). Overall, the water budget results for the 27-year historical period indicates a cumulative change in groundwater storage of about -33,000 AF, which equals an average annual change in groundwater storage of about -1,200 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.14 AF per acre on average over the 27 years and an annual decrease of -0.15 AF per acre across the entire GSA (approximately 7,900 acres).

For the calibrated historical period, inflows to the GWS include net stream seepage (on average 5,700 AF per year), deep percolation (on average 9,200 AF per year), and subsidence (on average 680 AF per year). Outflows from the GWS include groundwater extraction (on average -16,000 AF per year) and net subsurface flows (on average -320 AF per year). Overall, the water budget results for the 35-year historical period indicates a cumulative change in groundwater storage of about -32,000 AF, which equals an average annual change in groundwater storage of about -910 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.03 AF per acre on average over the 35 years and an annual decrease of -0.12 AF per acre across the entire GSA (approximately 7,900 acres).

Table 4-72. Gravelly Ford Water District GSA Historical Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual GSP Historical Period (WY 1989-2015)	Average Annual Calibrated Historical Period (WY 1989-2023)
Net Stream Seepage	5,800	5,700
Deep Percolation	9,100	9,200
Groundwater Extractions	-16,000	-16,000
Subsidence	570	680
Net Subsurface Flows	-980	-320
Annual Change in Groundwater Storage	**-1,200**	**-910**

Projected with Projects

Summarized results for major components of the Projected with Projects water budget as they relate to the GWS are presented in **Table 4-73**.

For the Projected with Projects Implementation period, inflows to the GWS include net stream seepage (on average 8,900 AF per year), deep percolation (on average 7,400 AF per year), and subsidence (on average 210 AF per year). Outflows from the GWS include groundwater extraction (on average -16,000 AF per year) and net subsurface flows (on average -1,300 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -19,000 AF, which equals an average annual change in groundwater storage of about -1,200 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.41 AF per acre on average over the 16 years and an annual decrease of -0.15 AF per acre across the entire GSA (approximately 7,900 acres).

For the Projected with Projects Sustainability period, inflows to the GWS include net stream seepage (on average 11,000 AF per year) and deep percolation (on average 8,500 AF per year). Outflows from the GWS include groundwater extraction (on average -16,000 AF per year), subsidence (on average -8 AF per year), and net subsurface flows (on average -2,800 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 34,000 AF, which equals an average annual change in groundwater storage of about 670 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 4.30 AF per acre on average over the 51 years and an annual increase of 0.08 AF per acre across the entire GSA (approximately 7,900 acres).

Table 4-73. Gravelly Ford Water District GSA Projected with Projects Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	8,900	11,000
Deep Percolation	7,400	8,500
Groundwater Extractions	-16,000	-16,000
Subsidence	210	-8
Net Subsurface Flows	-1,300	-2,800
Annual Change in Groundwater Storage	**-1,200**	**670**

Summarized results for major components of the Projected with Projects and with Climate Change water budget as they relate to the GWS are presented in **Table 4-74**.

For the Projected with Projects and with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 8,000 AF per year), deep percolation (on average 7,400 AF per year), and subsidence (on average 450 AF per year). Outflows from the GWS include groundwater extraction (on average -17,000 AF per year) and net subsurface flows (on average -620 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -29,000 AF, which equals an average annual change in groundwater storage of about -1,800 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -3.66 AF per acre on average over the 16 years and an annual decrease of -0.23 AF per acre across the entire GSA (approximately 7,900 acres).

For the Projected with Projects and with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 9,500 AF per year), deep percolation (on average 8,500 AF per year), and subsidence (on average 50 AF per year). Outflows from the GWS include groundwater extraction (on average -16,000 AF per year) and net subsurface flows (on average -1,200 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 21,000 AF, which equals an average annual change in groundwater storage of about 410 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 2.68 AF per acre on average over the 51 years and an annual increase of 0.05 AF per acre across the entire GSA (approximately 7,900 acres).

Table 4-74. Gravelly Ford Water District GSA Projected with Projects and with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	8,000	9,500
Deep Percolation	7,400	8,500
Groundwater Extractions	-17,000	-16,000
Subsidence	450	50
Net Subsurface Flows	-620	-1,200
Annual Change in Groundwater Storage	**-1,800**	**410**

Projected (No Action)

Summarized results for major components of the Projected (No Action) water budget as they relate to the GWS are presented in **Table 4-75**.

For the Projected (No Action) Implementation period, inflows to the GWS include net stream seepage (on average 5,100 AF per year), deep percolation (on average 7,400 AF per year), subsidence (on average 580 AF per year), and net subsurface flows (on average 1,100 AF per year). Outflows from the GWS include groundwater extraction (on average -16,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -34,000 AF, which equals an average annual change in groundwater storage of about -2,100 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.29 AF per acre on average over the 16 years and an annual decrease of -0.27 AF per acre across the entire GSA (approximately 7,900 acres).

For the Projected (No Action) Sustainability period, inflows to the GWS include net stream seepage (on average 6,200 AF per year), deep percolation (on average 8,400 AF per year), subsidence (on average 420 AF per year), and net subsurface flows (on average 410 AF per year). Outflows from the GWS include groundwater extraction (on average -16,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -22,000 AF, which equals an average annual change in groundwater storage of about -430 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.79 AF per acre on average over the 51 years and an annual decrease of -0.05 AF per acre across the entire GSA (approximately 7,900 acres).

Table 4-75. Gravelly Ford Water District GSA Projected (No Action) Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	5,100	6,200
Deep Percolation	7,400	8,400
Groundwater Extractions	-16,000	-16,000
Subsidence	580	420
Net Subsurface Flows	1,100	410
Annual Change in Groundwater Storage	**-2,100**	**-430**

Summarized results for major components of the Projected (No Action) with Climate Change water budget as they relate to the GWS are presented in **Table 4-76**.

For the Projected (No Action) with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 5,100 AF per year), deep percolation (on average 7,400 AF per year), subsidence (on average 790 AF per year), and net subsurface flows (on average 1,100 AF per year). Outflows from the GWS include groundwater extraction (on average 17,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -41,000 AF, which equals an average annual change in groundwater storage of about -2,600 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.19 AF per acre on average over the 16 years and an annual decrease of -0.32 AF per acre across the entire GSA (approximately 7,900 acres).

For the Projected (No Action) with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 6,200 AF per year), deep percolation (on average 8,500 AF per year), subsidence (on average 520 AF per year), and net subsurface flows (on average 550 AF per year). Outflows from the GWS include groundwater extraction (on average -16,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -31,000 AF, which equals an average annual change in groundwater storage of about -610 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -3.93 AF per acre on average over the 51 years and an annual decrease of -0.08 AF per acre across the entire GSA (approximately 7,900 acres).

Table 4-76. Gravelly Ford Water District GSA Projected (No Action) with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	5,100	6,200
Deep Percolation	7,400	8,500
Groundwater Extractions	-17,000	-16,000
Subsidence	790	520
Net Subsurface Flows	1,100	550
Annual Change in Groundwater Storage	**-2,600**	**-610**

New Stone Water District GSA

The following section summarizes the analyses and results relating to the New Stone Water District GSA (NSWD) within Madera Subbasin. Detailed results for each of the individual water budget components for each scenario are presented in **Appendix D.2.f**.

Historical

Summarized results for major components of the historical water budget as they relate to the GWS are presented in **Table 4-77**.

For the GSP historical period, inflows to the GWS include net stream seepage (on average 3,400 AF per year), deep percolation (on average 3,900 AF per year), subsidence (on average 540 AF per year), and net subsurface flows (on average 2,300 AF per year). Outflows from the GWS include groundwater extraction (on average -10,000 AF per year). Overall, the water budget results for the 27-year historical period indicates a cumulative change in groundwater storage of about -6,900 AF, which equals an average annual change in groundwater storage of about -260 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -1.65 AF per acre on average over the 27 years and an annual decrease of -0.06 AF per acre across the entire GSA (approximately 4,200 acres).

For the calibrated historical period, inflows to the GWS include net stream seepage (on average 3,800 AF per year), deep percolation (on average 3,800 AF per year), subsidence (on average 630 AF per year), and net subsurface flows (on average 2,000 AF per year). Outflows from the GWS include groundwater extraction (on average -10,000 AF per year). Overall, the water budget results for the 35-year historical period indicates a cumulative change in groundwater storage of about 870 AF, which equals an average annual change in groundwater storage of about 25 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 0.21 AF per acre on average over the 35 years and an annual increase of 0.01 AF per acre across the entire GSA (approximately 4,200 acres).

Table 4-77. New Stone Water District GSA Historical Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	Average Annual GSP Historical Period (WY 1989-2015)	Average Annual Calibrated Historical Period (WY 1989-2023)
Net Stream Seepage	3,400	3,800
Deep Percolation	3,900	3,800
Groundwater Extractions	-10,000	-10,000
Subsidence	540	630
Net Subsurface Flows	2,300	2,000
Annual Change in Groundwater Storage	**-260**	**25**

Projected with Projects

Summarized results for major components of the Projected with Projects water budget as they relate to the GWS are presented in **Table 4-78**.

For the Projected with Projects Implementation period, inflows to the GWS include net stream seepage (on average 3,700 AF per year), deep percolation (on average 3,300 AF per year), subsidence (on average 190 AF per year), and net subsurface flows (on average 510 AF per year). Outflows from the GWS include groundwater extraction (on average -7,900 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -3,300 AF, which equals an average annual change in groundwater storage of about -210 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -0.80 AF per acre on average over the 16 years and an annual decrease of -0.05 AF per acre across the entire GSA (approximately 4,200 acres).

For the Projected with Projects Sustainability period, inflows to the GWS include net stream seepage (on average 3,600 AF per year), deep percolation (on average 4,800 AF per year), and net subsurface flows (on average 150 AF per year). Outflows from the GWS include groundwater extraction (on average -8,000 AF per year) and subsidence (on average -34 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 24,000 AF, which equals an average annual change in groundwater storage of about 470 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 5.76 AF per acre on average over the 51 years and an annual increase of 0.11 AF per acre across the entire GSA (approximately 4,200 acres).

Table 4-78. New Stone Water District GSA Projected with Projects Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	3,700	3,600
Deep Percolation	3,300	4,800
Groundwater Extractions	-7,900	-8,000
Subsidence	190	-34
Net Subsurface Flows	510	150
Annual Change in Groundwater Storage	**-210**	**470**

Summarized results for major components of the Projected with Projects and with Climate Change water budget as they relate to the GWS are presented in **Table 4-79**.

For the Projected with Projects and with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 3,900 AF per year), deep percolation (on average 3,200 AF per year), subsidence (on average 290 AF per year), and net subsurface flows (on average 230 AF per year). Outflows from the GWS include groundwater extraction (on average -8,100 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -7,600 AF, which equals an average annual change in groundwater storage of about -470 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of -1.81 AF per acre on average over the 16 years and an annual decrease of -0.11 AF per acre across the entire GSA (approximately 4,200 acres).

For the Projected with Projects and with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 5,400 AF per year) and deep percolation (on average 4,800 AF per year). Outflows from the GWS include groundwater extraction (on average -8,100 AF per year), subsidence (on average -18 AF per year), and net subsurface flows (on average -1,600 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 22,000 AF, which equals an average annual change in groundwater storage of about 430 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 5.31 AF per acre on average over the 51 years and an annual increase of 0.10 AF per acre across the entire GSA (approximately 4,200 acres).

Table 4-79. New Stone Water District GSA Projected with Projects and with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	3,900	5,400
Deep Percolation	3,200	4,800
Groundwater Extractions	-8,100	-8,100
Subsidence	290	-18
Net Subsurface Flows	230	-1,600
Annual Change in Groundwater Storage	**-470**	**430**

Projected (No Action)

Summarized results for major components of the Projected (No Action) water budget as they relate to the GWS are presented in **Table 4-80**.

For the Projected (No Action) Implementation period, inflows to the GWS include net stream seepage (on average 3,600 AF per year), deep percolation (on average 2,500 AF per year), subsidence (on average 690 AF per year), and net subsurface flows (on average 250 AF per year). Outflows from the GWS include groundwater extraction (on average -8,300 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -19,000 AF, which equals an average annual change in groundwater storage of about -1,200 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -4.58 AF per acre on average over the 16 years and an annual decrease of -0.29 AF per acre across the entire GSA (approximately 4,200 acres).

For the Projected (No Action) Sustainability period, inflows to the GWS include net stream seepage (on average 5,800 AF per year), deep percolation (on average 2,900 AF per year), and subsidence (on average 470 AF per year). Outflows from the GWS include groundwater extraction (on average -8,500 AF per year) and net subsurface flows (on average -710 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -5,400 AF, which equals an average annual change in groundwater storage of about -110 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -1.29 AF per acre on average over the 51 years and an annual decrease of -0.03 AF per acre across the entire GSA (approximately 4,200 acres).

Table 4-80. New Stone Water District GSA Projected (No Action) Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	3,600	5,800
Deep Percolation	2,500	2,900
Groundwater Extractions	-8,300	-8,500
Subsidence	690	470
Net Subsurface Flows	250	-710
Annual Change in Groundwater Storage	**-1,200**	**-110**

Summarized results for major components of the Projected (No Action) with Climate Change water budget as they relate to the GWS are presented in **Table 4-81**.

For the Projected (No Action) with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 3,700 AF per year), deep percolation (on average 2,600 AF per year), and subsidence (on average 940 AF per year). Outflows from the GWS include groundwater extraction (on average -8,500 AF per year) and net subsurface flows (on average -33 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -22,000 AF, which equals an average annual change in groundwater storage of -1,400 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.36 AF per acre on average over the 16 years and an annual decrease of -0.33 AF per acre across the entire GSA (approximately 4,200 acres).

For the Projected (No Action) with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 6,000 AF per year), deep percolation (on average 2,900 AF per year), and subsidence (on average 650 AF per year). Outflows from the GWS include groundwater extraction (on average -8,800 AF per year) and net subsurface flows (on average -930 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -9,500 AF, which equals an average annual change in groundwater storage of about -190 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.29 AF per acre on average over the 51 years and an annual decrease of -0.04 AF per acre across the entire GSA (approximately 4,200 acres).

Table 4-81. New Stone Water District GSA Projected (No Action) with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	3,700	6,000
Deep Percolation	2,600	2,900
Groundwater Extractions	-8,500	-8,800
Subsidence	940	650
Net Subsurface Flows	-33	-930
Annual Change in Groundwater Storage	**-1,400**	**-190**

Root Creek Water District GSA

The following section summarizes the analyses and results relating to the Root Creek Water District GSA (RCWD) within Madera Subbasin. Detailed results for each of the individual water budget components for each scenario are presented in **Appendix D.2.g**.

Historical

Summarized results for major components of the historical water budget as they relate to the GWS are presented in **Table 4-82**.

For the GSP historical period, inflows to the GWS include net stream seepage (on average 2,000 AF per year), deep percolation (on average 8,600 AF per year), subsidence (on average 460 AF per year), and net subsurface flows (on average 14,000 AF per year). Outflows from the GWS include groundwater extraction (on average -25,000 AF per year). Overall, the water budget results for the 27-year historical period indicates a cumulative change in groundwater storage of about 1,200 AF, which equals an average annual change in groundwater storage of about 46 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 0.12 AF per acre on average over the 27 years and an annual increase of less than 0.01 AF per acre across the entire GSA (approximately 10,000 acres).

For the calibrated historical period, inflows to the GWS include net stream seepage (on average 2,300 AF per year), deep percolation (on average 8,200 AF per year), subsidence (on average 470 AF per year), and net subsurface flows (on average 13,000 AF per year). Outflows from the GWS include groundwater extraction (on average -24,000 AF per year). Overall, the water budget results for the 35-year historical period indicates a cumulative change in groundwater storage of about -580 AF, which equals an average annual change in groundwater storage of about -17 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -0.06 AF per acre on average over the 35 years and an annual decrease of less than -0.01 AF per acre across the entire GSA (approximately 10,000 acres).

Table 4-82. Root Creek Water District GSA Historical Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual GSP Historical Period (WY 1989-2015)	Average Annual Calibrated Historical Period (WY 1989-2023)
Net Stream Seepage	2,000	2,300
Deep Percolation	8,600	8,200
Groundwater Extractions	-25,000	-24,000
Subsidence	460	470
Net Subsurface Flows	14,000	13,000
Annual Change in Groundwater Storage	**46**	**-17**

Projected with Projects

Summarized results for major components of the Projected with Projects water budget as they relate to the GWS are presented in **Table 4-83**.

For the Projected with Projects Implementation period, inflows to the GWS include net stream seepage (on average 7,800 AF per year), deep percolation (on average 5,600 AF per year), subsidence (on average 46 AF per year), and net subsurface flows (on average 7,800 AF per year). Outflows from the GWS include groundwater extraction (on average -21,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about 13,000 AF, which equals an average annual change in groundwater storage of about 830 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 1.32 AF per acre on average over the 16 years and an annual increase of 0.08 AF per acre across the entire GSA (approximately 10,000 acres).

For the Projected with Projects Sustainability period, inflows to the GWS include net stream seepage (on average 7,400 AF per year), deep percolation (on average 6,100 AF per year), and net subsurface flows (on average 6,700 AF per year). Outflows from the GWS include groundwater extraction (on average -20,000 AF per year) and subsidence (on average -34 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 20,000 AF, which equals an average annual change in groundwater storage of about 390 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 1.96 AF per acre on average over the 51 years and an annual increase of 0.04 AF per acre across the entire GSA (approximately 10,000 acres).

Table 4-83. Root Creek Water District GSA Projected with Projects Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	7,800	7,400
Deep Percolation	5,600	6,100
Groundwater Extractions	-21,000	-20,000
Subsidence	46	-34
Net Subsurface Flows	7,800	6,700
Annual Change in Groundwater Storage	**830**	**390**

Summarized results for major components of the Projected with Projects and with Climate Change water budget as they relate to the GWS are presented in **Table 4-84**.

For the Projected with Projects and with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 6,900 AF per year), deep percolation (on average 5,600 AF per year), subsidence (on average 170 AF per year), and net subsurface flows (on average 8,500 AF per year). Outflows from the GWS include groundwater extraction (on average -21,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -1,900 AF, which equals an average annual change in groundwater storage of -120 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -0.18 AF per acre on average over the 16 years and an annual decrease of -0.01 AF per acre across the entire GSA (approximately 10,000 acres).

For the Projected with Projects and with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 6,000 AF per year), deep percolation (on average 6,100 AF per year), subsidence (on average 12 AF per year), and net subsurface flows (on average 8,300 AF per year). Outflows from the GWS include groundwater extraction (on average -20,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 4,900 AF, which equals an average annual change in groundwater storage of about 97 AF per year. These change in storage estimates equate to total increases in storage in the GSA of about 0.49 AF per acre on average over the 51 years and an annual increase of 0.01 AF per acre across the entire GSA (approximately 10,000 acres).

Table 4-84. Root Creek Water District GSA Projected with Projects and with Climate Change

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	6,900	6,000
Deep Percolation	5,600	6,100
Groundwater Extractions	-21,000	-20,000
Subsidence	170	12
Net Subsurface Flows	8,500	8,300
Annual Change in Groundwater Storage	**-120**	**97**

Projected (No Action)

Summarized results for major components of the Projected (No Action) water budget as they relate to the GWS are presented in **Table 4-85**.

For the Projected (No Action) Implementation period, inflows to the GWS include net stream seepage (on average 3,200 AF per year), deep percolation (on average 5,700 AF per year), subsidence (on average 540 AF per year), and net subsurface flows (on average 10,000 AF per year). Outflows from the GWS include groundwater extraction (on average -21,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -29,000 AF, which equals an average annual change in groundwater storage of about -1,800 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -2.85 AF per acre on average over the 16 years and an annual decrease of -0.18 AF per acre across the entire GSA (approximately 10,000 acres).

For the Projected (No Action) Sustainability period, inflows to the GWS include net stream seepage (on average 3,400 AF per year), deep percolation (on average 6,400 AF per year), subsidence (on average 490 AF per year), and net subsurface flows (on average 9,700 AF per year). Outflows from the GWS include groundwater extraction (on average -21,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -58,000 AF, which equals an average annual change in groundwater storage of about -1,100 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -5.76 AF per acre on average over the 51 years and an annual decrease of -0.11 AF per acre across the entire GSA (approximately 10,000 acres).

Table 4-85. Root Creek Water District GSA Projected (No Action) Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	**Average Annual Implementation Period (WY 2024-2039)**	**Average Annual Sustainability Period (WY 2040-2090)**
Net Stream Seepage	3,200	3,400
Deep Percolation	5,700	6,400
Groundwater Extractions	-21,000	-21,000
Subsidence	540	490
Net Subsurface Flows	10,000	9,700
Annual Change in Groundwater Storage	**-1,800**	**-1,100**

Summarized results for major components of the Projected (No Action) with Climate Change water budget as they relate to the GWS are presented in **Table 4-86**.

For the Projected (No Action) with Climate Change Implementation period, inflows to the GWS include net stream seepage (on average 3,300 AF per year), deep percolation (on average 5,700 AF per year), subsidence (on average 650 AF per year), and net subsurface flows (on average 10,000 AF per year). Outflows from the GWS include groundwater extraction (on average -22,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -34,000 AF, which equals an average annual change in groundwater storage of about -2,100 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -3.39 AF per acre on average over the 16 years and an annual decrease of -0.21 AF per acre across the entire GSA (approximately 10,000 acres).

For the Projected (No Action) with Climate Change Sustainability period, inflows to the GWS include net stream seepage (on average 3,500 AF per year), deep percolation (on average 6,400 AF per year), subsidence (on average 530 AF per year), and net subsurface flows (on average 10,000 AF per year). Outflows from the GWS include groundwater extraction (on average -22,000 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about -60,000 AF, which equals an average annual change in groundwater storage of about -1,200 AF per year. These change in storage estimates equate to total decreases in storage in the GSA of about -6.00 AF per acre on average over the 51 years and an annual decrease of -0.12 AF per acre across the entire GSA (approximately 10,000 acres).

Table 4-86. Root Creek Water District GSA Projected (No Action) with Climate Change Groundwater System Annual Water Budget Summary (acre-feet)		
Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	3,300	3,500
Deep Percolation	5,700	6,400
Groundwater Extractions	-22,000	-22,000
Subsidence	650	530
Net Subsurface Flows	10,000	10,000
Annual Change in Groundwater Storage	**-2,100**	**-1,200**

4.6. Additional Scenarios

As a GSP implementation tool, MCSim is intended to evaluate a range of potential scenarios and outcomes within the Chowchilla and Madera Subbasins.

4.6.1. Sensitivity – Projected with Projects Scenario

A sensitivity scenario was developed based on the Projected with Projects Scenario described above. In this scenario, the projects implementation within Madera Subbasin is scaled back to a less aggressive approach. This scaled back approach was applied specifically to the Madera County GSA.

Madera Subbasin Model Results

Summarized results for major components of the Sensitivity – Projected with Projects water budget as they relate to the GWS are presented in **Table 4-87**.

For the Sensitivity – Projected with Projects Implementation period, inflows to the GWS include net stream seepage (on average 190,000 AF per year), deep percolation (on average 190,000 AF per year), subsidence (on average 12,000 AF per year), and net subsurface flows (on average 73,000 AF per year). Outflows from the GWS include groundwater extraction (on average -480,000 AF per year). Overall, the water budget results for the 16-year implementation period indicate a cumulative change in groundwater storage of about -310,000 AF, which equals an average annual change in groundwater storage of about -19,000 AF per year. These change in storage estimates equate to total decreases in storage in the Subbasin of about -0.88 AF per acre on average over the 16 years and an annual decrease of -0.06 AF per acre across the entire Subbasin (approximately 349,000 acres).

For the Sensitivity – Projected with Projects Sustainability period, inflows to the GWS include net stream seepage (on average 230,000 AF per year), deep percolation (on average 210,000 AF per year), and net subsurface flows (on average 18,000 AF per year). Outflows from the GWS include groundwater extraction (on average -430,000 AF per year) and subsidence (on average -1,200 AF per year). Overall, the water budget results for the 51-year sustainability period indicate a cumulative change in groundwater storage of about 970,000 AF, which equals an average annual change in groundwater storage of about 19,000 AF per year. These change in storage estimates equate to total increases in storage in the Subbasin of about 2.78 AF per acre on average over the 51 years and an annual increase of 0.05 AF per acre across the entire Subbasin (approximately 349,000 acres).

Detailed results for each of the individual water budget components in the Sensitivity – Projected with Projects water budget are presented in **Appendix D.2**, simulated groundwater elevation hydrographs at select wells are presented in **Appendix E.2.f**, and simulated subsidence hydrographs are presented in **Appendix F.2.f**.

Table 4-87. Madera Subbasin Sensitivity – Projected with Projects Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	Average Annual Implementation Period (WY 2024-2039)	Average Annual Sustainability Period (WY 2040-2090)
Net Stream Seepage	190,000	230,000
Deep Percolation	190,000	210,000
Groundwater Extractions	-480,000	-430,000
Subsidence	12,000	-1,200
Net Subsurface Flows	73,000	18,000
Annual Change in Groundwater Storage	**-19,000**	**19,000**

By GSA Model Results

Summarized results for major components of the Sensitivity – Projected with Projects Implementation Period water budget as they relate to the GWS are presented in **Table 4-88**.

On average, the annual change in storage for the City of Madera GSA is 410 AF per year. Inflows include net stream seepage (on average 6,100 AF per year), deep percolation (on average 3,300 AF per year), subsidence (on average 380 AF per year), and net subsurface flows (on average 160 AF per year). Outflows include groundwater extraction (on average -9,500 AF per year). Detailed results for the City of Madera GSA are presented in **Appendix D.2.a**.

On average, the annual change in storage for the Madera County GSA is -5,600 AF per year. Inflows include net stream seepage (on average 51,000 AF per year), deep percolation (on average 79,000 AF per year), subsidence (on average 5,800AF per year), and net subsurface flows (on average 60,000 AF per year). Outflows include groundwater extraction (on average -210,000 AF per year). Detailed results for the Madera County GSA are presented in **Appendix D.2.b**.

On average, the annual change in storage for the Madera Irrigation District GSA is -13,000 AF per year. Inflows include net stream seepage (on average 110,000 AF per year), deep percolation (on average 87,000 AF per year), subsidence (on average 5,100 AF per year), and net subsurface flows (on average

4,200 AF per year). Outflows include groundwater extraction (on average -220,000 AF per year). Detailed results for the Madera Irrigation District GSA are presented in **Appendix D.2.c**.

On average, the annual change in storage for the Madera Water District GSA is -53 AF per year. Inflows include net stream seepage (on average 2,500 AF per year), deep percolation (on average 2,400 AF per year), subsidence (on average 260 AF per year), and net subsurface flows (on average 840 AF per year). Outflows include groundwater extraction (on average -6,100AF per year). Detailed results for the Madera Water District GSA are presented in **Appendix D.2.d**.

On average, the annual change in storage for the Gravelly Ford Water District GSA is -1,400 AF per year. Inflows include net stream seepage (on average 8,900 AF per year), deep percolation (on average 7,400 AF per year), and subsidence (on average 280 AF per year). Outflows include groundwater extraction (on average -16,000 AF per year) and net subsurface flows (on average -1,600 AF per year). Detailed results for the Gravelly Ford Water District GSA are presented in **Appendix D.2.e**.

On average, the annual change in storage for the New Stone Water District GSA is -410 AF per year. Inflows include net stream seepage (on average 3,800 AF per year), deep percolation (on average 3,200 AF per year), subsidence (on average 280 AF per year), and net subsurface flows (on average 140 AF per year). Outflows include groundwater extraction (on average -7,900 AF per year). Detailed results for the New Stone Water District GSA are presented in **Appendix D.2.f**.

On average, the annual change in storage for the Root Creek Water District GSA is 520 AF per year. Inflows include net stream seepage (on average 7,900 AF per year), deep percolation (on average 5,600 AF per year), subsidence (on average 140 AF per year), and net subsurface flows (on average 7,400 AF per year). Outflows include groundwater extraction (on average -21,000 AF per year). Detailed results for the Root Creek Water District GSA are presented in **Appendix D.2.g**.

Table 4-88. Madera Subbasin GSAs Sensitivity – Projected with Projects Implementation Period (Water Years 2024-2039) Groundwater System Annual Water Budget Summary (acre-feet)							
Water Budget Component	City of Madera GSA	Madera County GSA	Madera Irrigation District GSA	Madera Water District GSA	Gravelly Ford Water District GSA	New Stone Water District GSA	Root Creek Water District GSA
Net Stream Seepage	6,100	51,000	110,000	2,500	8,900	3,800	7,900
Deep Percolation	3,300	79,000	87,000	2,400	7,400	3,200	5,600
Groundwater Extractions	-9,500	-210,000	-220,000	-6,100	-16,000	-7,900	-21,000
Subsidence	380	5,800	5,100	260	280	280	140
Net Subsurface Flows	160	60,000	4,200	840	-1,600	140	7,400
Annual Change in Groundwater Storage	**410**	**-5,600**	**-13,000**	**-53**	**-1,400**	**-410**	**520**

Summarized results for major components of the Sensitivity – Projected with Projects Sustainability Period water budget as they relate to the GWS are presented in **Table 4-89**.

On average, the annual change in storage for the City of Madera GSA is 440 AF per year. Inflows include net stream seepage (on average 7,900 AF per year), deep percolation (on average 4,700 AF per year), and net subsurface flows (on average 360 AF per year). Outflows include groundwater extraction (on average -12,000 AF per year) and subsidence (on average -39 AF per year). Detailed results for the City of Madera GSA are presented in **Appendix D.2.a**.

On average, the annual change in storage for the Madera County GSA is 9,300 AF per year. Inflows include net stream seepage (on average 61,000 AF per year), deep percolation (on average 82,000 AF per year), and net subsurface flows (on average 12,000 AF per year). Outflows include groundwater extraction (on average -150,000 AF per year) and subsidence (on average -710 AF per year). Detailed results for the Madera County GSA are presented in **Appendix D.2.b**.

On average, the annual change in storage for the Madera Irrigation District GSA is 7,600 AF per year. Inflows include net stream seepage (on average 130,000 AF per year) and deep percolation (on average 99,000 AF per year). Outflows include groundwater extraction (on average -220,000 AF per year), subsidence (on average -370 AF per year), and net subsurface flows (on average -970 AF per year). Detailed results for the Madera Irrigation District GSA are presented in **Appendix D.2.c**.

On average, the annual change in storage for the Madera Water District GSA is 350 AF per year. Inflows include net stream seepage (on average 3,100 AF per year), deep percolation (on average 2,700 AF per year), and net subsurface flows (on average 1,000 AF per year). Outflows include groundwater extraction (on average -6,400 AF per year) and subsidence (on average -27 AF per year). Detailed results for the Madera Water District GSA are presented in **Appendix D.2.d**.

On average, the annual change in storage for the Gravelly Ford Water District GSA is 600 AF per year. Inflows include net stream seepage (on average 11,000 AF per year), deep percolation (on average 8,500 AF per year), and subsidence (on average 9 AF per year). Outflows include groundwater extraction (on average -16,000 AF per year) and net subsurface flows (on average -2,900 AF per year) Detailed results for the Gravelly Ford Water District GSA are presented in **Appendix D.2.e**.

On average, the annual change in storage for the New Stone Water District GSA is 480 AF per year. Inflows include net stream seepage (on average 4,800 AF per year) and deep percolation (on average 4,800 AF per year). Outflows include groundwater extraction (on average -8,900 AF per year), subsidence (on average -29 AF per year), and net subsurface flows (on average -1,100 AF per year). Detailed results for the New Stone Water District GSA are presented in **Appendix D.2.f**.

On average, the annual change in storage for the Root Creek Water District GSA is 280 AF per year. Inflows include net stream seepage (on average 7,500 AF per year), deep percolation (on average 6,100 AF per year), and net subsurface flows (on average 6,500 AF per year). Outflows include groundwater extraction (on average-20,000 AF per year) and subsidence (on average -17 AF per year). Detailed results for the Root Creek Water District GSA are presented in **Appendix D.2.g**.

Table 4-89. Madera Subbasin GSAs Sensitivity – Projected with Projects Sustainability Period (Water Years 2040-2090) Groundwater System Annual Water Budget Summary (acre-feet)

Water Budget Component	City of Madera GSA	Madera County GSA	Madera Irrigation District GSA	Madera Water District GSA	Gravelly Ford Water District GSA	New Stone Water District GSA	Root Creek Water District GSA
Net Stream Seepage	7,900	27,000	34,000	61,000	130,000	3,100	11,000
Deep Percolation	4,700	56,000	26,000	82,000	99,000	2,700	8,500
Groundwater Extractions	-12,000	-94,000	-51,000	-150,000	-220,000	-6,400	-16,000
Subsidence	-39	-580	-130	-710	-370	-27	9
Net Subsurface Flows	360	17,000	-4,700	12,000	-970	1,000	-2,900
Annual Change in Groundwater Storage	**440**	**5,700**	**3,600**	**9,300**	**7,600**	**350**	**600**

5. SENSITIVITY ANALYSIS AND MODEL UNCERTAINTY

5.1. Sensitivity Analysis

A model response or prediction depends on the governing equations it solves, the mechanisms and structure of the model, and the values of the model parameters. Sensitivity analysis is a means of evaluating model uncertainty due to parameter estimates by systematically altering one of the model parameters and examining the associated change in the model response. After the groundwater model was calibrated, a quantitative sensitivity analysis was performed using the model parameters that were most uncertain and likely to affect the simulation results. The calibrated flow was used as the baseline simulation and sensitivity simulations were compared with those of the baseline simulation at all observation points. Model sensitivity was evaluated for model parameters using UCODE- 2014. The basis of a model parameter's sensitivity was based on groundwater elevation observations given a 1% parameter value perturbation. Sensitivity was evaluated through the Composite Scaled Sensitivity (CSS) statistic described by Hill and Tiedman (2007).

Sensitivity of simulated groundwater elevations to parameter perturbations are presented in **Figure 5-1**. The CSS statistic shows the model is most sensitive to the Anisotropy Ratio (VKA) and Horizontal Hydraulic Conductivity of Fine Materials (KHF) parameters within the aquifer system defined in **Table 4-4**. The Anisotropy Ratio parameter is applied to the horizontal hydraulic conductivity values at each node and layer to estimate vertical hydraulic conductivity. Therefore, the high sensitivity to the Anisotropy Ratio suggests a sensitivity to the vertical hydraulic conductivity of the model. The model is less sensitive to specific yield and specific storage parameters.

5.2. Model Uncertainty and Limitations

All groundwater flow models are a simplification of the natural environment, and therefore have uncertainty and limitations that are important to recognize. For this reason, uncertainty exists in the ability of any numerical model to completely represent groundwater flow. Some of the uncertainty is associated with limitations in available data. Considerable effort was made to reduce model uncertainty by using measured values as model inputs whenever available, and by conducting quality assurance and quality control assessments of data that were obtained. Where limited data exist to develop input values for parameters or other inputs with high uncertainty, a conservative approach to assigning input values was followed.

Uncertainty associated with water budget results estimated using MCSim_v2 depends in part on the model inputs relating to the surface water system with additional sources of uncertainty associated with model inputs relating to the groundwater system, including aquifer and streambed properties, specification of boundary conditions, and other factors. The uncertainty estimates associated with surface water system water budget components that are also inputs or outputs of the groundwater system water budget are discussed in Section 2.2.3 of the GSP. Recognizing the uncertainty of the surface water system water budget components, the overall uncertainty of other water budget components simulated for the groundwater system, including subsurface flows, groundwater discharging to surface water, and change in groundwater storage are estimated to be in the range of 10 to 30 percent. These groundwater system water budget components are subject to slightly higher uncertainty as they incorporate uncertainty in the surface water system water inflows and outflows with additional uncertainty resulting from limitations in available input data and simplification required in modeling of the subsurface heterogeneity. However, the uncertainty in the groundwater system water budget derived from a numerical model such as MCSim_v2 depends to a considerable degree on the calibration of the model and can vary by location and depth within the model domain. MCSim_v2 is a product of local refinement and improvements made to the C2VSimFG model. MCSim_v2 simulates the integrated groundwater and surface water systems and metrics relating to the calibration of the model indicate the model is reasonably well calibrated in accordance with generally accepted professional guidelines and is sufficient for GSP-related applications. The finding and conclusions of this study are focused on a regional scale and use of the model for site specific analysis should be conducted with an understanding that representation of local site-specific conditions may be approximate and should be verified with local site-specific investigations. The flow model was developed in a manner consistent with the level of care and skill normally exercised by professionals practicing under similar conditions in the area. There is no warranty, expressed or implied that this modeling study has considered or addresses all hydrogeological, hydrological, environmental, geotechnical or other characteristics and properties associated with the subject model domain and the simulated system.

6. CONCLUSIONS AND RECOMMENDATIONS

Based on the calibration of MCSim_v2 to historical conditions for the calibration period from water year 1989 to 2023 and accompanying assessment of model sensitivity, the MCSim groundwater flow model is suitable for use as a tool to support management of water resources within the Madera and Chowchilla Subbasins.

6.1. Conclusions

MCSim_v2 provides a useful tool for evaluating a wide variety of future scenarios and informing the decision-making process to achieve and maintain sustainable groundwater management in both the Madera and Chowchilla Subbasins. A numerical model can be a convenient and cost-efficient tool for providing insights into groundwater responses to various perturbations including natural variability and change, and also changes associated with management decisions or other humanmade conditions. However, as with any other modeling tool, information obtained from a numerical model also has a level of uncertainty, especially for long-term predictions or forecasts. The level of uncertainty associated with model simulations are likely to increase the more the scenarios extend beyond the range of historical conditions and processes over which the model was calibrated, such as for long-term predictive scenarios or predictive scenarios with extreme alterations to the hydrologic conditions.

6.2. Recommendations

Future and ongoing updates to MCSim_v2 will be valuable for improving the model performance and verifying the accuracy of the model predictions. Using data from the ongoing monitoring efforts and forthcoming GSP monitoring, MCSim_v2 should be updated periodically, including through extending of the model period and associated inputs. Although the frequency of conducting model updates may depend on a variety of factors, including evaluation of the model performance in predicting future conditions, such an update could initially be considered every five years. This frequency of model update should be adequate and cost effective to test and improve MCSim_v2 periodically with new site specific and monitoring information. Groundwater elevations, groundwater pumping, subsidence measurements, rainfall, and stream discharge should be collected on an ongoing basis, to the extent possible, at intervals of at least monthly for pumpage, rainfall, and streamflow, and less frequently (semi-annually at least) for groundwater levels and subsidence. The new groundwater data should be compared with the respective model simulation results so that the flow model can be verified in the future. If the differences between the measured groundwater data and MCSim_v2's predicted results are significant, adjustment and modification may be applied to the model input parameters.

MCSim has been calibrated and verified. It adheres closely to site-specific observed data so that model input parameters are reasonable and appropriate especially within the Chowchilla and Madera Subbasins. Additional model revisions should be conducted in areas outside the Chowchilla and Madera Subbasins as that data is obtained from adjacent GSAs.

Further refinement to MCSim_v2 should be made by addressing key data gaps. Upon release of DWR's Guidance Document on Interconnected Surface Water, an evaluation should be done to incorporate any relevant aspects of the model into MCSim, as appropriate and necessary. Through upcoming GSP-related monitoring, additional groundwater level data can be used to refine boundary condition water levels and improve model calibration. Additional improvements to model calibration can be made by the potential linking of additional well construction information to calibration wells, development and incorporation of longer periods of record for subsidence monitoring stations, incorporation of additional stream flow data on ungaged streams, and refinements to the simulation of surface water distribution systems. Further refinements to MCSim can be made by extending the historical base period and ongoing updating of model calibration in preparation for 5-year GSP Plan Amendments and/or Periodic Evaluations.

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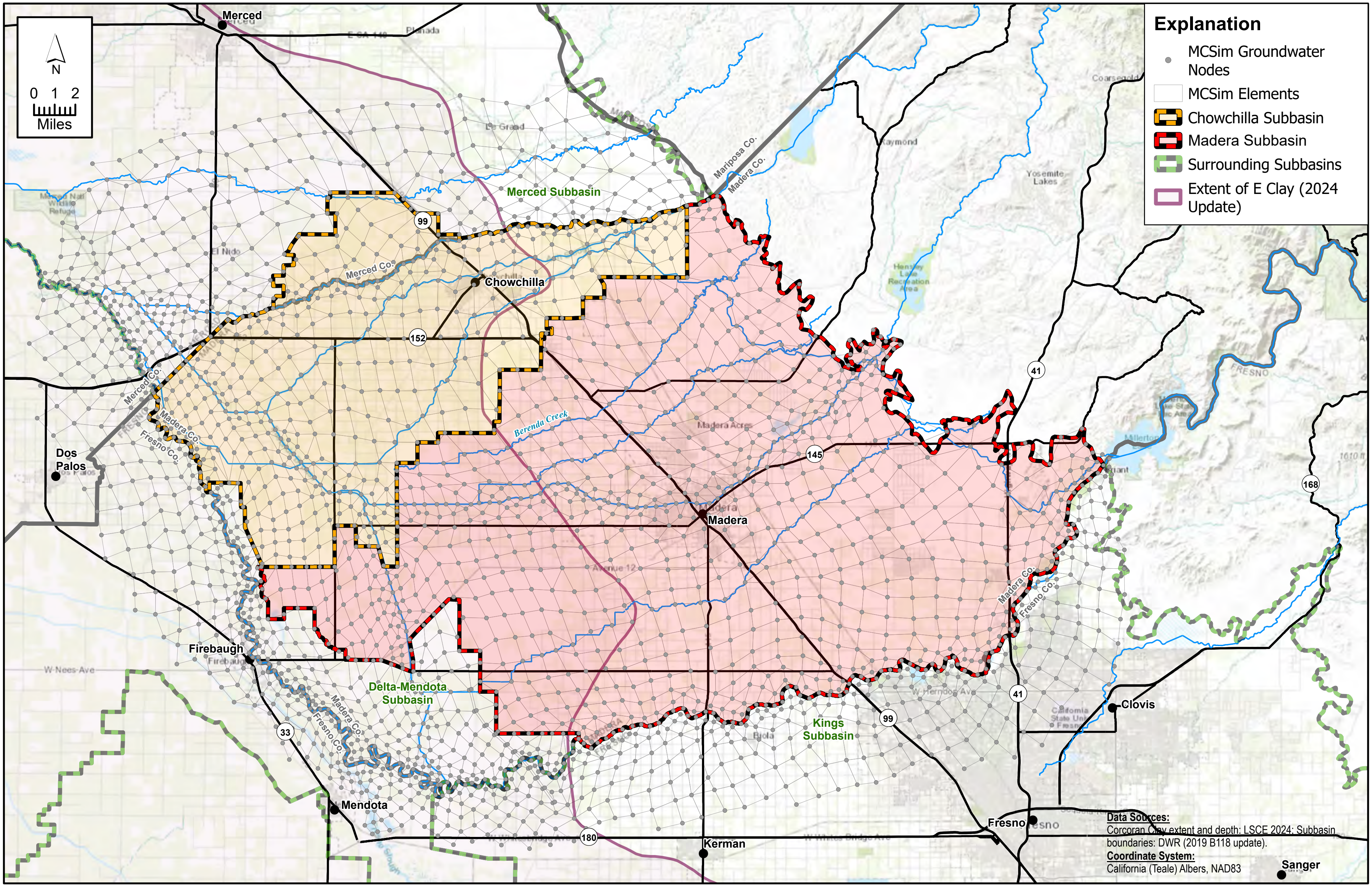

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FIGURE 3-1

MCSim Model Domain

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

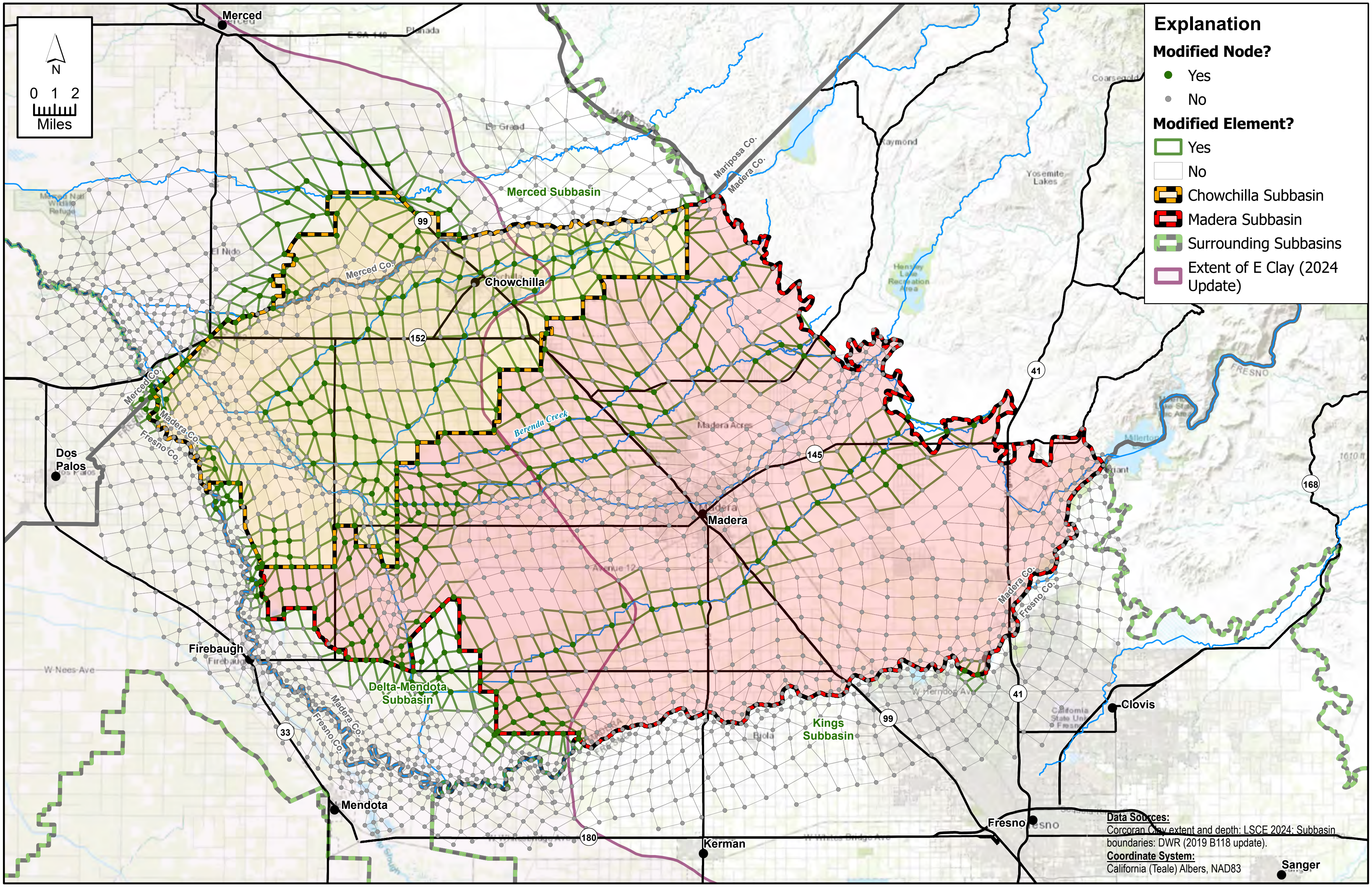

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FIGURE 3-2

Modified Nodes and Elements in MCSim

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

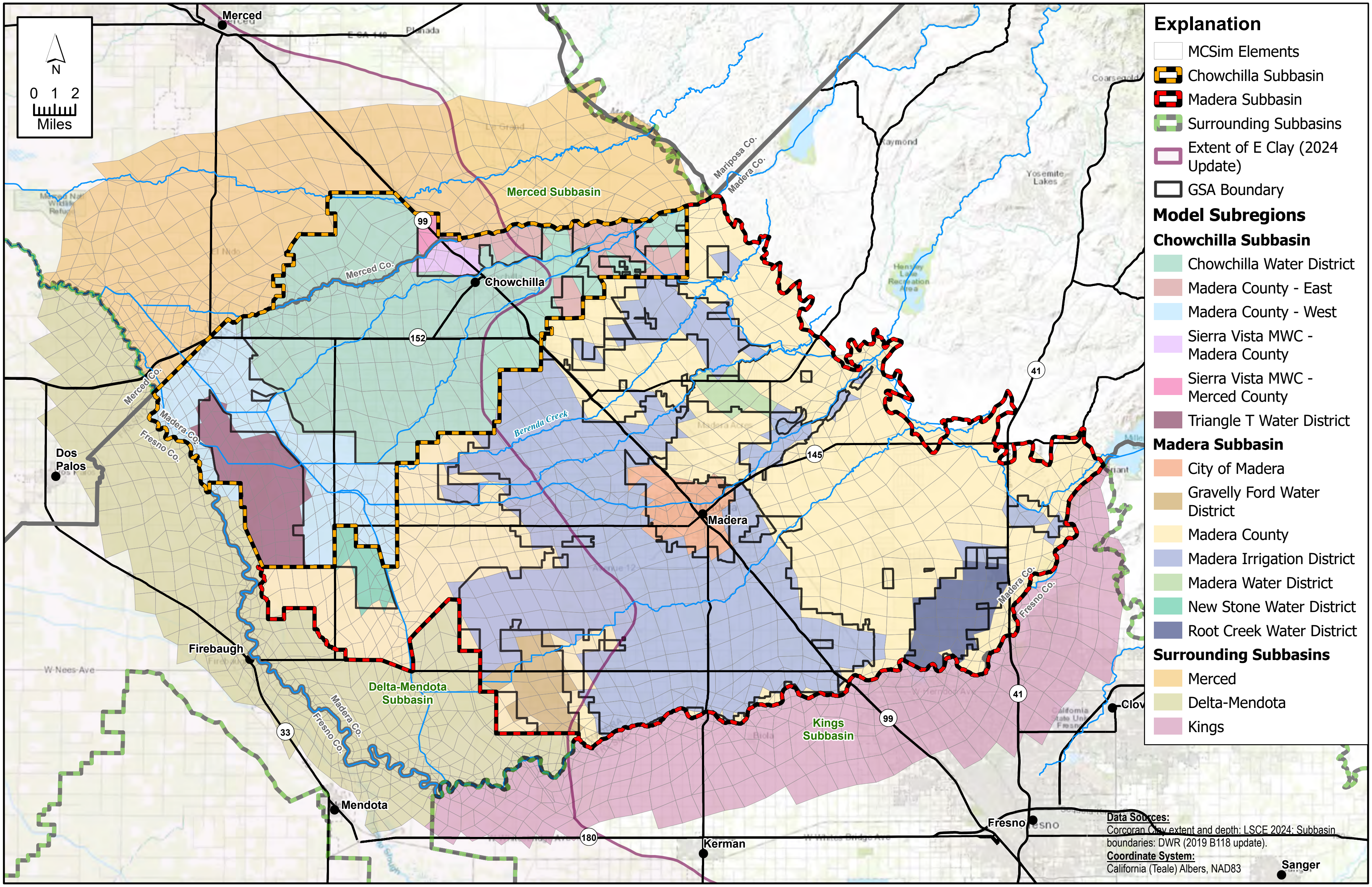

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FIGURE 3-3

Subregions in MCSim

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

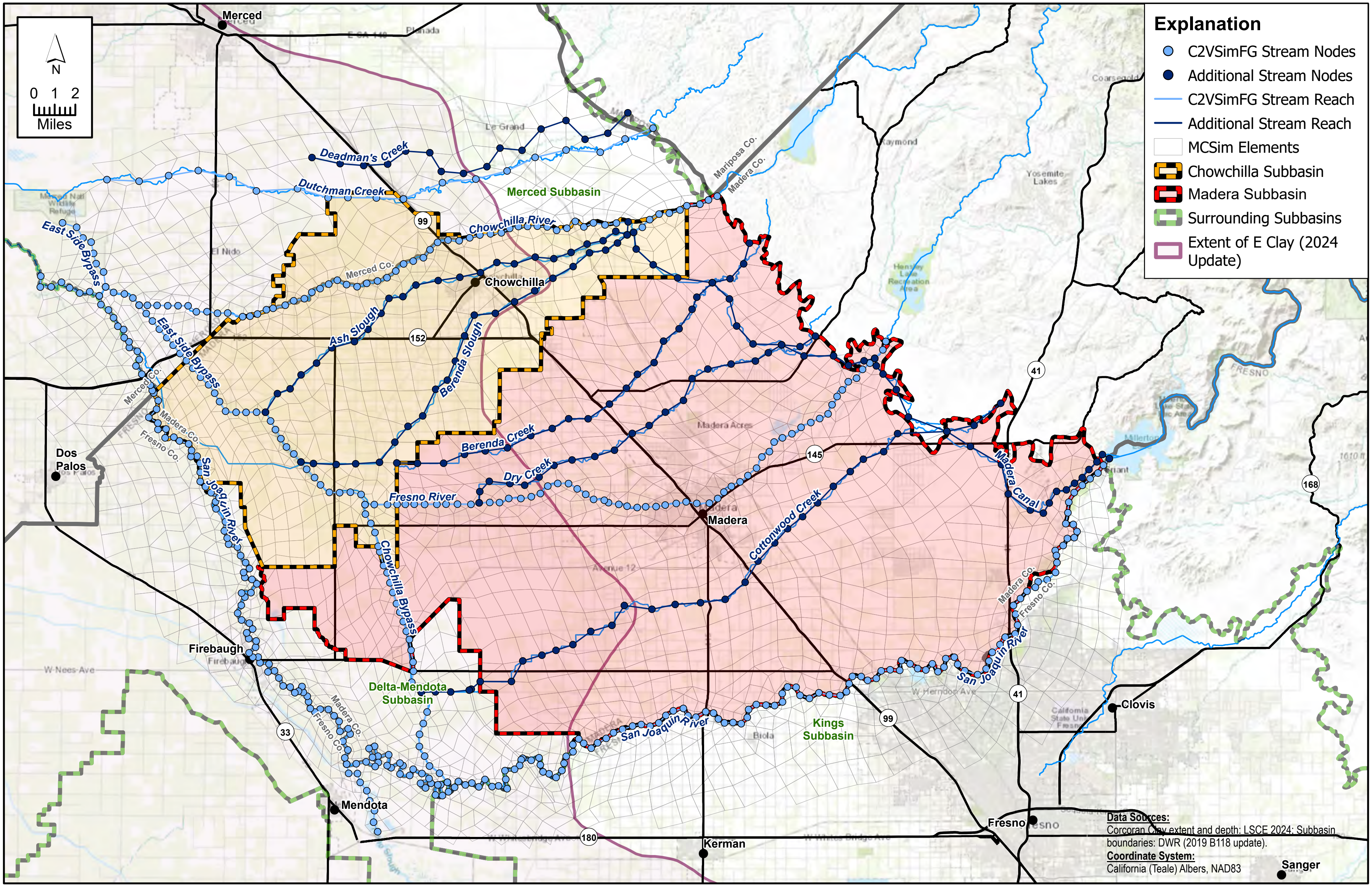

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FIGURE 3-4

MCSim Stream Network

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

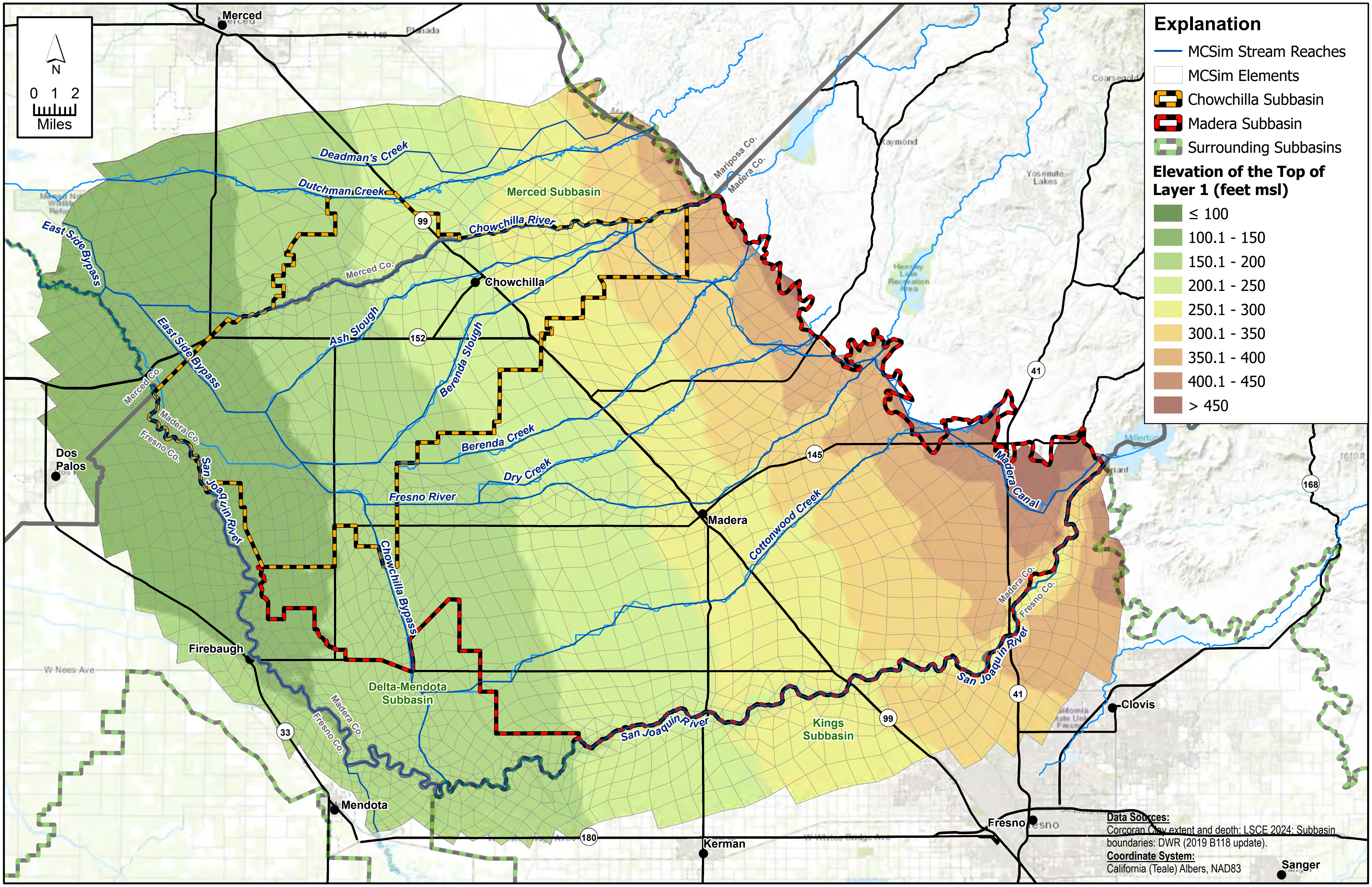

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FIGURE 3-5

Elevation of the Top of the Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

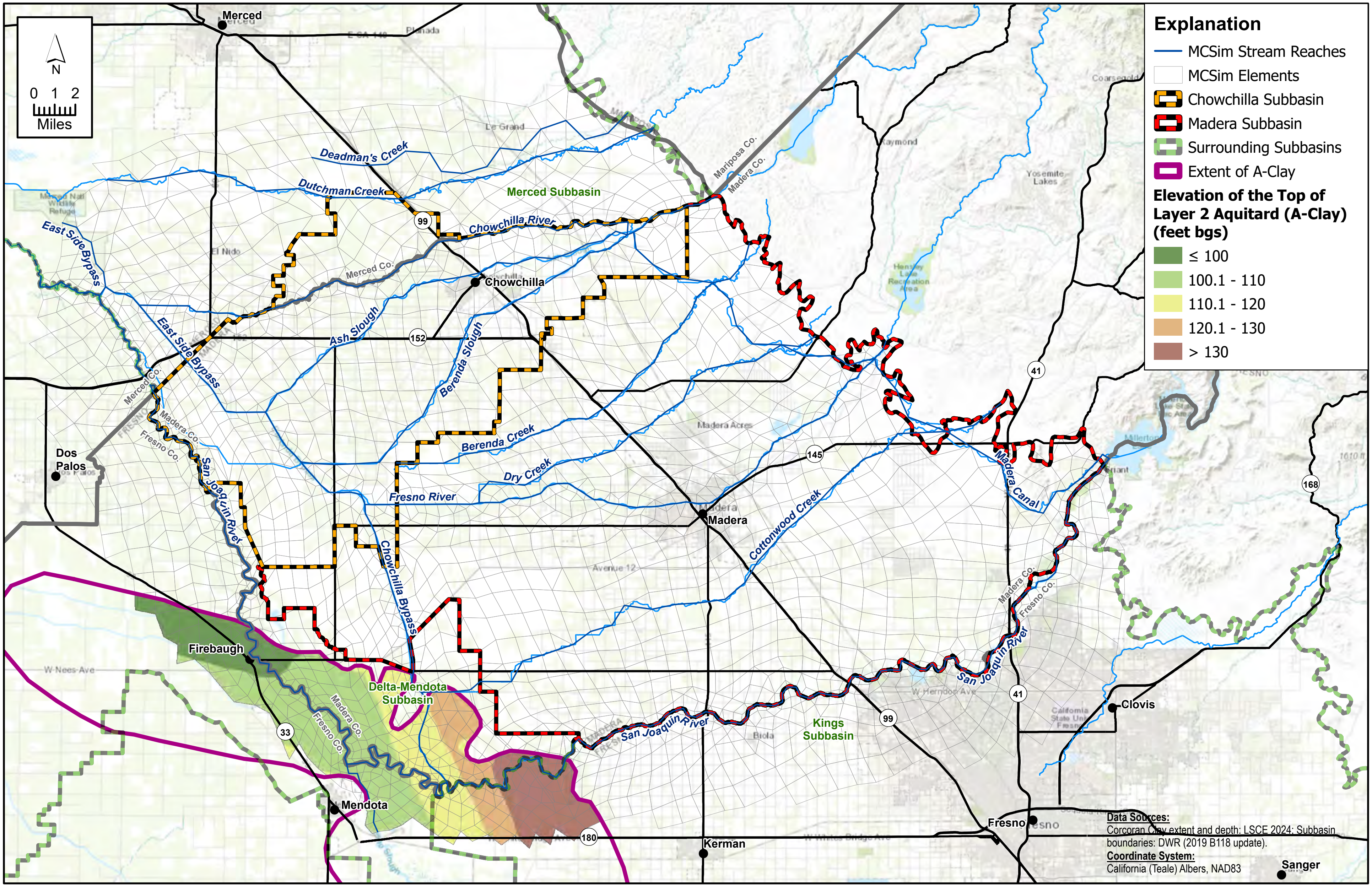

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FIGURE 3-6

Elevation of the Top of the Layer 2 Aquitard (A-Clay)

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

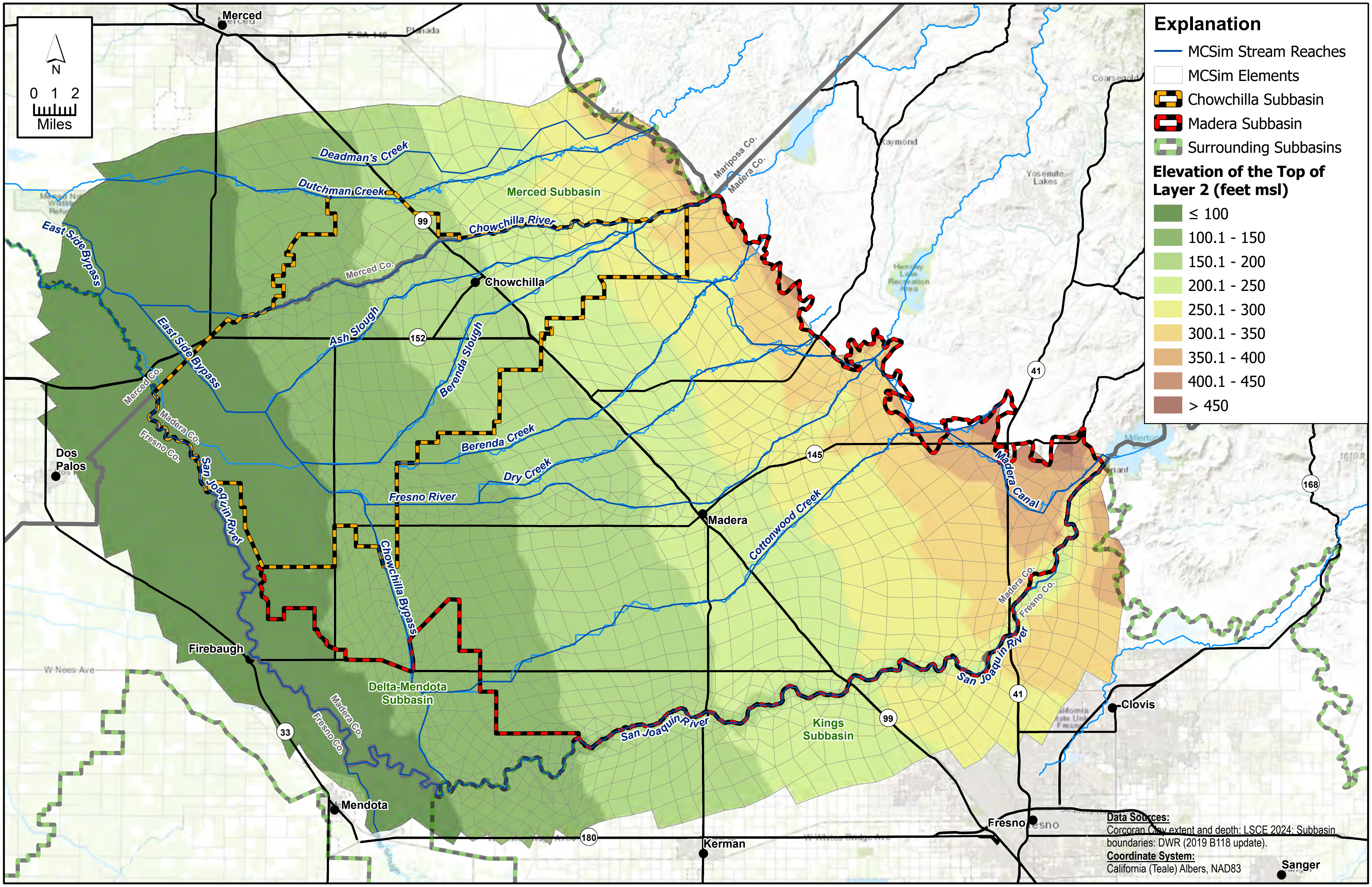

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FIGURE 3-7

Elevation of the Top of the Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

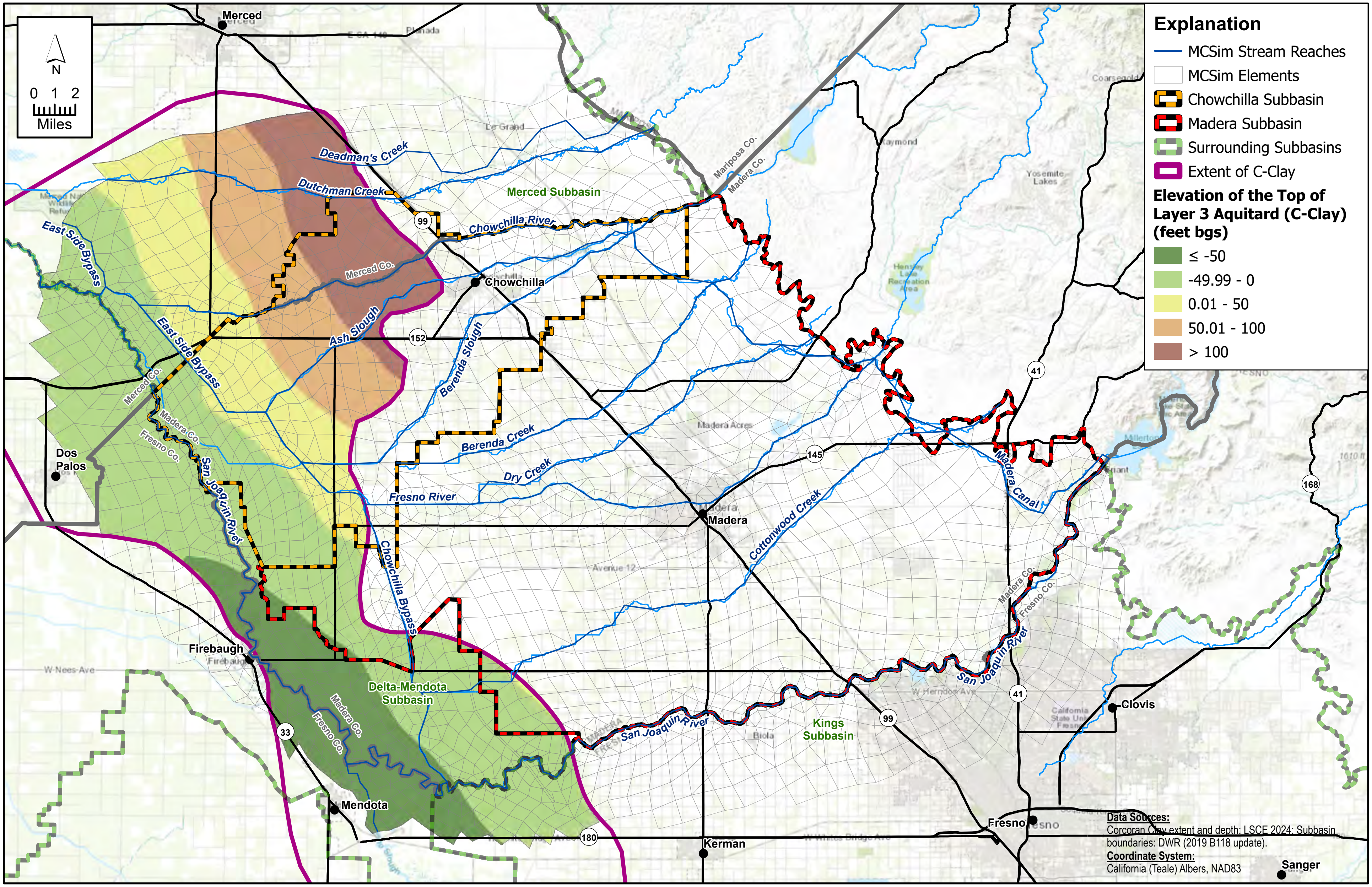

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FIGURE 3-8

Elevation of the Top of the Layer 3 Aquitard (C-Clay)

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

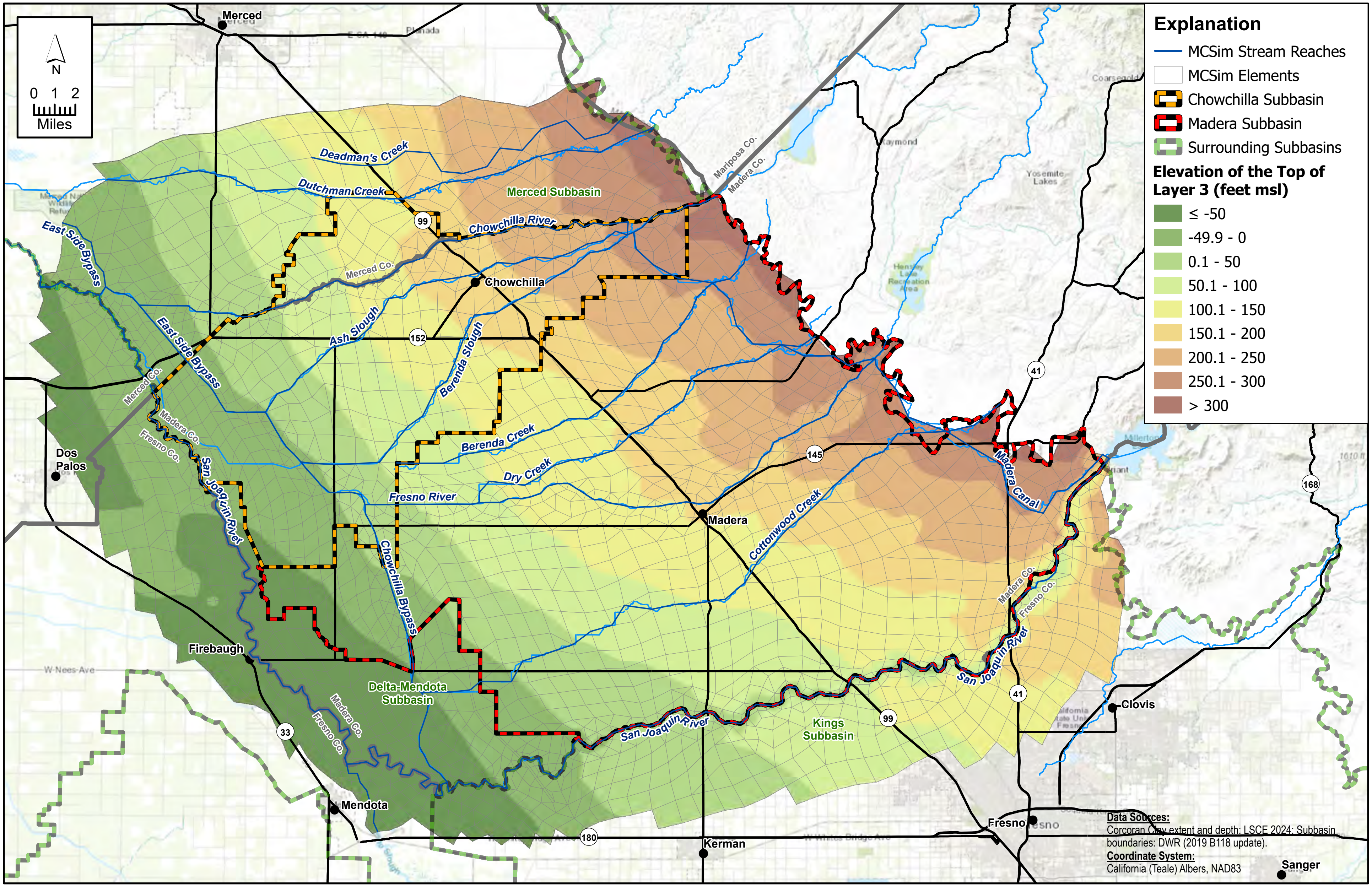

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FIGURE 3-9

Elevation of the Top of the Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

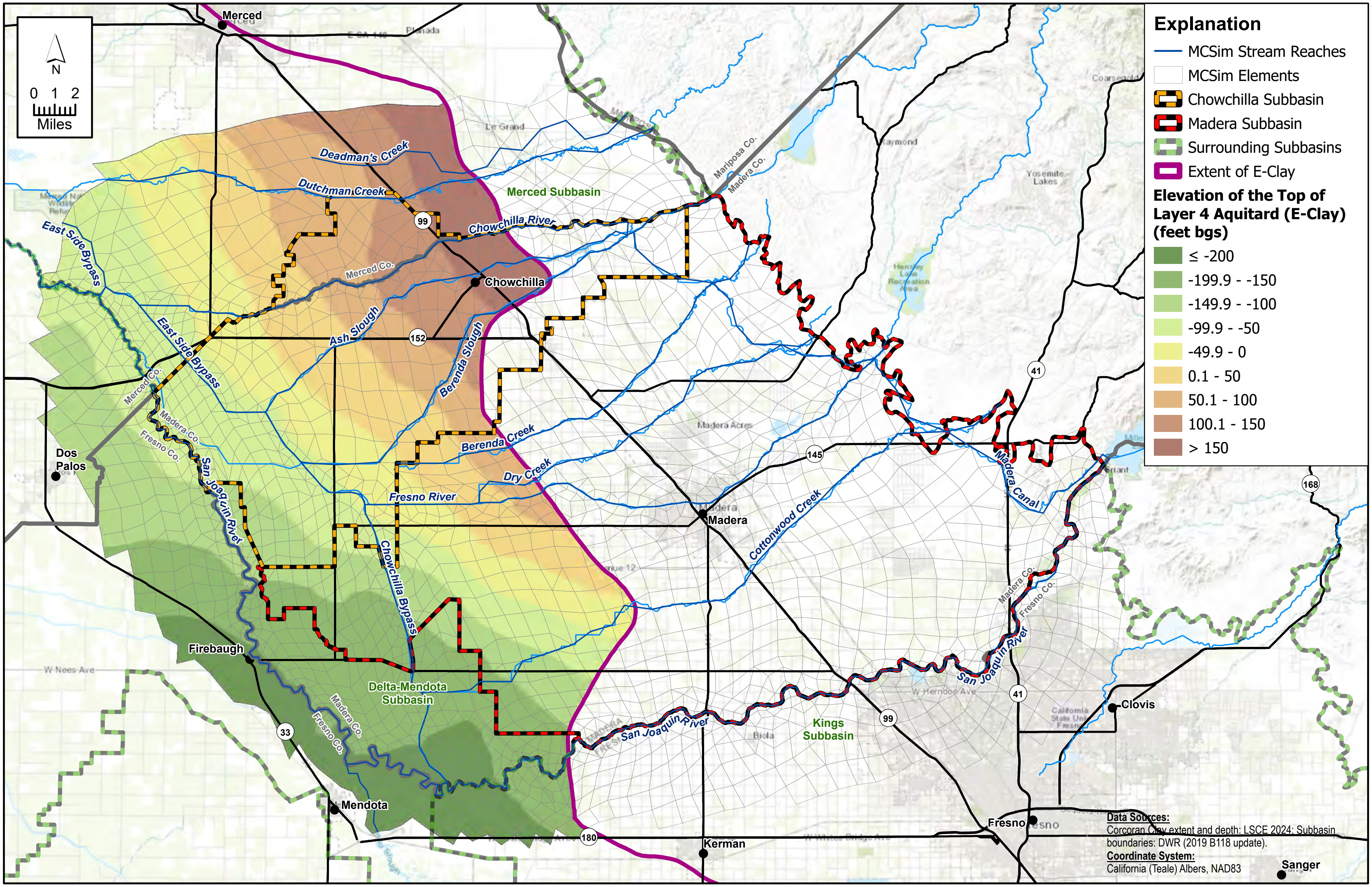

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FIGURE 3-10

Elevation of the Top of the Layer 4 Aquitard (E-Clay)

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

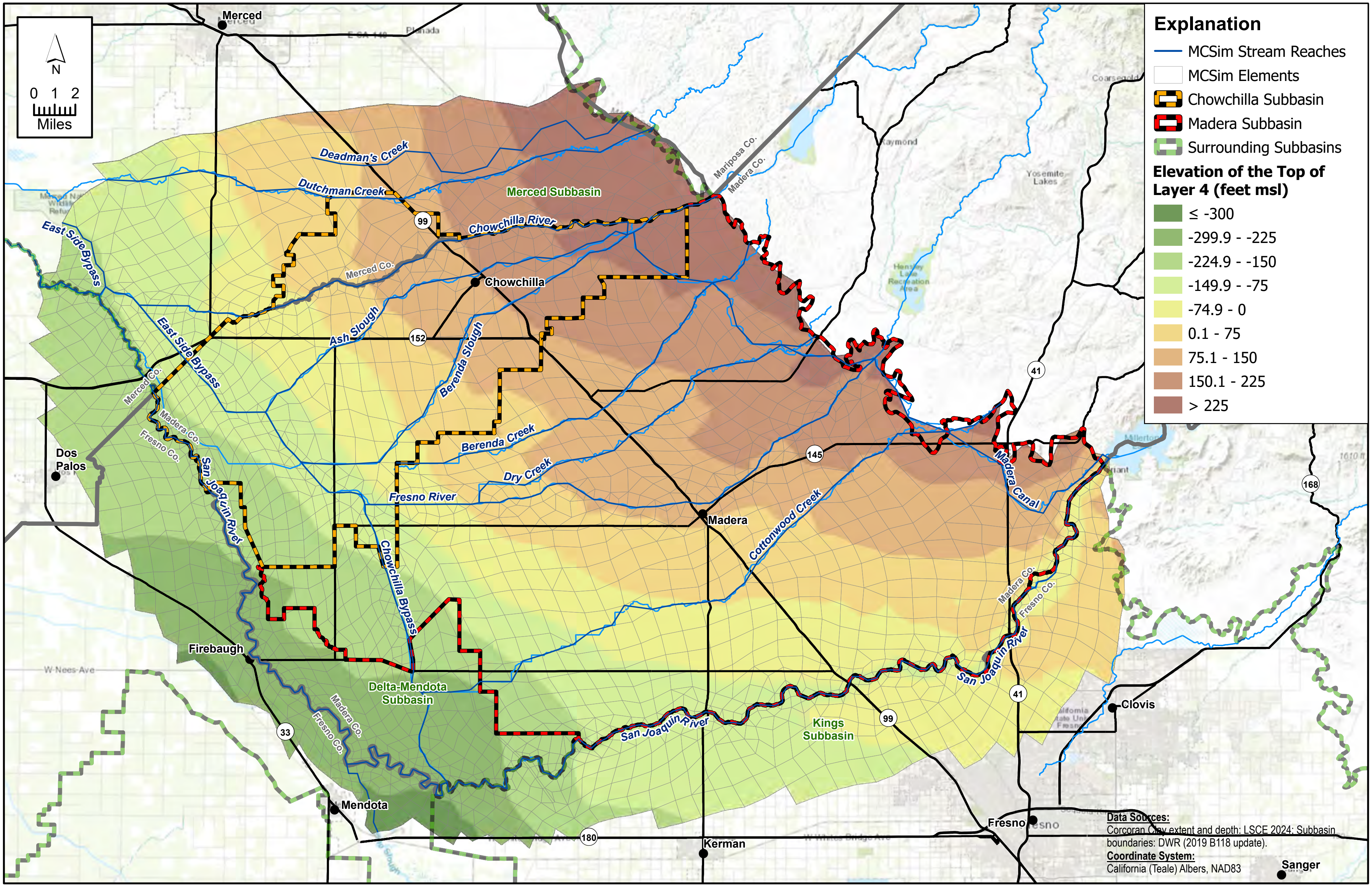

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FIGURE 3-11

Elevation of the Top of the Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

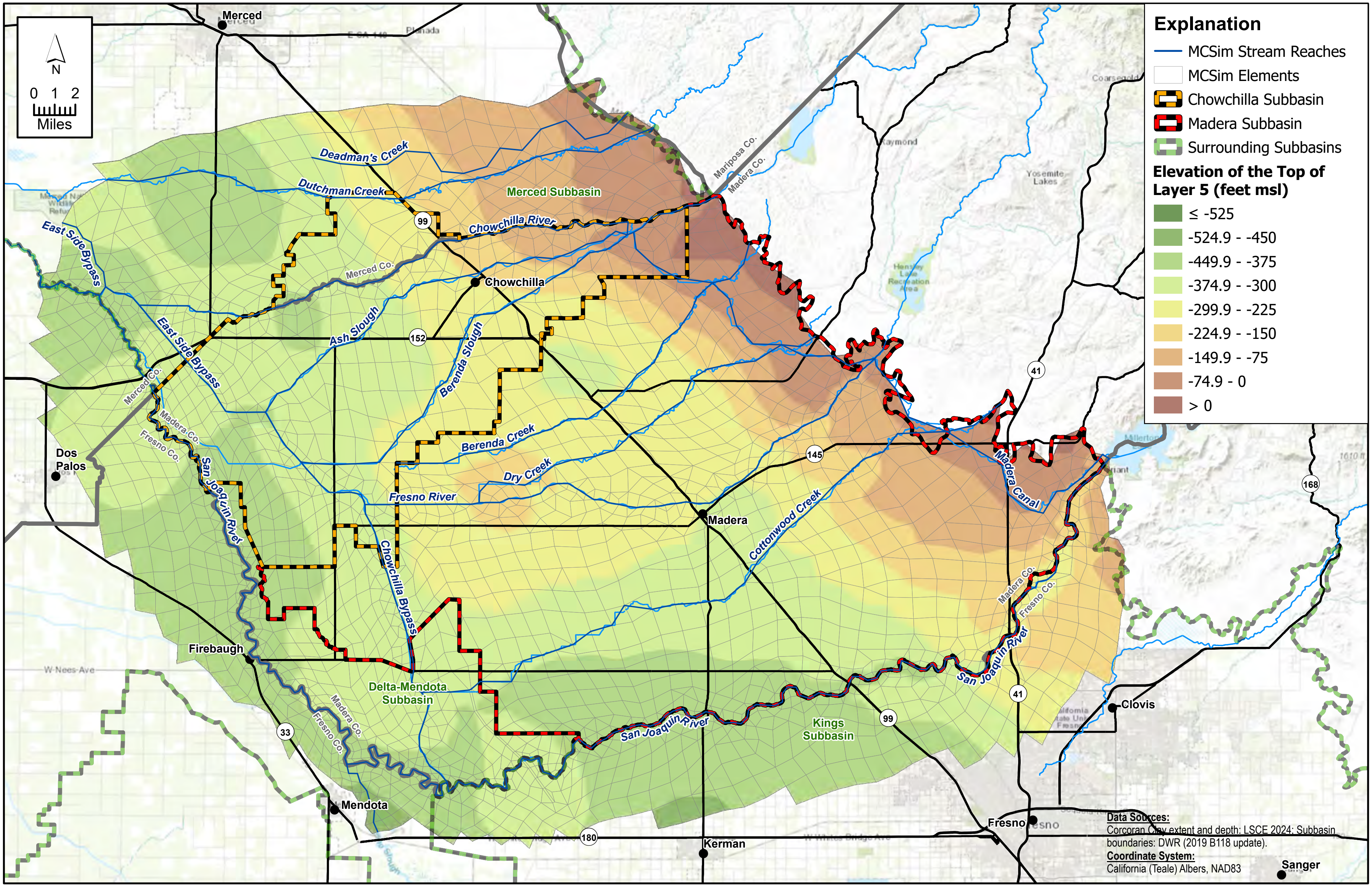

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FIGURE 3-12

Elevation of the Top of the Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

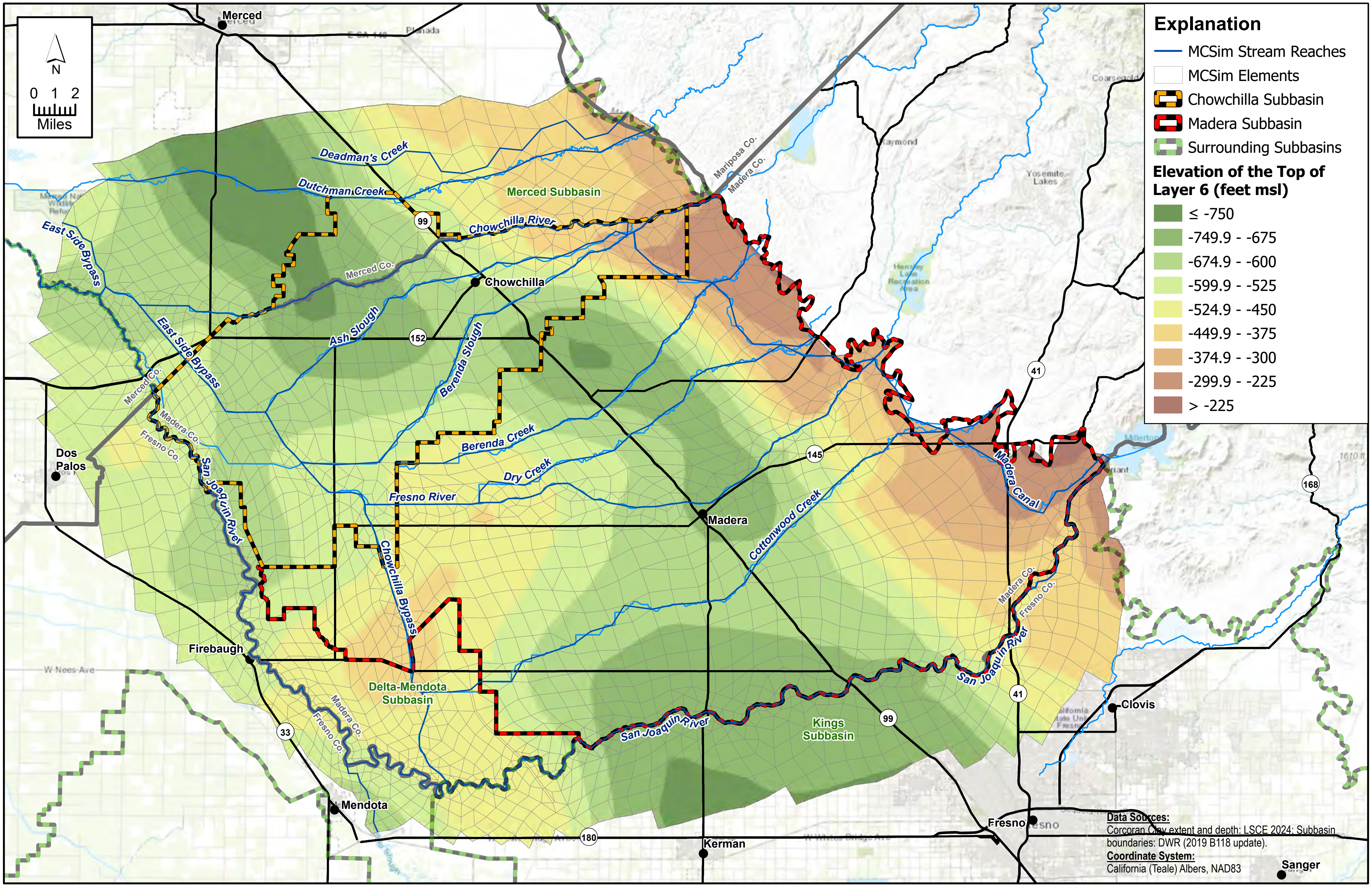

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FIGURE 3-13

Elevation of the Top of the Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

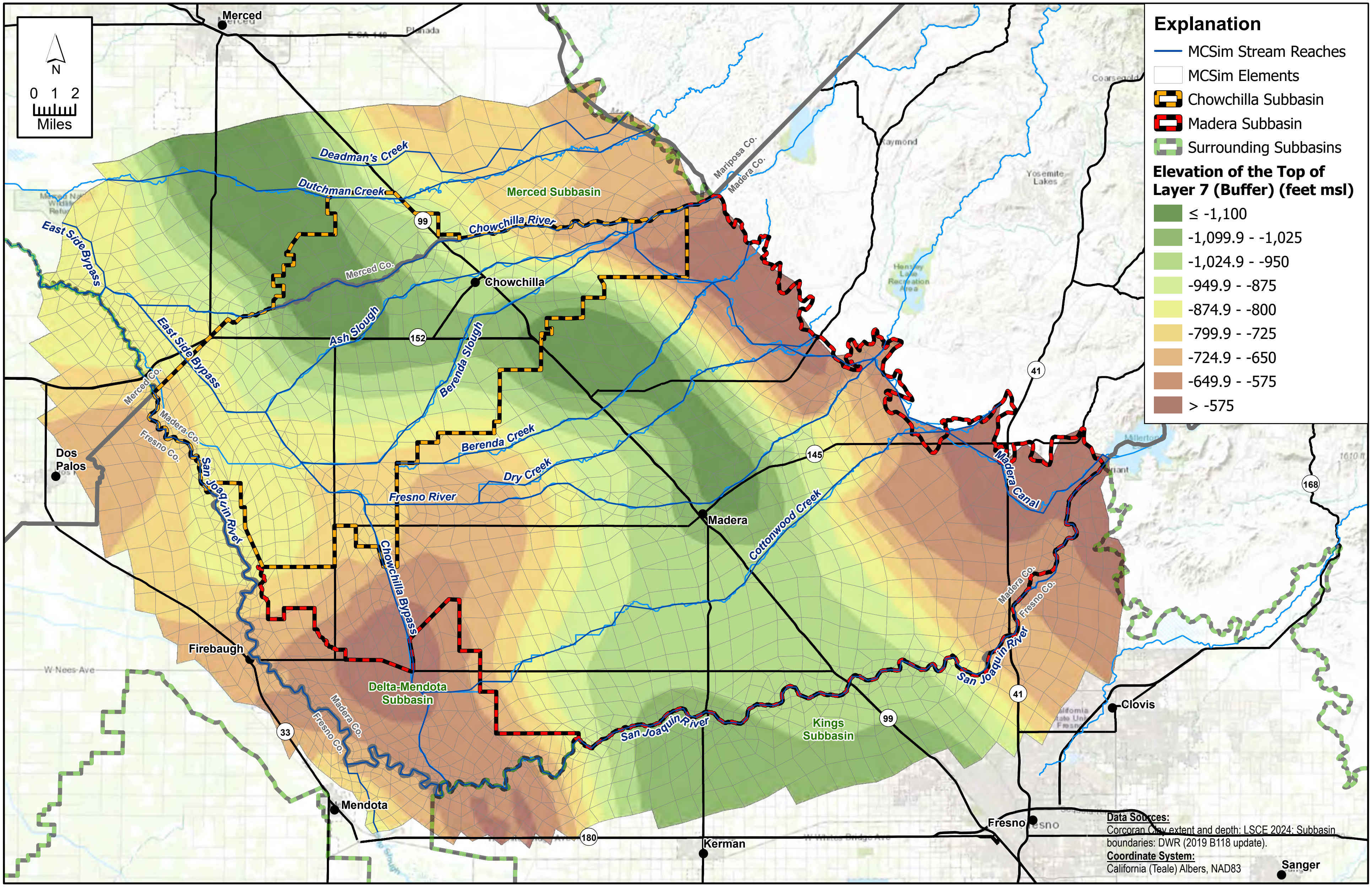

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FIGURE 3-14

Elevation of the Top of the Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

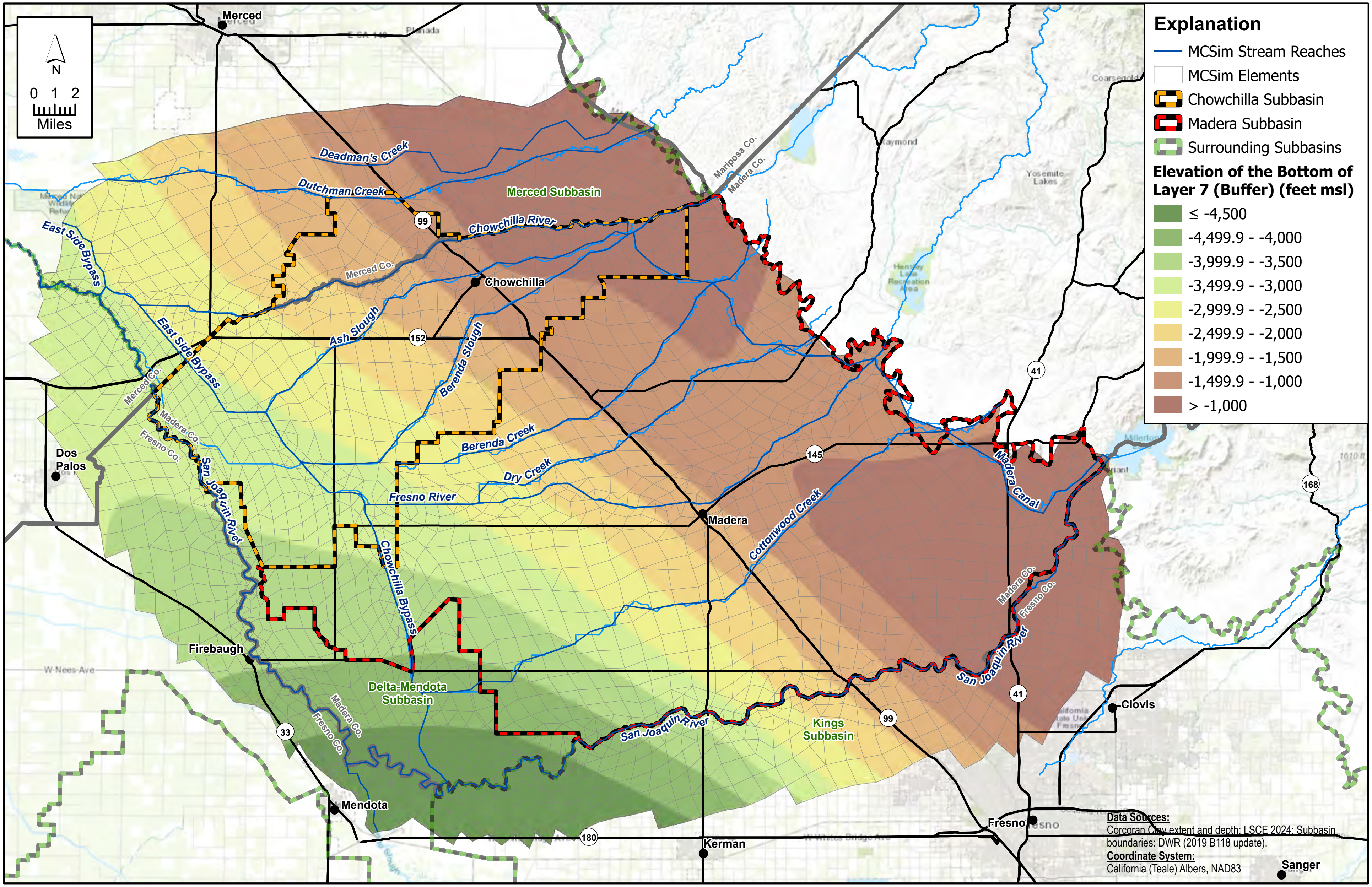

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FIGURE 3-15

Elevation of the Bottom of the Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

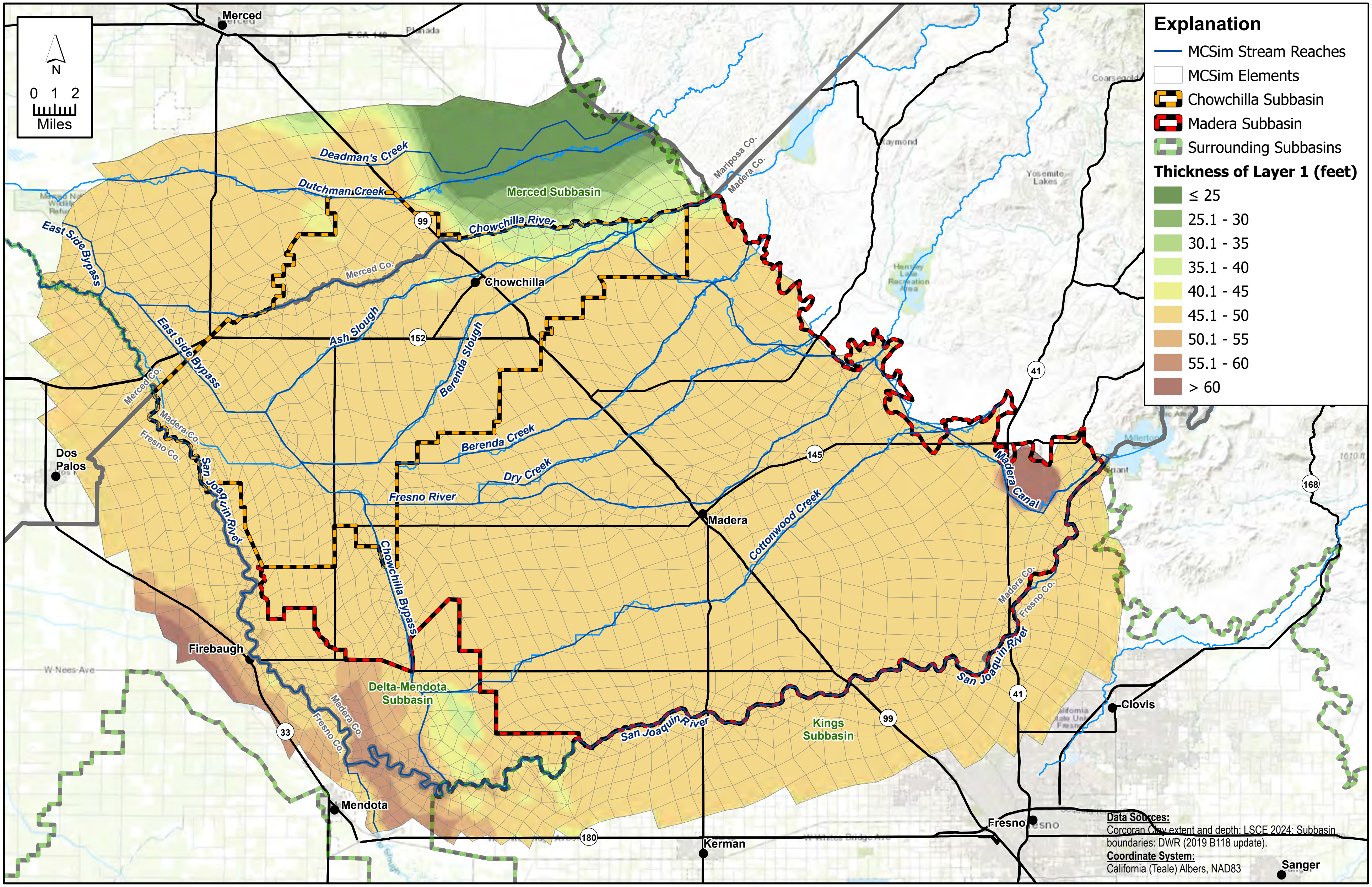

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FIGURE 3-16

Thickness of Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

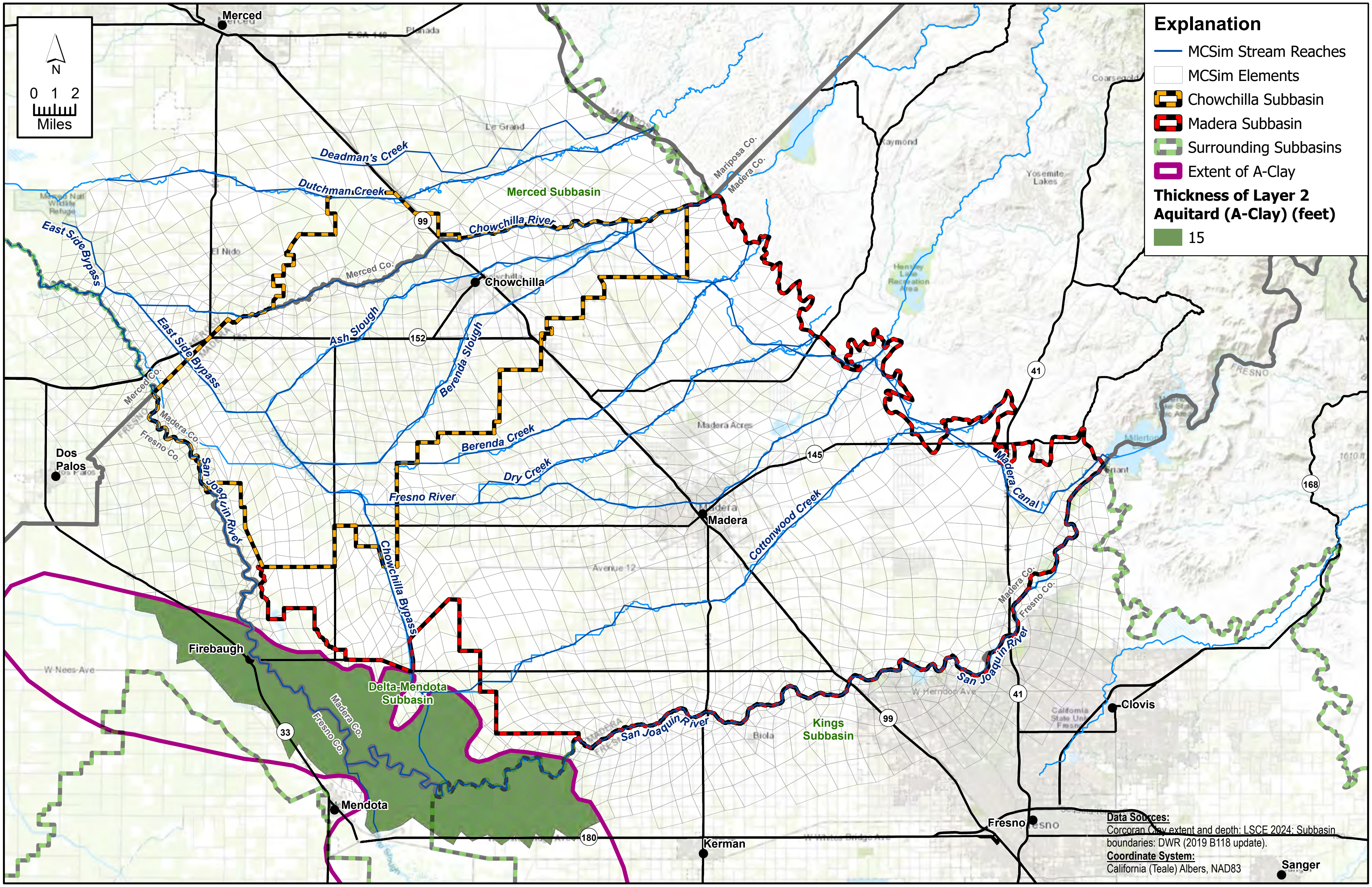

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FIGURE 3-17

Thickness of the Layer 2 Aquitard (A-Clay)

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

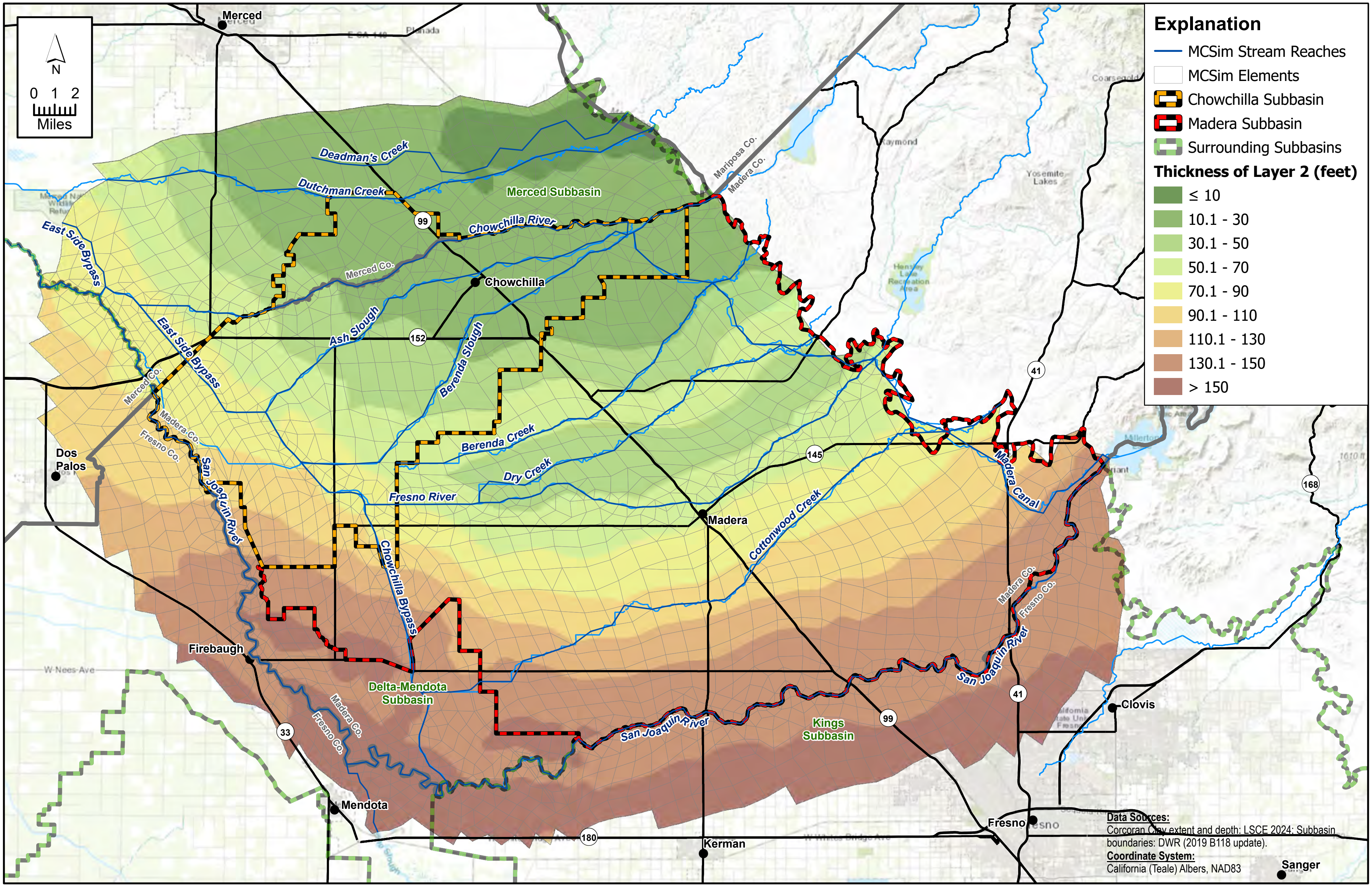

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FIGURE 3-18

Thickness of Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

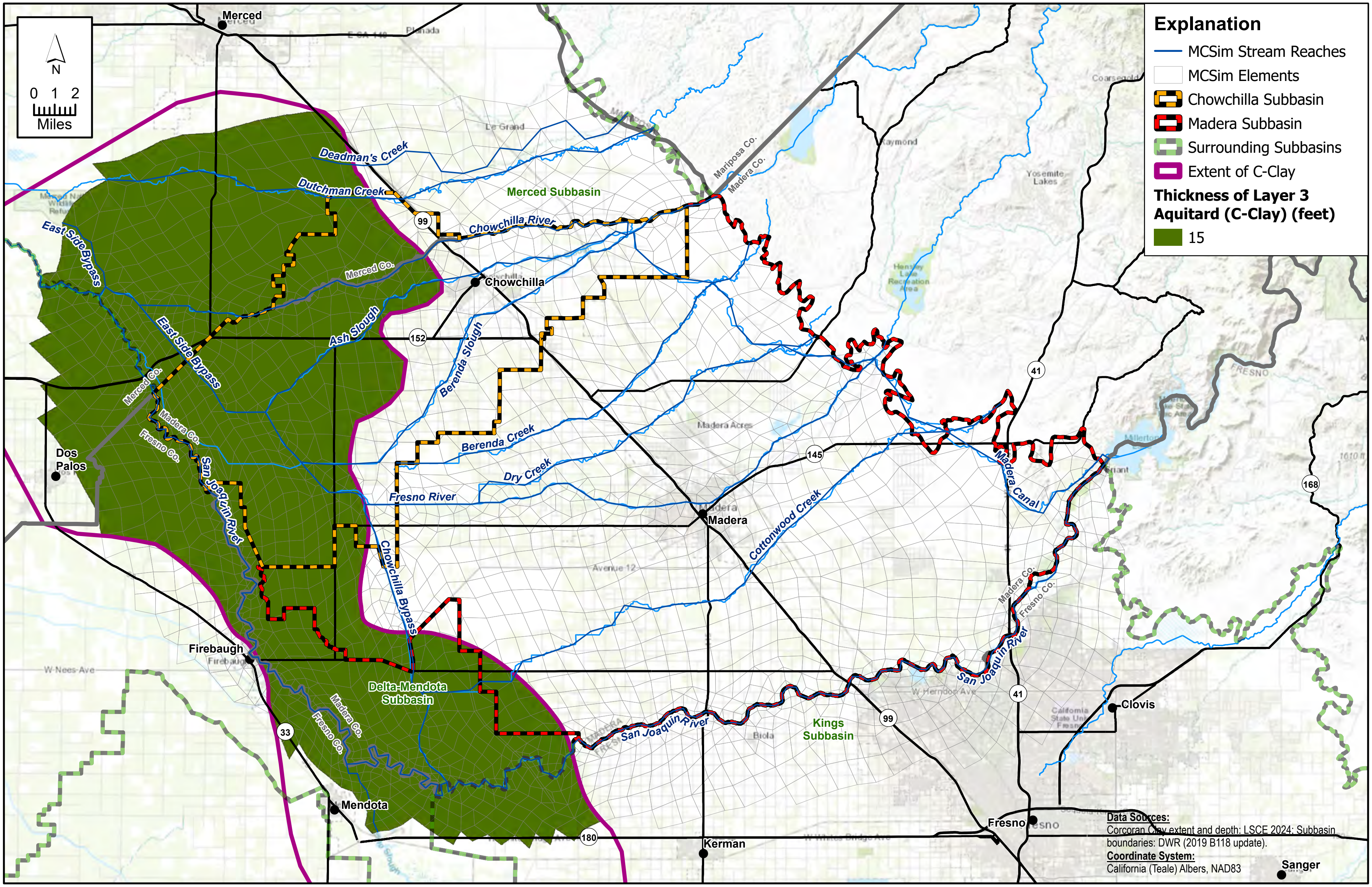

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FIGURE 3-19

Thickness of the Layer 3 Aquitard (C-Clay)

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

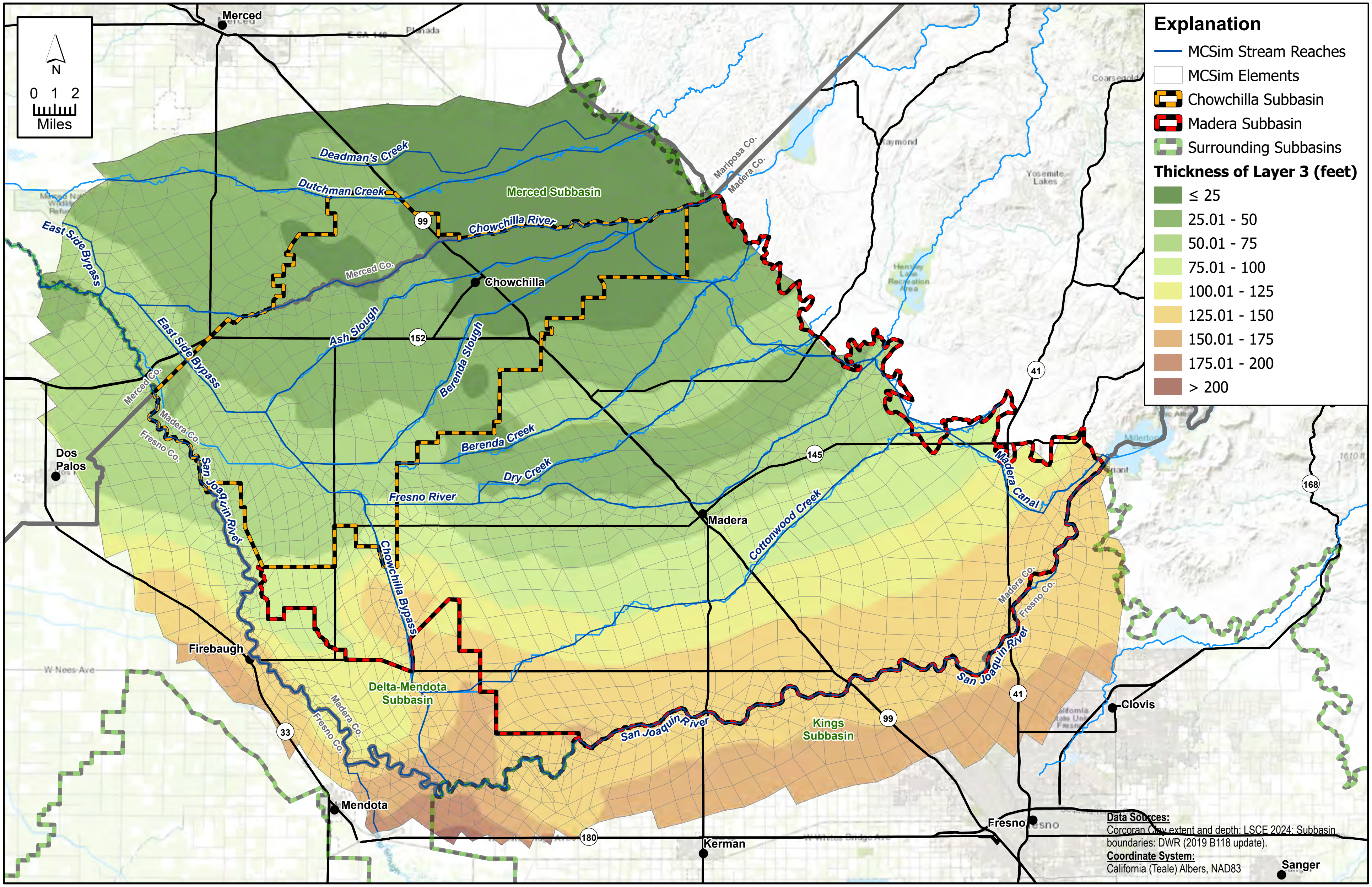

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FIGURE 3-20

Thickness of Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

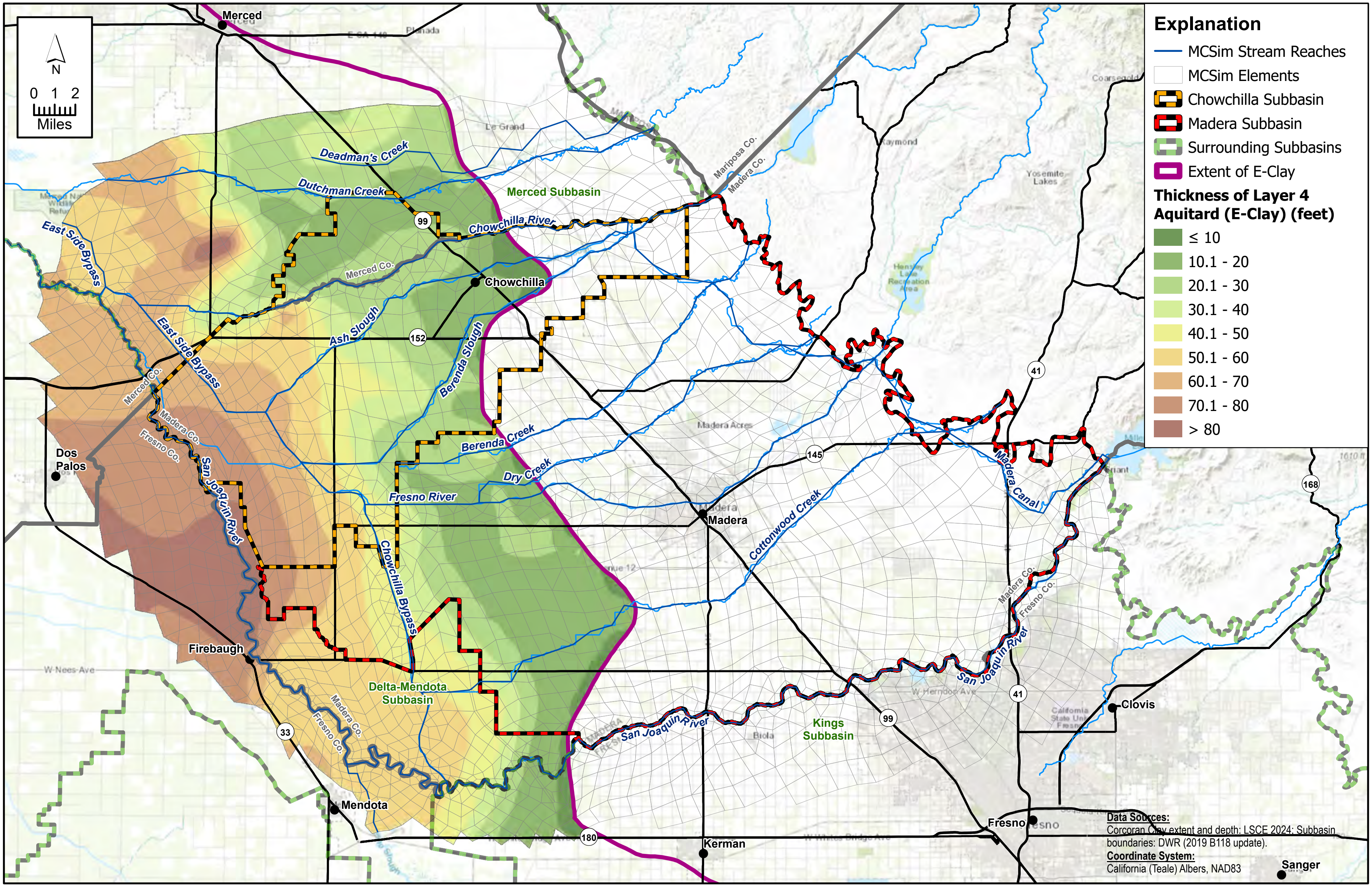

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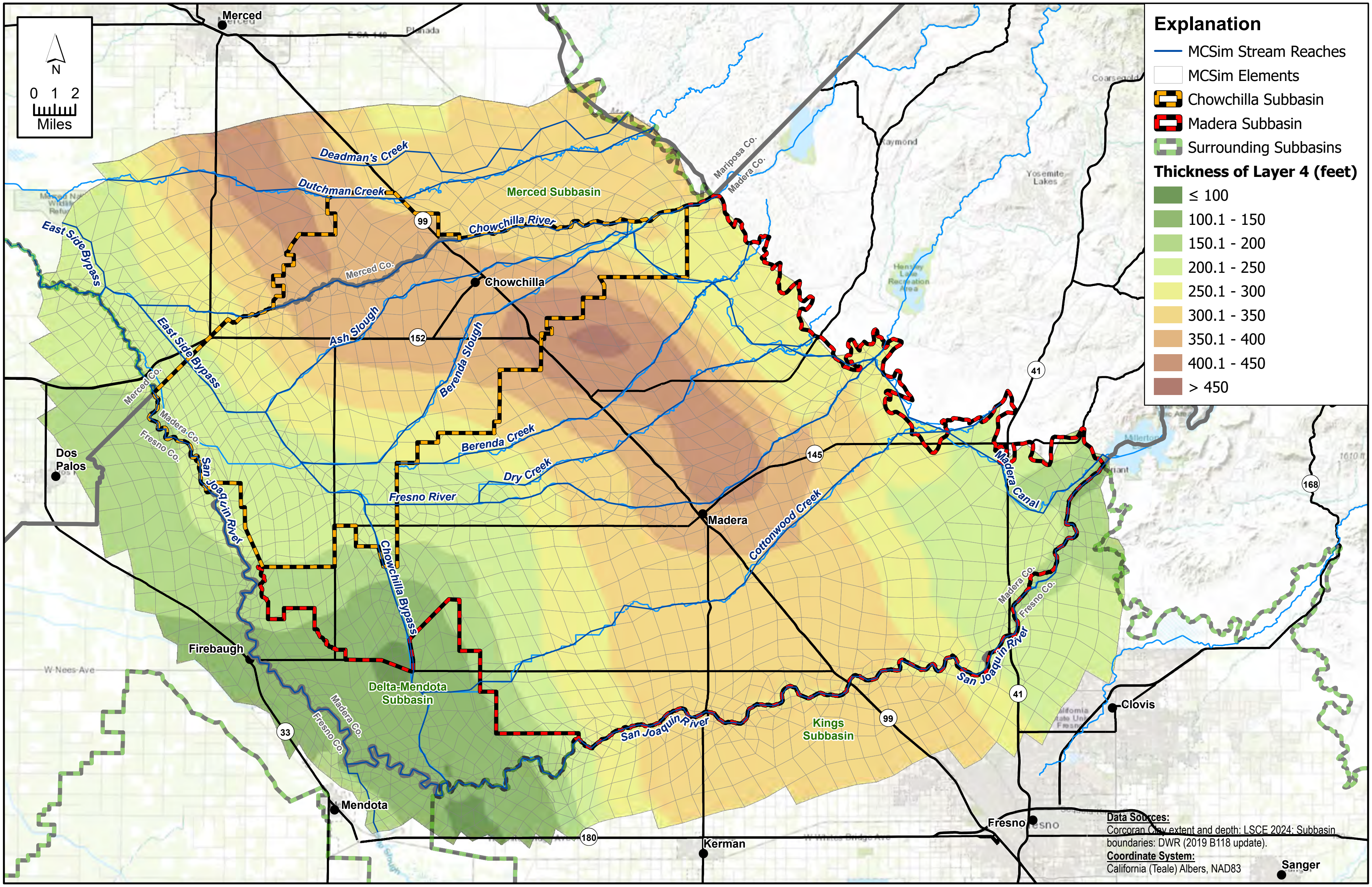
FIGURE 3-21

Thickness of the Layer 4 Aquitard (E-Clay)

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; STRAT_Layering_Thickness

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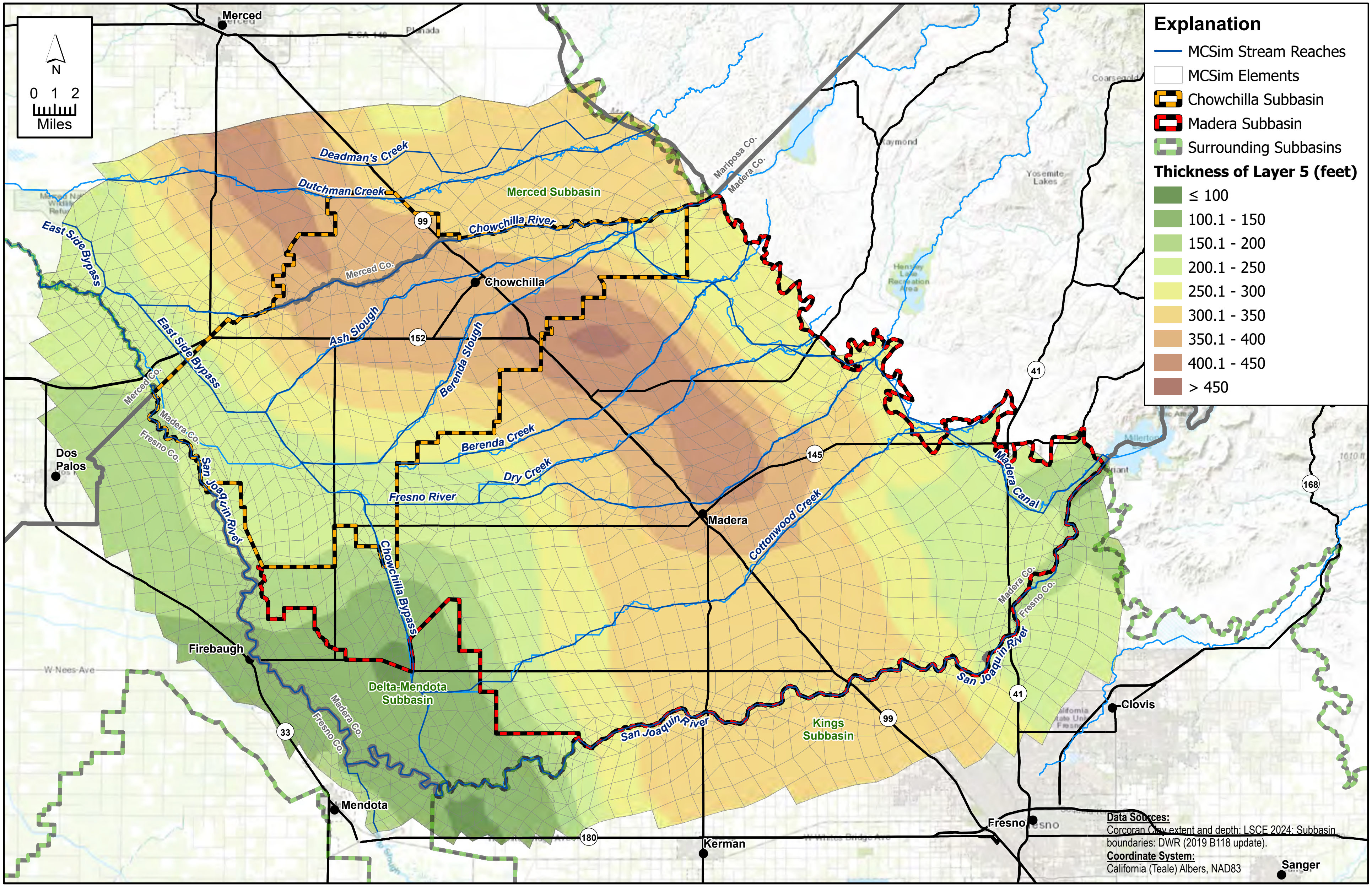
FIGURE 3-22

Thickness of Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; STRAT_Layering_Thickness

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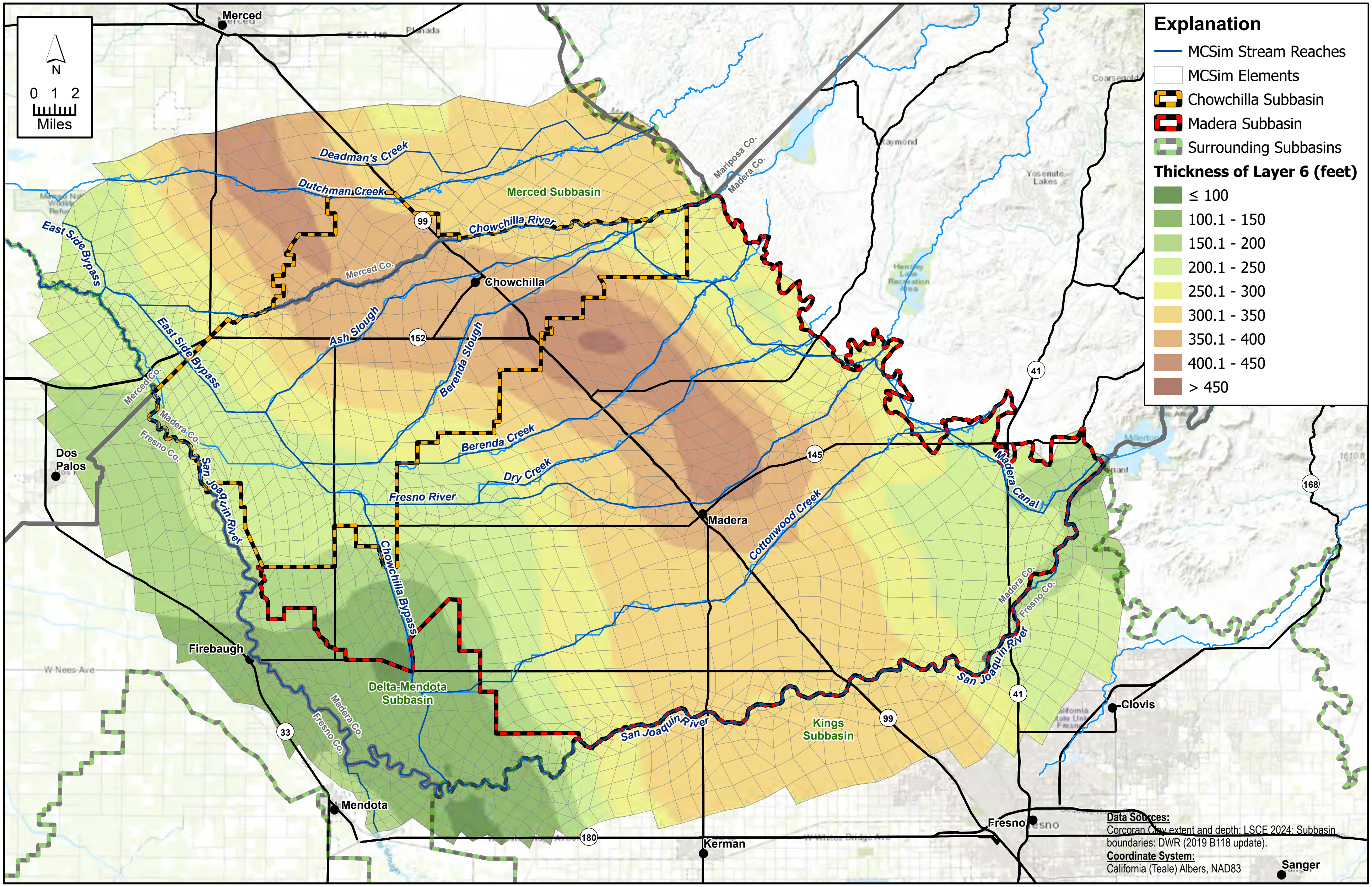
FIGURE 3-23

Thickness of Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; STRAT_Layering_Thickness

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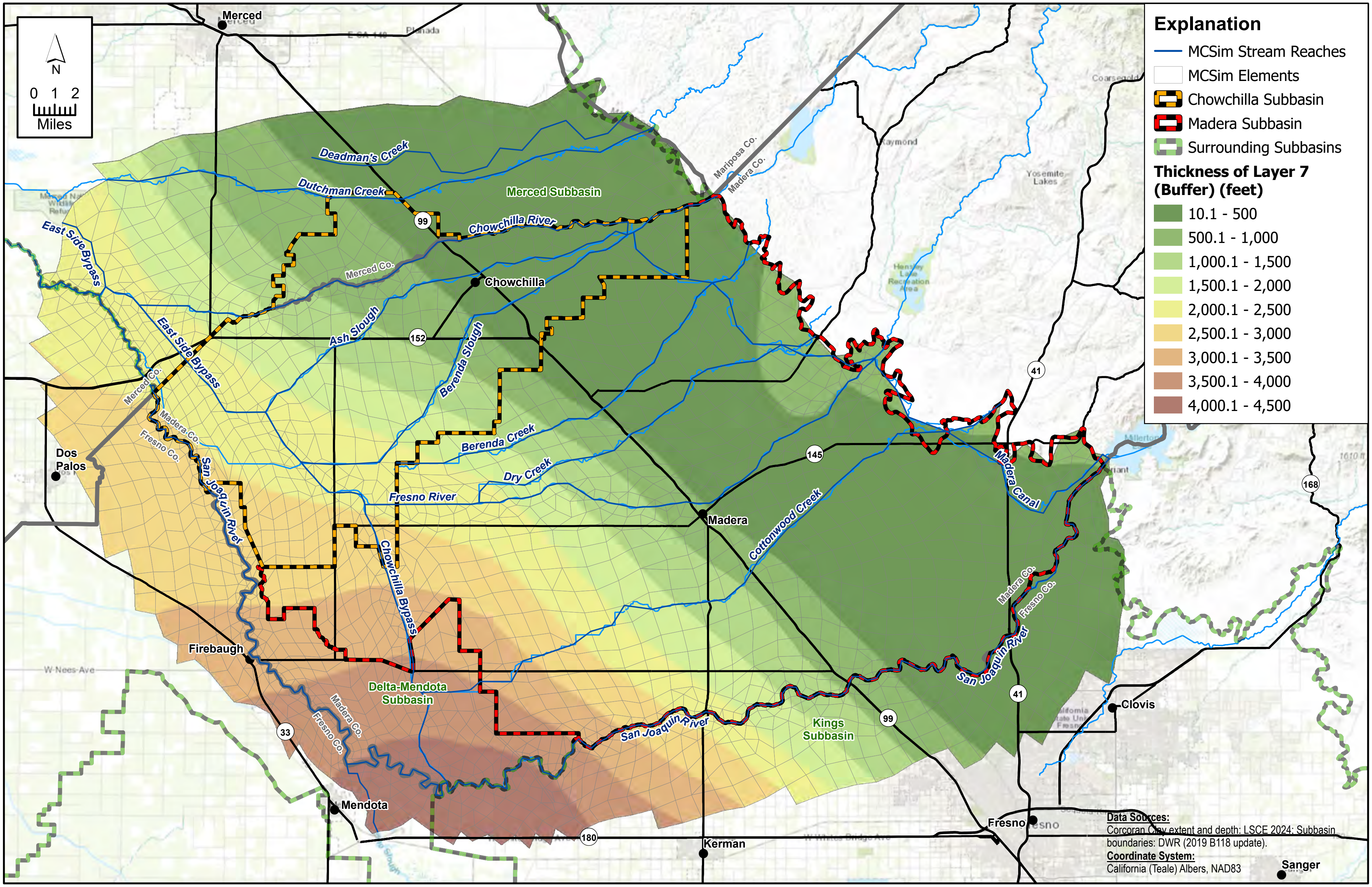
FIGURE 3-24

Thickness of Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; STRAT_Layering_Thickness

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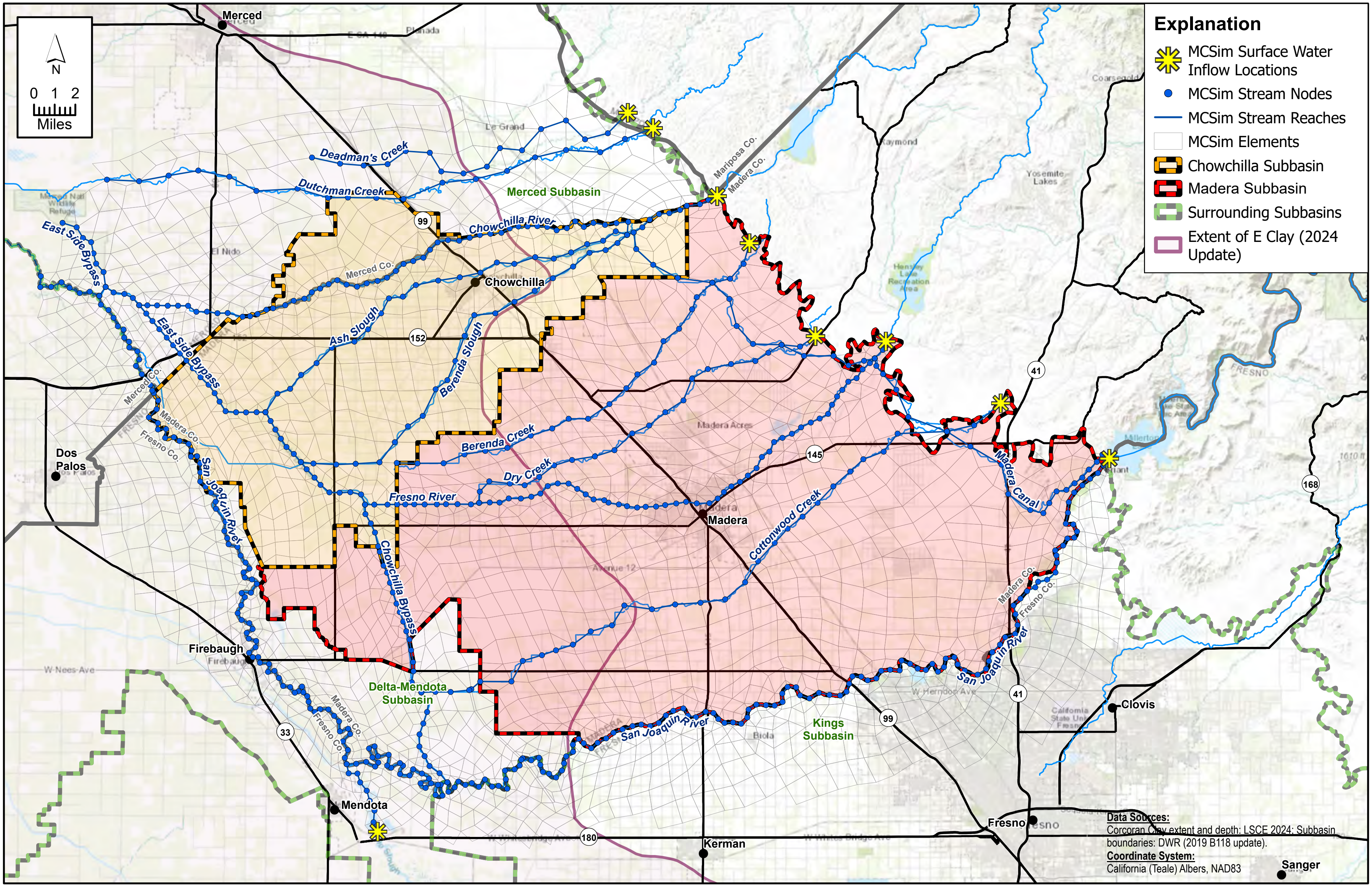
FIGURE 3-25

Thickness of Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; Fig3-26_Surface Water Inflows

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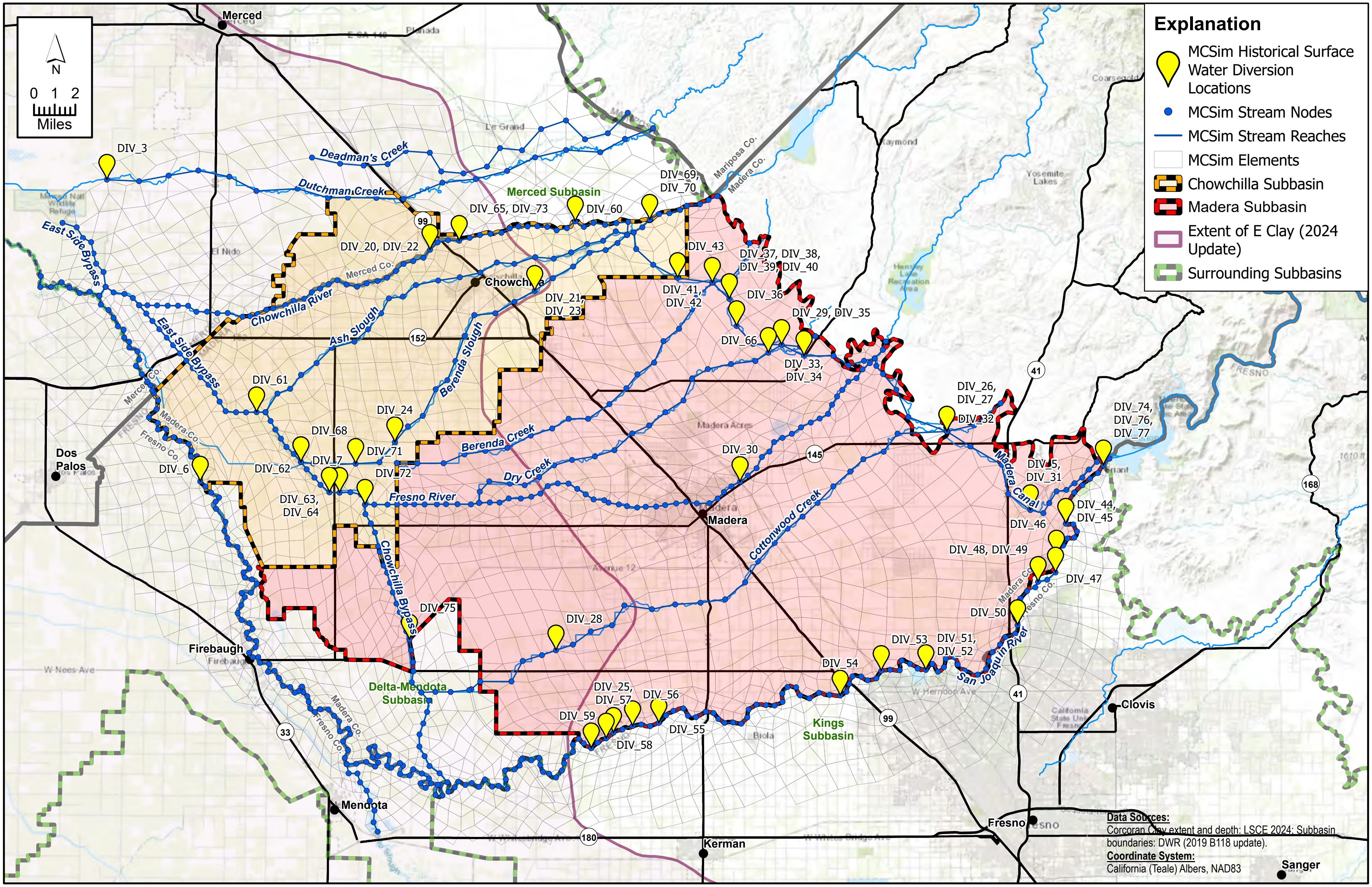
FIGURE 3-26

MCSim Surface Water Inflow Locations

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; Fig3-27_Historical Surface Water Diversions

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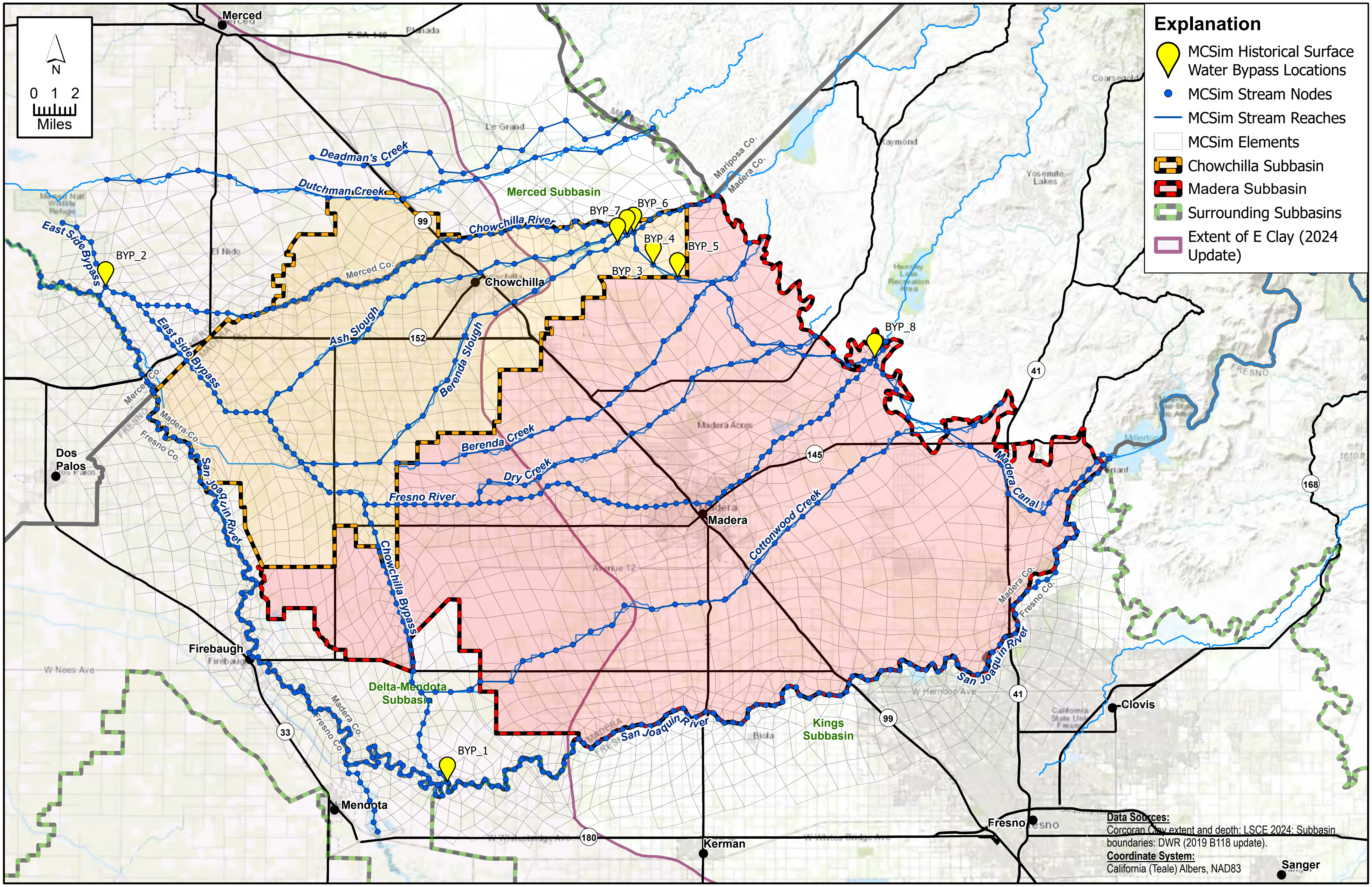
FIGURE 3-27

MCSim Historical Surface Water Diversions Locations

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; Fig3-28_Historical Surface Water Bypasses

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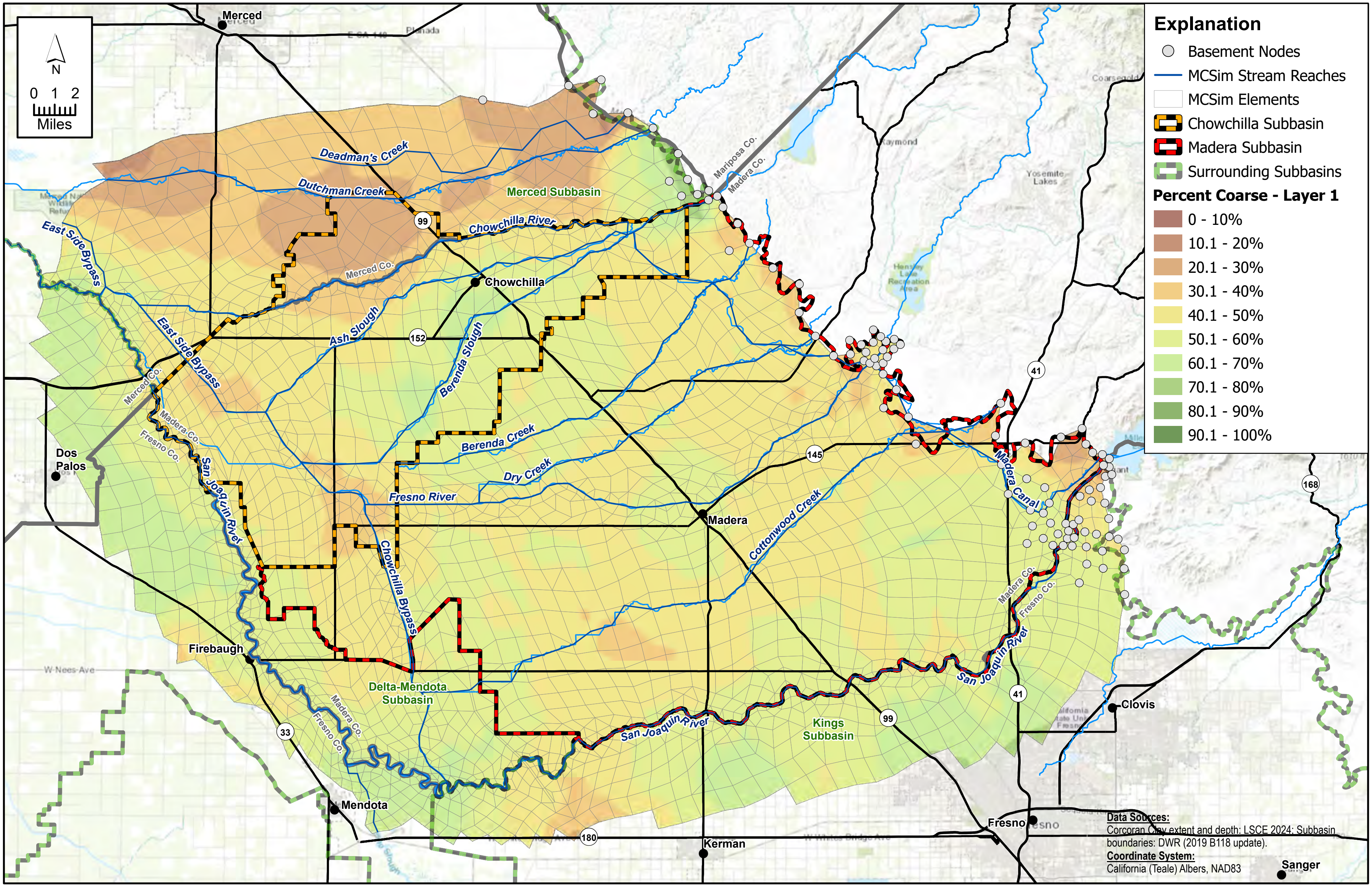
FIGURE 3-28

MCSim Historical Surface Water Bypass Locations

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; TEXTURE_Percent_Coarse

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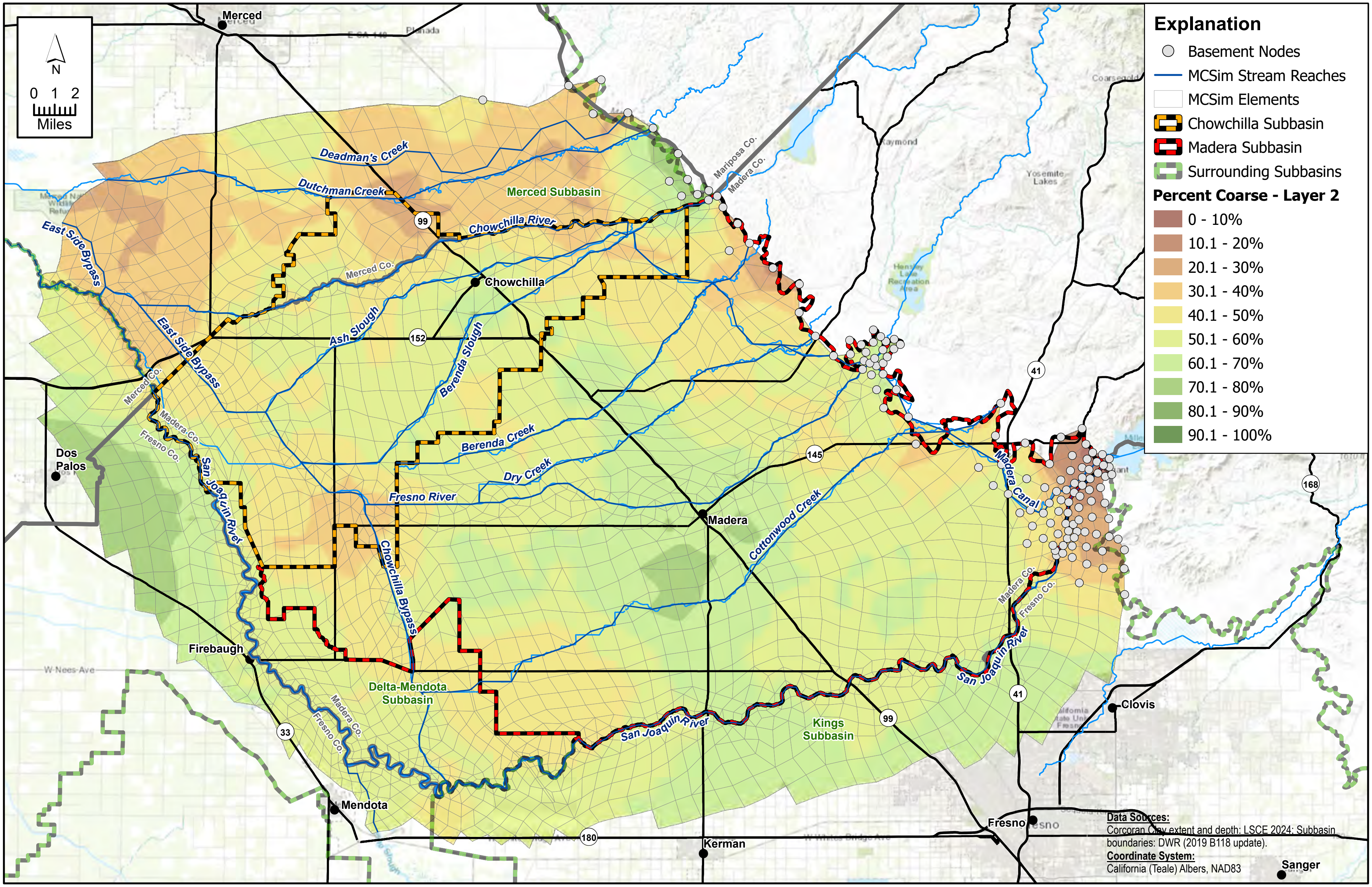
FIGURE 3-29

Percent Coarse - Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; TEXTURE_Percent_Coarse

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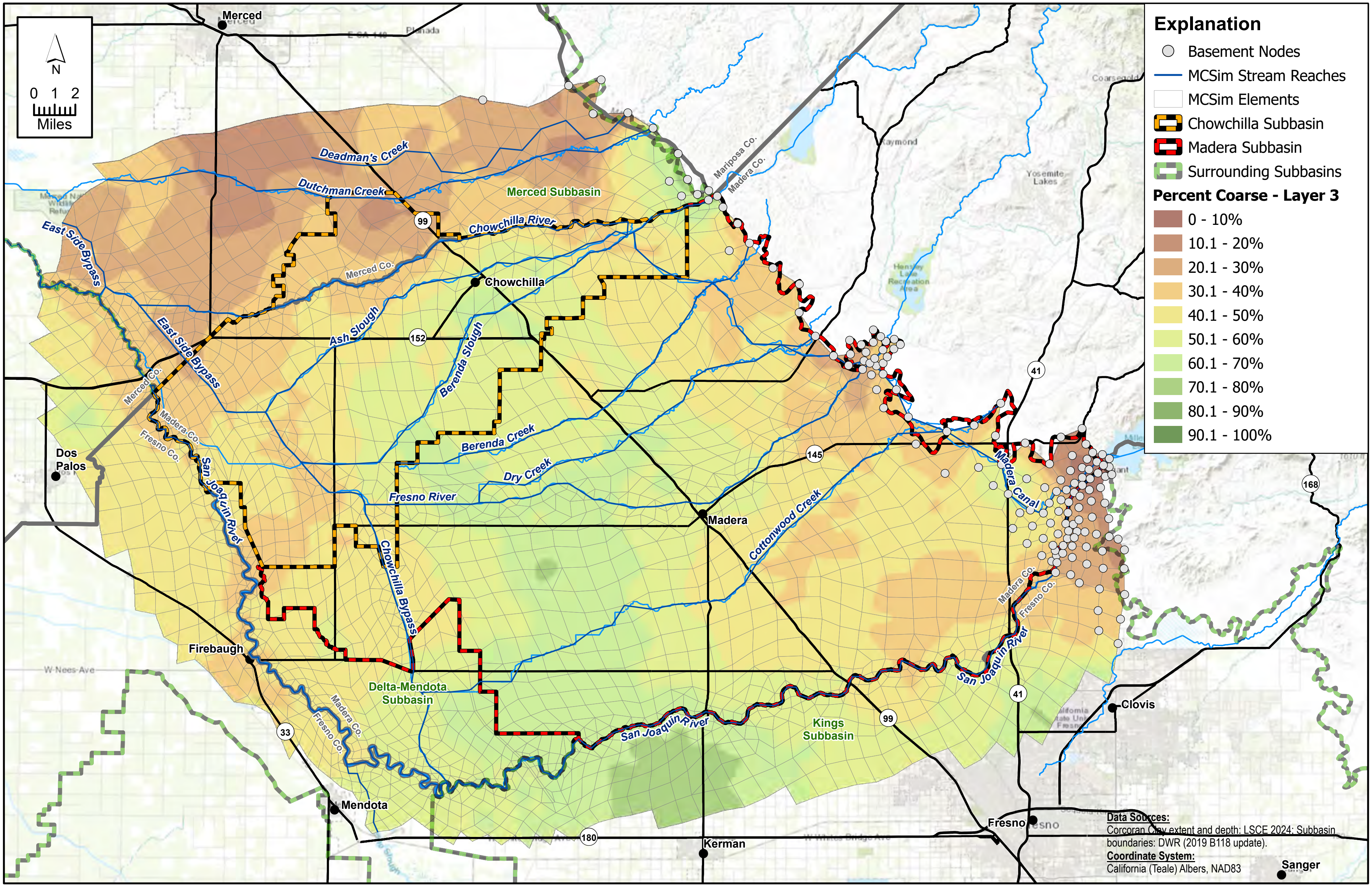
FIGURE 3-30

Percent Coarse - Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; TEXTURE_Percent_Coarse

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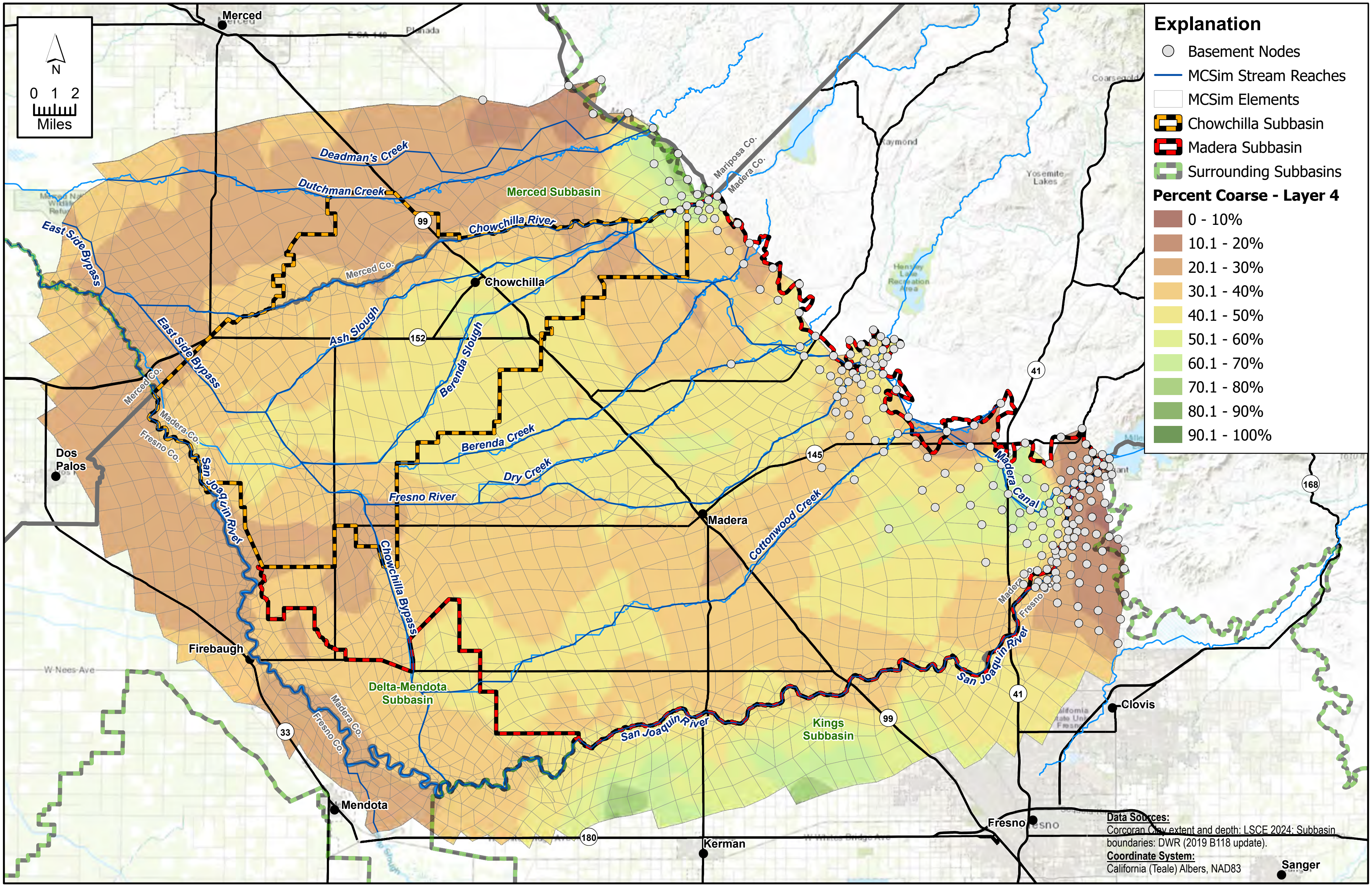
FIGURE 3-31

Percent Coarse - Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; TEXTURE_Percent_Coarse

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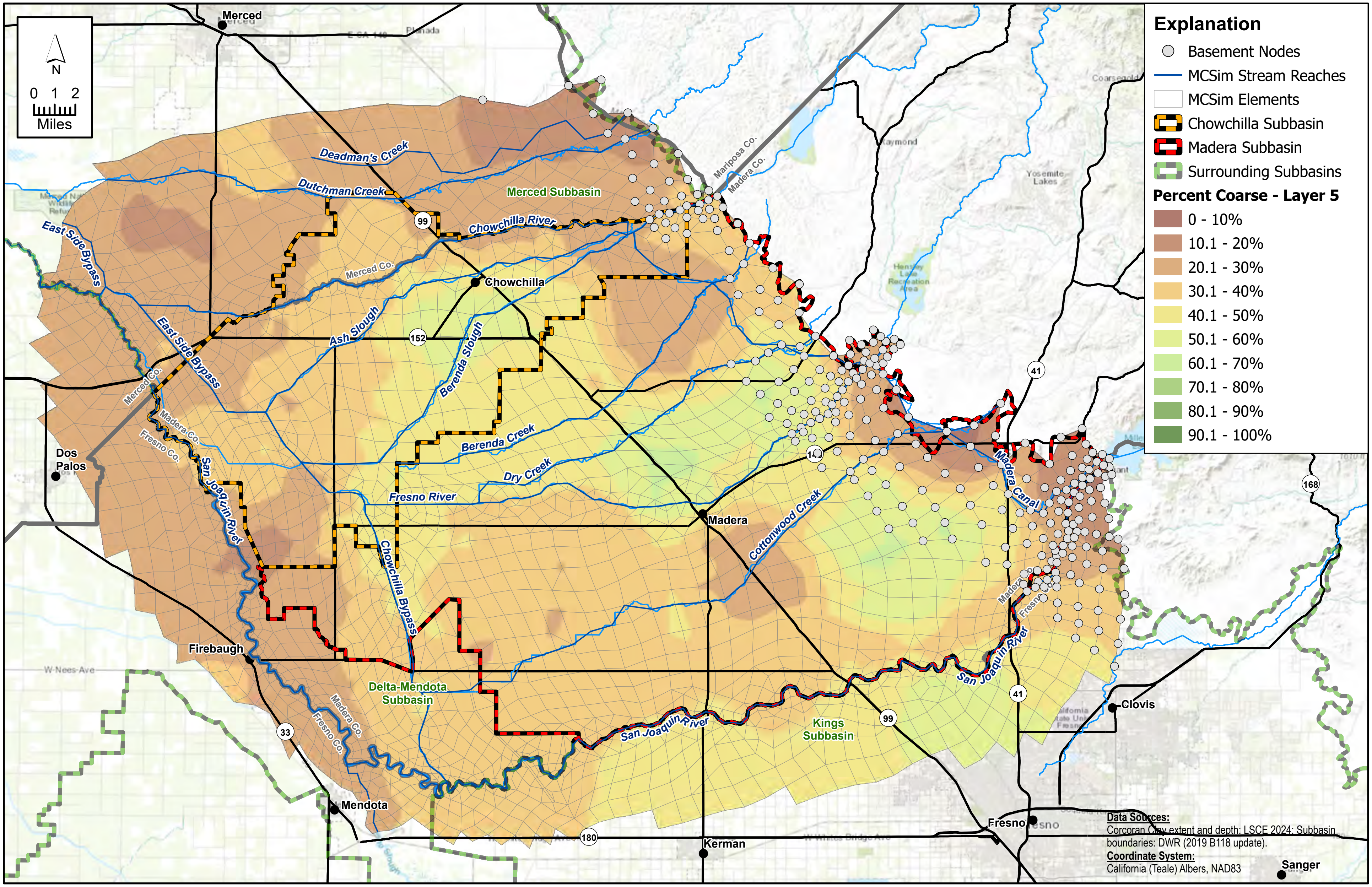
FIGURE 3-32

Percent Coarse - Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; TEXTURE_Percent_Coarse

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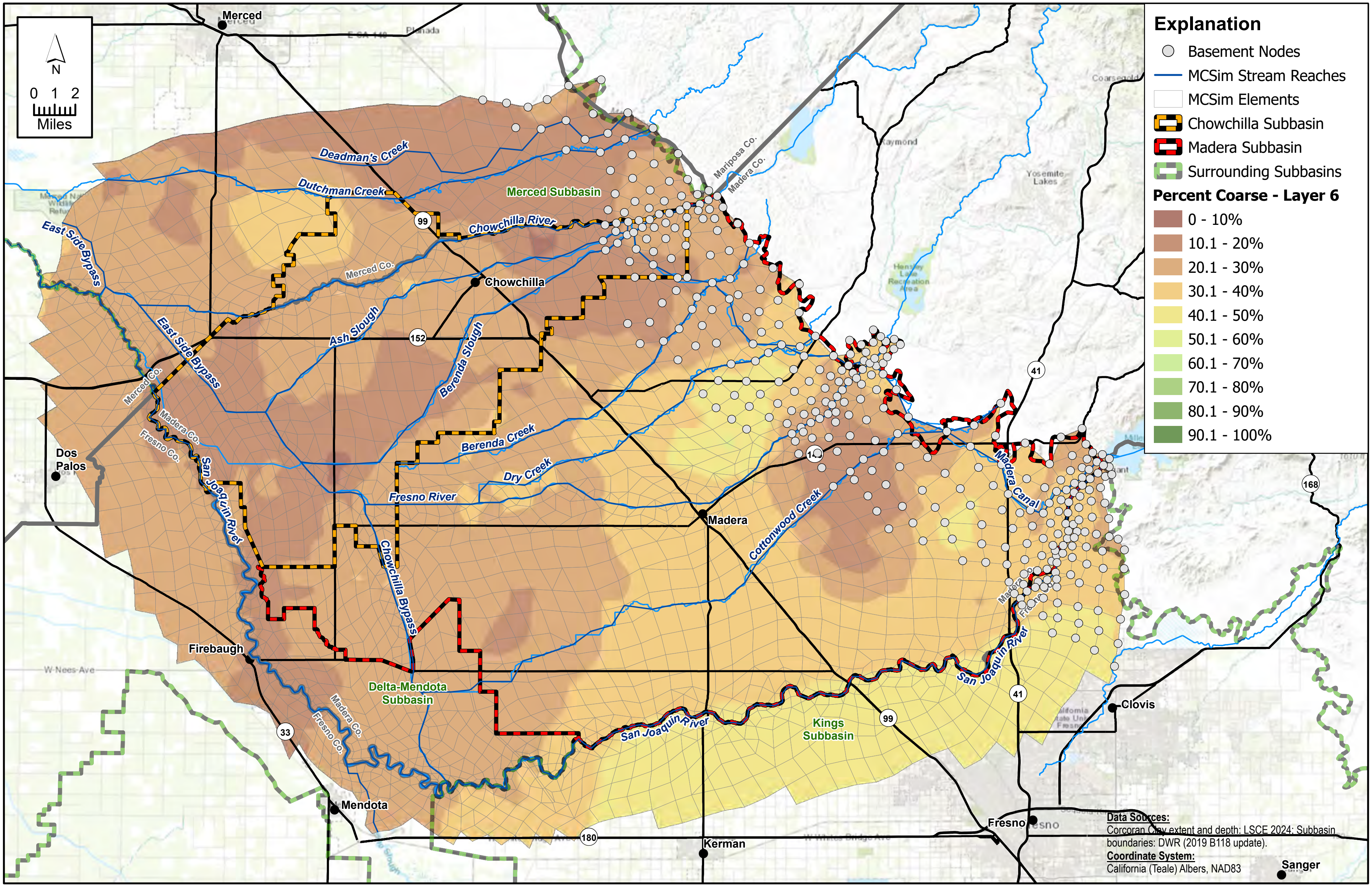
FIGURE 3-33

Percent Coarse - Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; TEXTURE_Percent_Coarse

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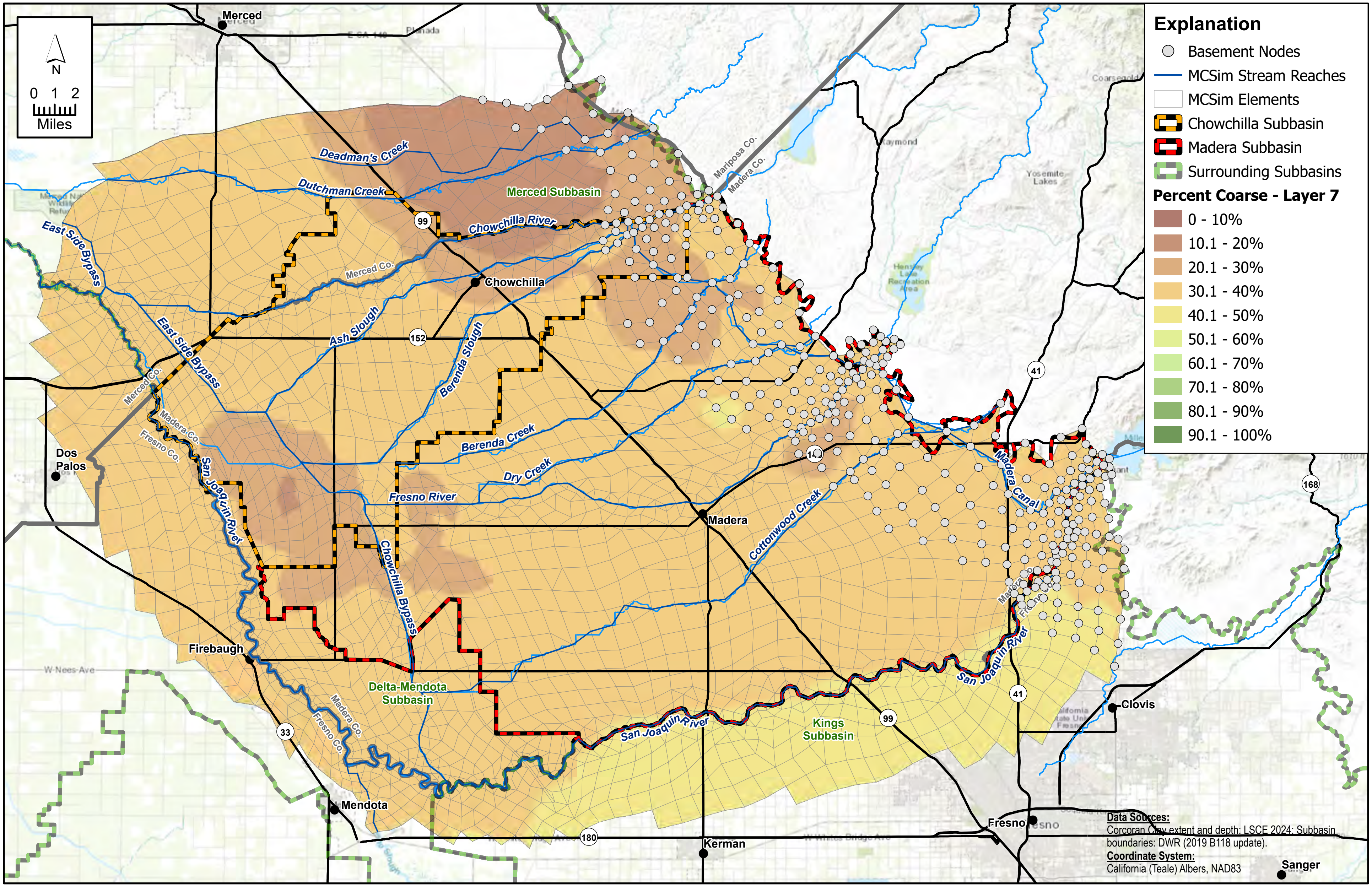
FIGURE 3-34

Percent Coarse - Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; TEXTURE_Percent_Coarse

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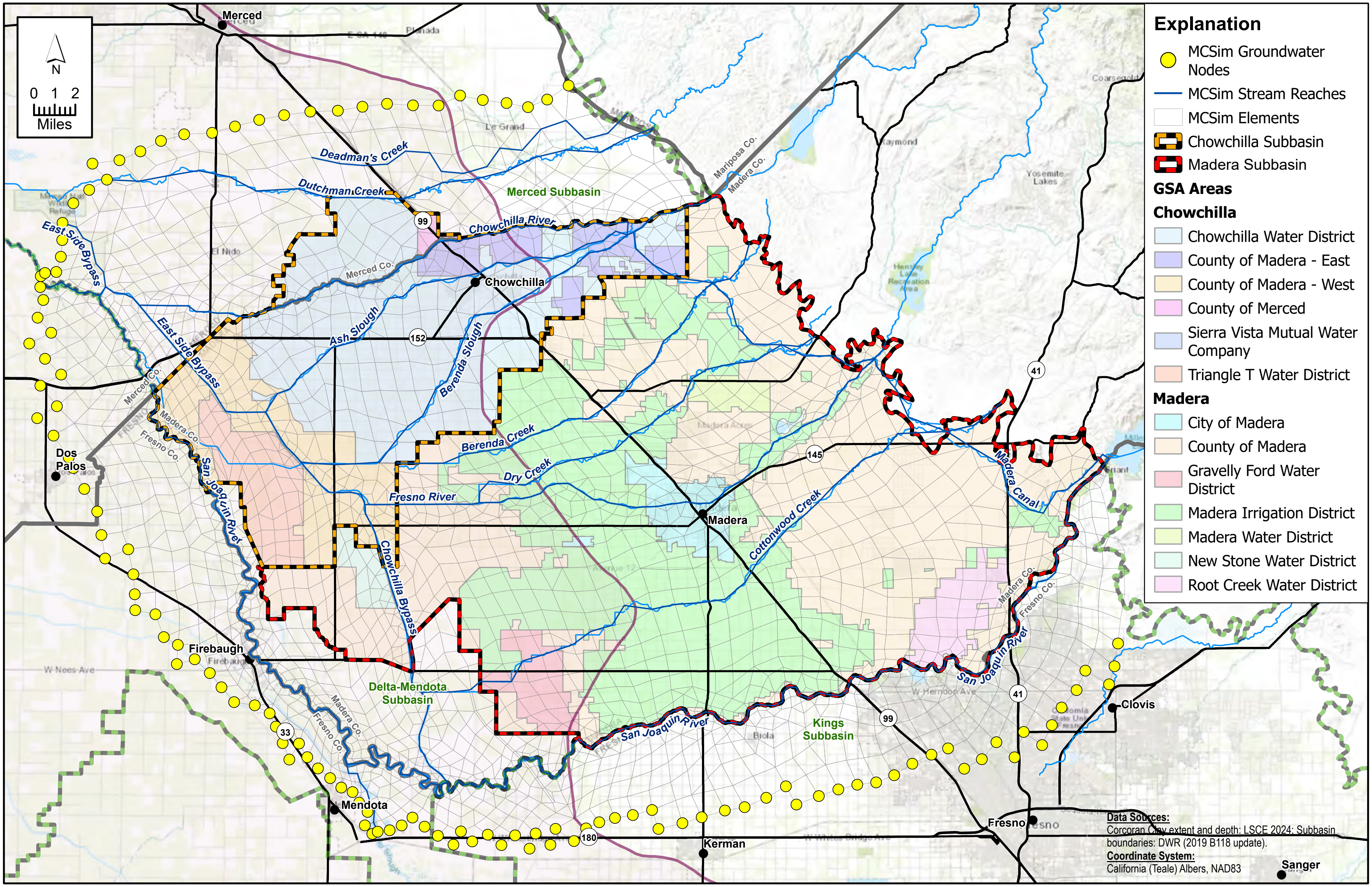
FIGURE 3-35

Percent Coarse - Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; Boundary Conditions

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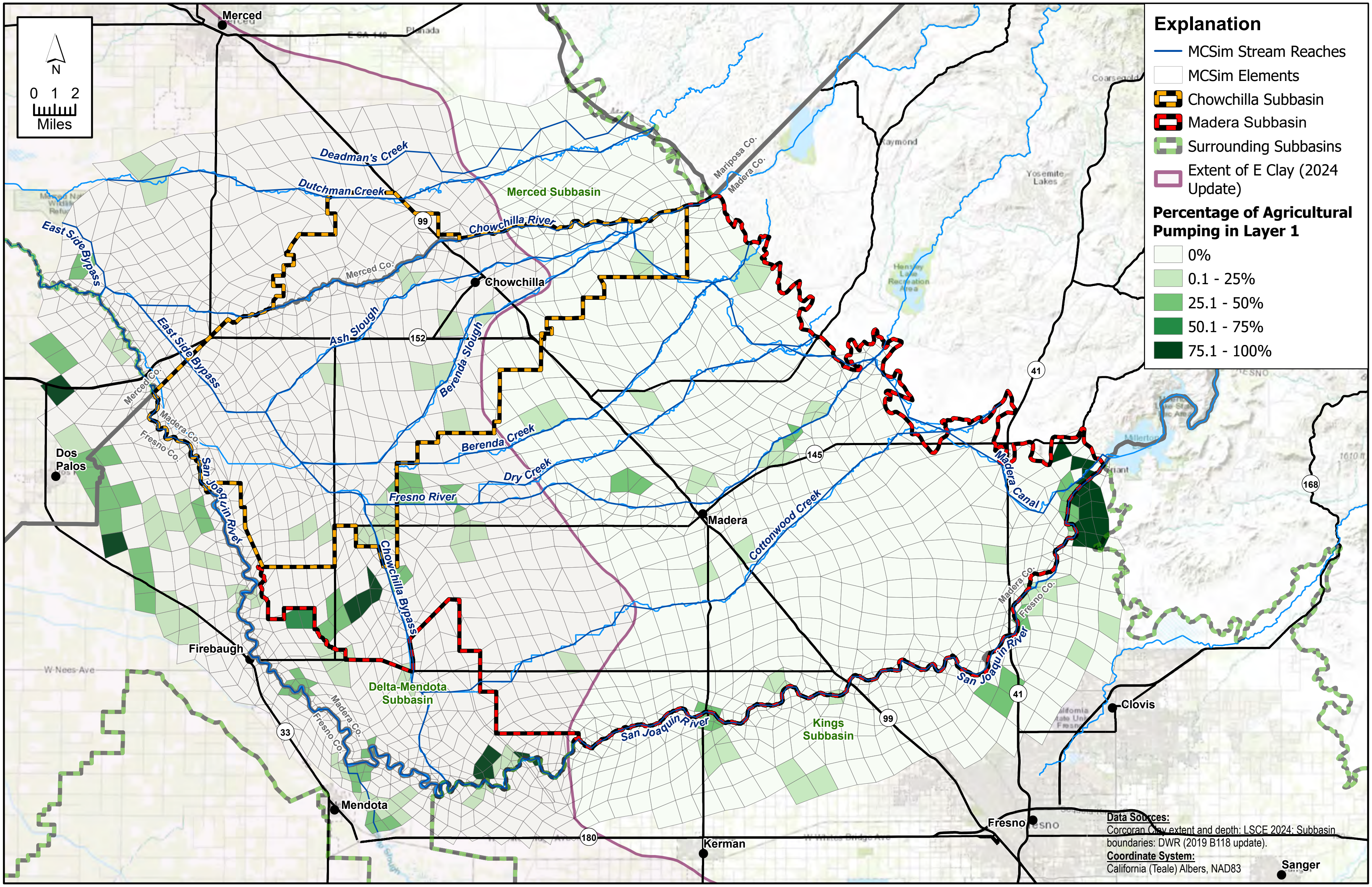
FIGURE 3-36

Groundwater Nodes with Boundary Conditions Specified in MCSim_v2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_ELEM_PUMP_AG

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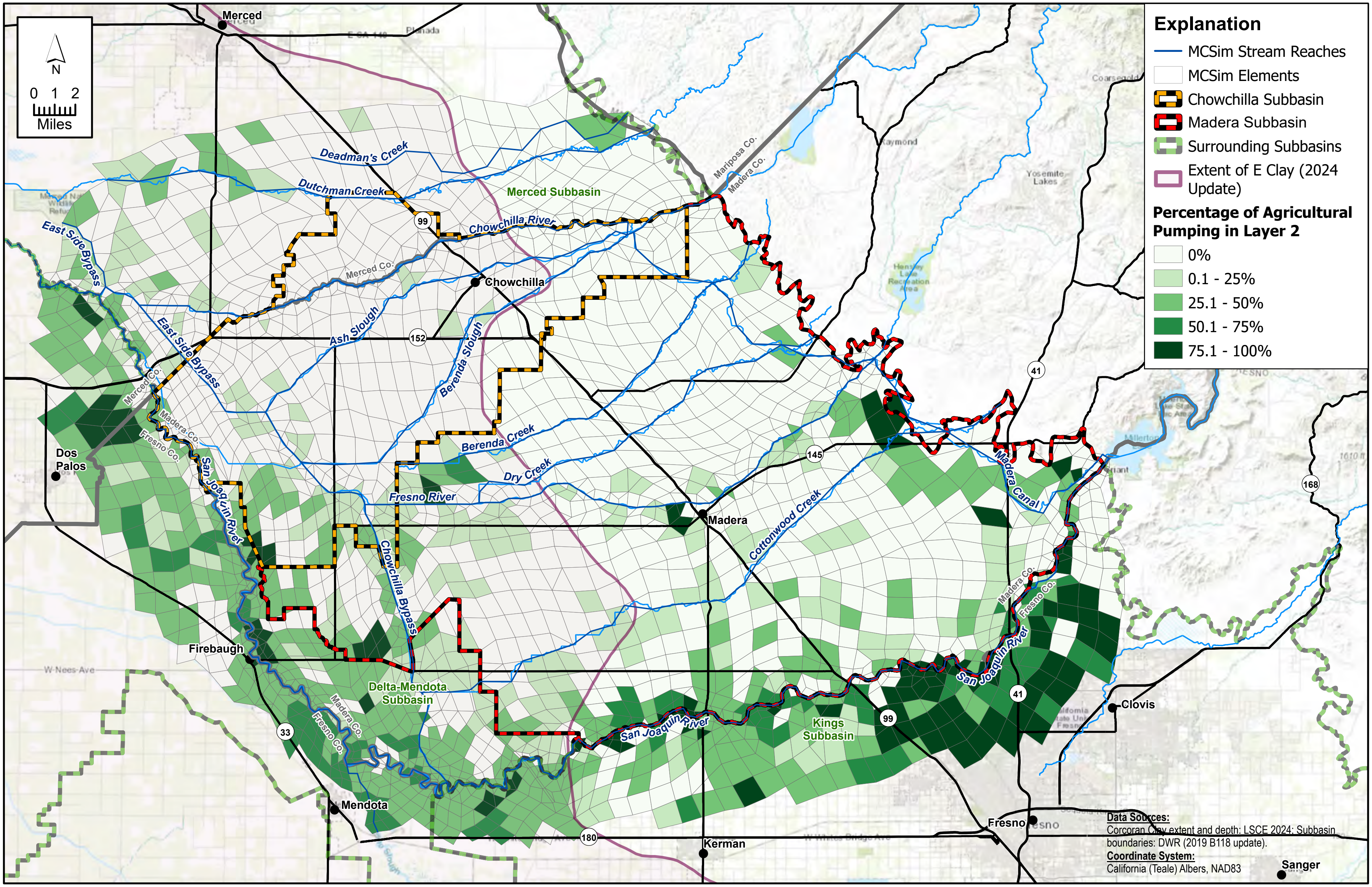
FIGURE 3-37

Vertical Distribution of Historical Agricultural Pumping - Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_ELEM_PUMP_AG

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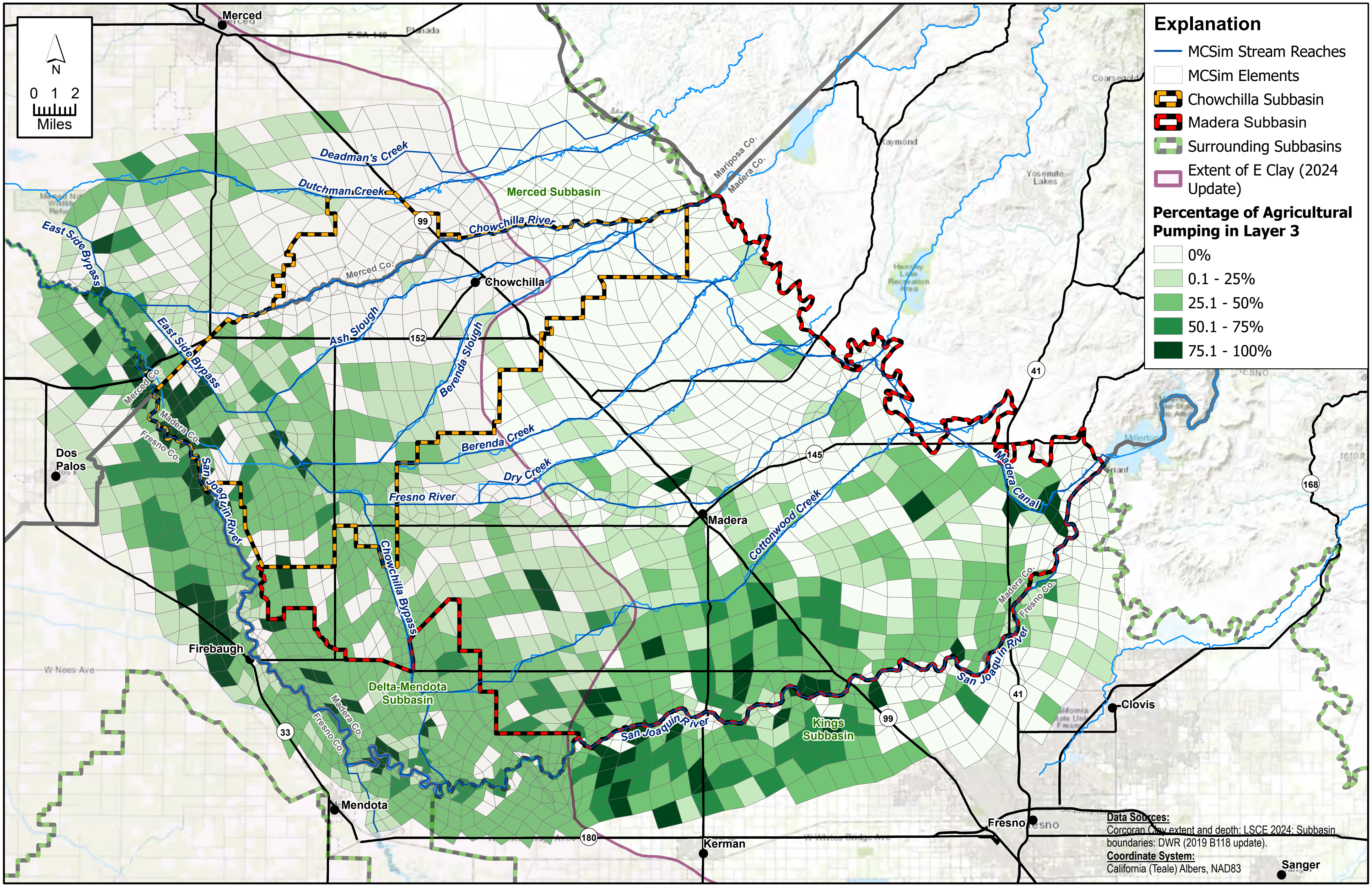
FIGURE 3-38

Vertical Distribution of Historical Agricultural Pumping - Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

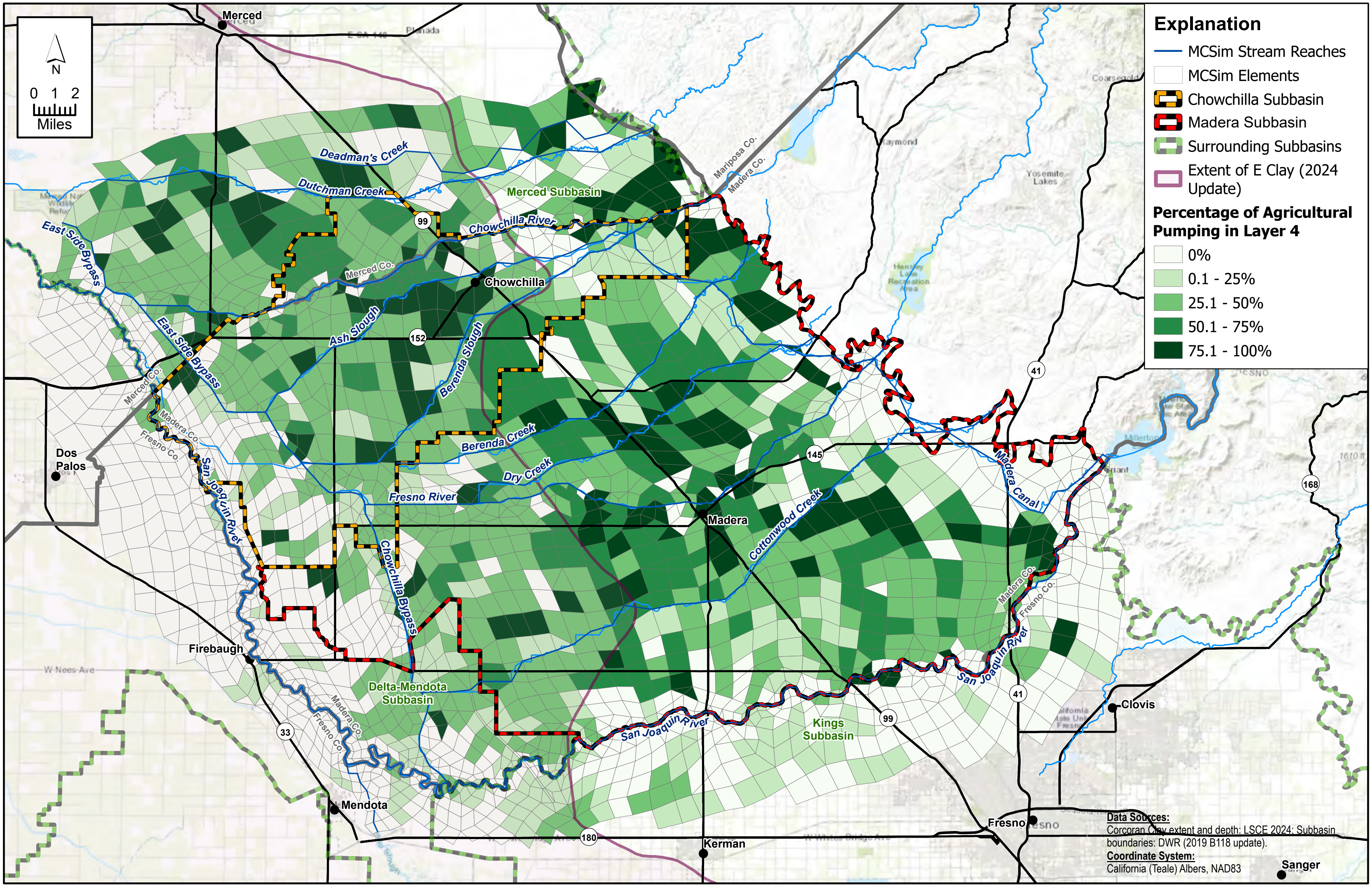


X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_ELEM_PUMP_AG

FIGURE 3-39

Vertical Distribution of Historical Agricultural Pumping - Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_ELEM_PUMP_AG

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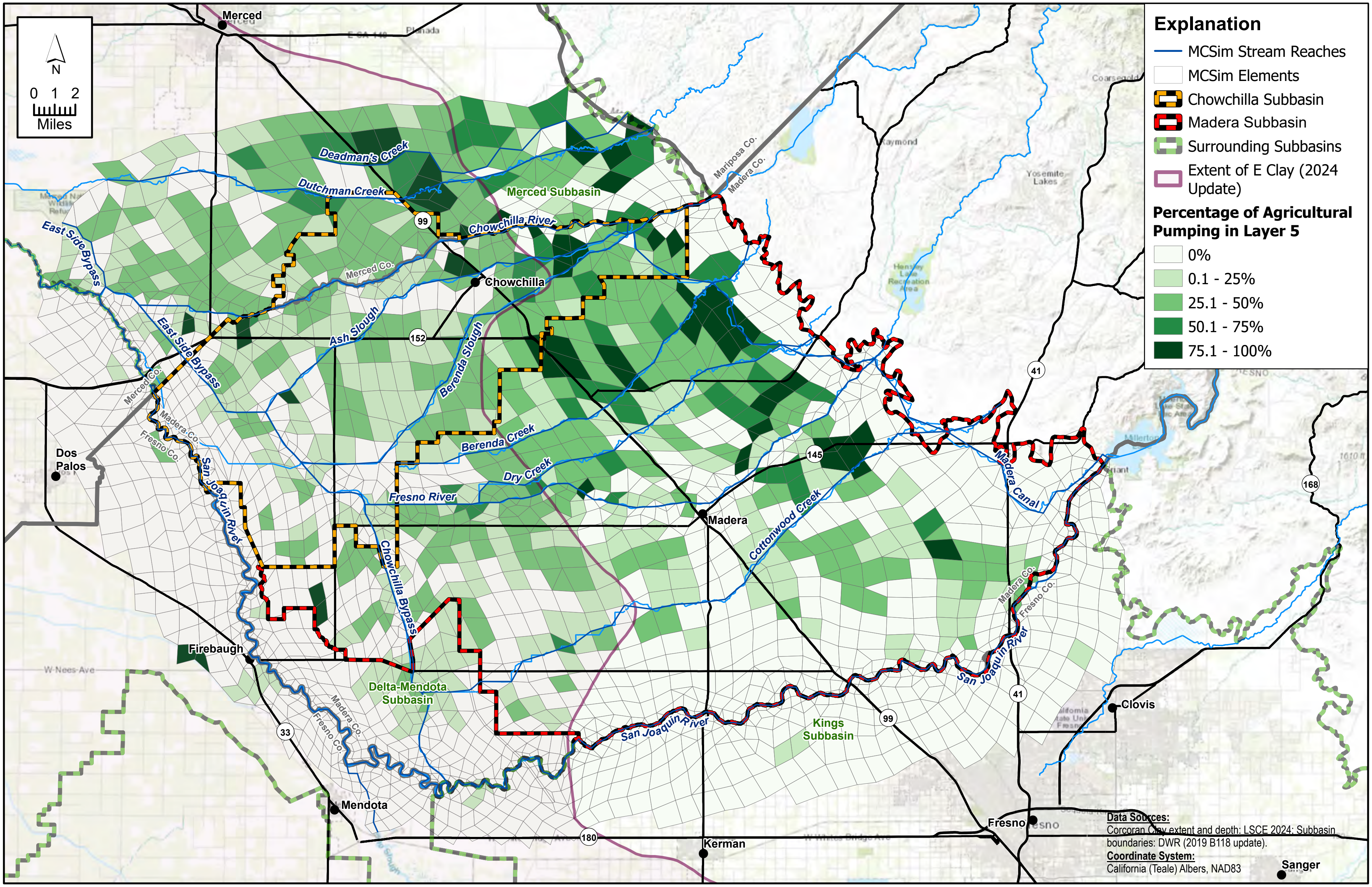
FIGURE 3-40

Vertical Distribution of Historical Agricultural Pumping - Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_ELEM_PUMP_AG

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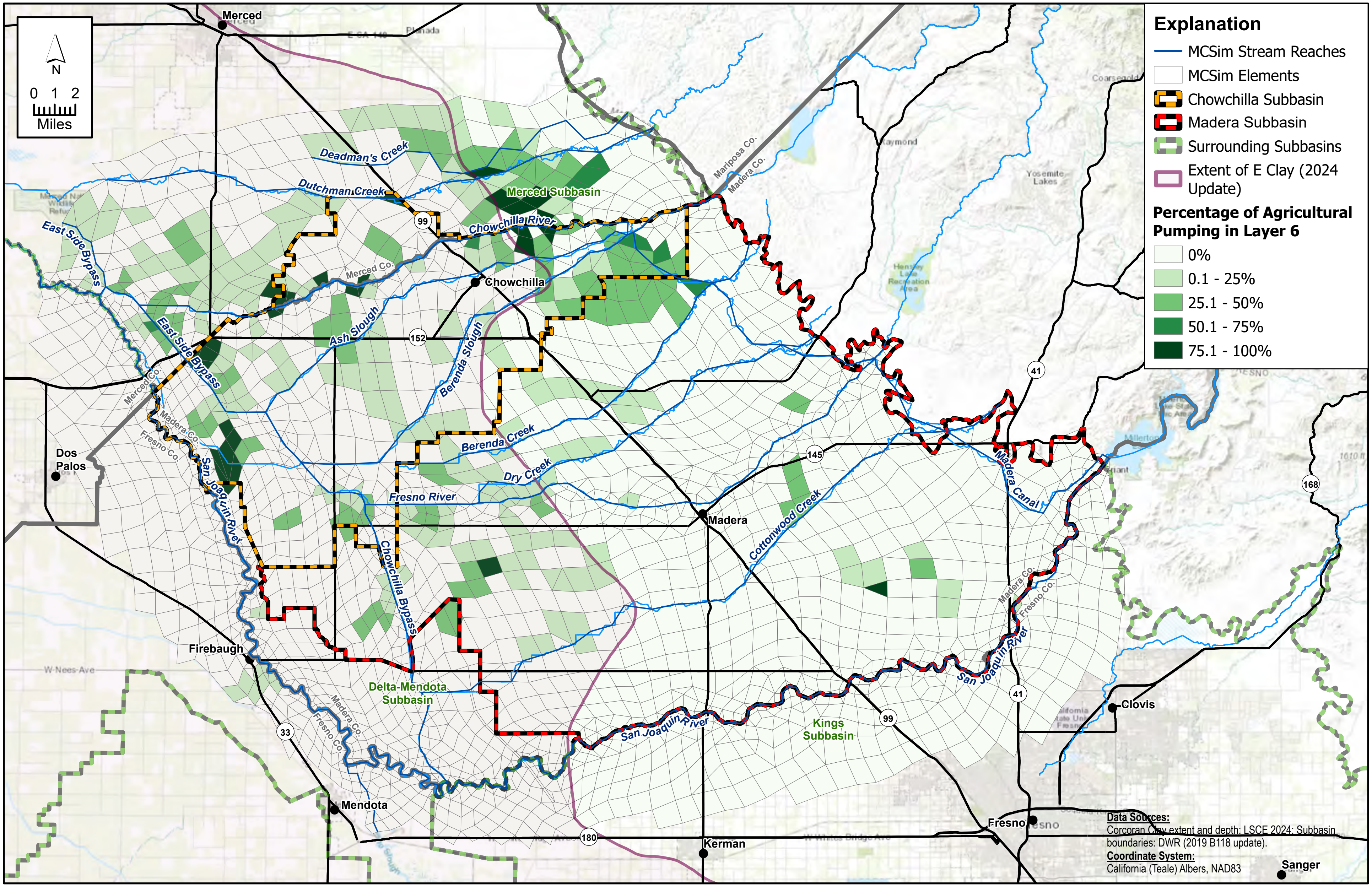
FIGURE 3-41

Vertical Distribution of Historical Agricultural Pumping - Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_ELEM_PUMP_AG

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FIGURE 3-42

Vertical Distribution of Historical Agricultural Pumping - Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

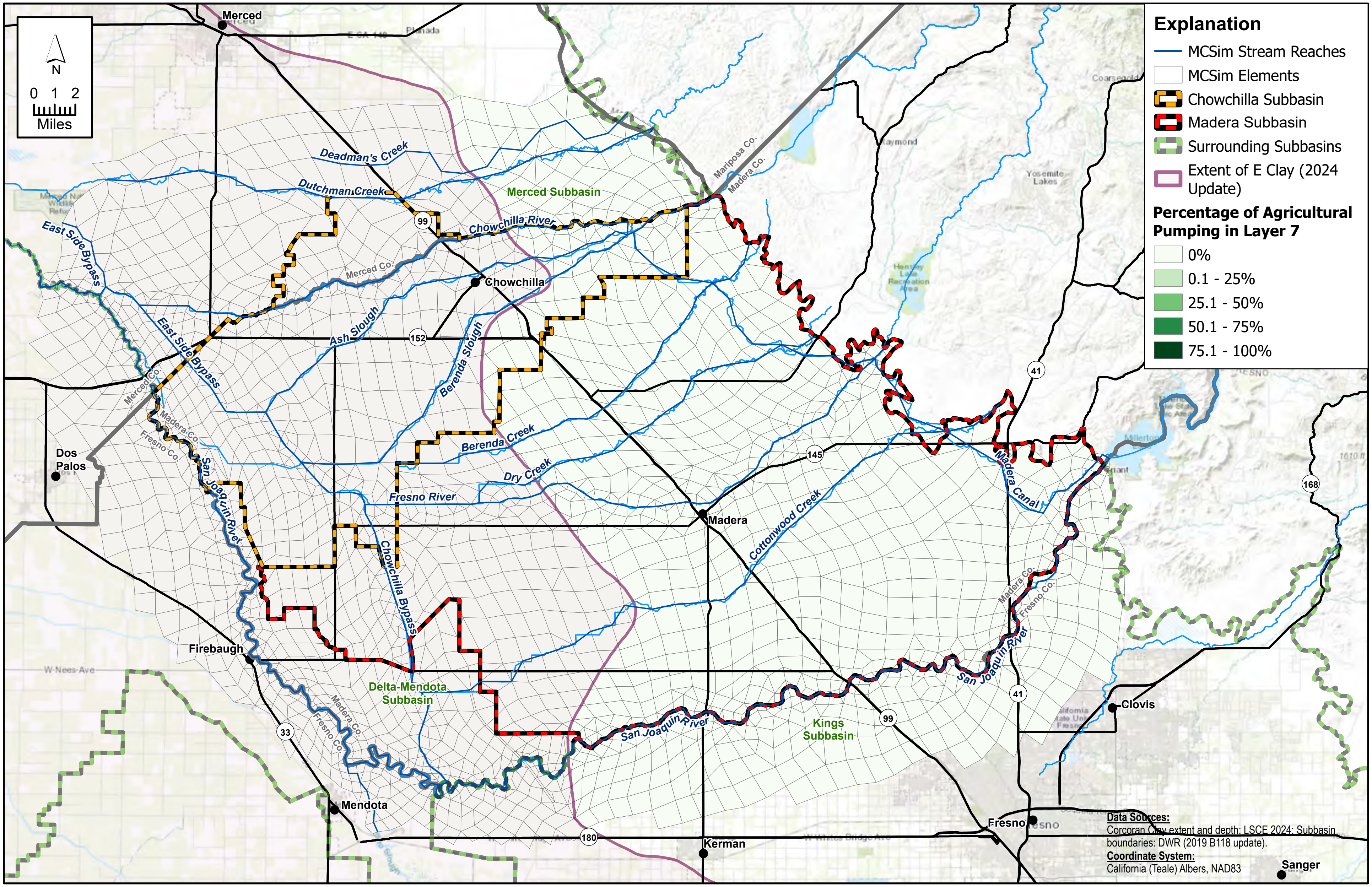

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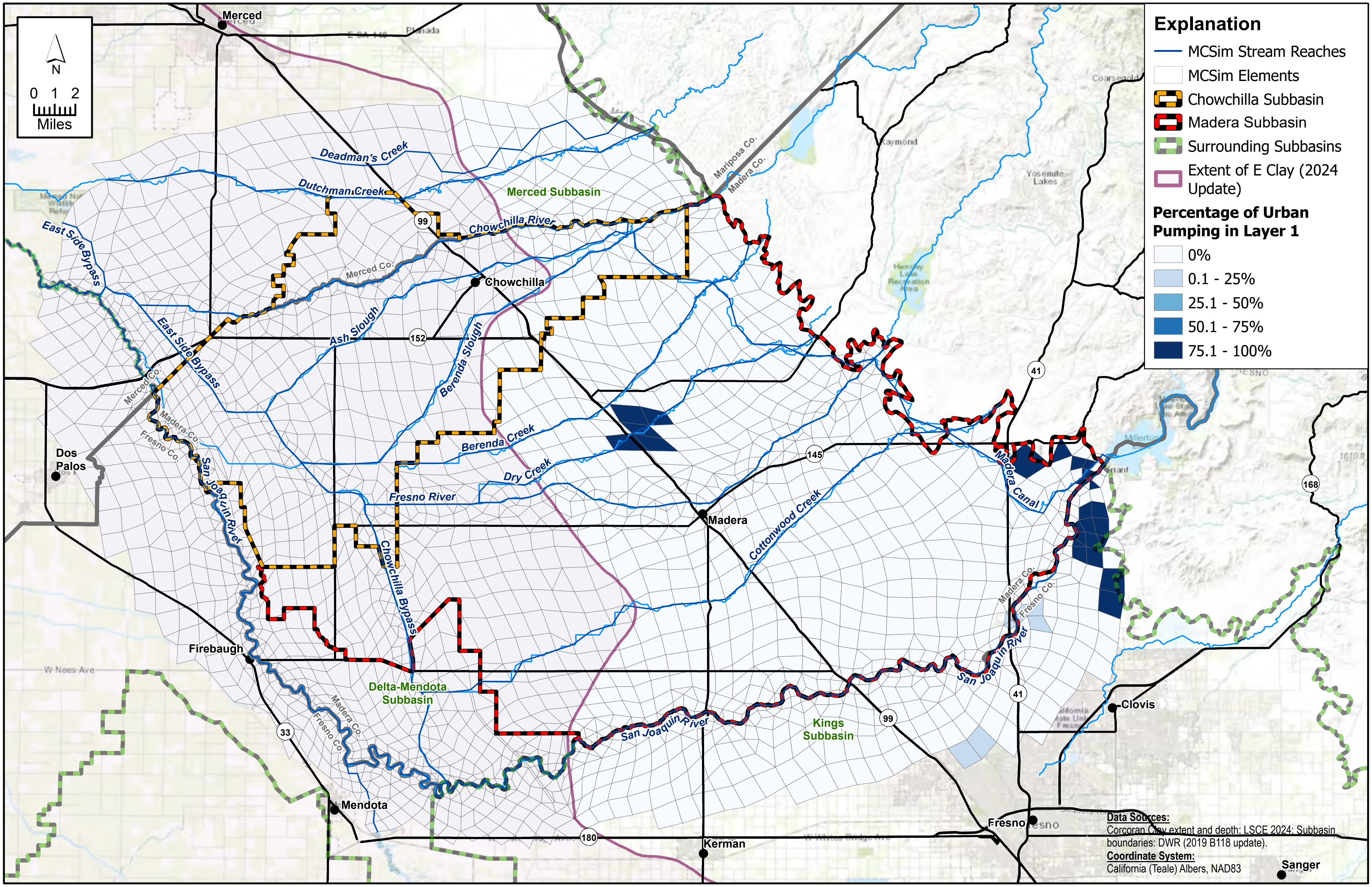
FIGURE 3-43

Vertical Distribution of Historical Agricultural Pumping - Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_ELEM_PUMP_URBAN

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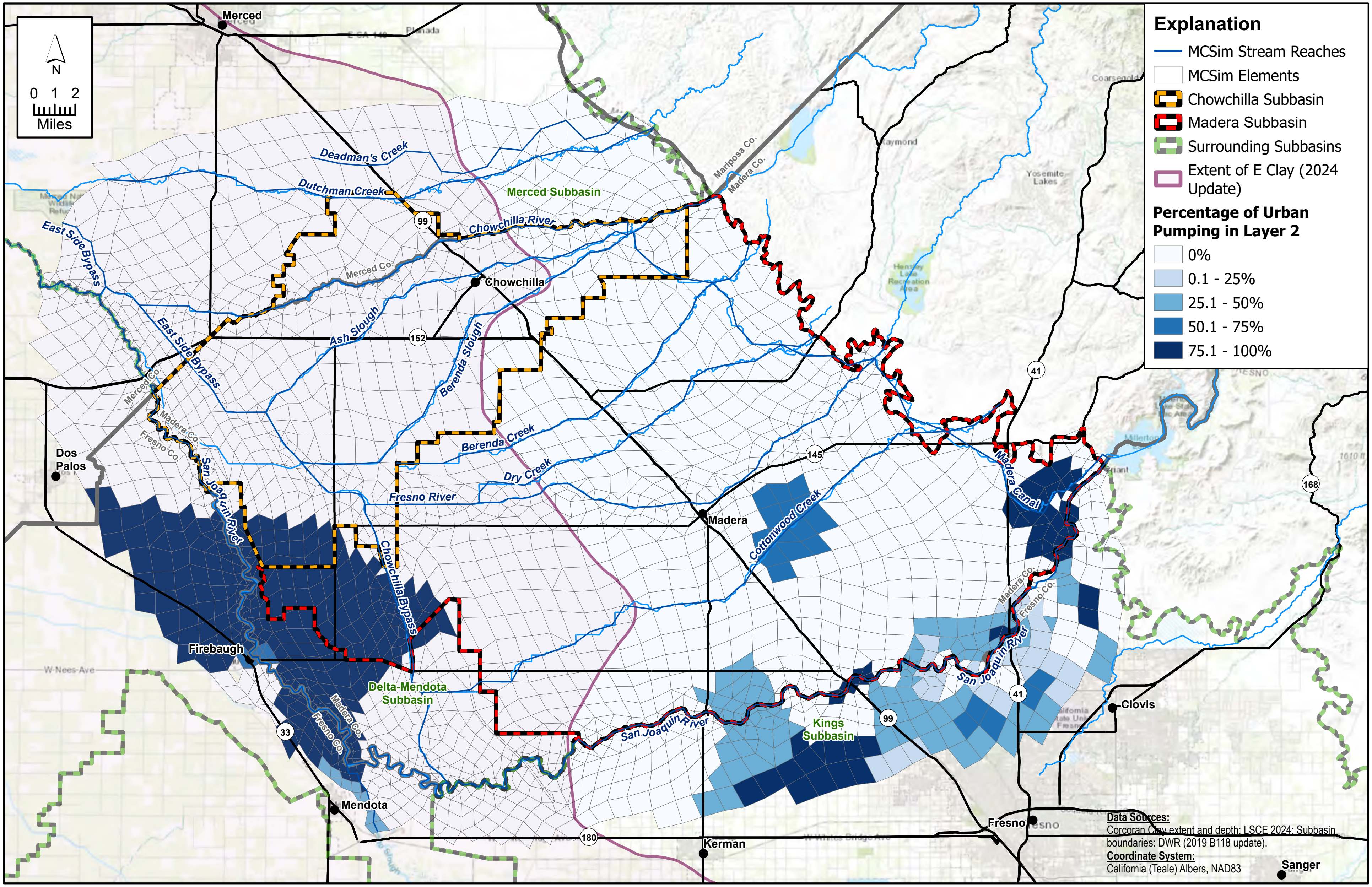
FIGURE 3-44

Vertical Distribution of Historical Urban Pumping - Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_ELEM_PUMP_URBAN

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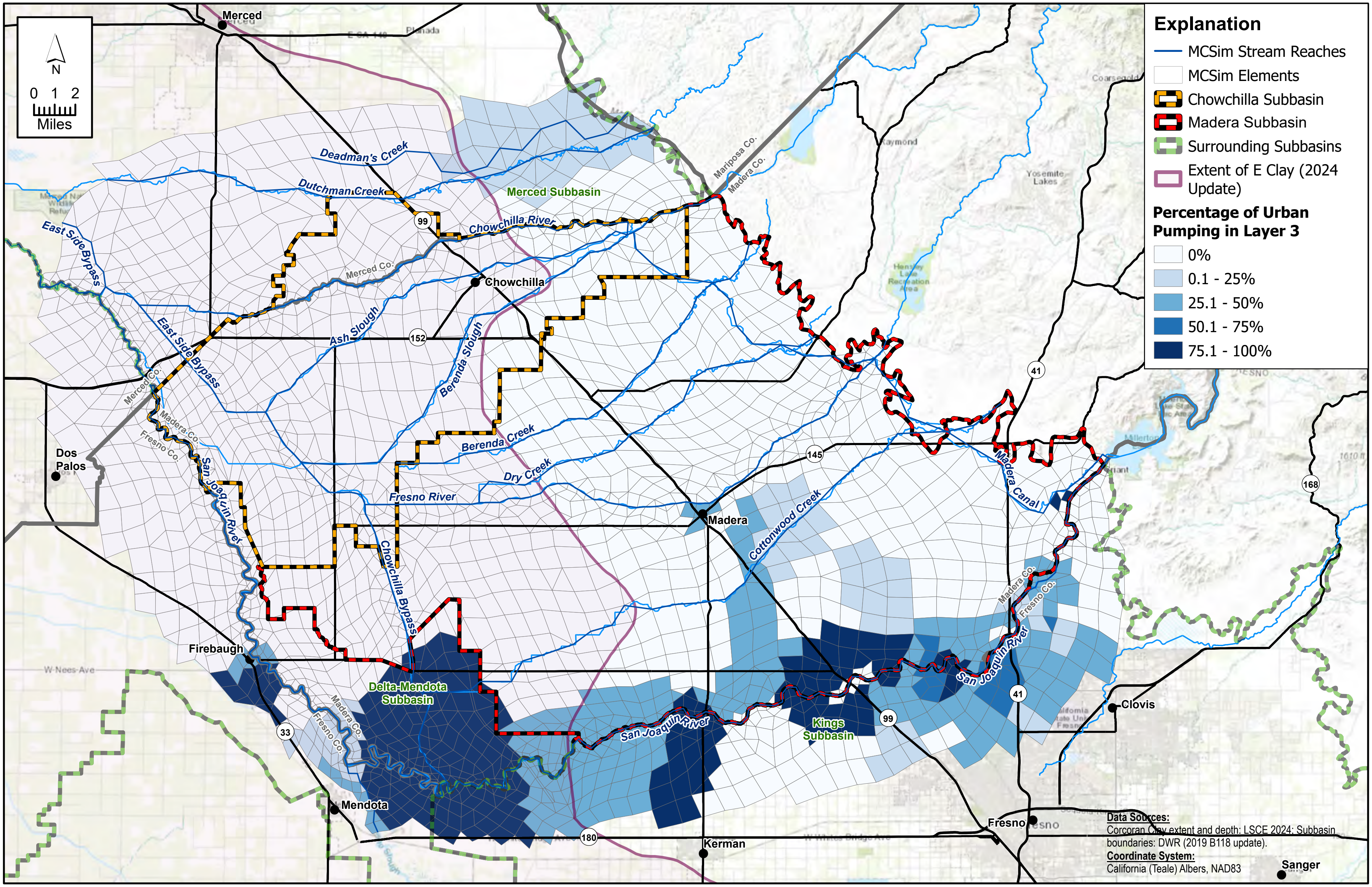
FIGURE 3-45

Vertical Distribution of Historical Urban Pumping - Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_ELEM_PUMP_URBAN

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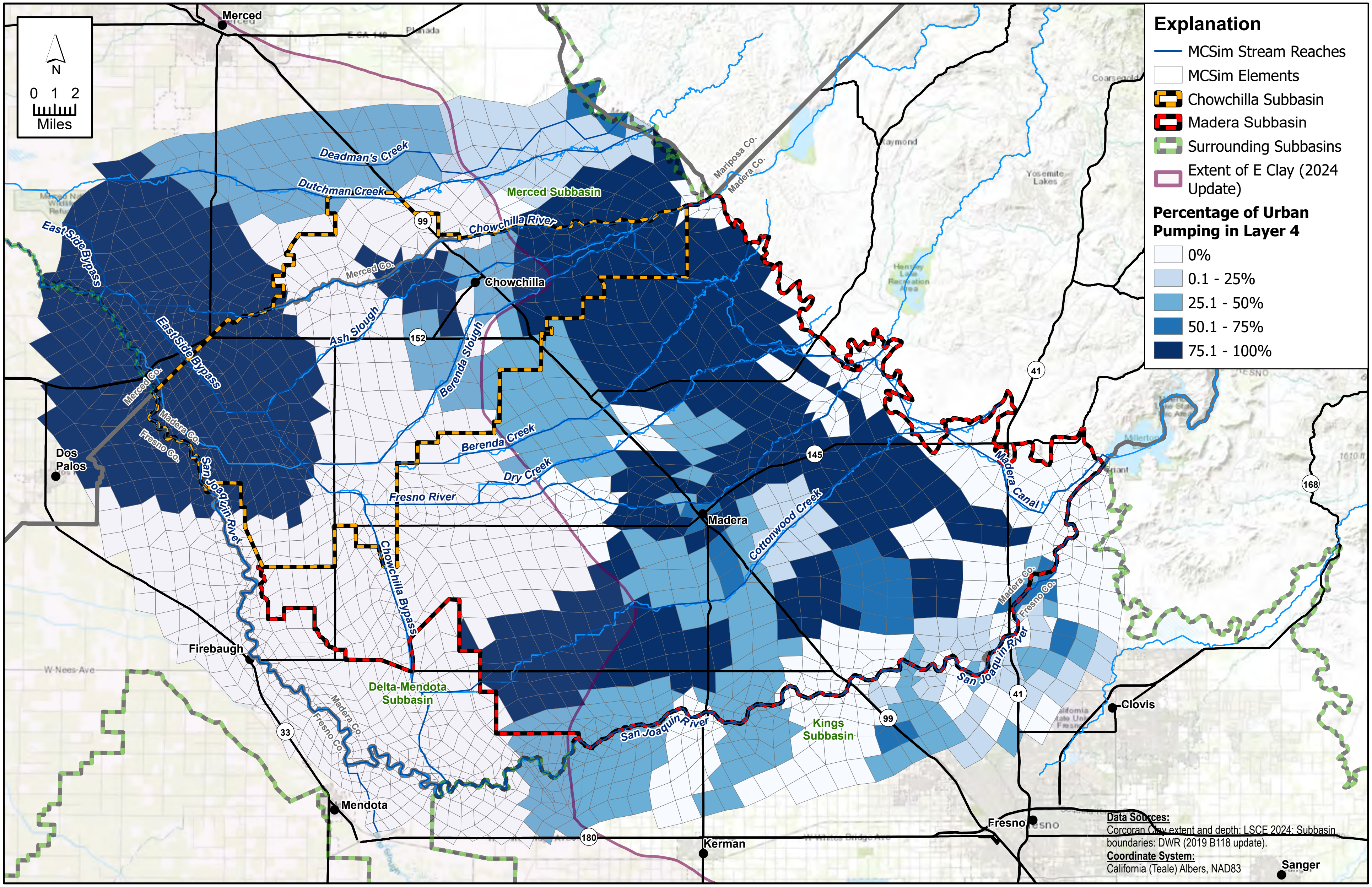
FIGURE 3-46

Vertical Distribution of Historical Urban Pumping - Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_ELEM_PUMP_URBAN

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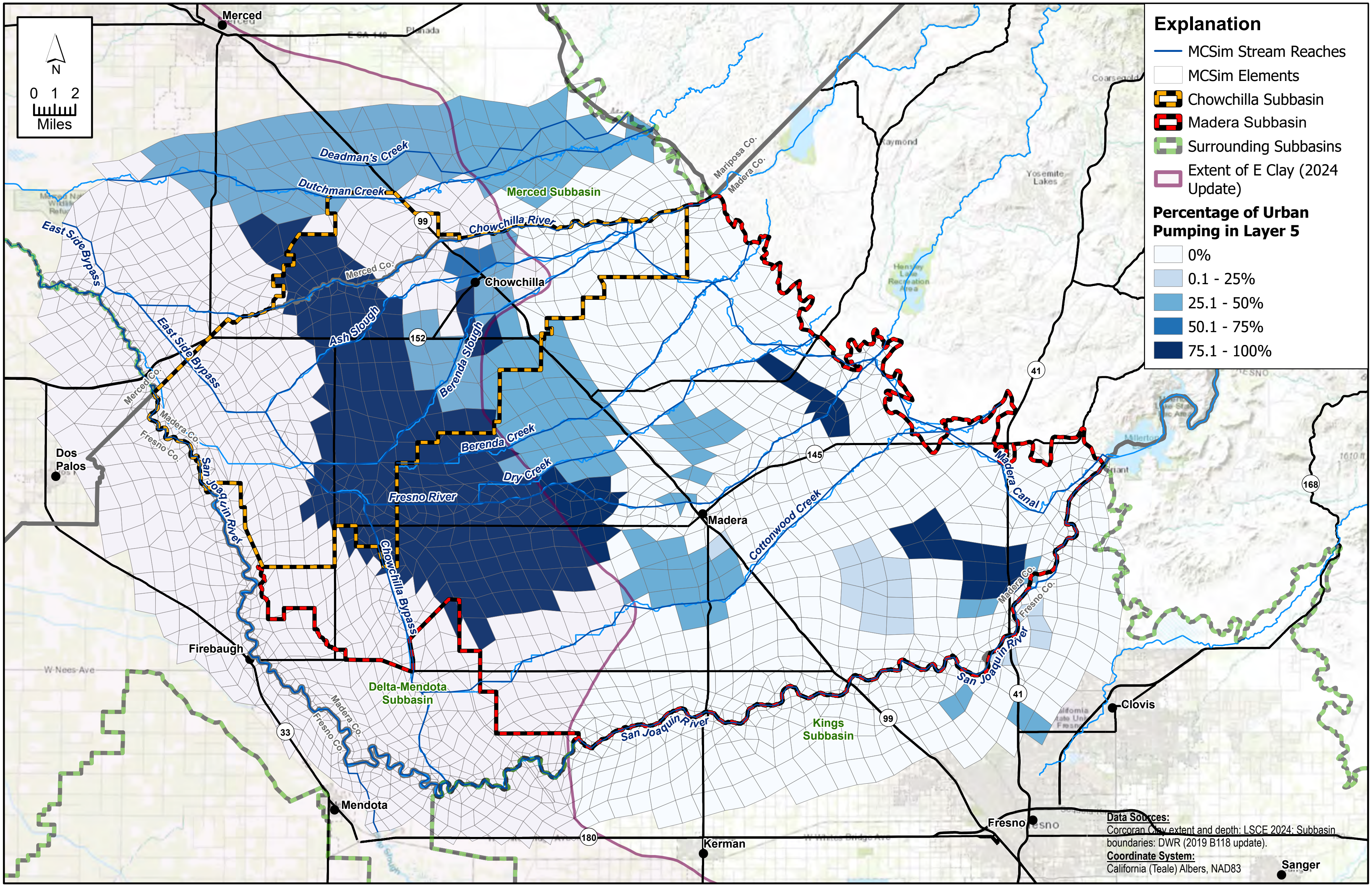
FIGURE 3-47

Vertical Distribution of Historical Urban Pumping - Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_ELEM_PUMP_URBAN

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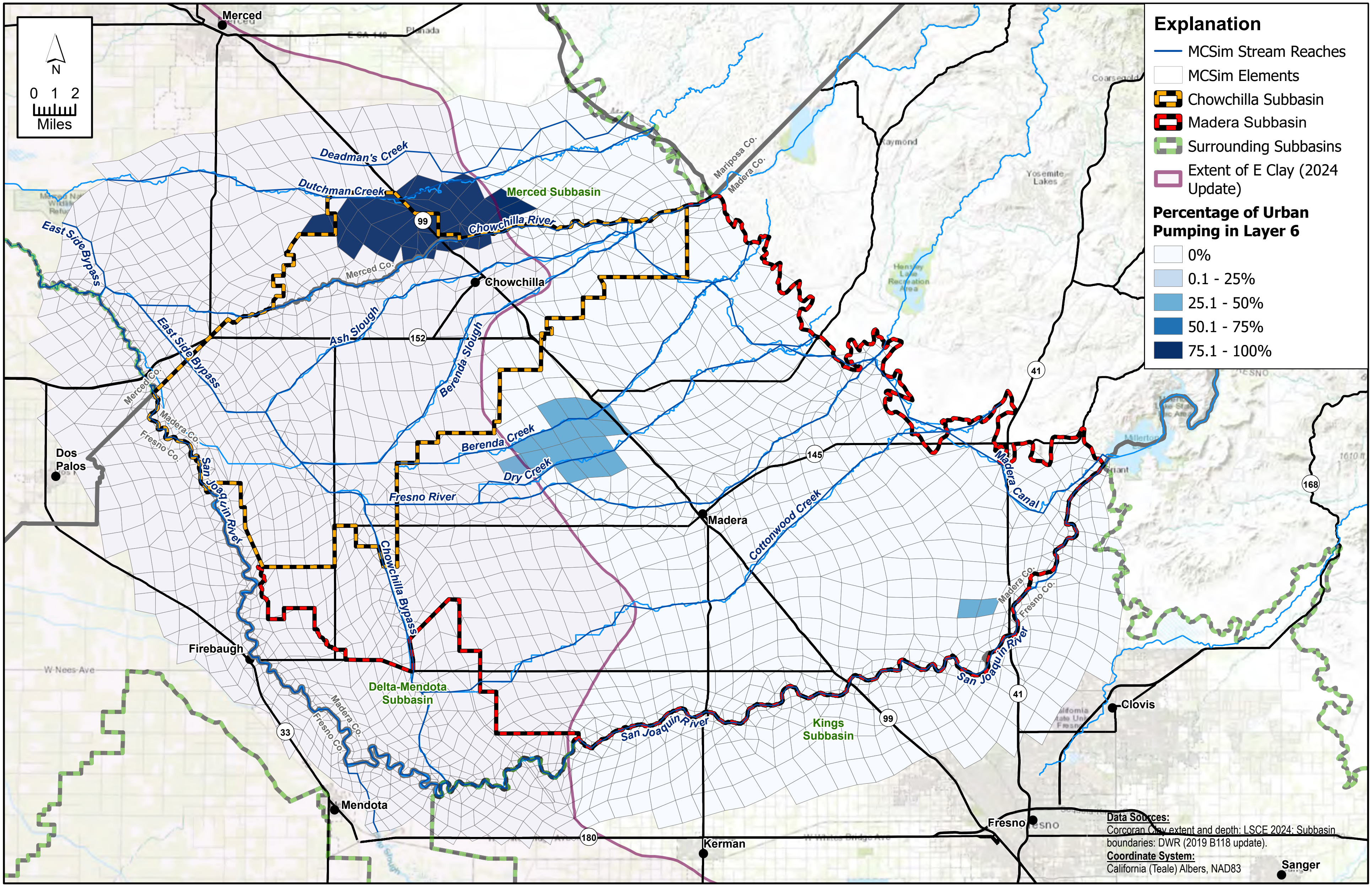
FIGURE 3-48

Vertical Distribution of Historical Urban Pumping - Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_ELEM_PUMP_URBAN

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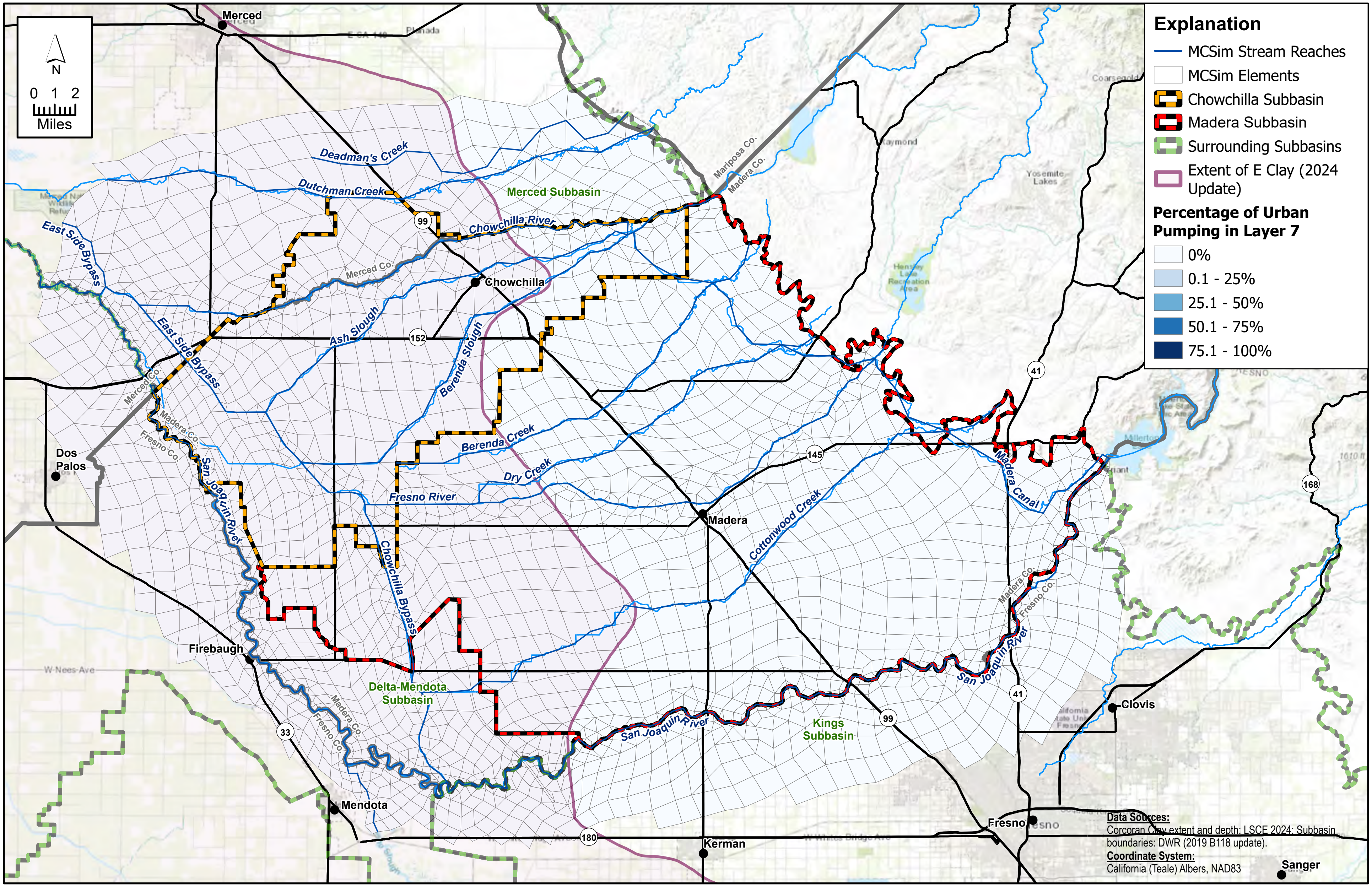
FIGURE 3-49

Vertical Distribution of Historical Urban Pumping - Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_ELEM_PUMP_URBAN

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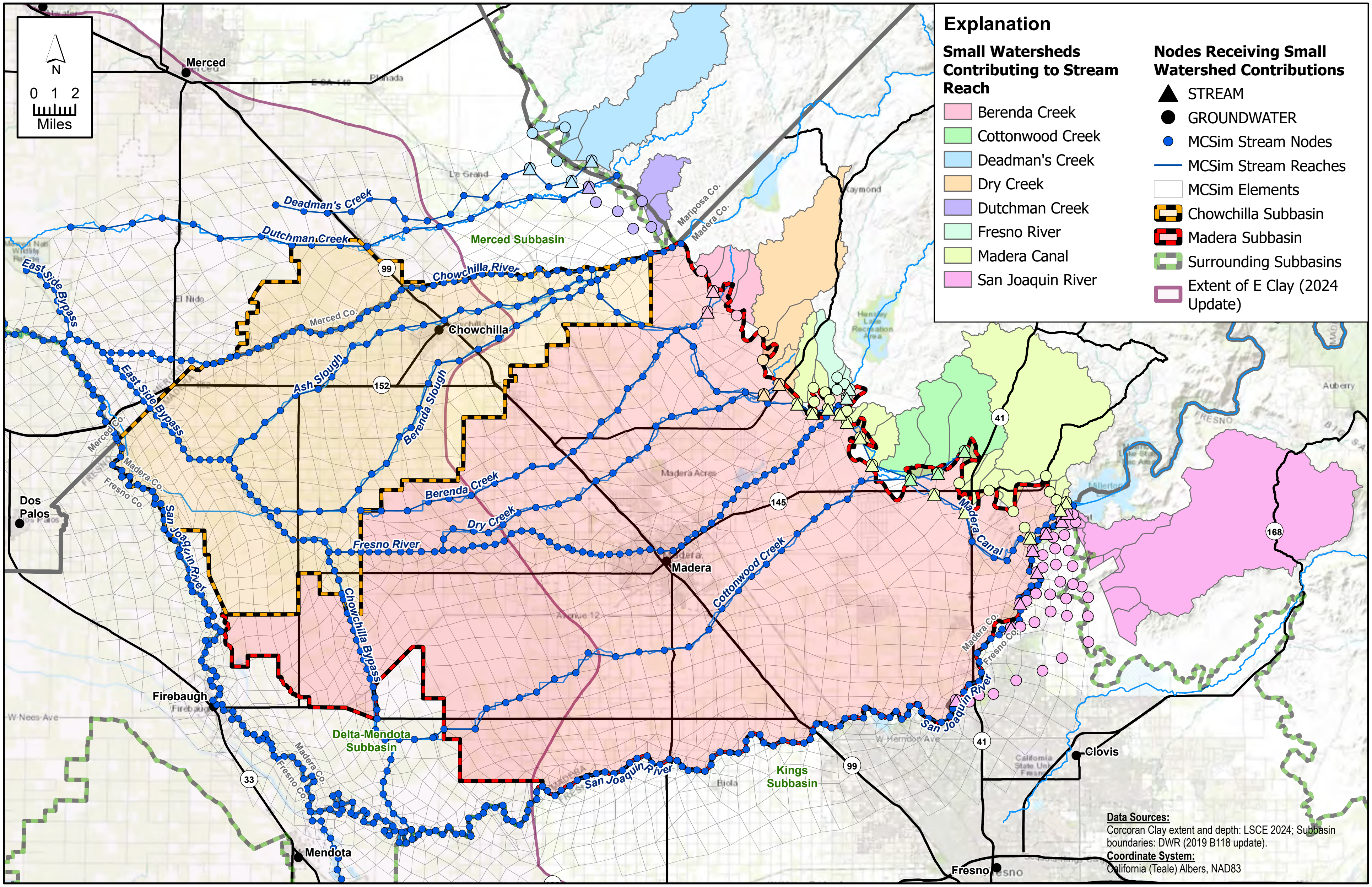
FIGURE 3-50

Vertical Distribution of Historical Urban Pumping - Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; SWSHED_working

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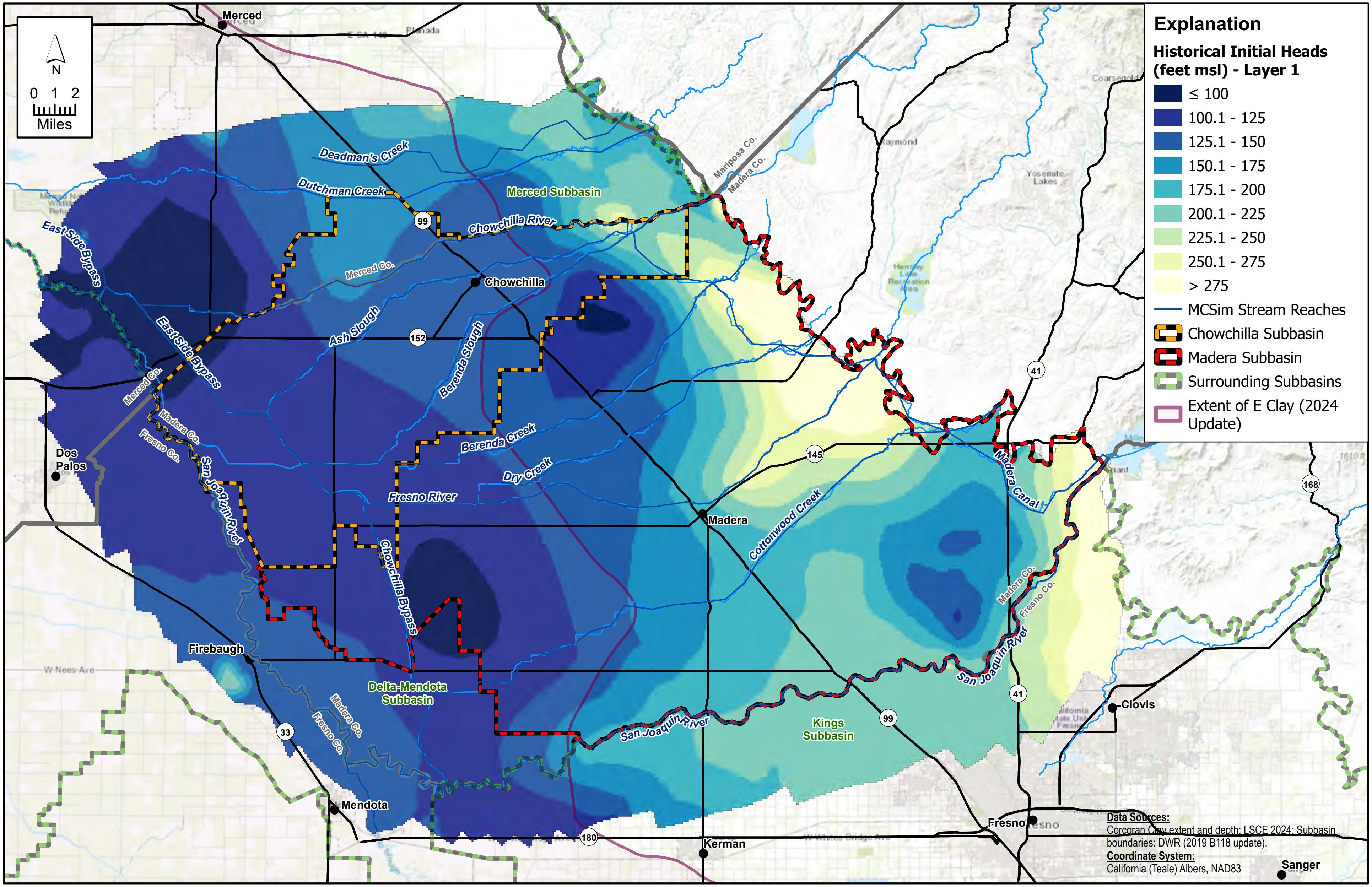
FIGURE 3-51

Nodes Receiving Small Watershed Contributions in MCSim_v2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; InCond_HIST_20241029_3

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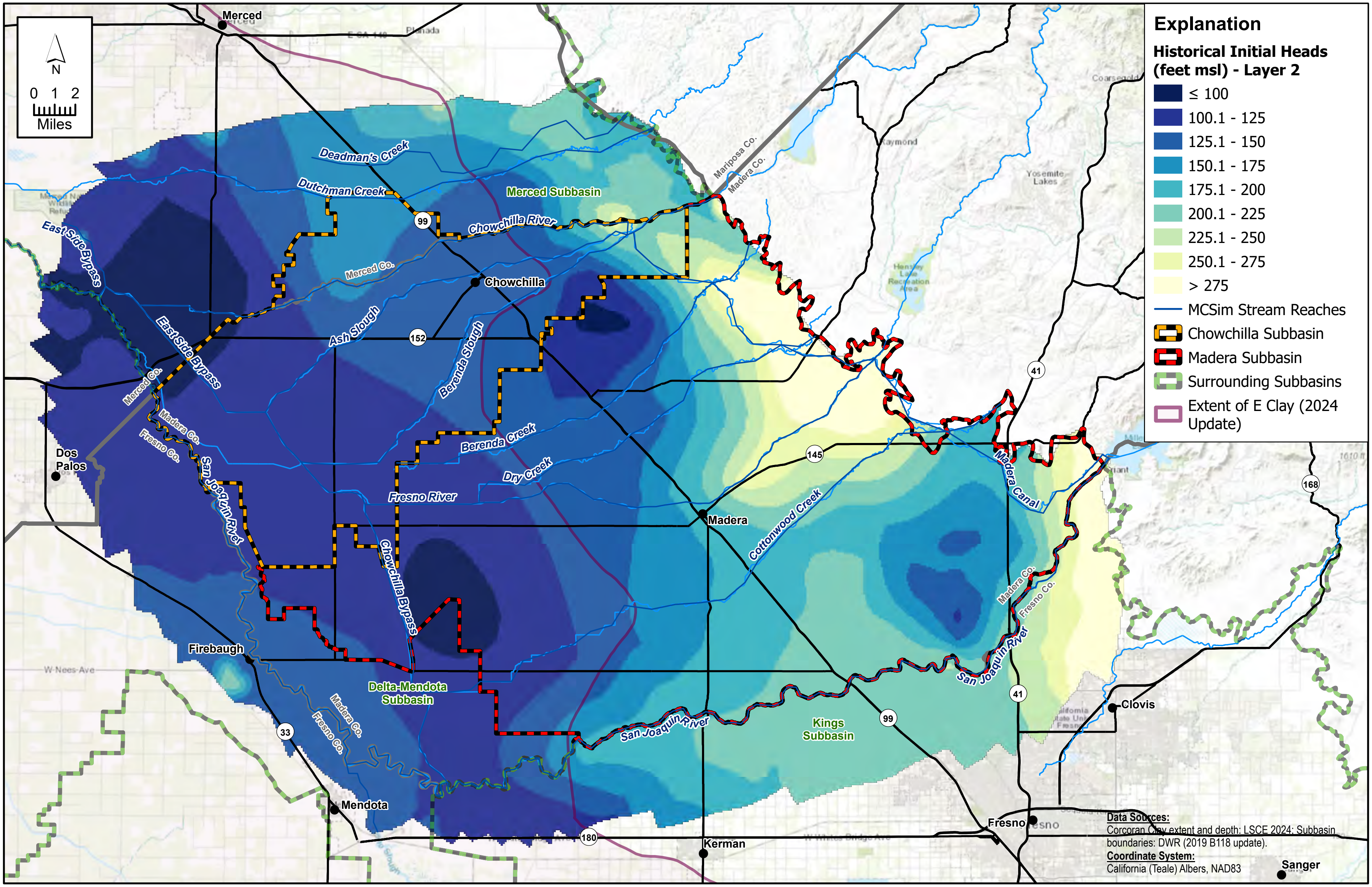
FIGURE 3-52

Historical Initial Groundwater Heads - Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; InCond_HIST_20241029_3

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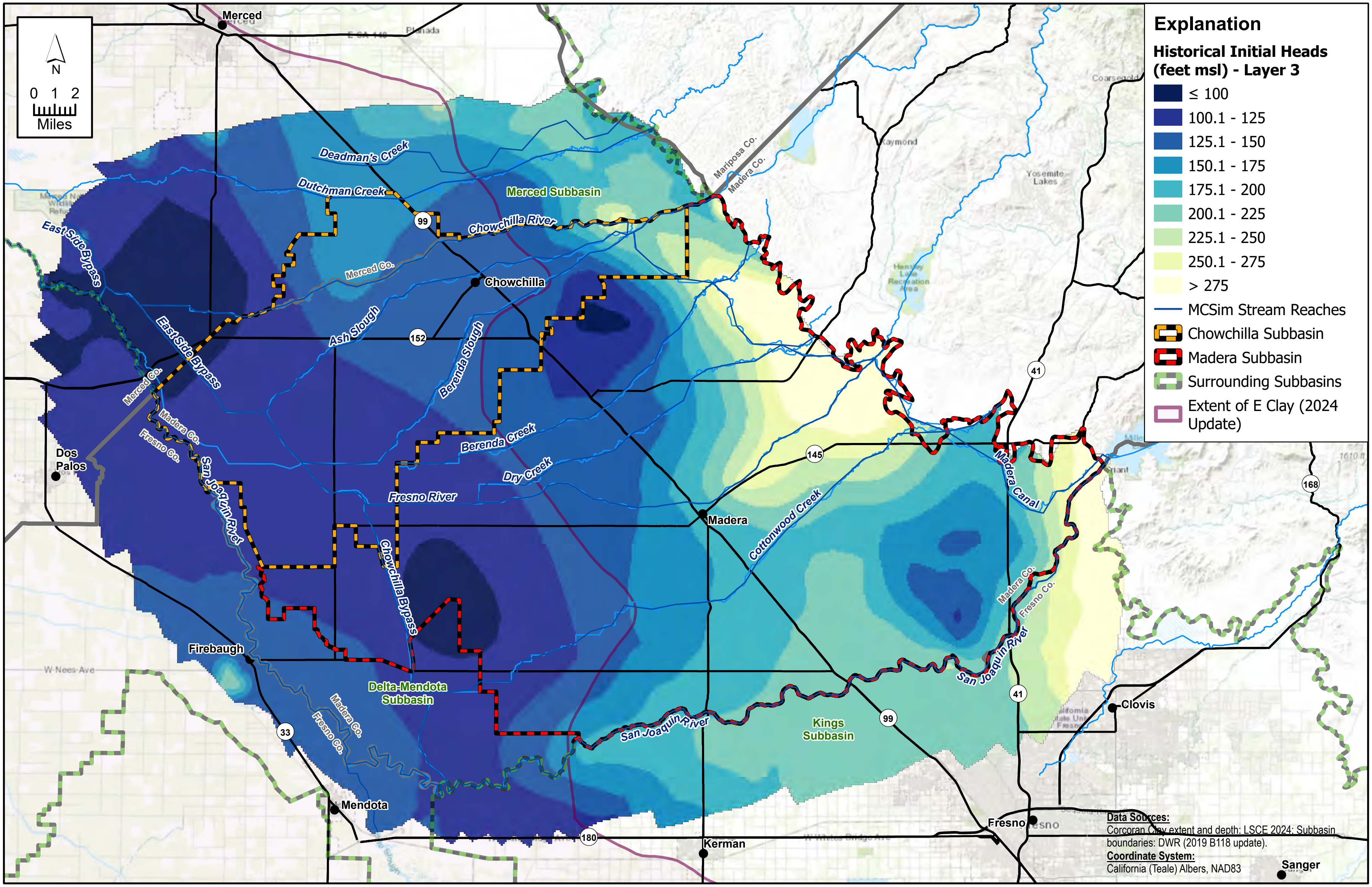
FIGURE 3-53

Historical Initial Groundwater Heads - Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; InCond_HIST_20241029_3

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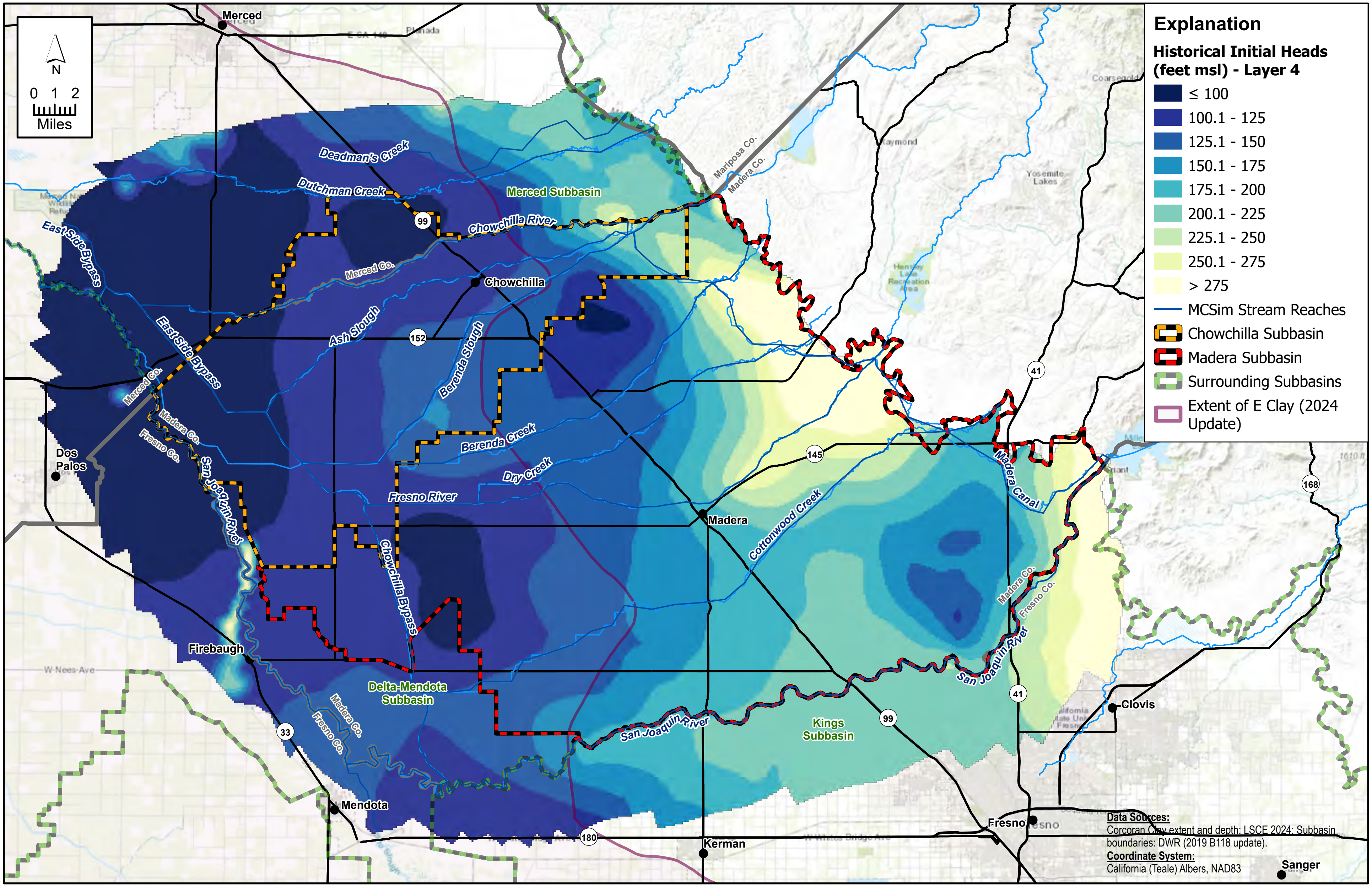
FIGURE 3-54

Historical Initial Groundwater Heads - Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; InCond_HIST_20241029_3

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FIGURE 3-55

Historical Initial Groundwater Heads - Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

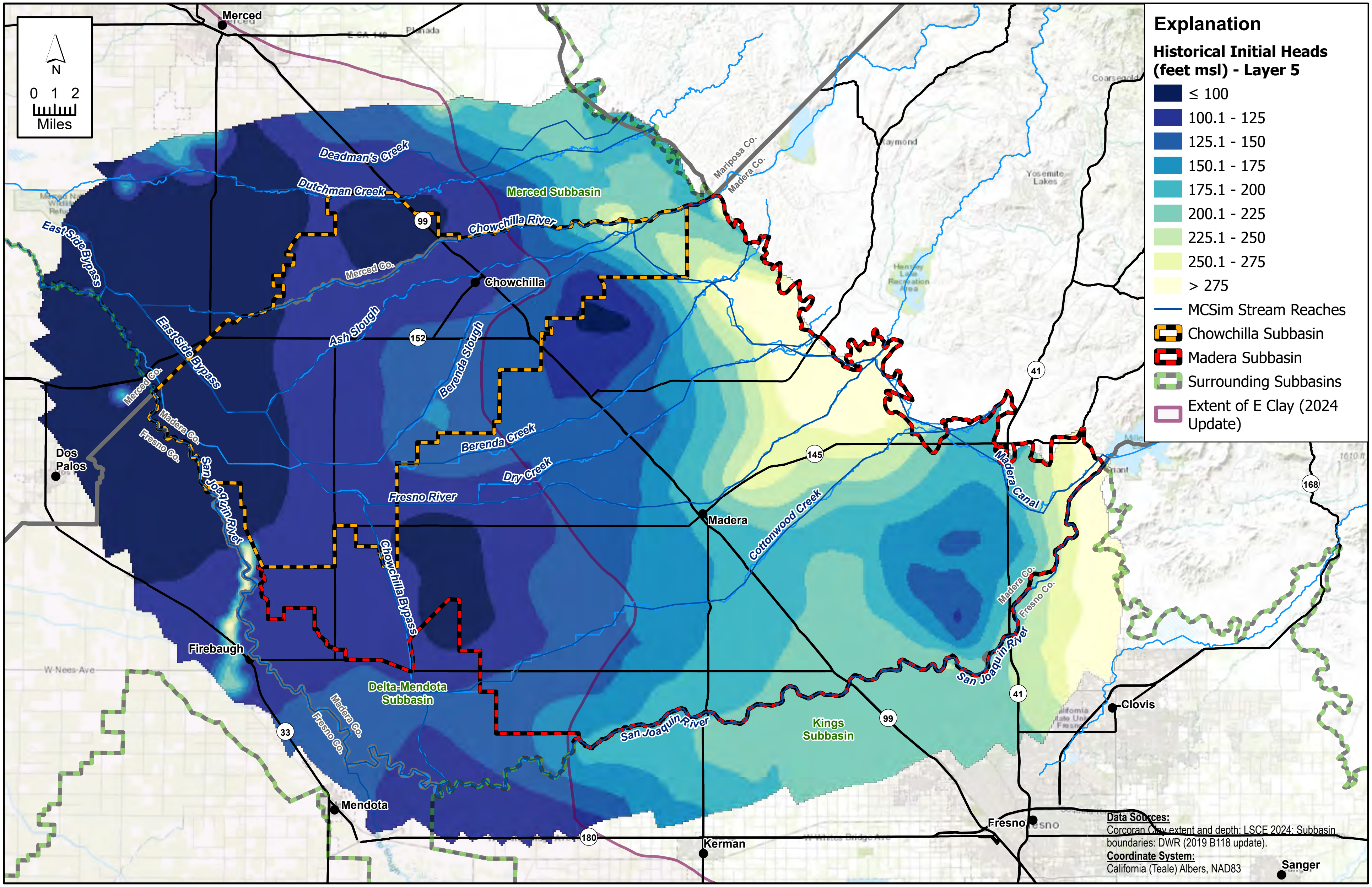

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FIGURE 3-56

Historical Initial Groundwater Heads - Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

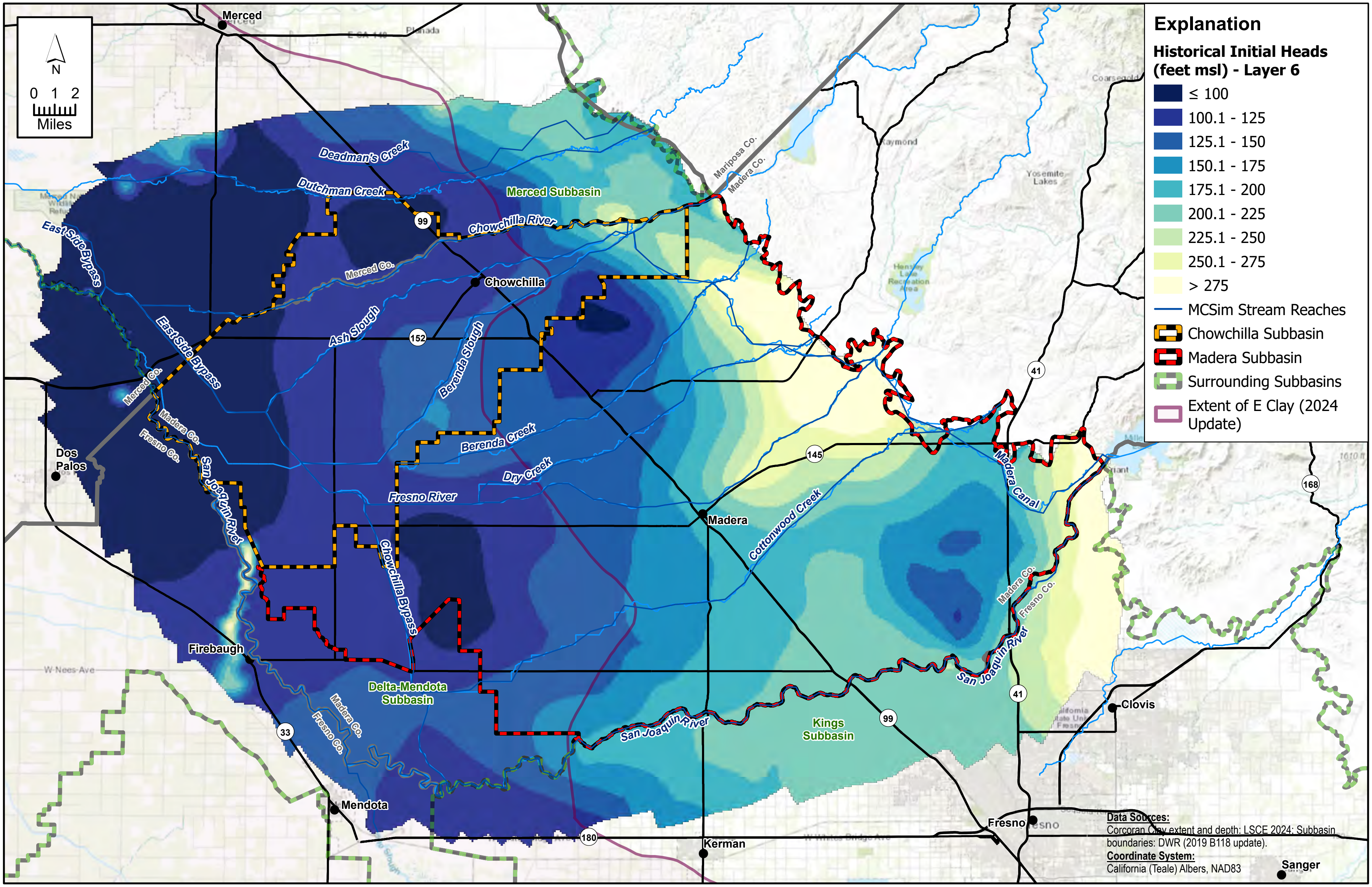

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FIGURE 3-57

Historical Initial Groundwater Heads - Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

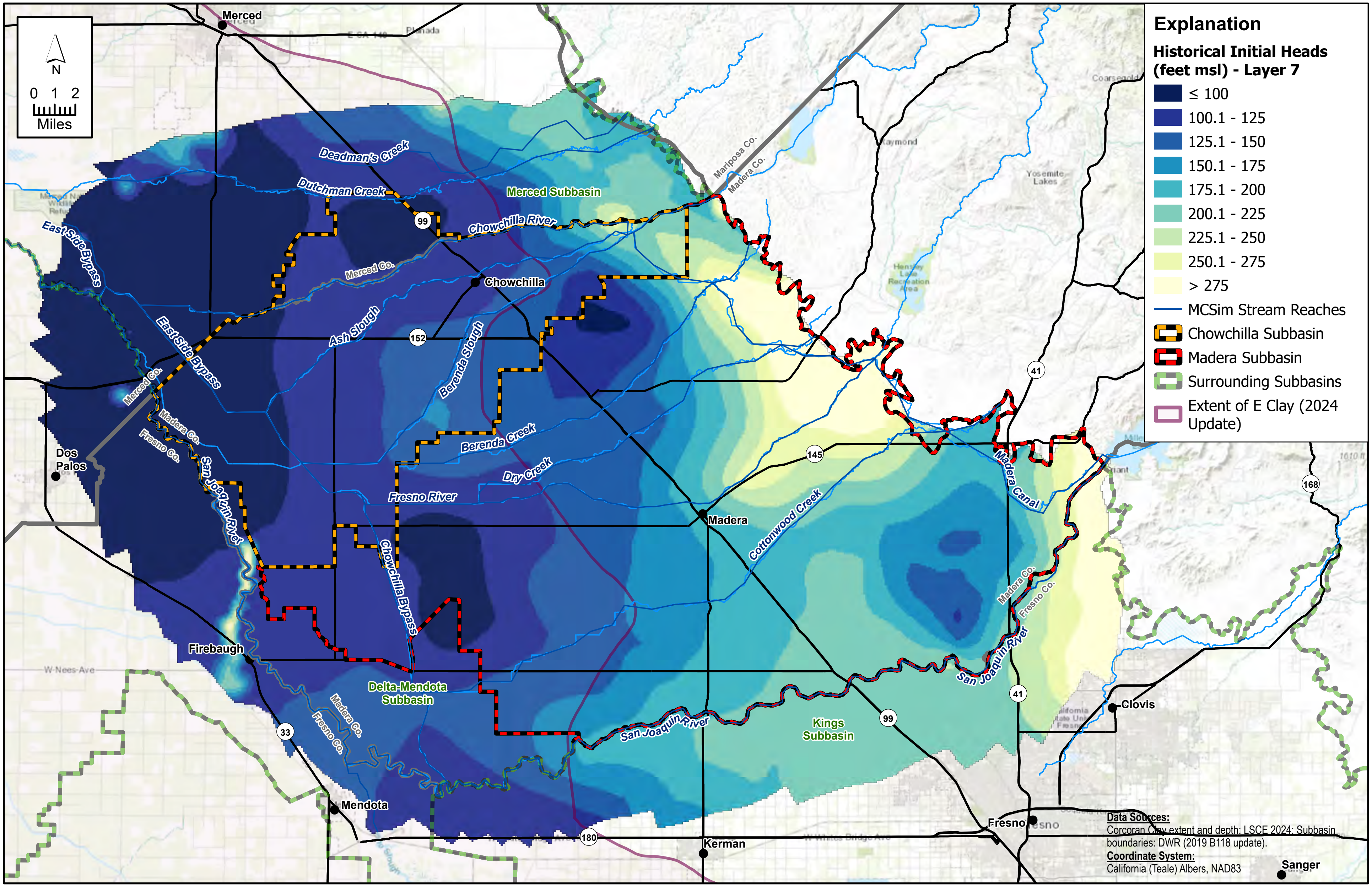

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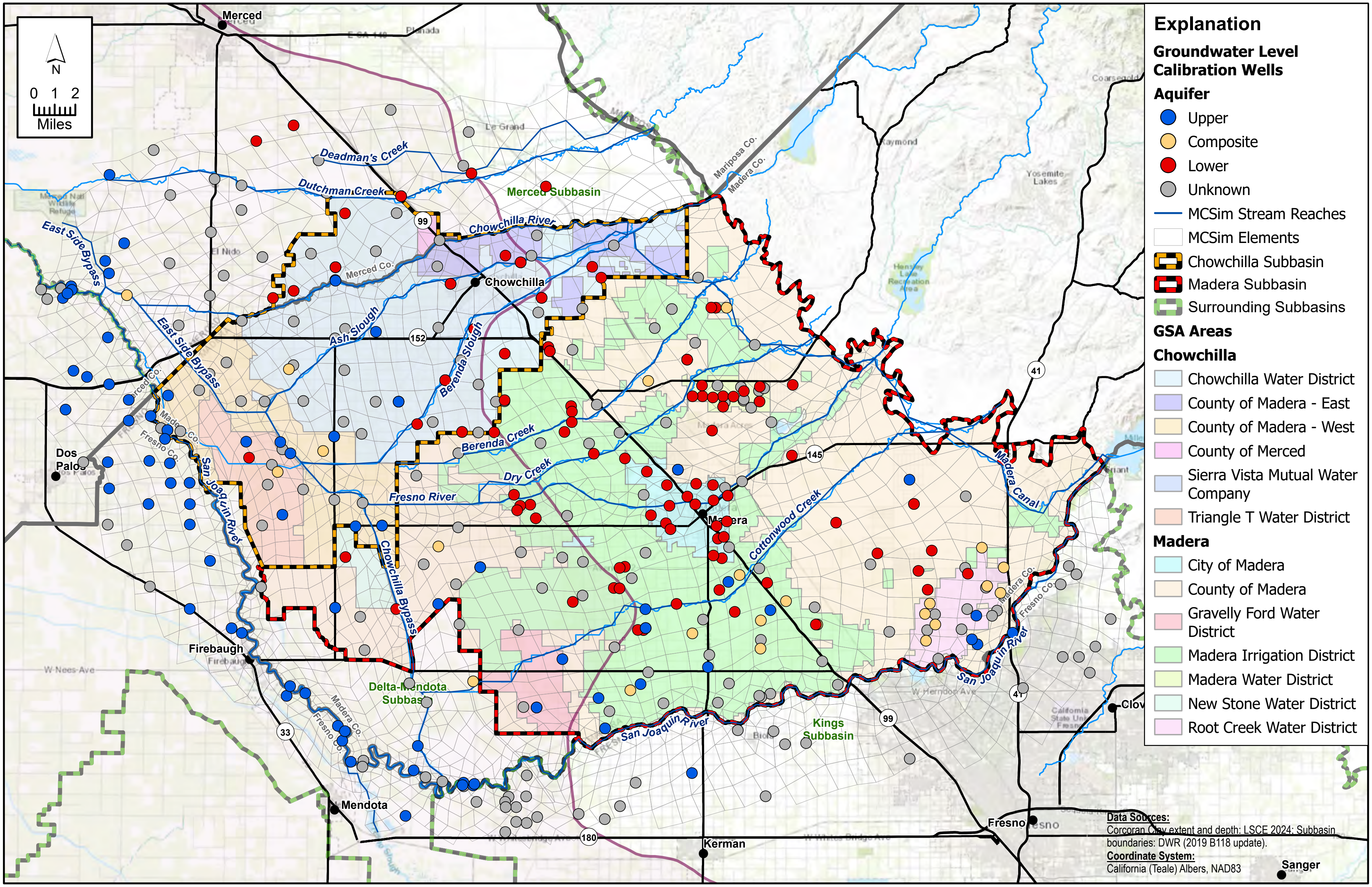
FIGURE 3-58

Historical Initial Groundwater Heads - Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; Calibration Points

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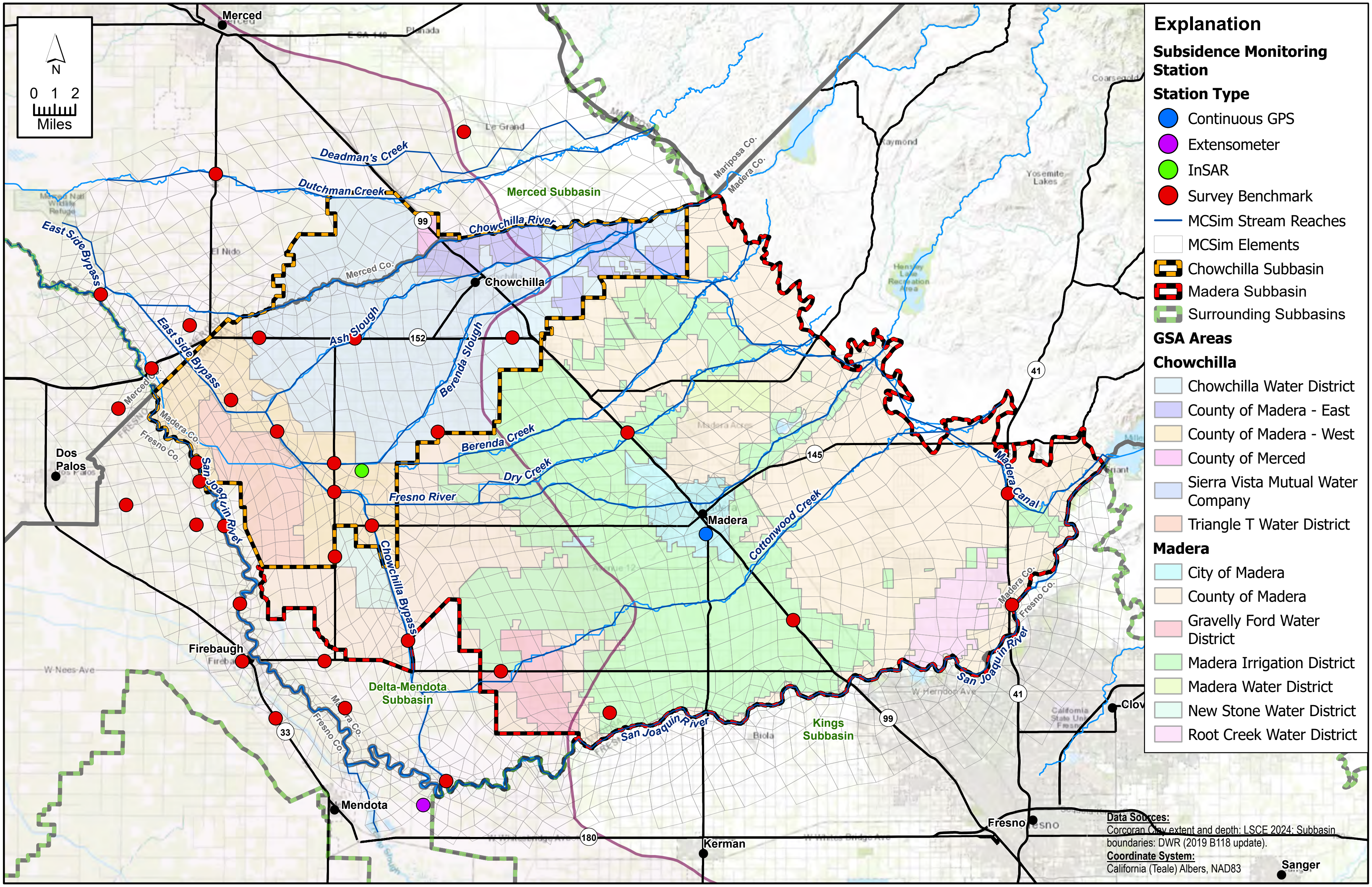
FIGURE 3-59

Map of Groundwater Level Calibration Wells

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; Calibration Points

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FIGURE 3-60

Map of Subsidence Calibration Stations

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

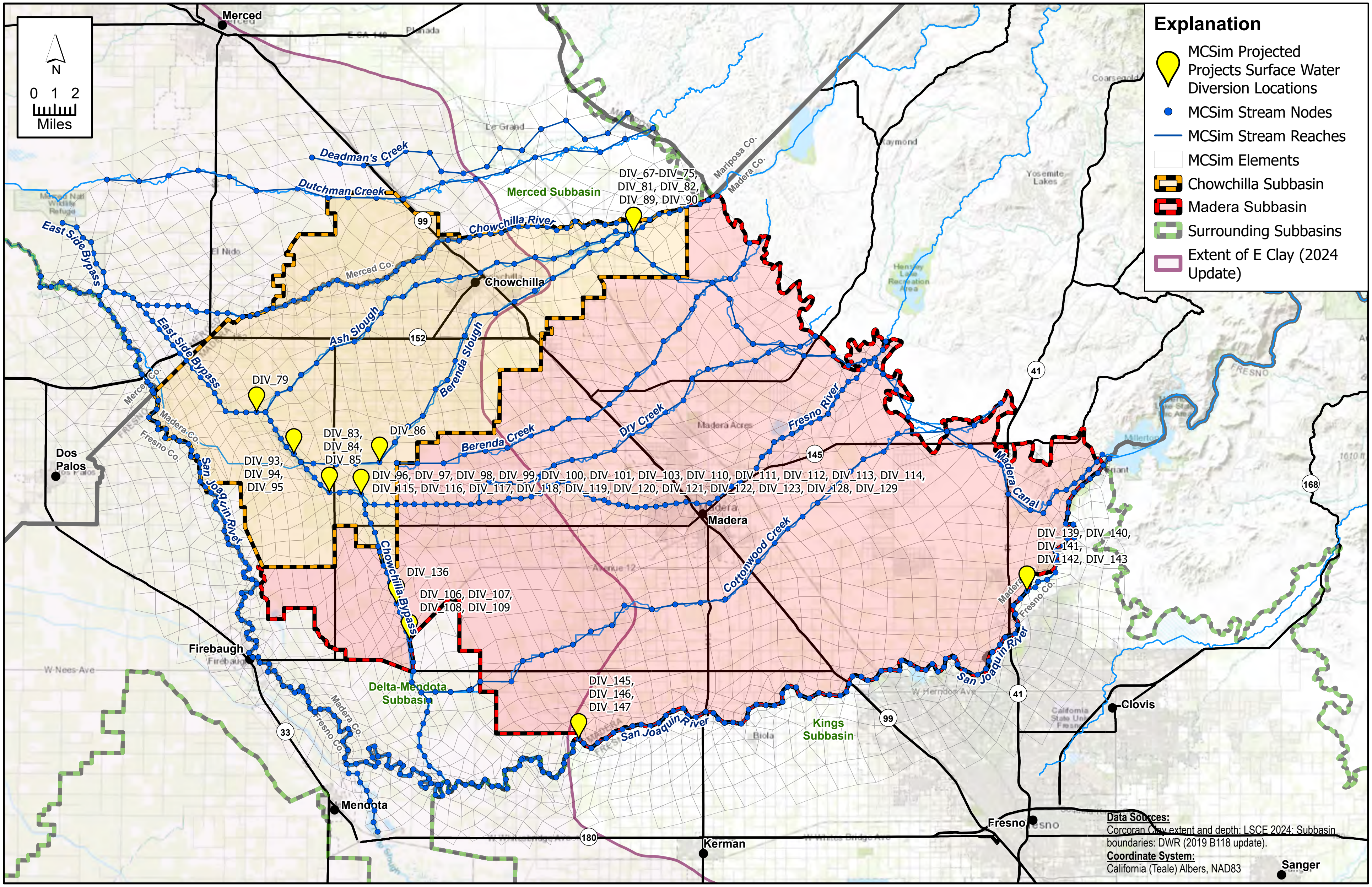

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FIGURE 3-61

MCSim Projected Projects Surface Water Diversions Locations

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

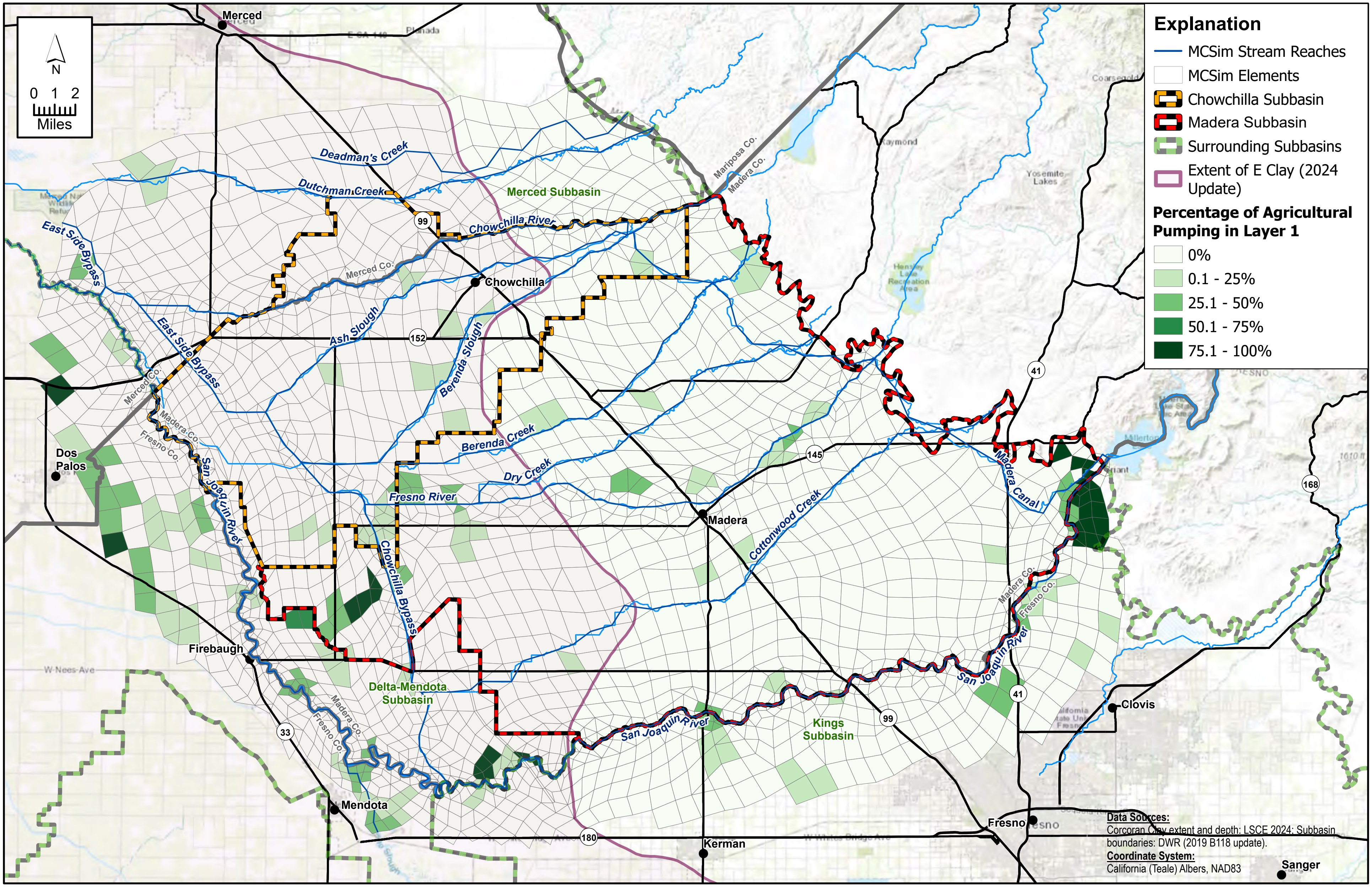

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FIGURE 3-62

Vertical Distribution of Projected Agricultural Pumping - Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

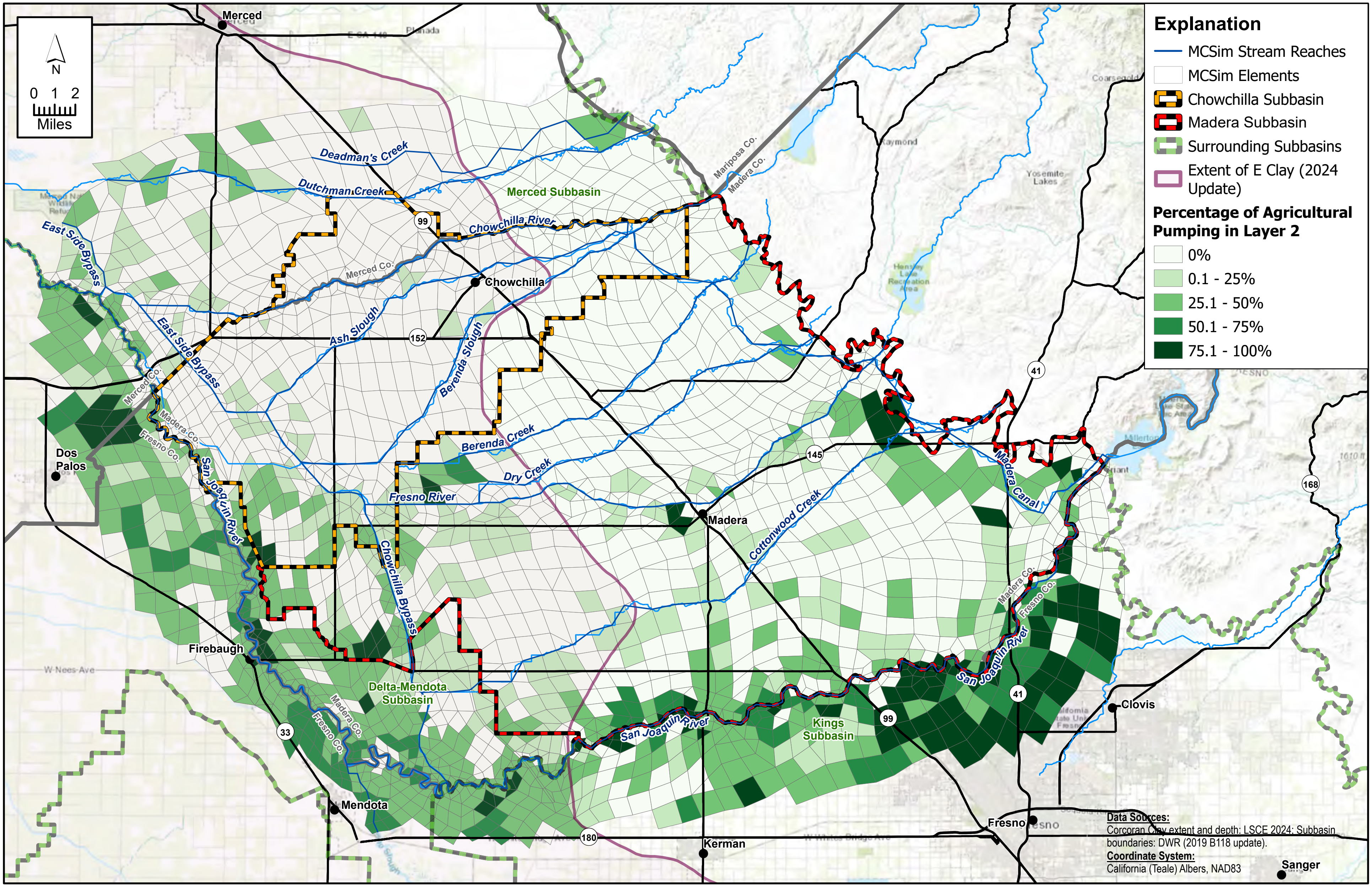

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FIGURE 3-63

Vertical Distribution of Projected Agricultural Pumping - Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

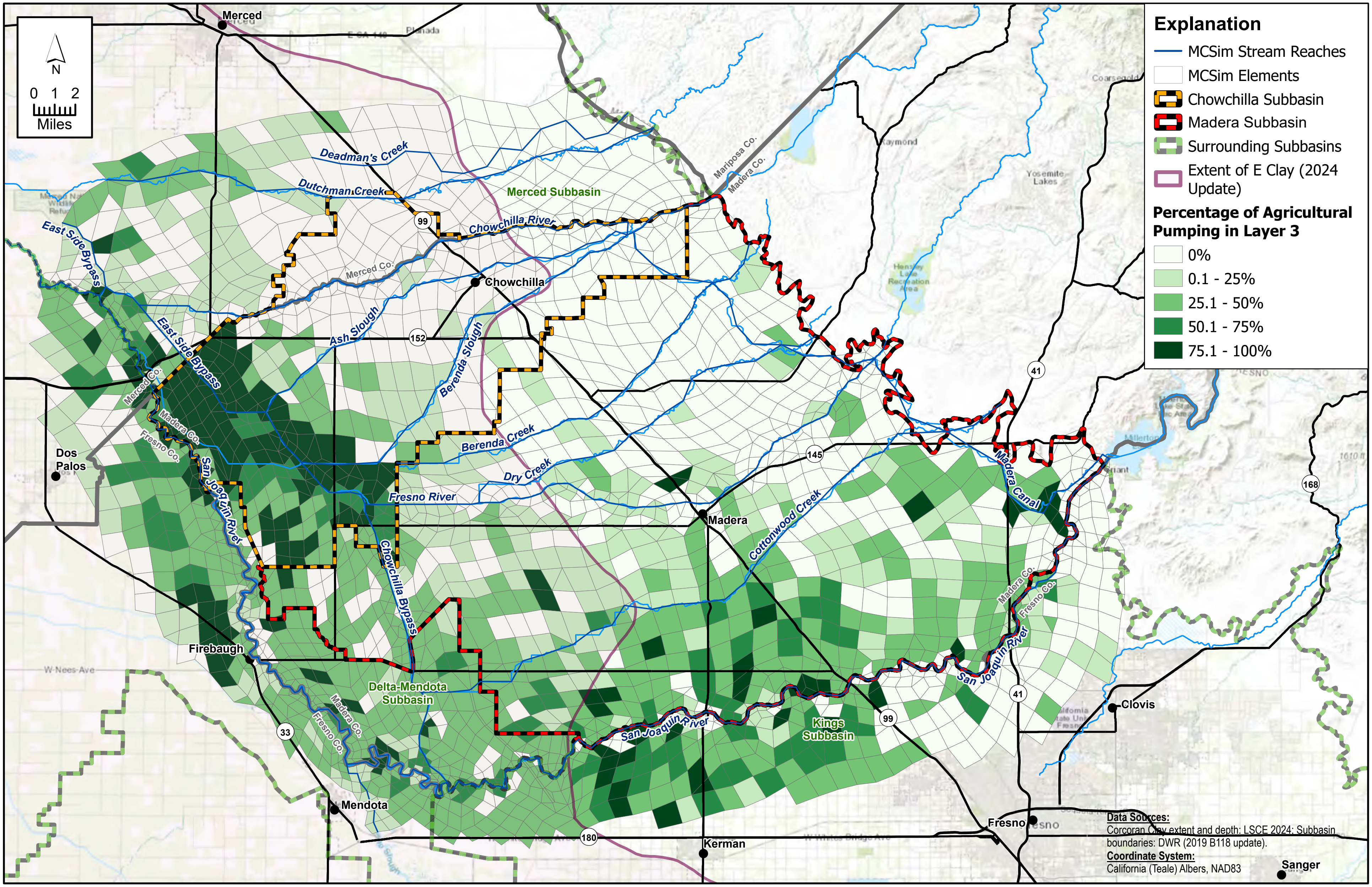

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FIGURE 3-64

Vertical Distribution of Projected Agricultural Pumping - Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

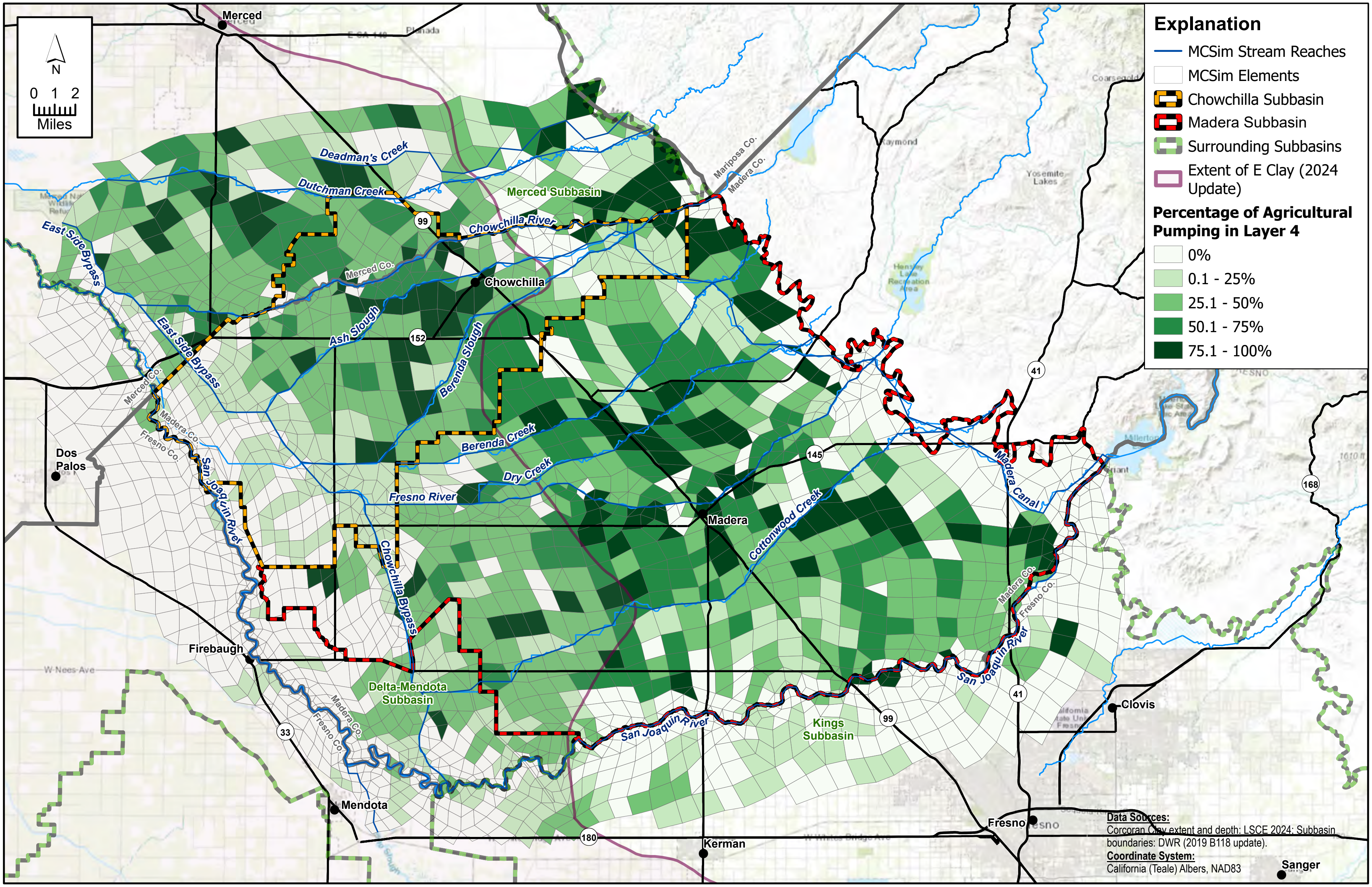

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FIGURE 3-65

Vertical Distribution of Projected Agricultural Pumping - Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

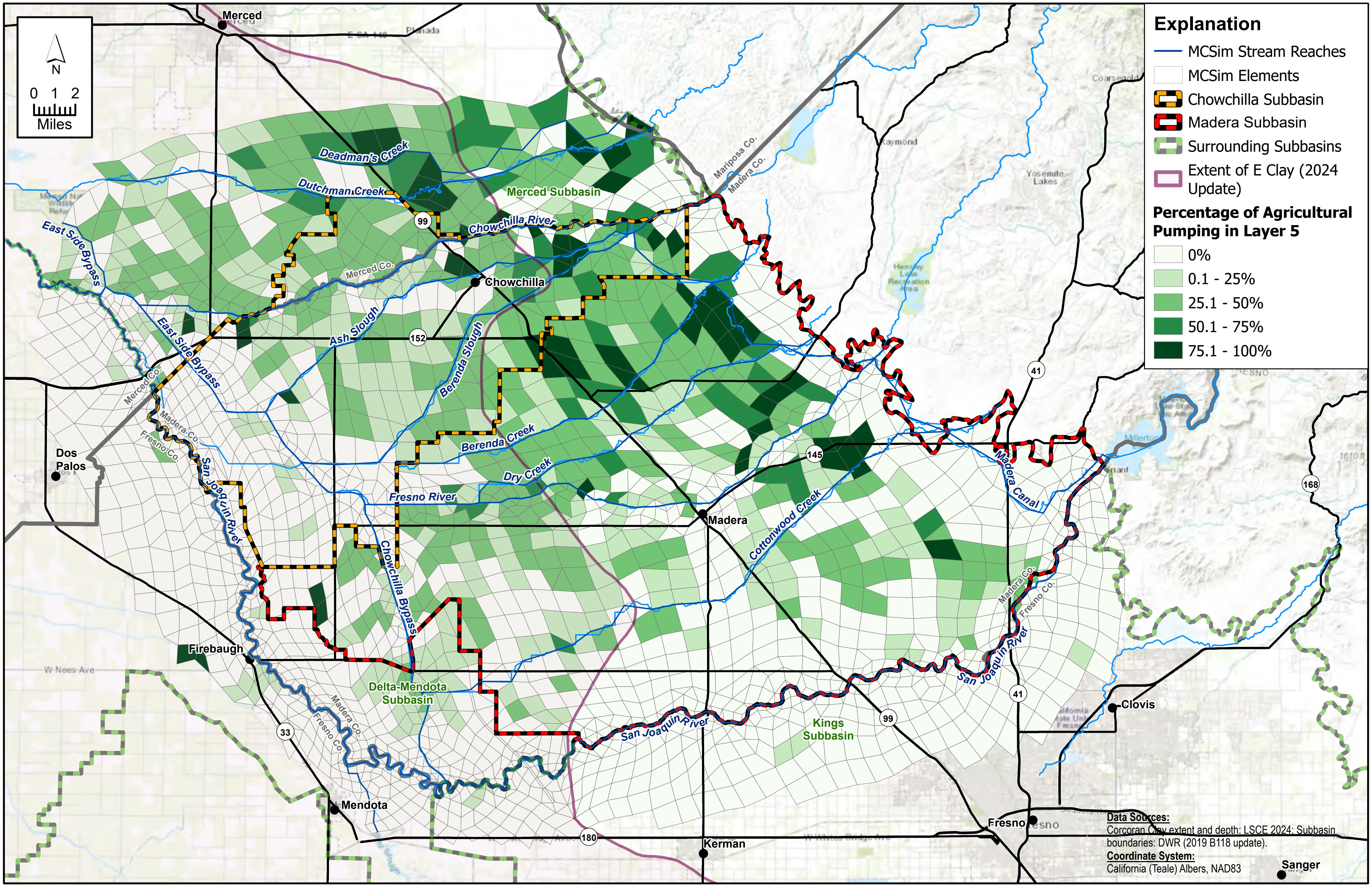

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FIGURE 3-66

Vertical Distribution of Projected Agricultural Pumping - Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

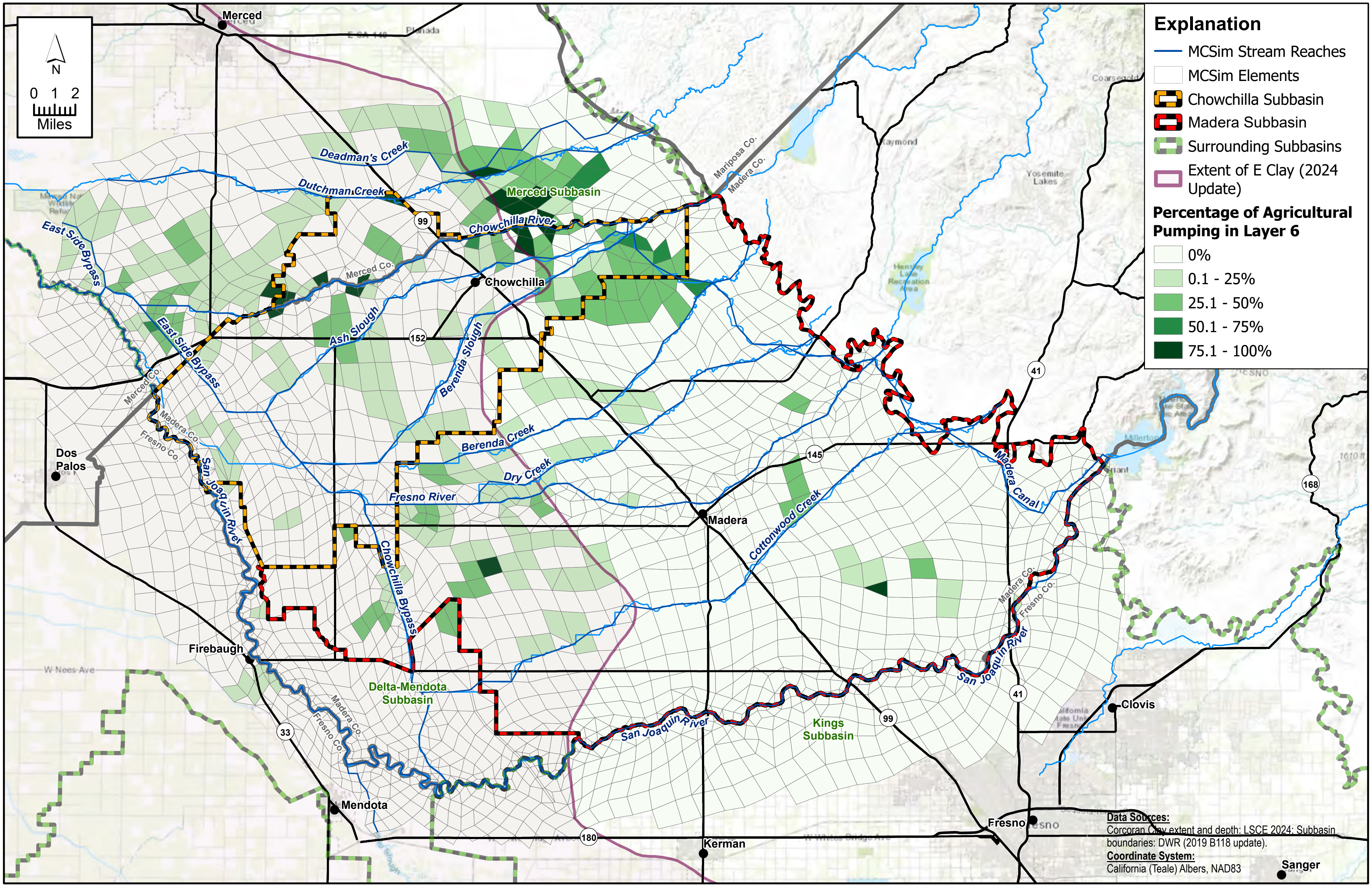

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FIGURE 3-67

Vertical Distribution of Projected Agricultural Pumping - Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

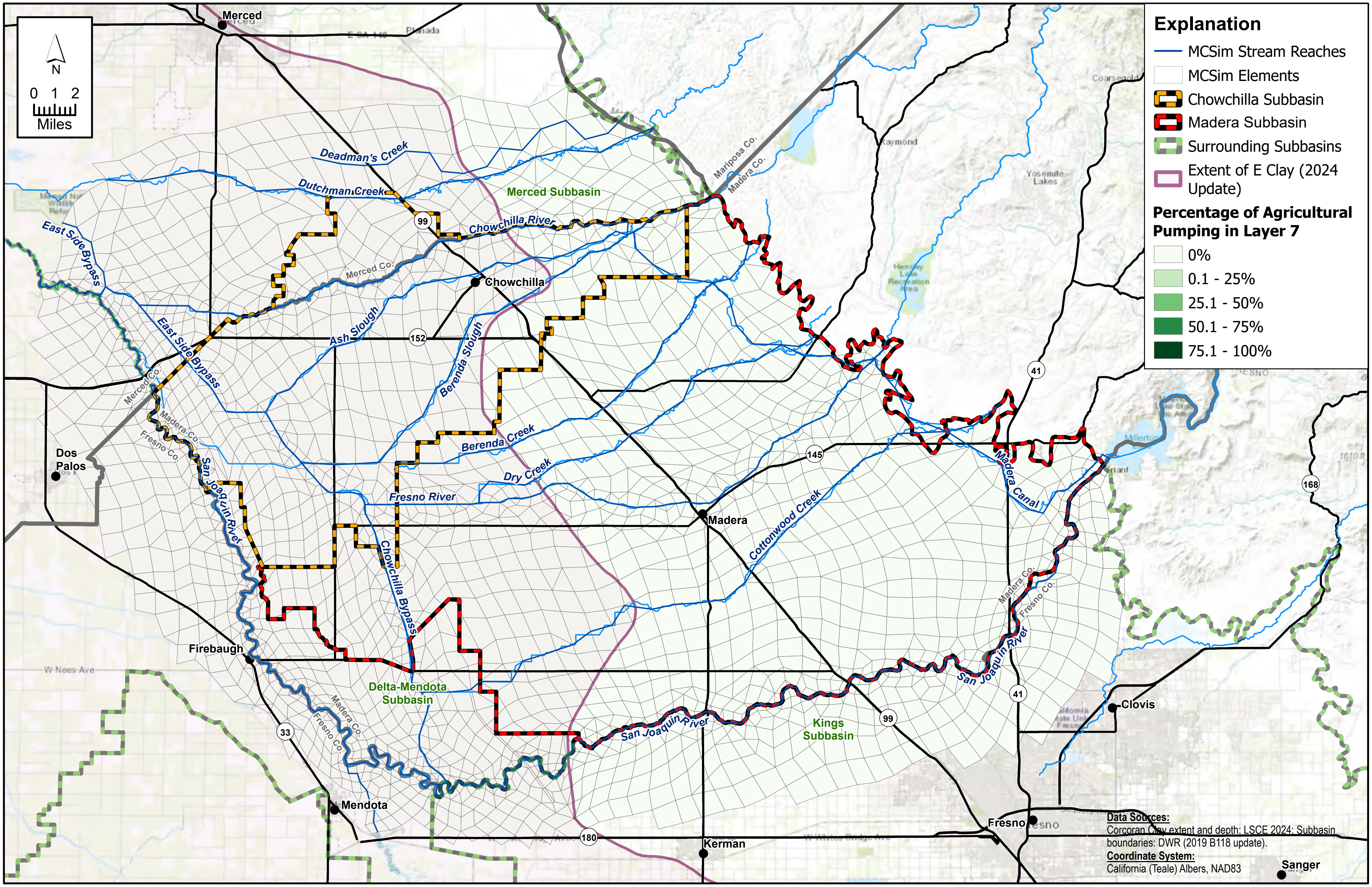

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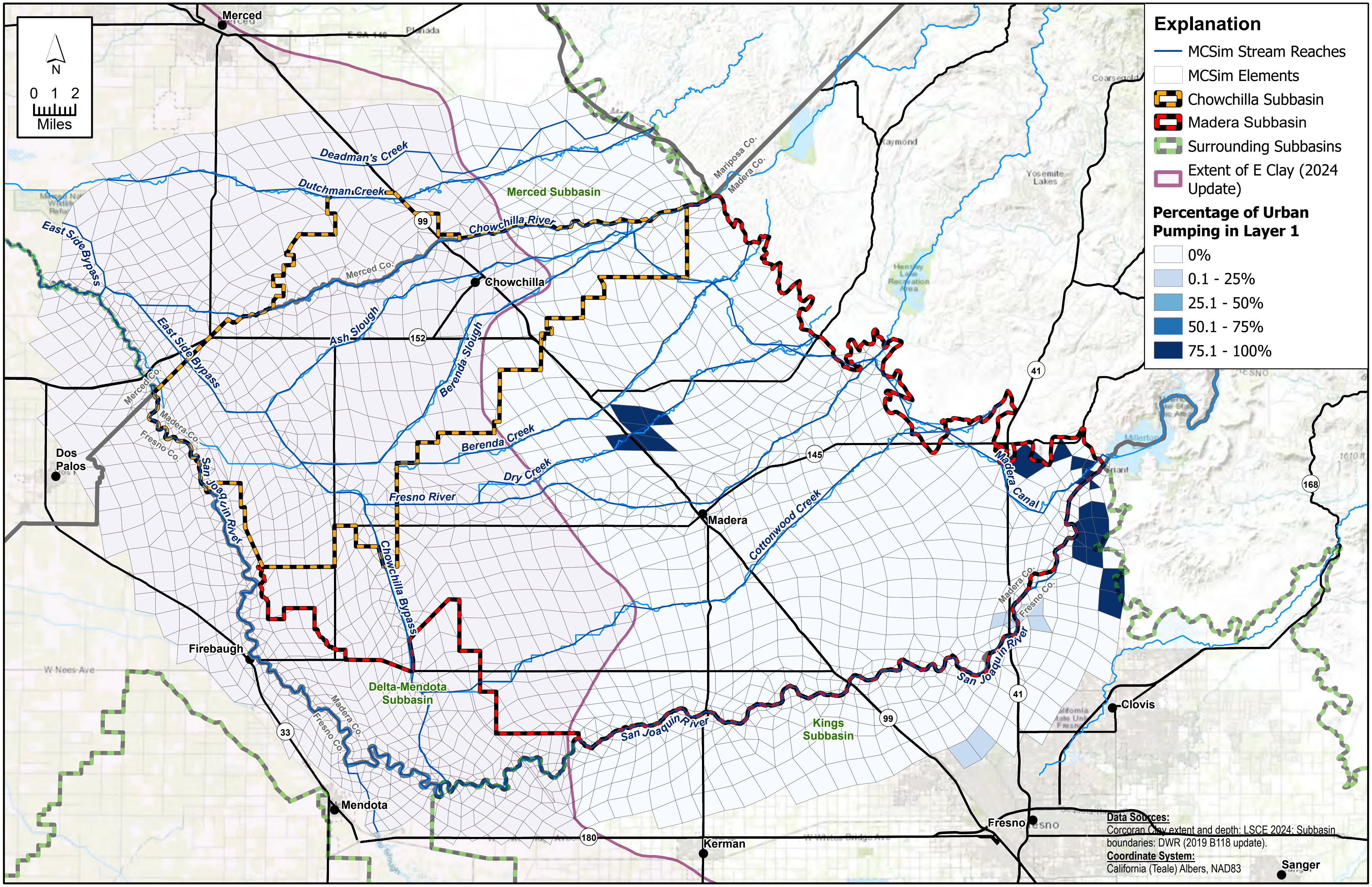
FIGURE 3-68

Vertical Distribution of Projected Agricultural Pumping - Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_PROJ_ELEM_PUMP_URBAN

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FIGURE 3-69

Vertical Distribution of Projected Urban Pumping - Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

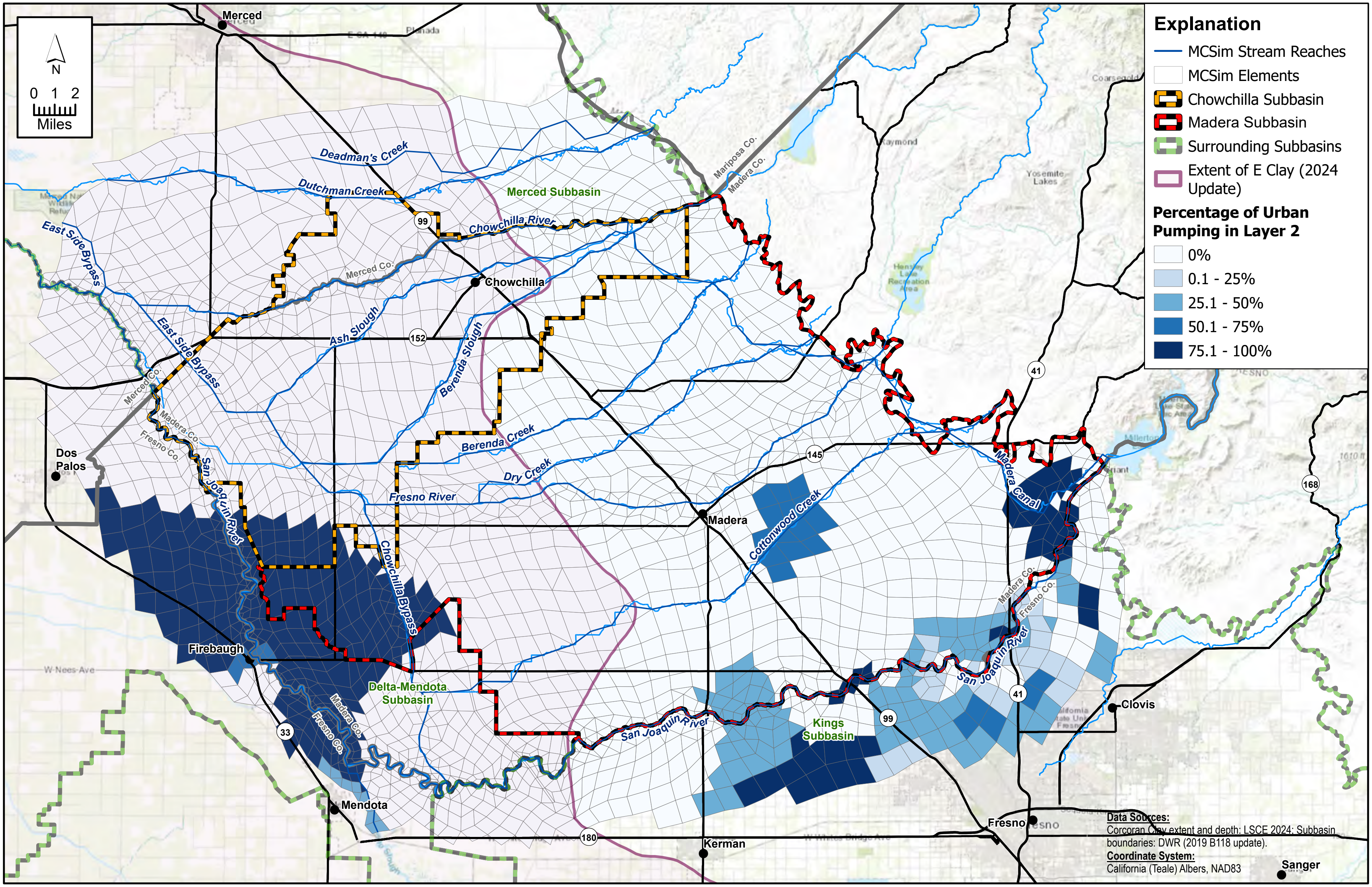

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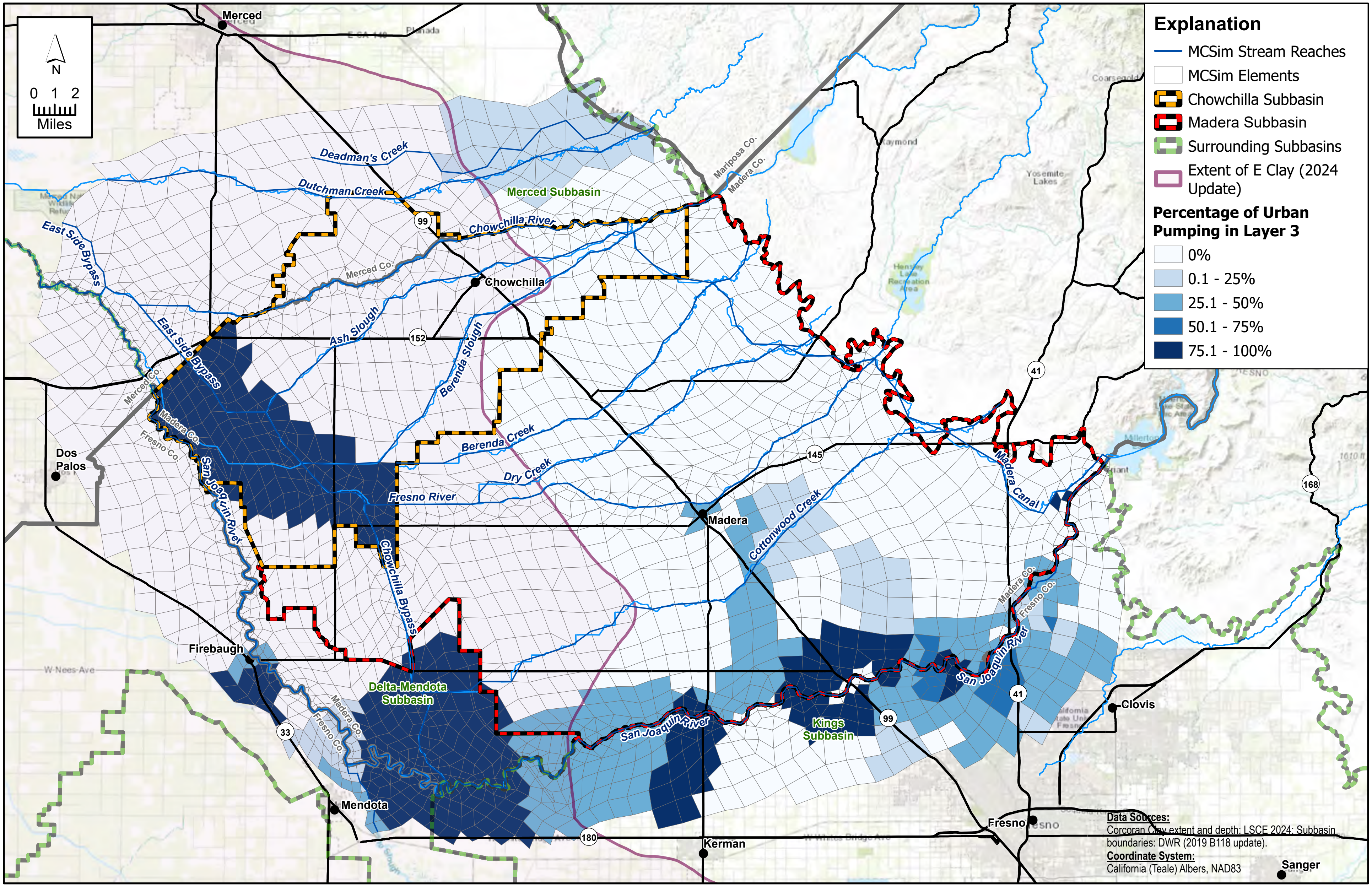
FIGURE 3-70

Vertical Distribution of Projected Urban Pumping - Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_PROJ_ELEM_PUMP_URBAN

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FIGURE 3-71

Vertical Distribution of Projected Urban Pumping - Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

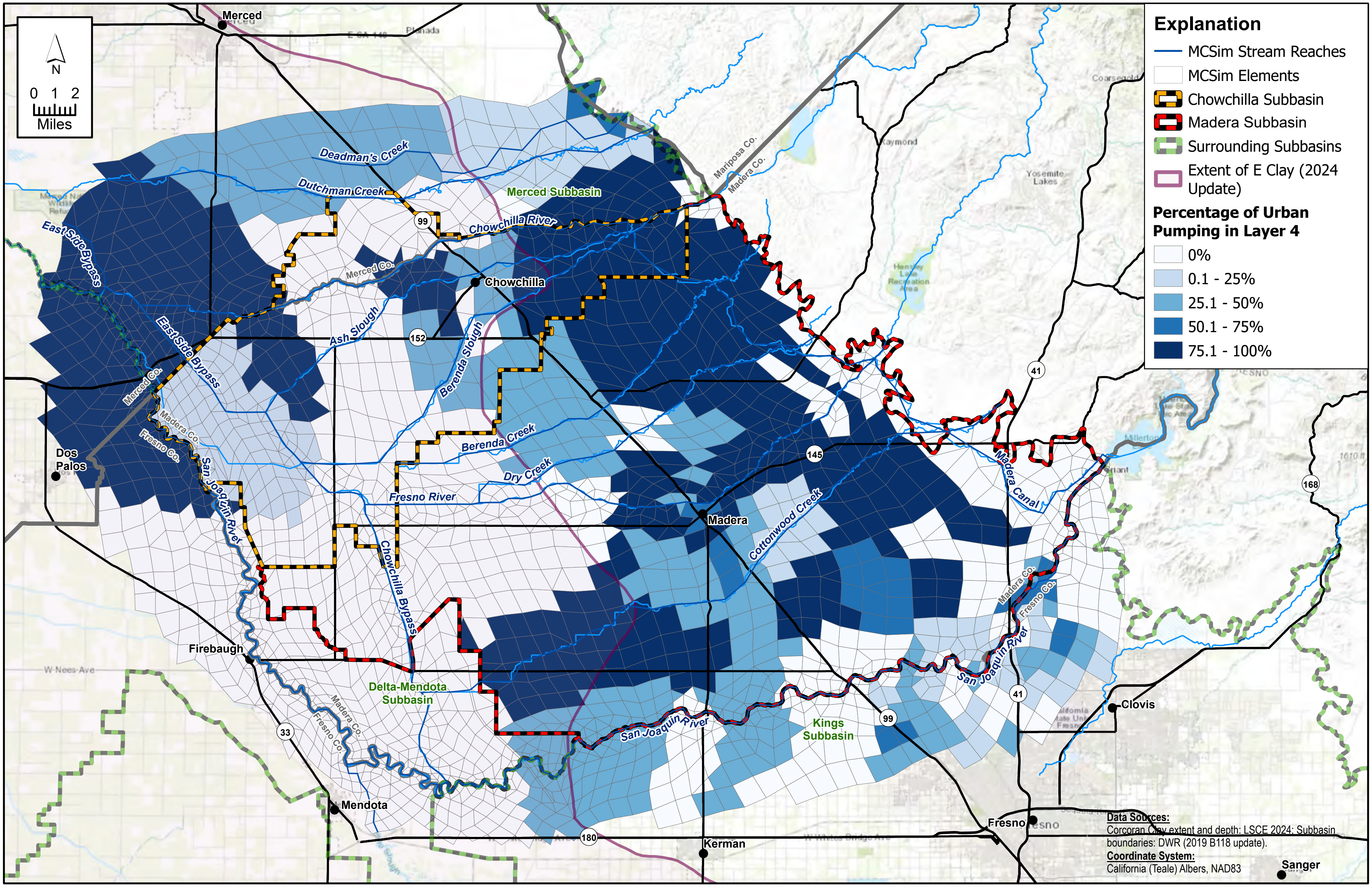

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FIGURE 3-72

Vertical Distribution of Projected Urban Pumping - Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

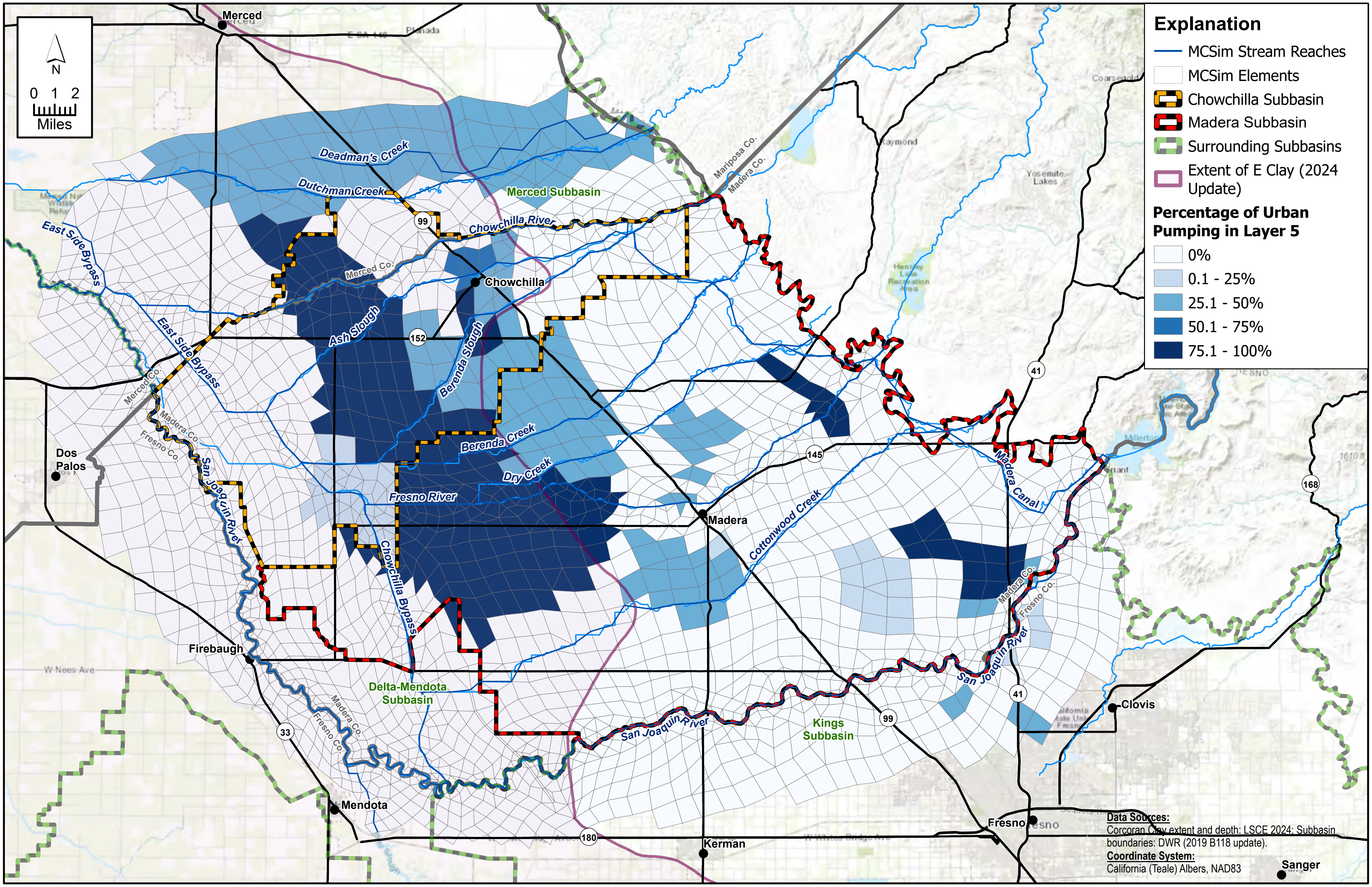

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FIGURE 3-73

Vertical Distribution of Projected Urban Pumping - Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

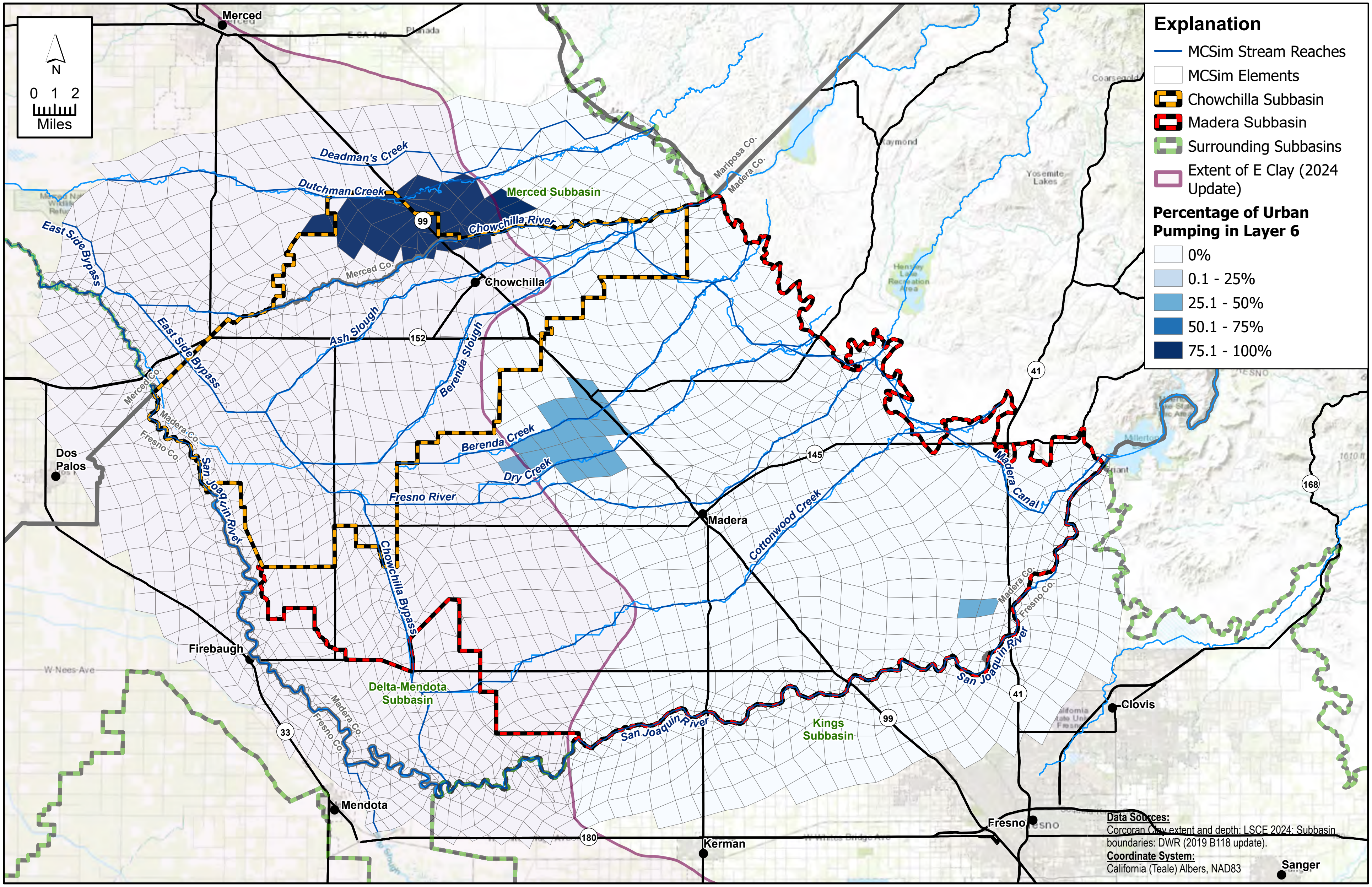

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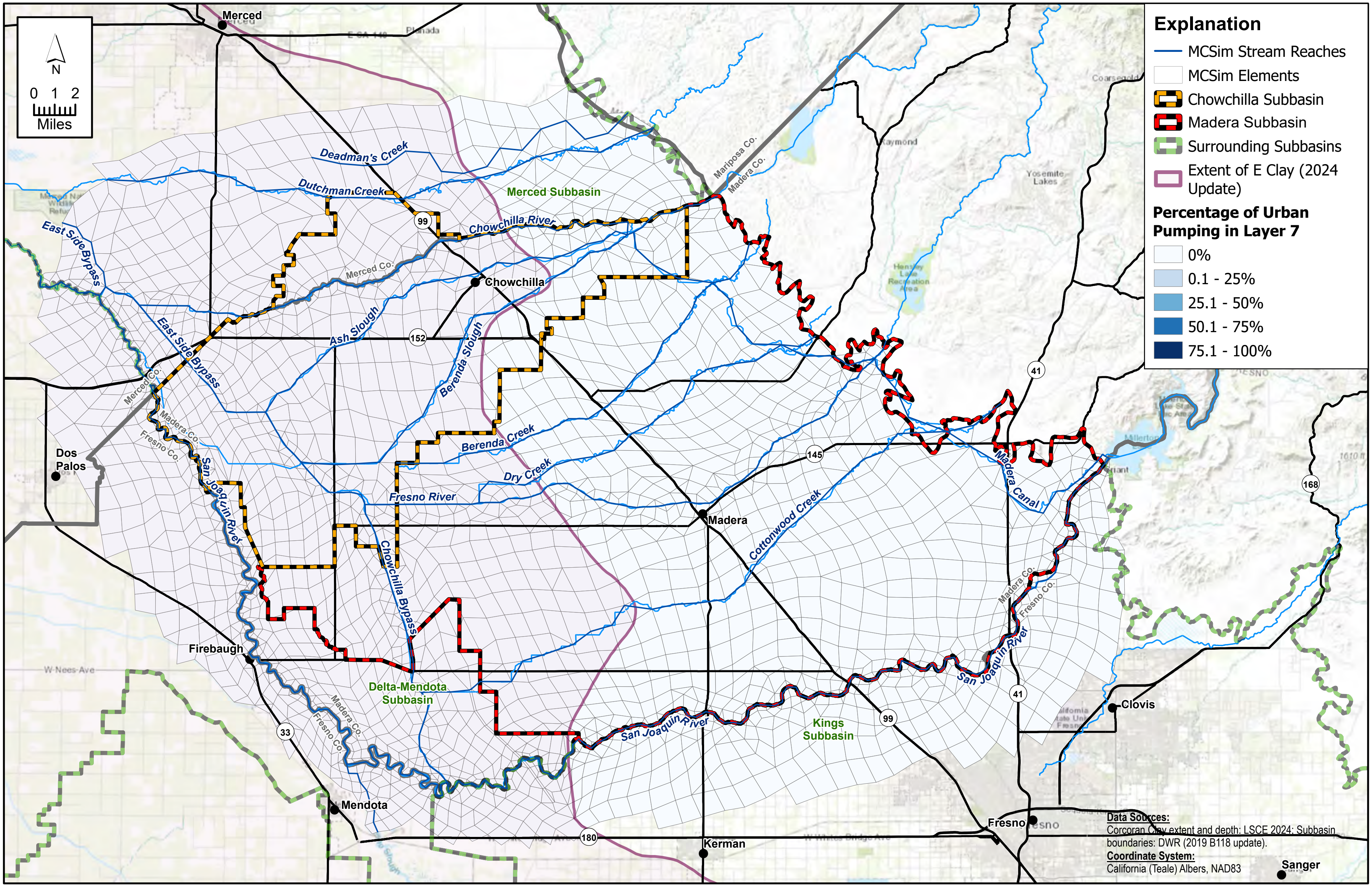
FIGURE 3-74

Vertical Distribution of Projected Urban Pumping - Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; GW_PROJ_ELEM_PUMP_URBAN

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FIGURE 3-75

Vertical Distribution of Projected Urban Pumping - Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

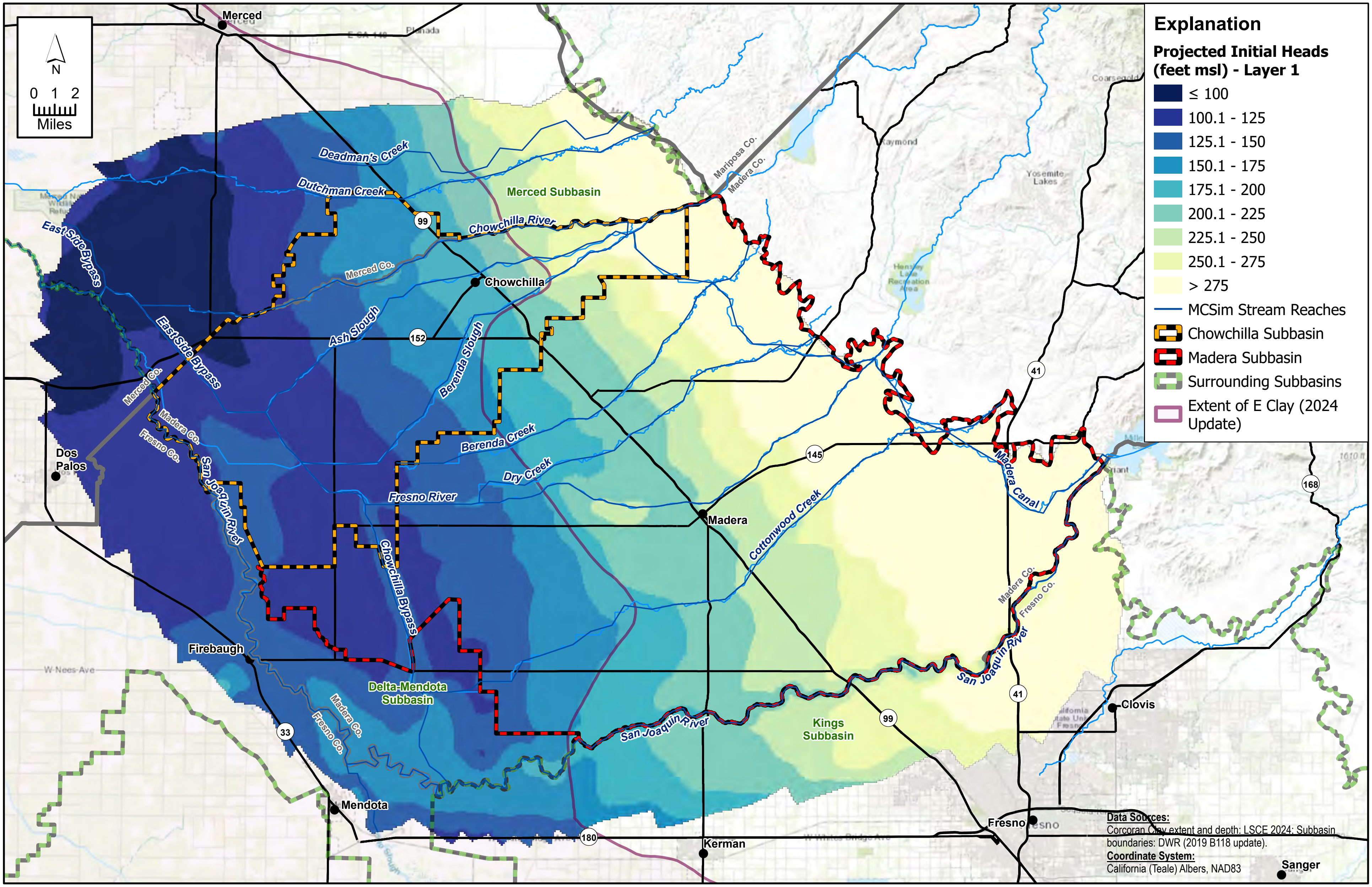

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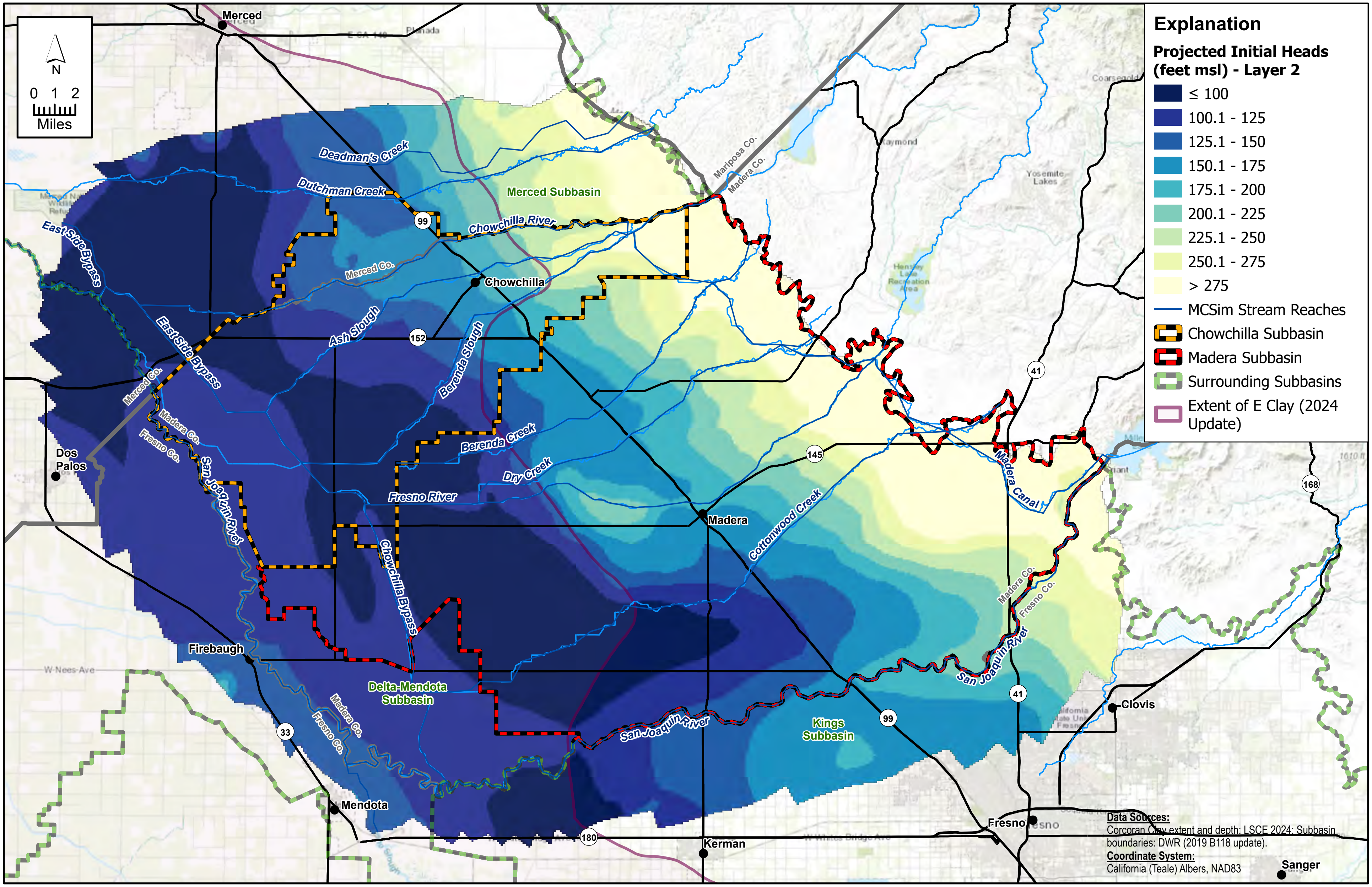
FIGURE 3-76

Projected Initial Groundwater Heads - Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; InCond_PROJ_20241029_1

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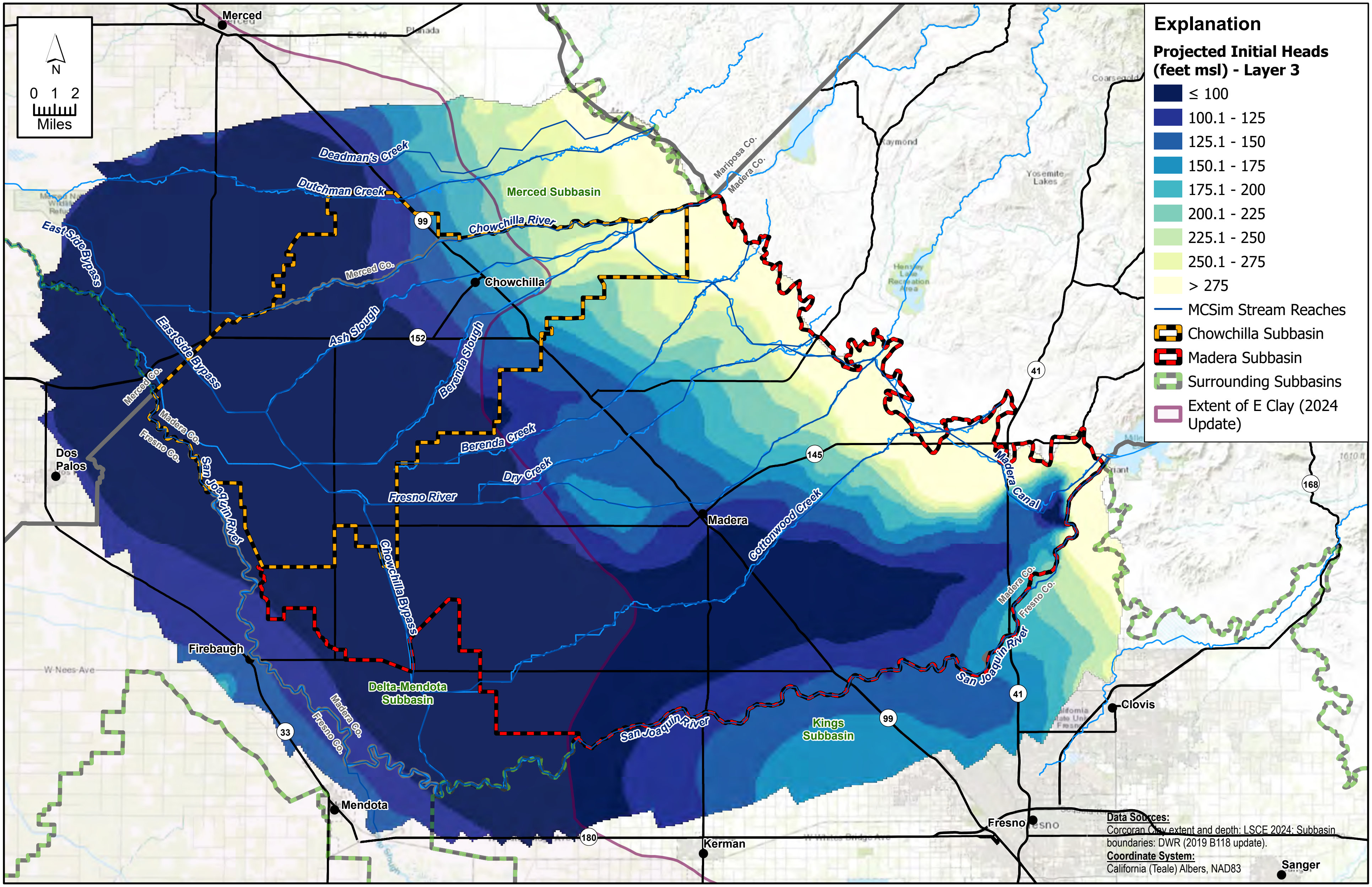
FIGURE 3-77

Projected Initial Groundwater Heads - Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; InCond_PROJ_20241029_1

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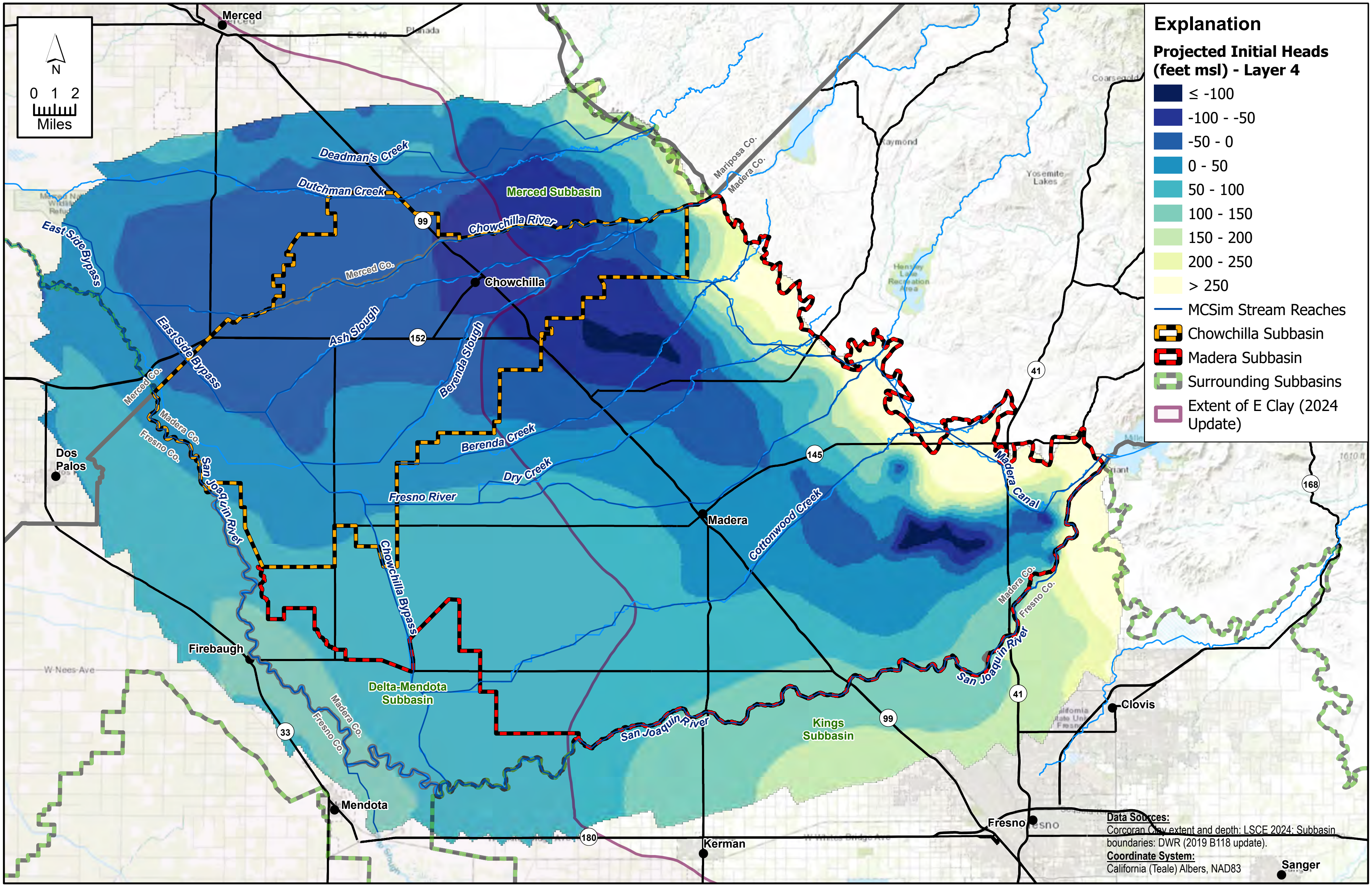
FIGURE 3-78

Projected Initial Groundwater Heads - Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; InCond_PROJ_20241029_1

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FIGURE 3-79

Projected Initial Groundwater Heads - Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

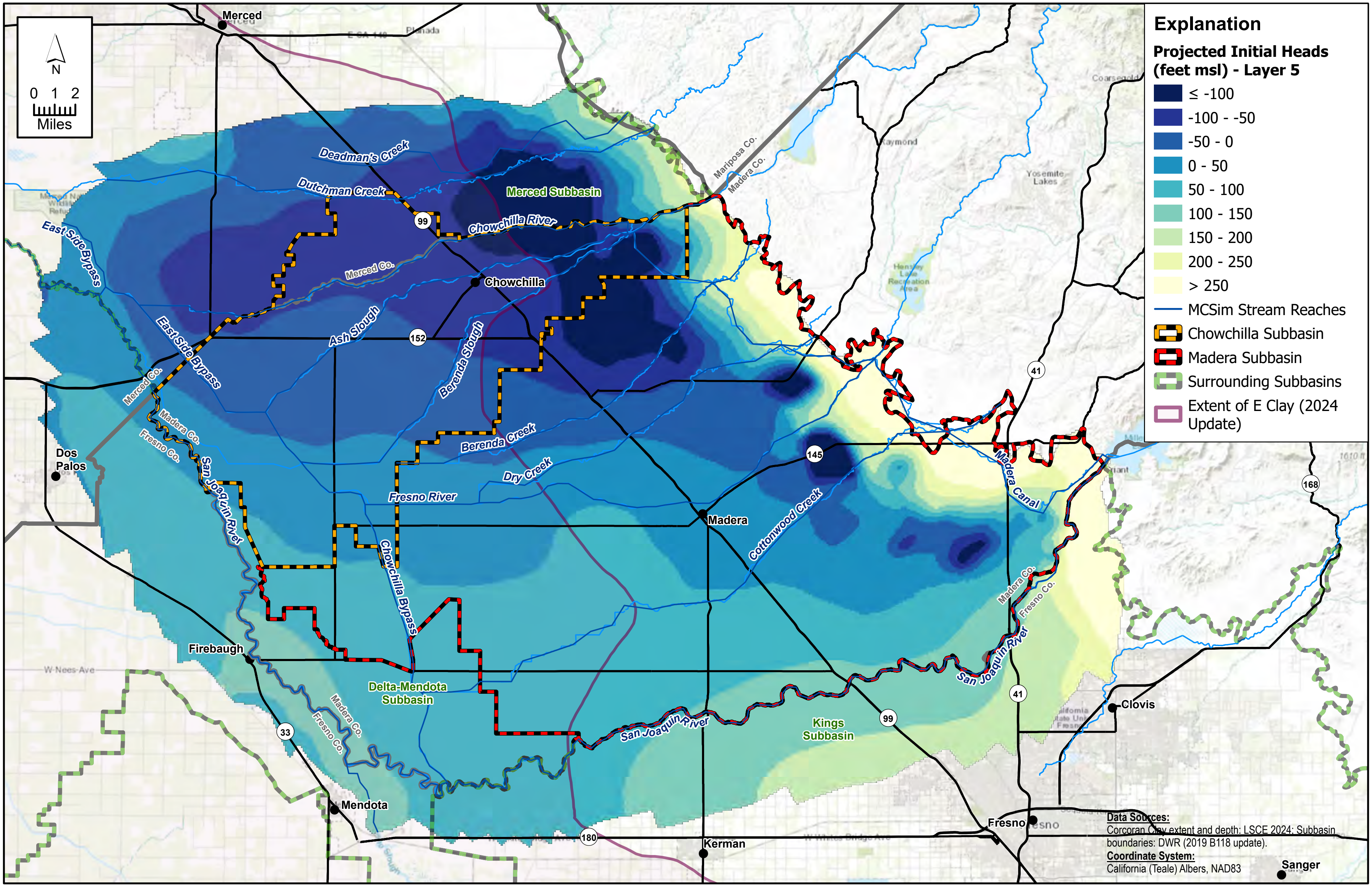

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FIGURE 3-80

Projected Initial Groundwater Heads - Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

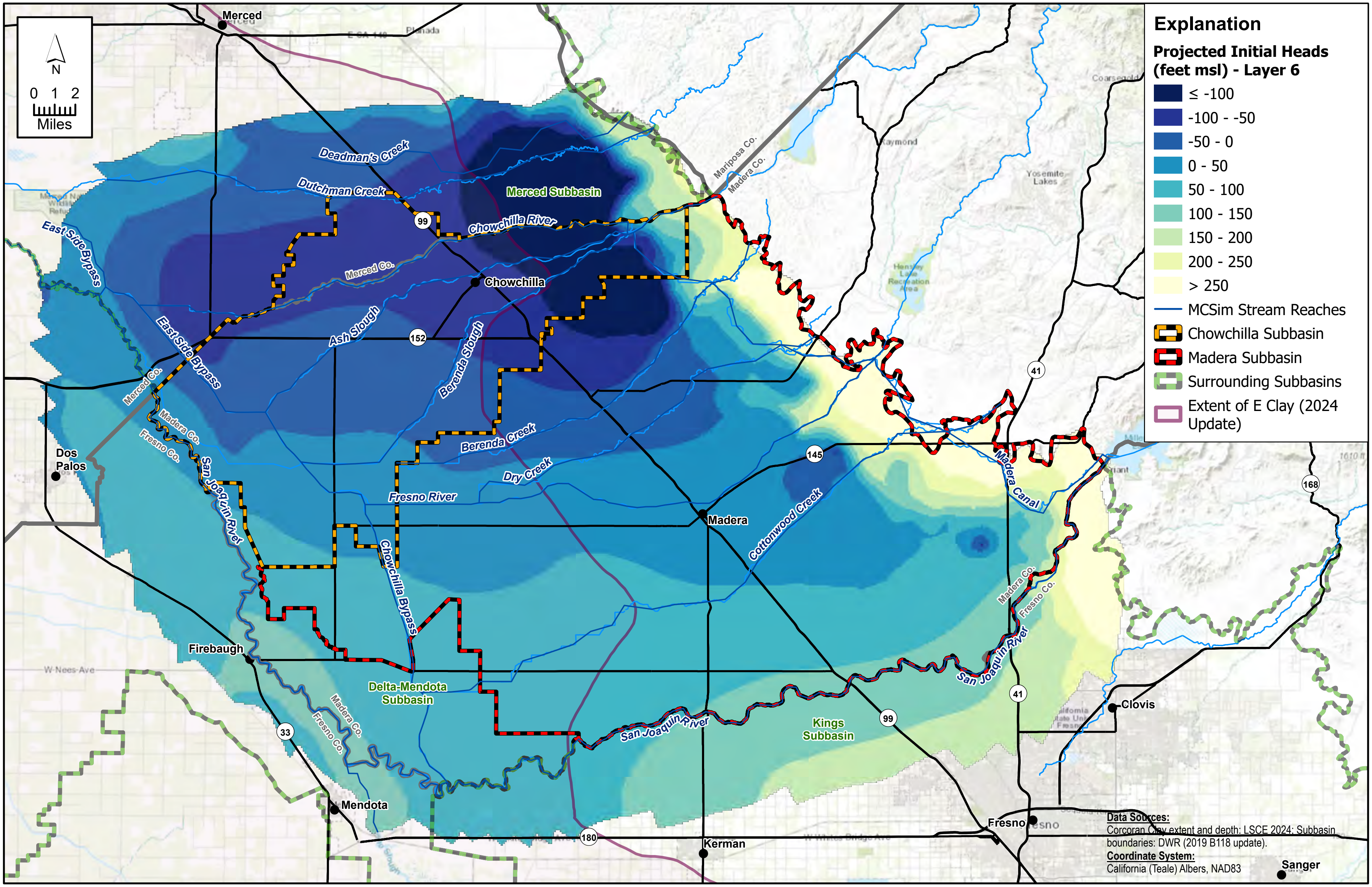

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FIGURE 3-81

Projected Initial Groundwater Heads - Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

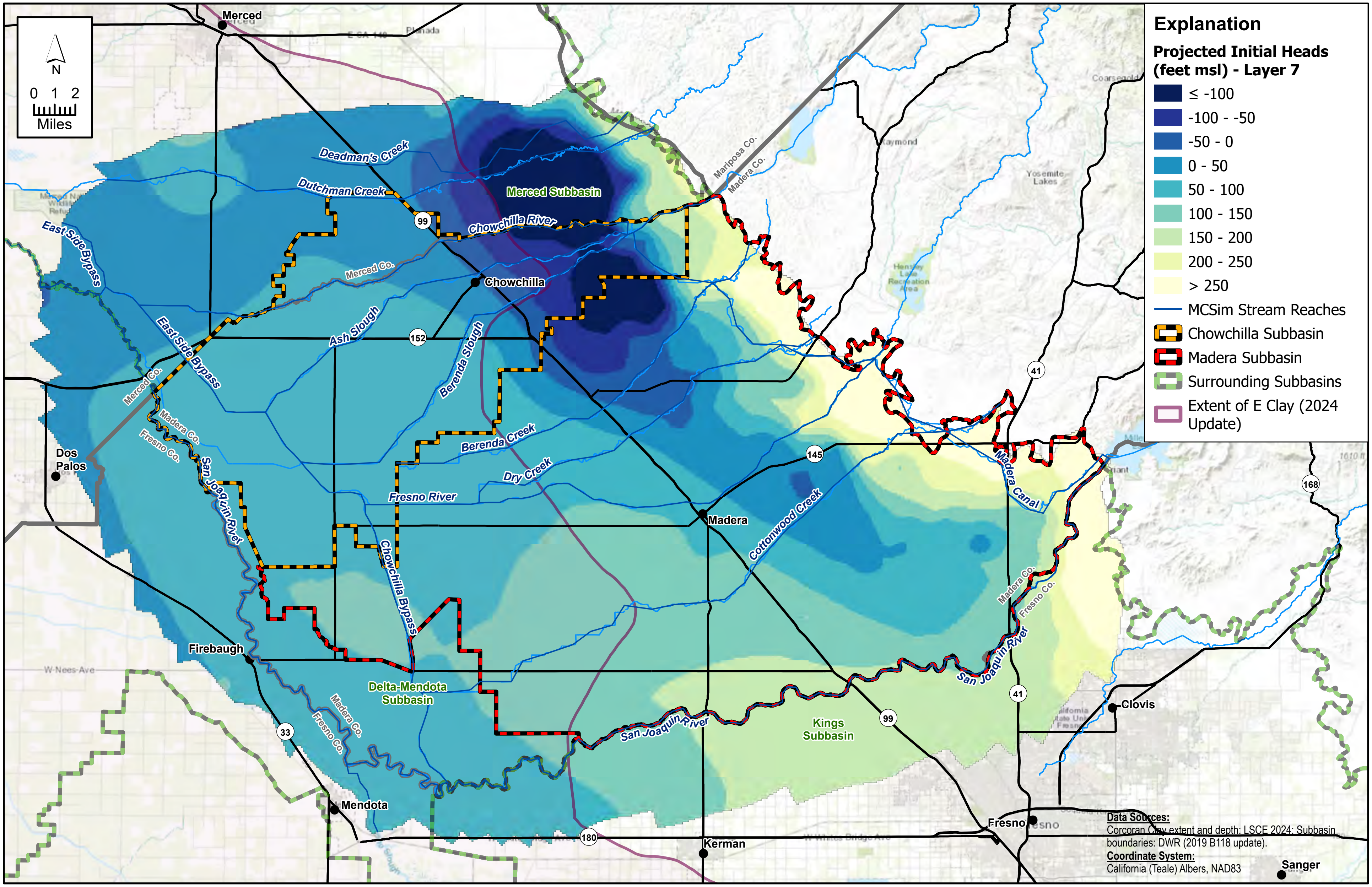

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FIGURE 3-82

Projected Initial Groundwater Heads - Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

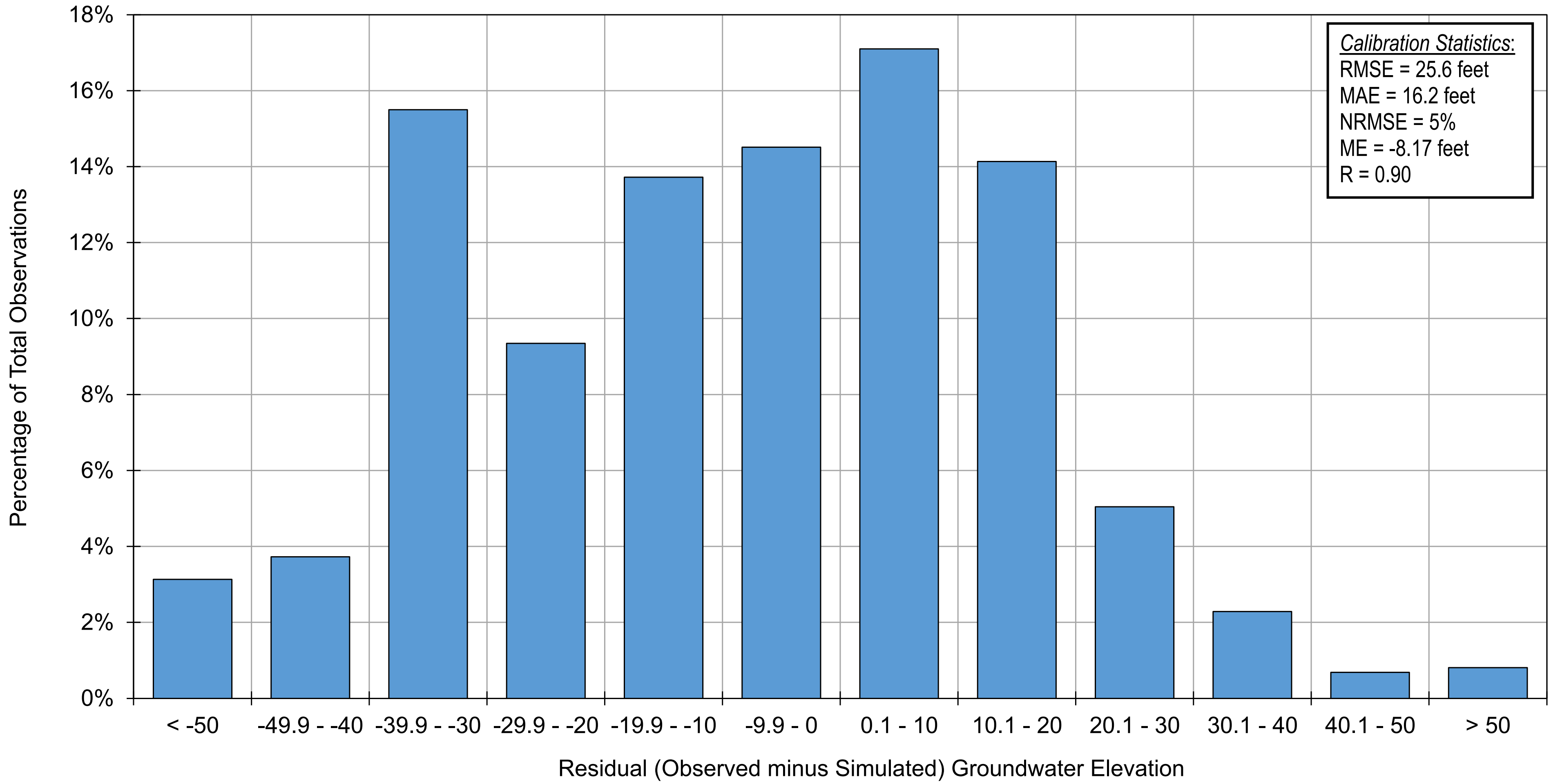

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FIGURE 4-1

Histogram of Residual (Simulated minus Observed) Groundwater Elevations in MCSim_v2 for All Observations

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

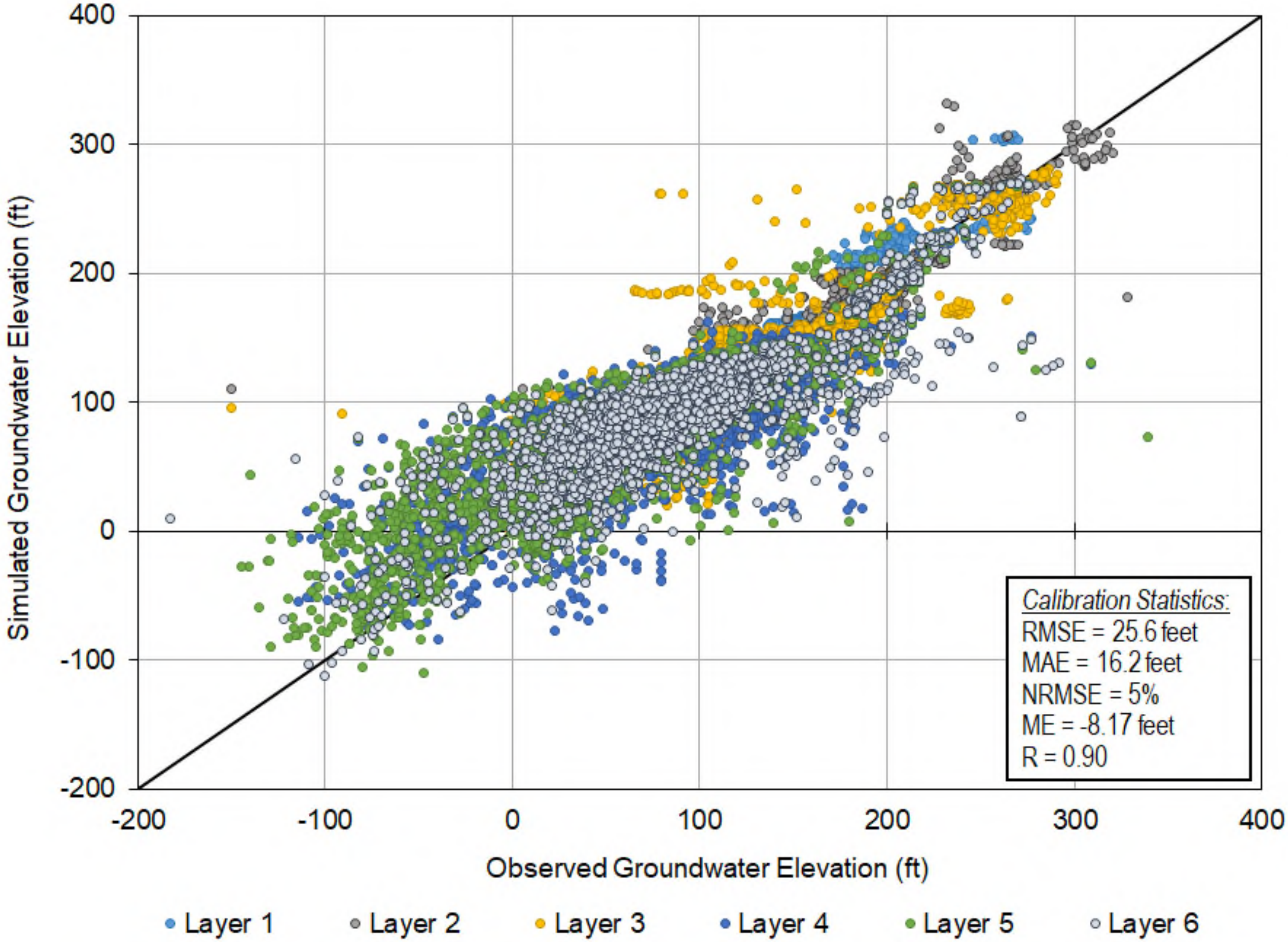

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FIGURE 4-2
Simulated vs. Observed Groundwater Elevations in MCSim_v2, By Layer

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

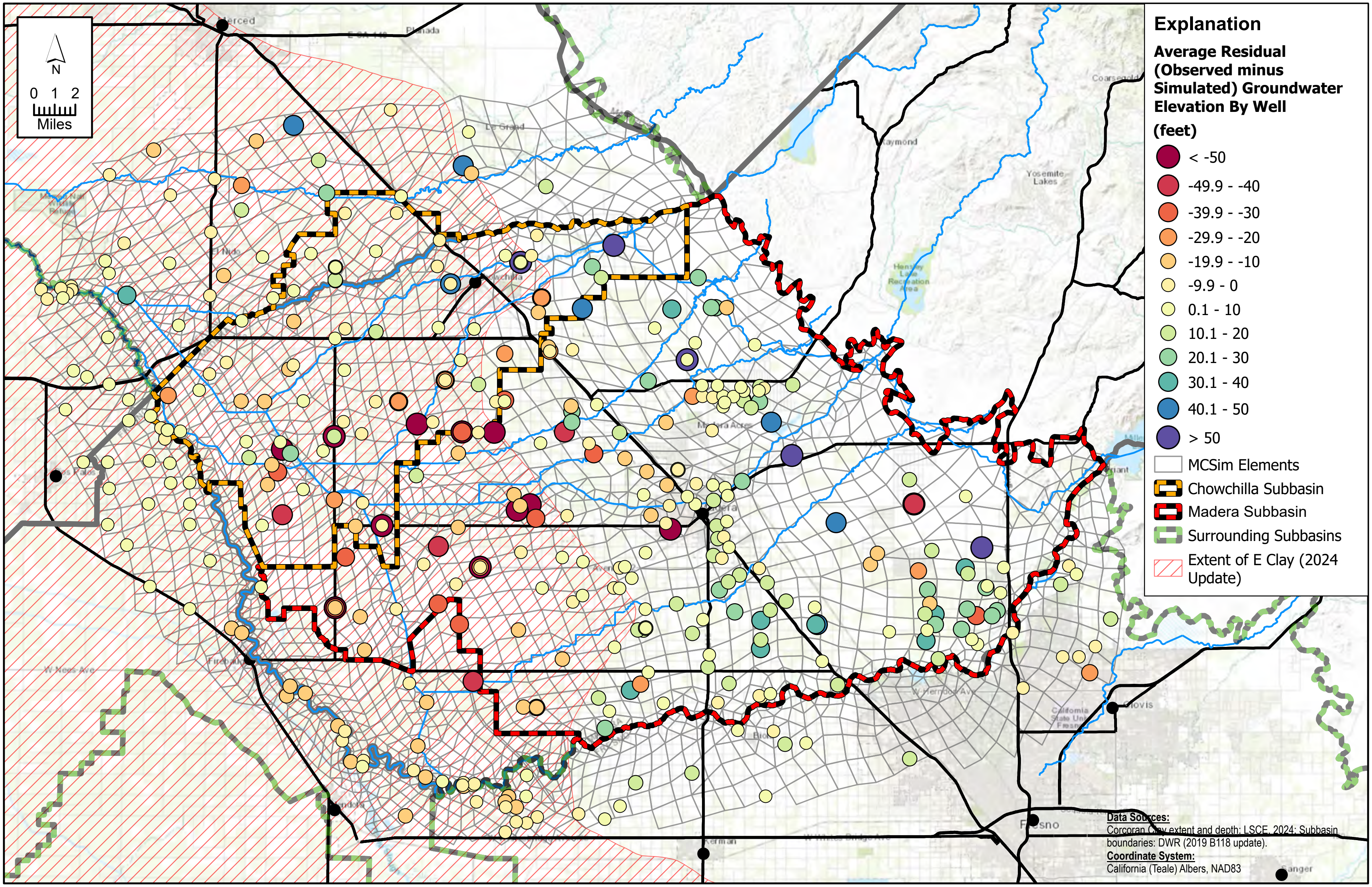

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FIGURE 4-3

Average Residual Groundwater Elevation by Calibration Well

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

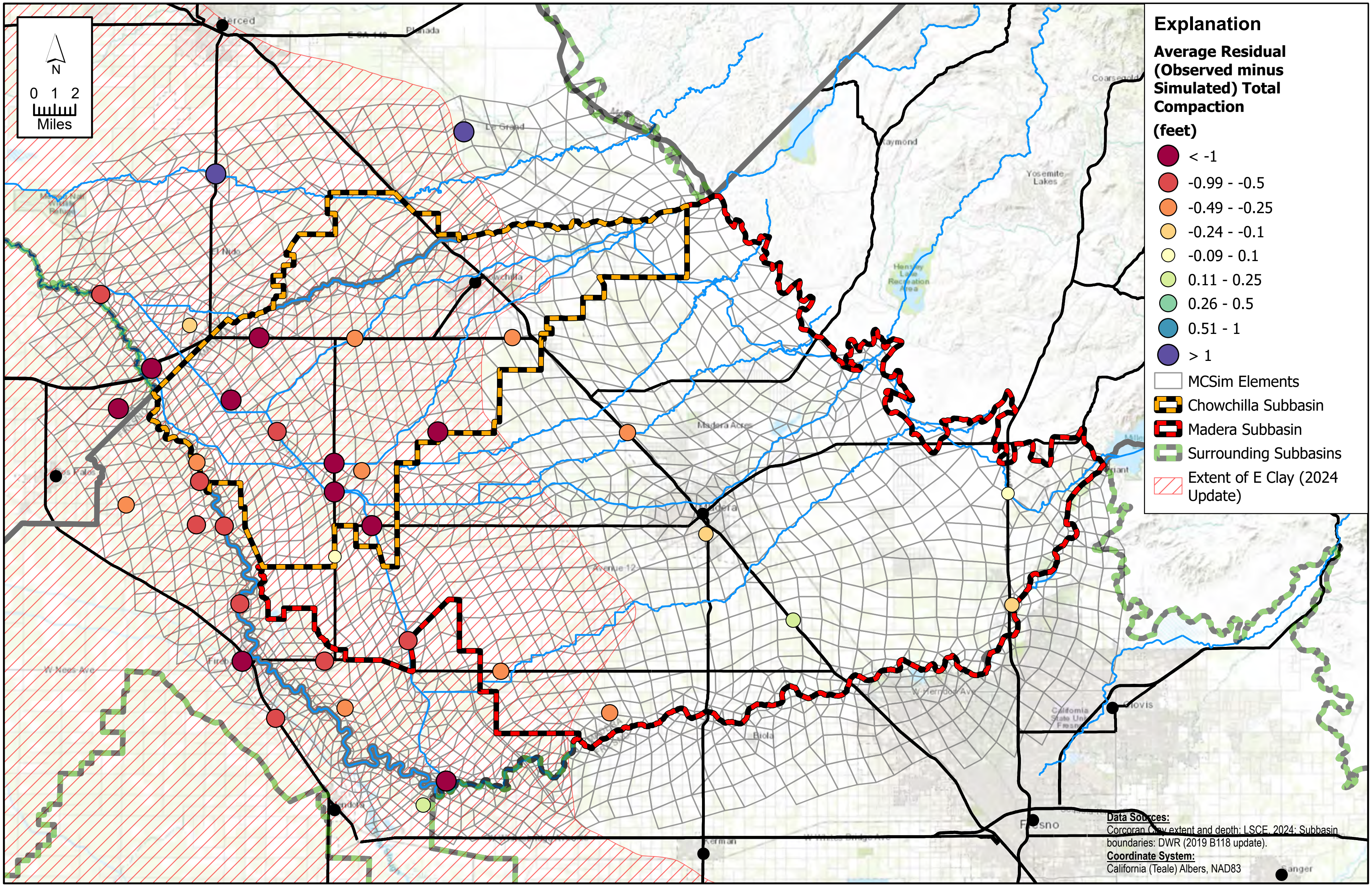

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FIGURE 4-4

Average Residual Total Compaction by Subsidence Monitoring Station

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

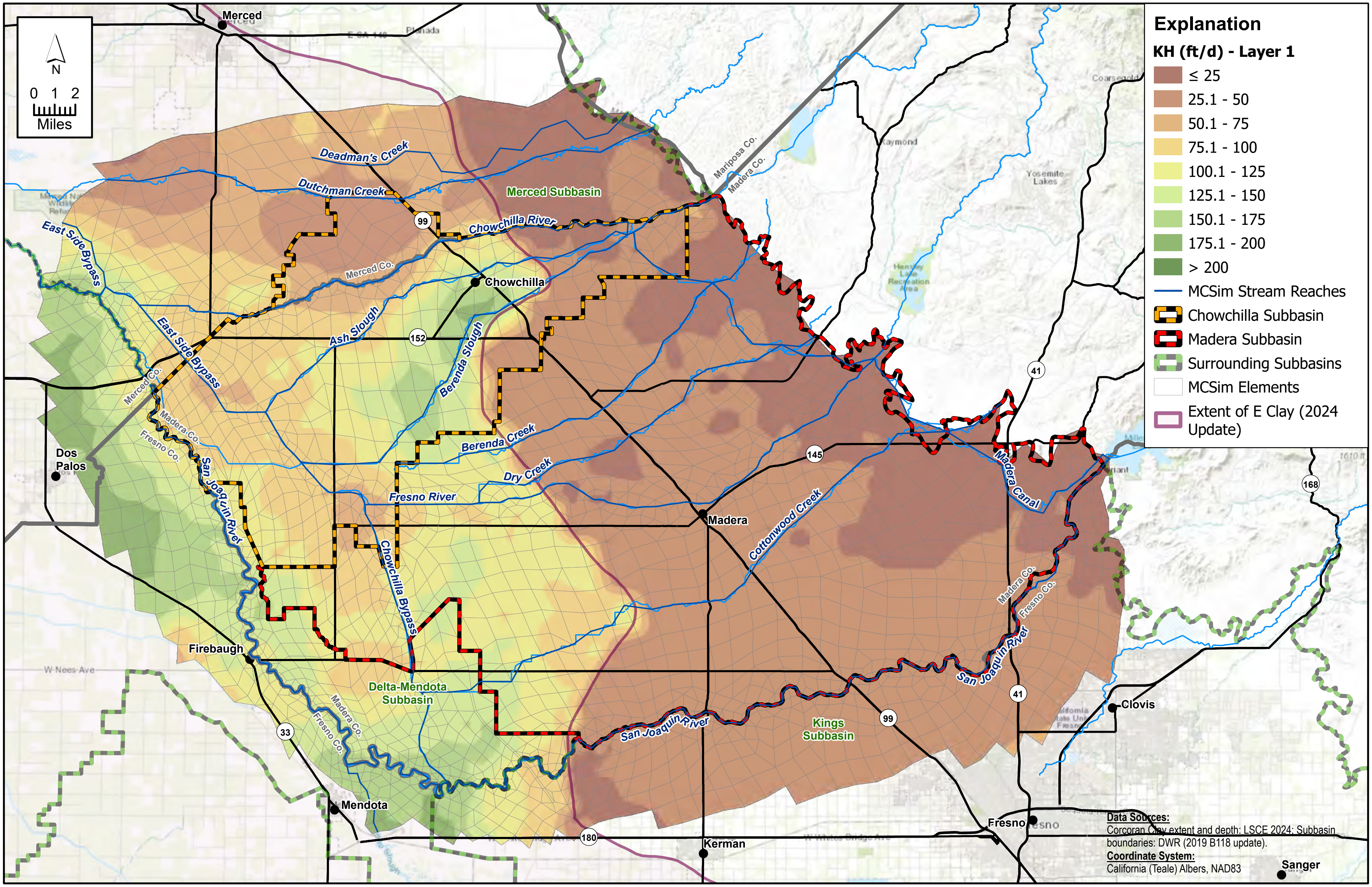

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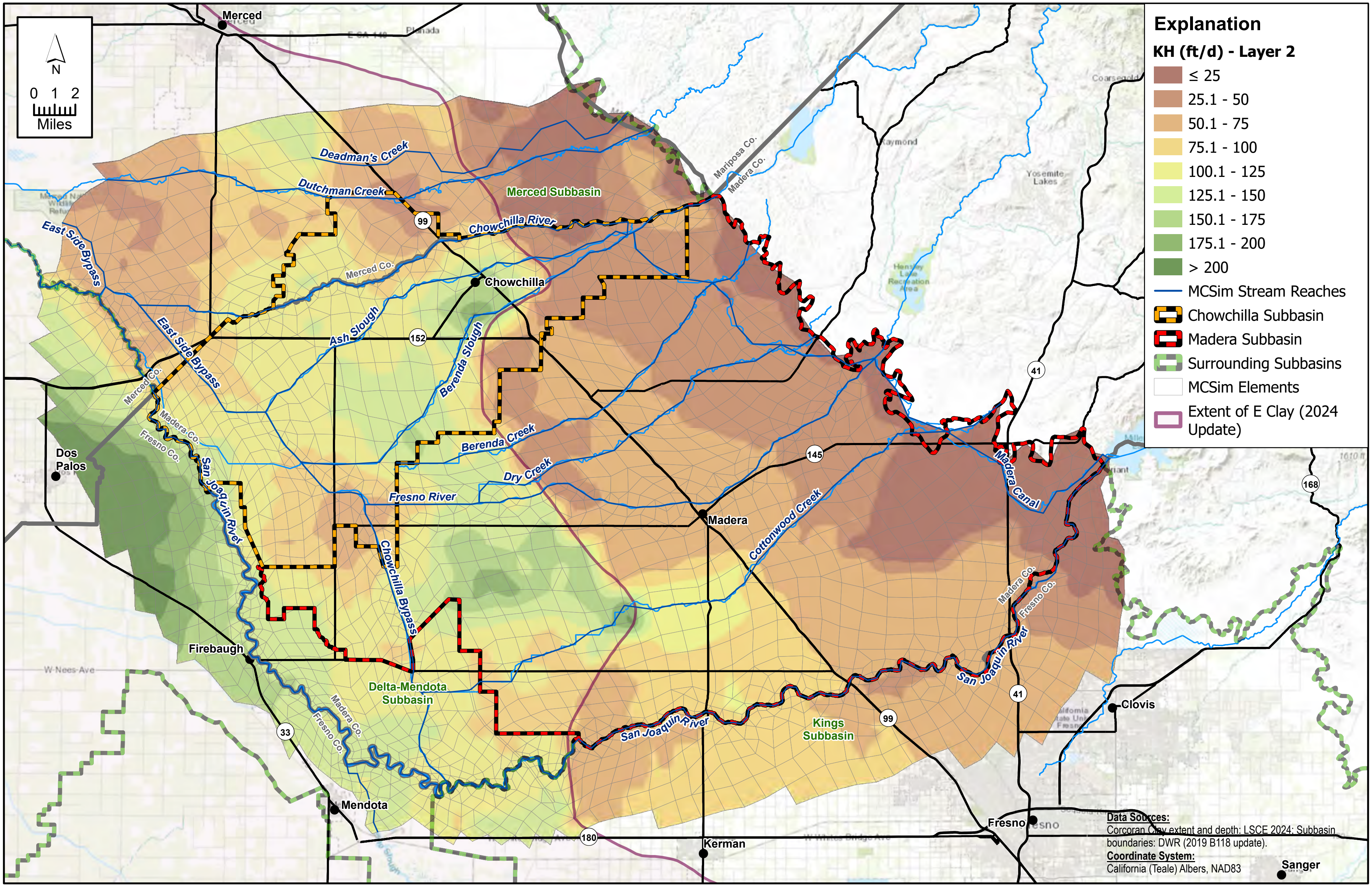
FIGURE 4-5

Calibrated Horizontal Hydraulic Conductivity (Kh) - Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_KH

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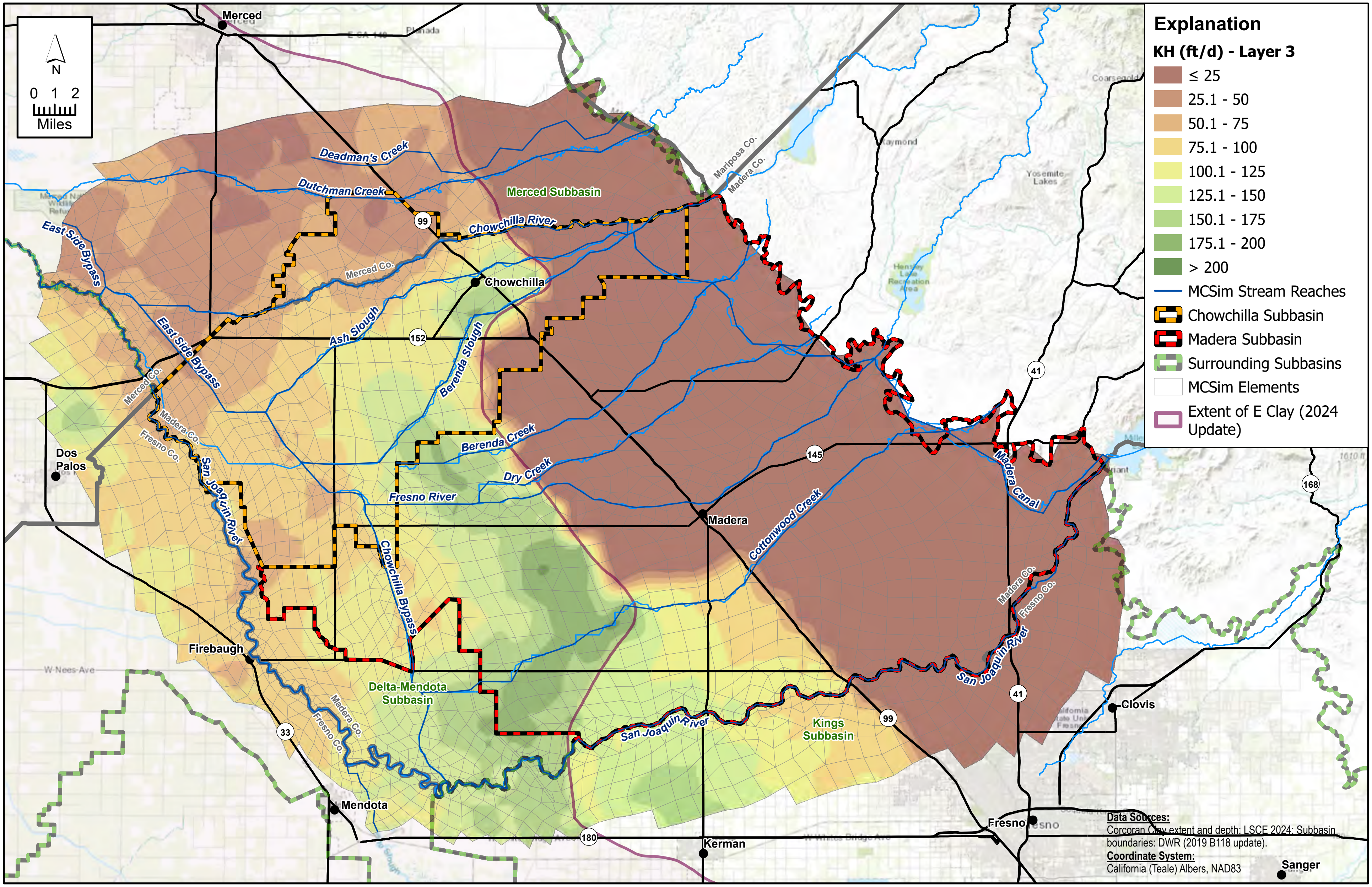
FIGURE 4-6

Calibrated Horizontal Hydraulic Conductivity (Kh) - Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_KH

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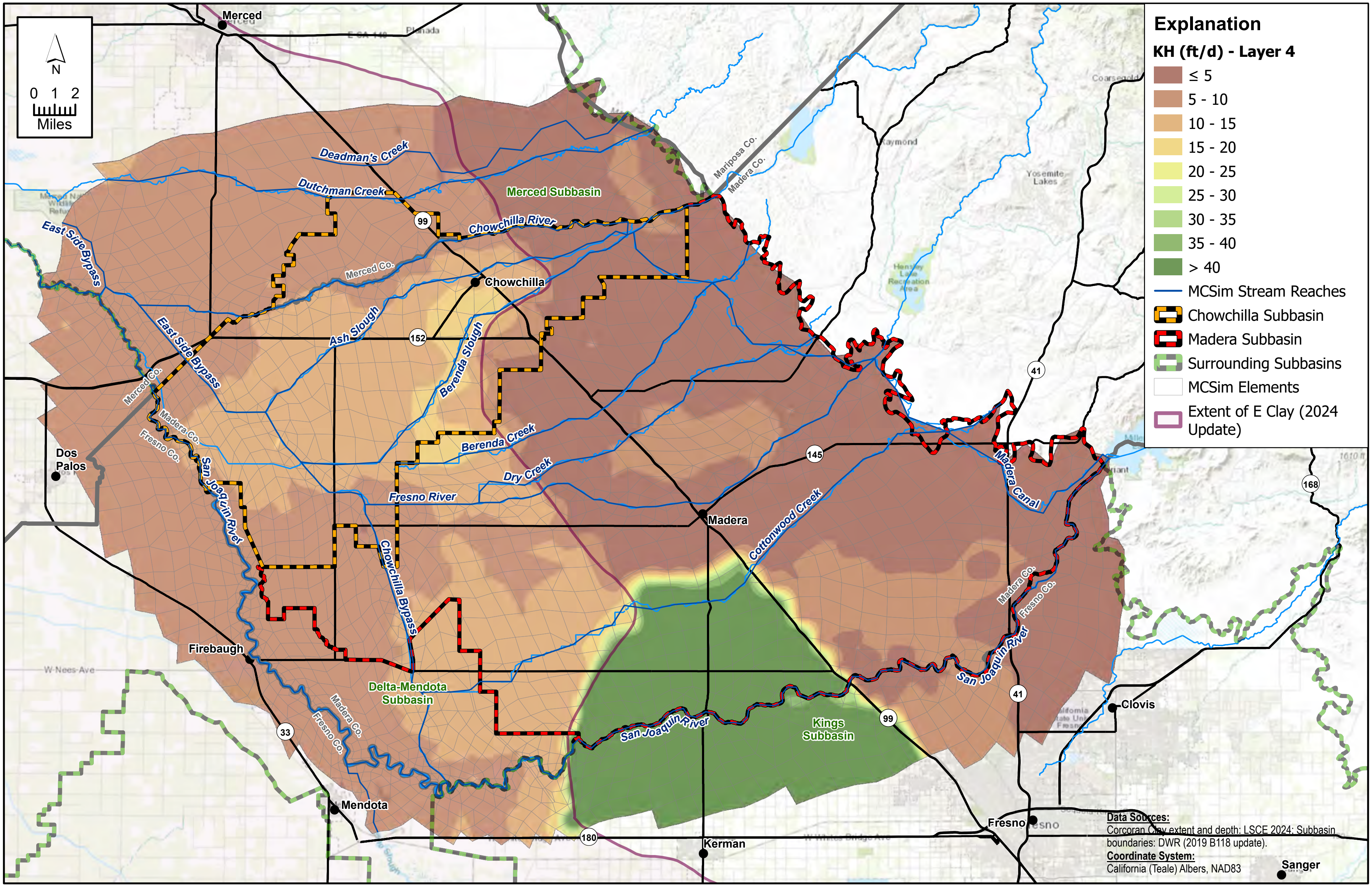
FIGURE 4-7

Calibrated Horizontal Hydraulic Conductivity (Kh) - Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_KH

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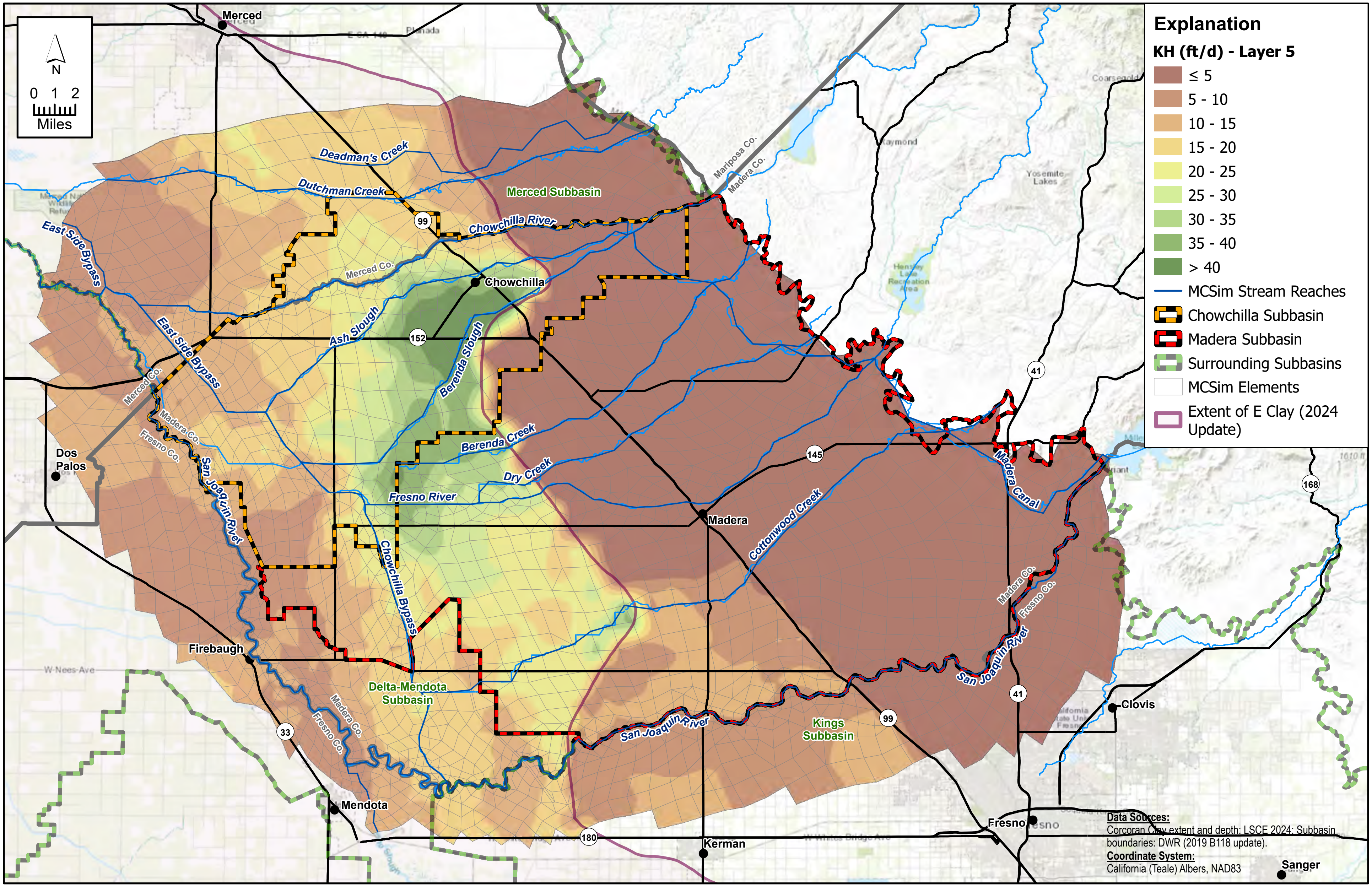
FIGURE 4-8

Calibrated Horizontal Hydraulic Conductivity (Kh) - Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_KH

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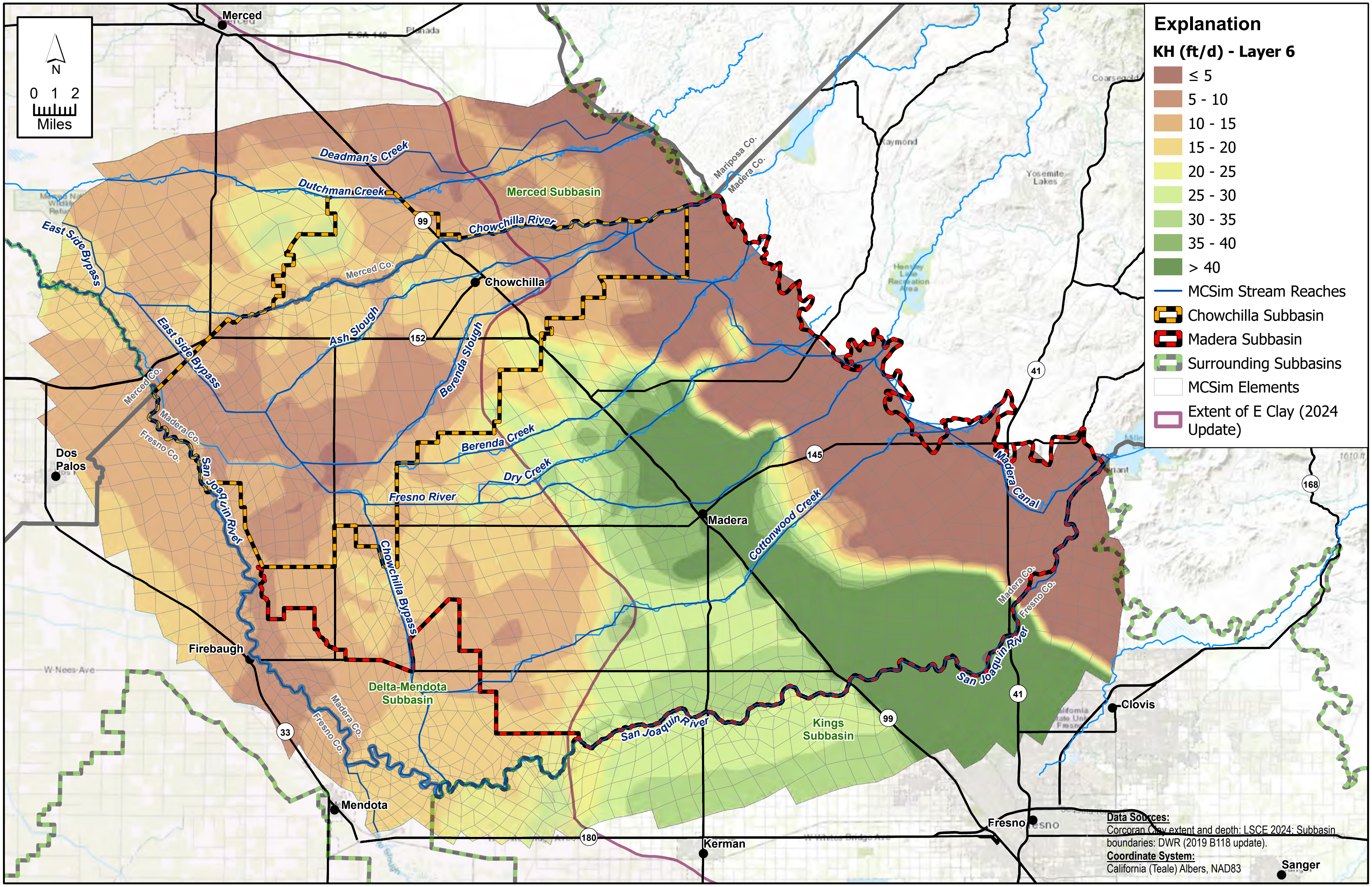
FIGURE 4-9

Calibrated Horizontal Hydraulic Conductivity (Kh) - Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_KH

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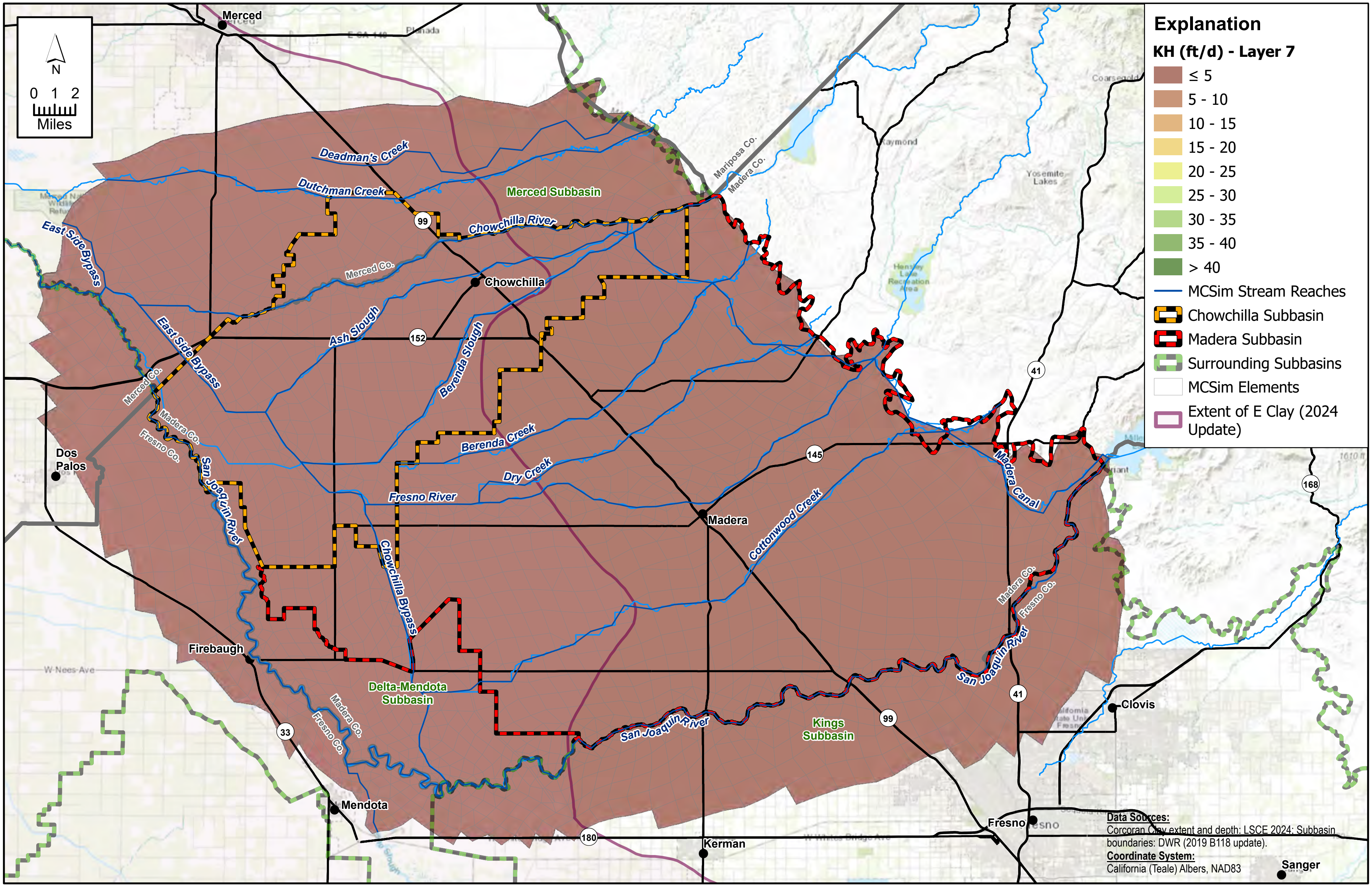
FIGURE 4-10

Calibrated Horizontal Hydraulic Conductivity (Kh) - Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_KH

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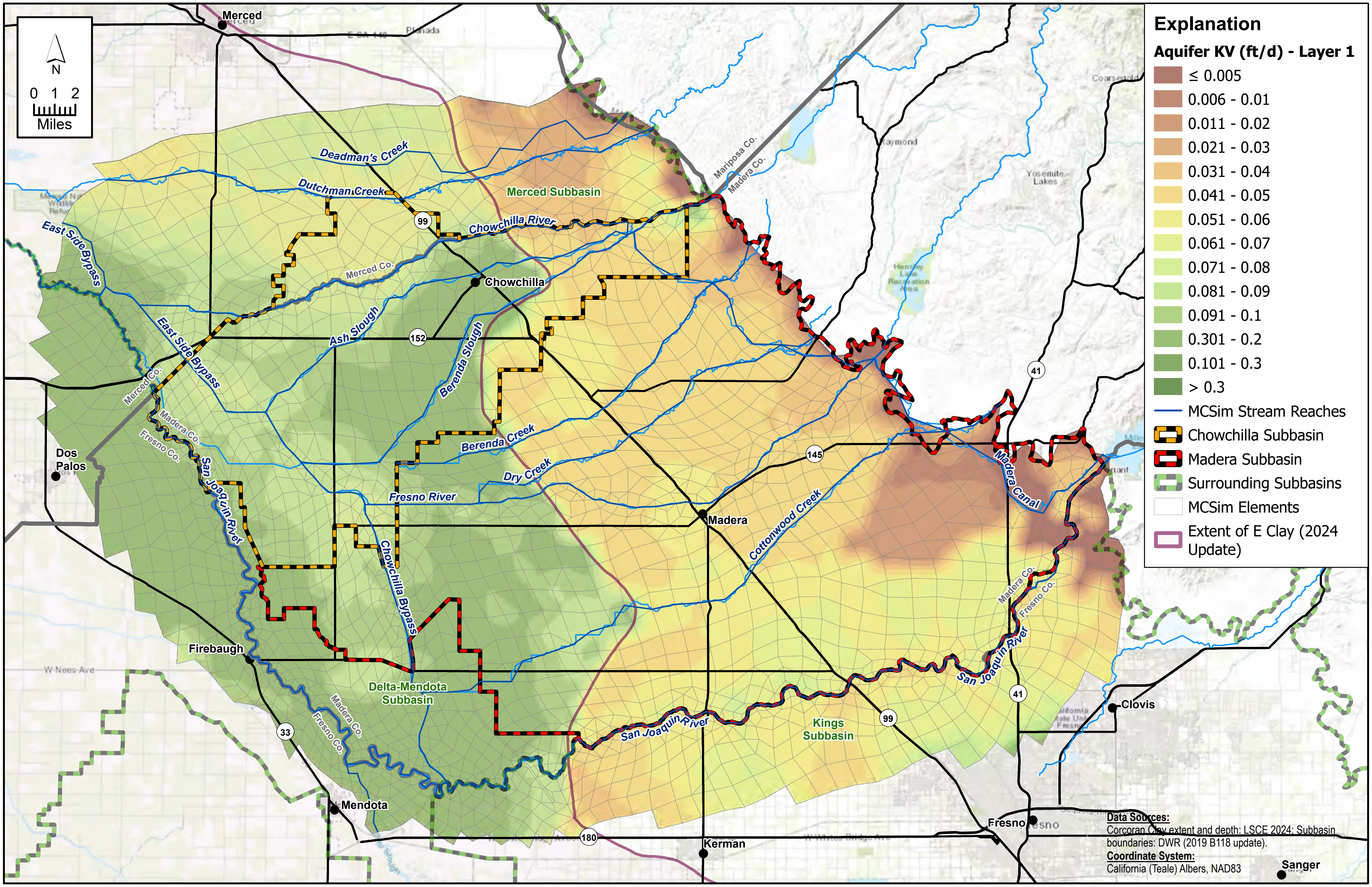
FIGURE 4-11

Calibrated Horizontal Hydraulic Conductivity (Kh) - Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_AQFR_KV

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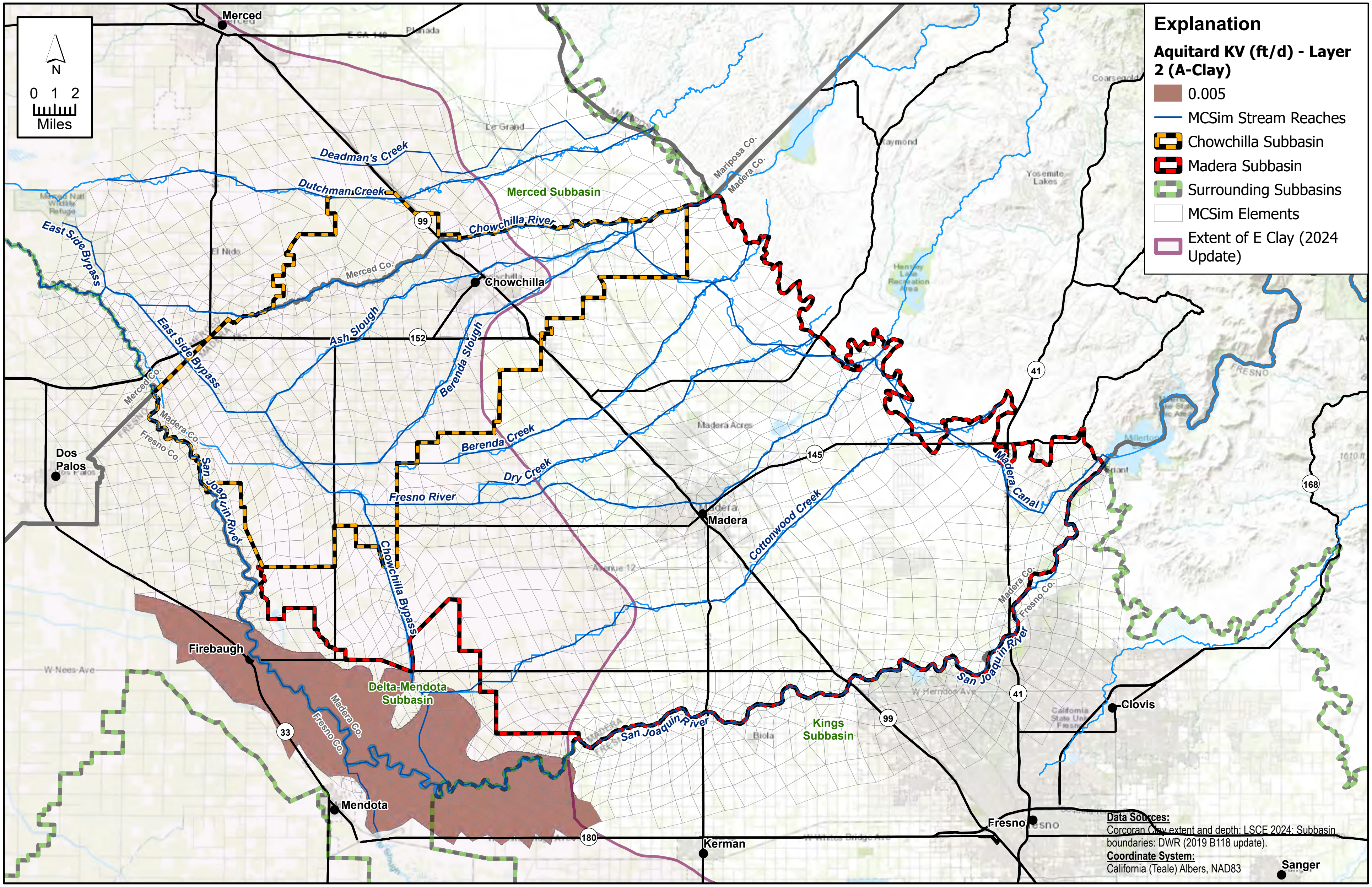
FIGURE 4-12

Calibrated Vertical Hydraulic Conductivity (Kv) - Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_AQTD_KV

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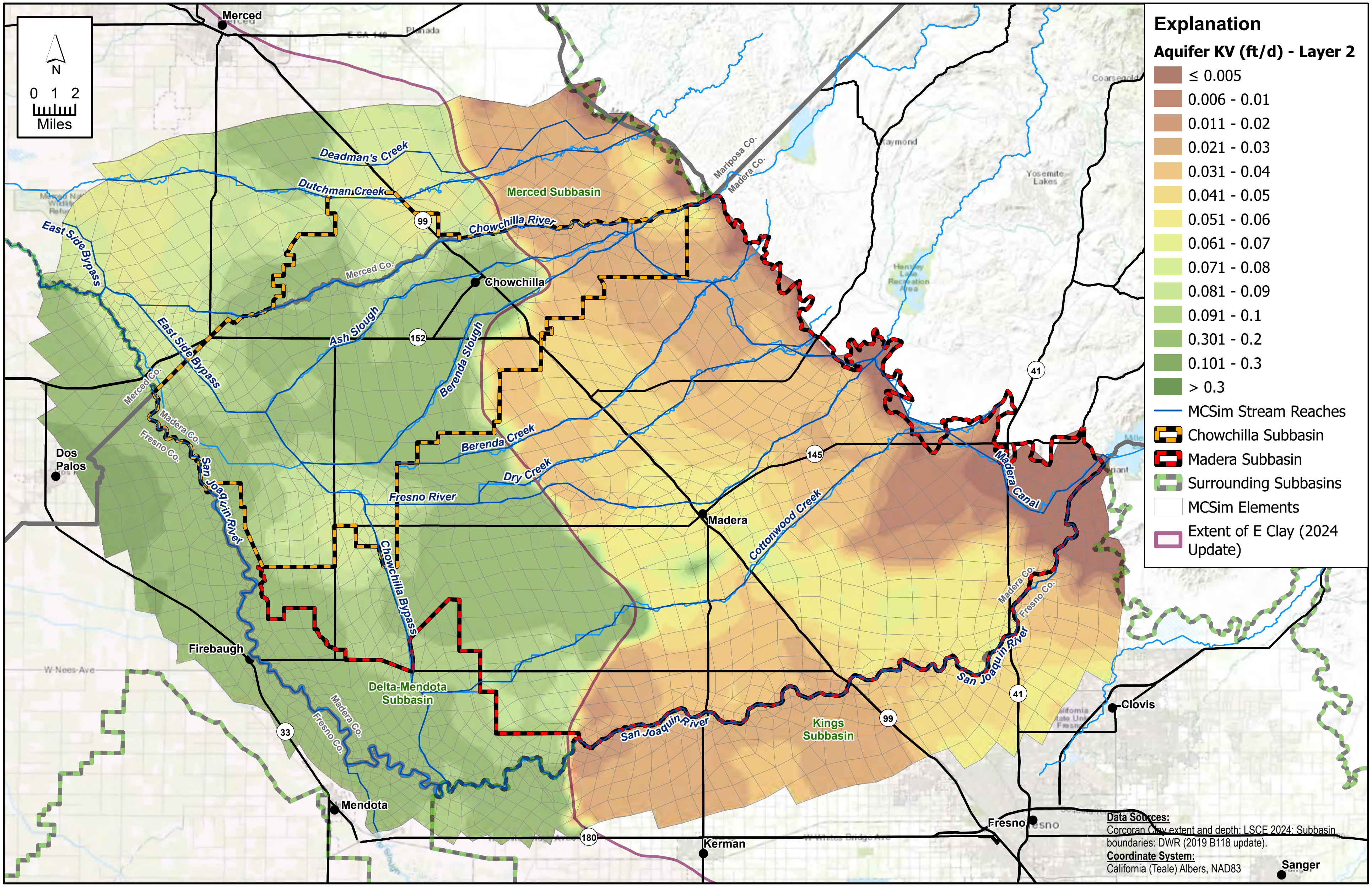
FIGURE 4-13

Calibrated Vertical Hydraulic Conductivity (Kv) - Layer 2 Aquitard

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_AQFR_KV

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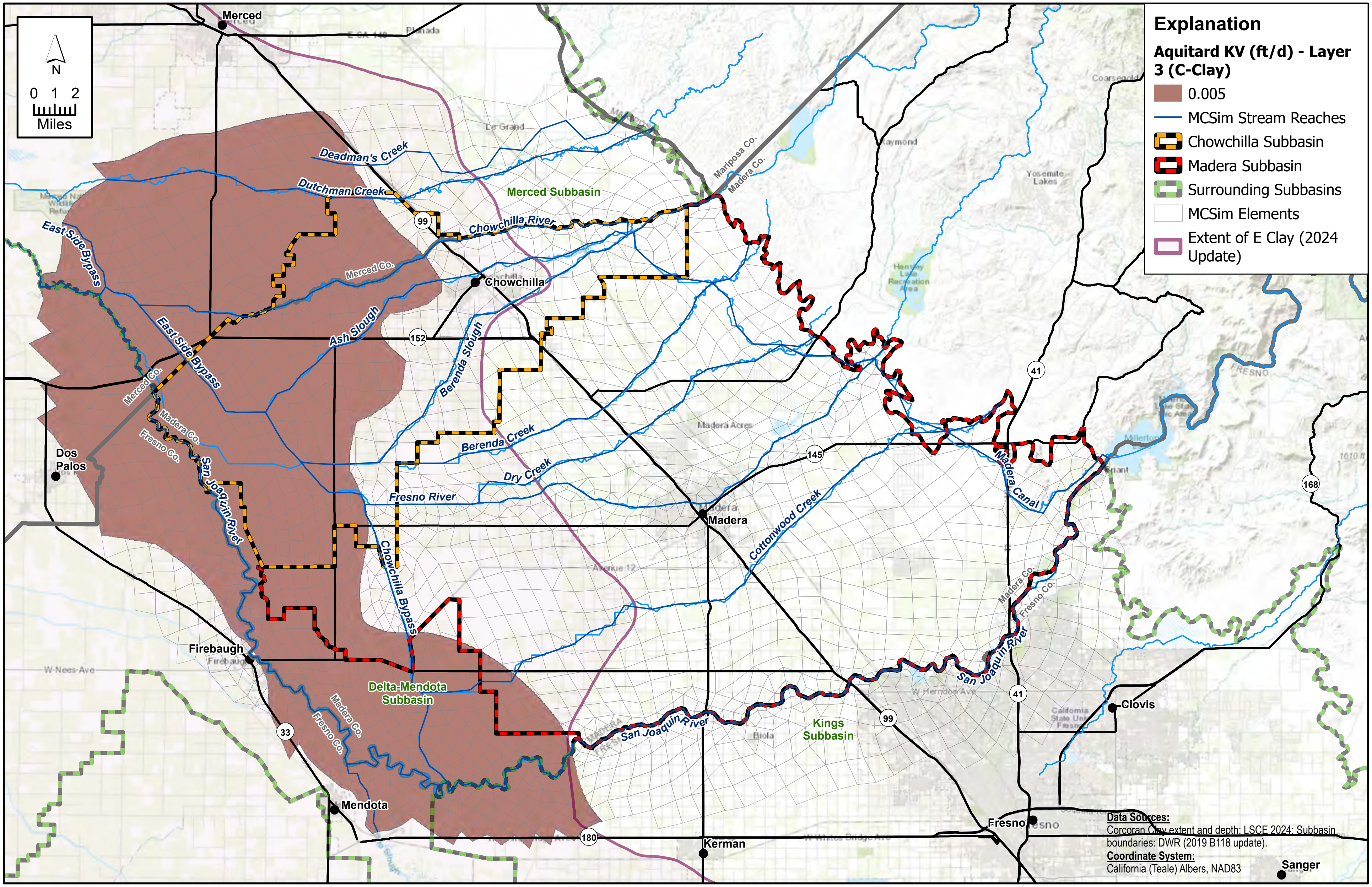
FIGURE 4-14

Calibrated Vertical Hydraulic Conductivity (Kv) - Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_AQTD_KV

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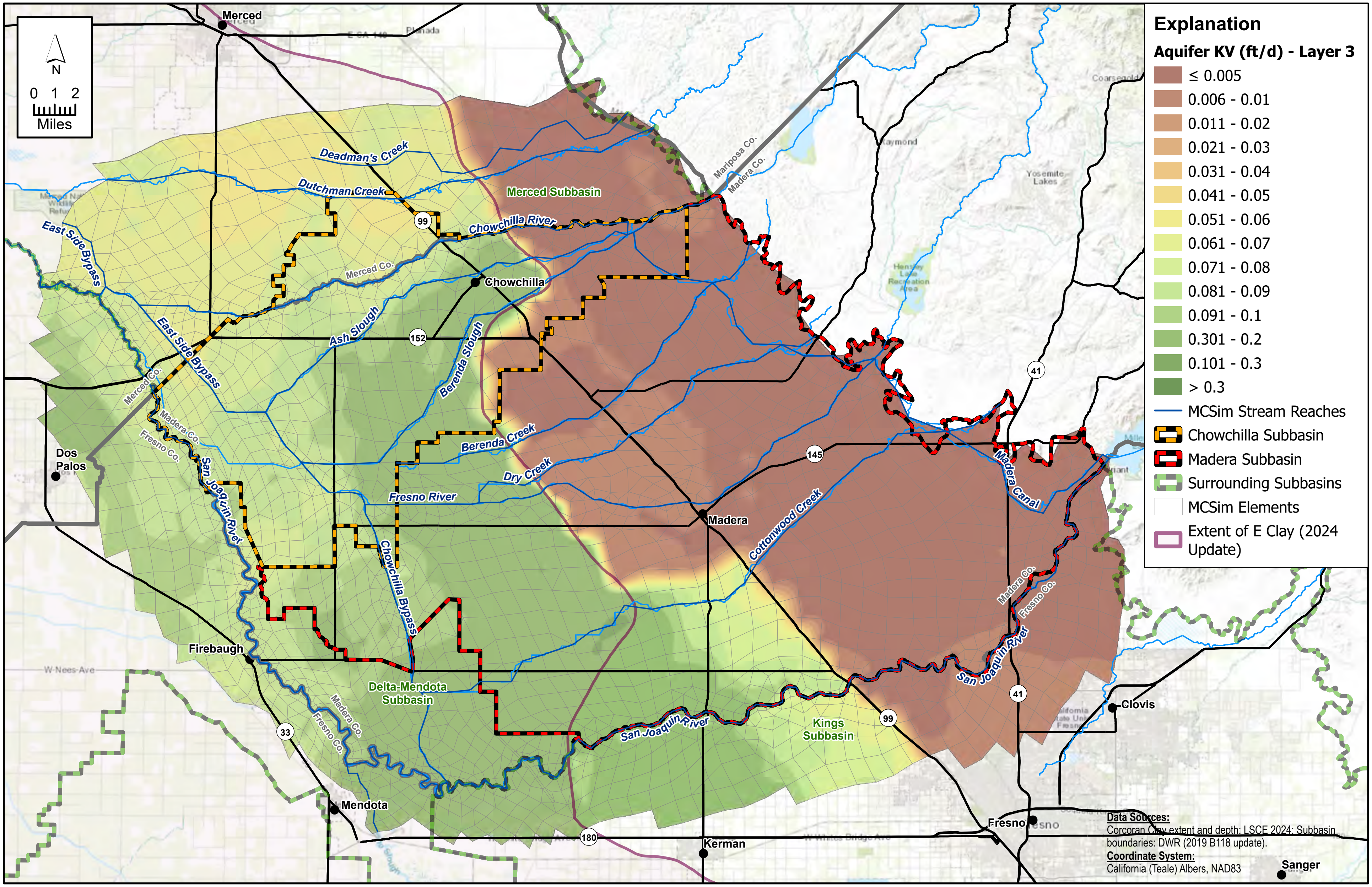
FIGURE 4-15

Calibrated Vertical Hydraulic Conductivity (Kv) - Layer 3 Aquitard

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_AQFR_KV

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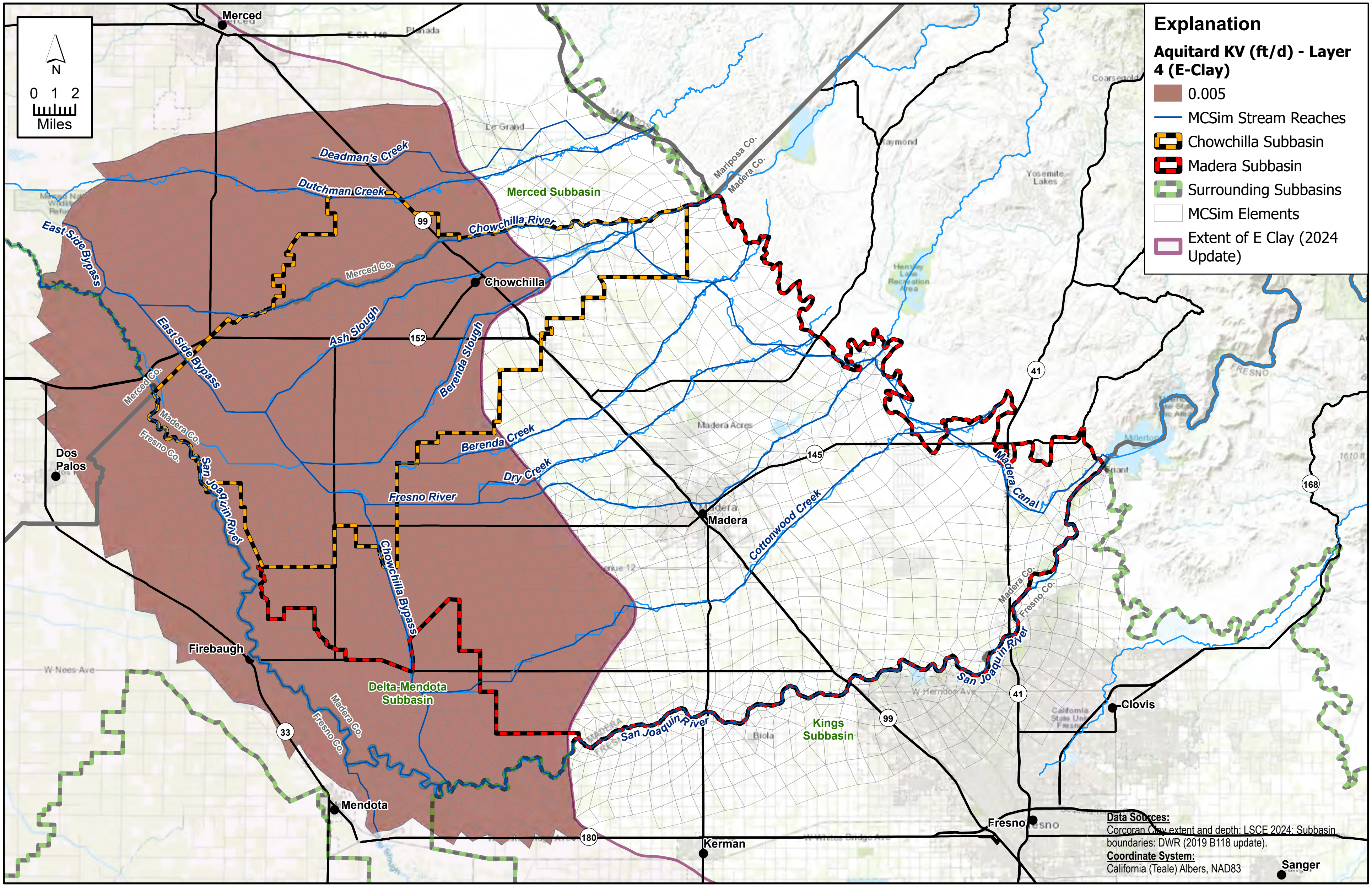
FIGURE 4-16

Calibrated Vertical Hydraulic Conductivity (Kv) - Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_AQTD_KV

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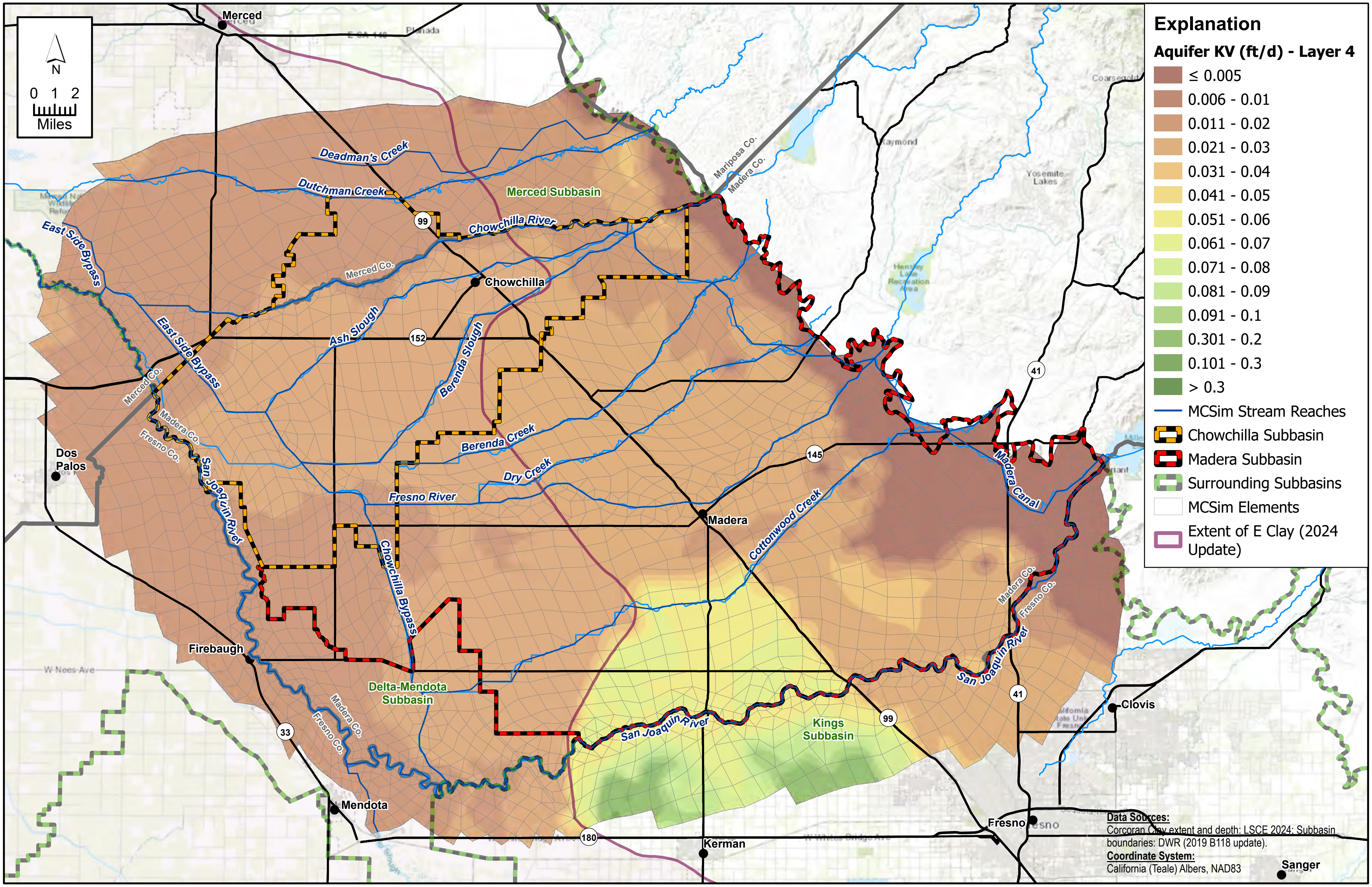
FIGURE 4-17

Calibrated Vertical Hydraulic Conductivity (Kv) - Layer 4 Aquitard

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_AQFR_KV

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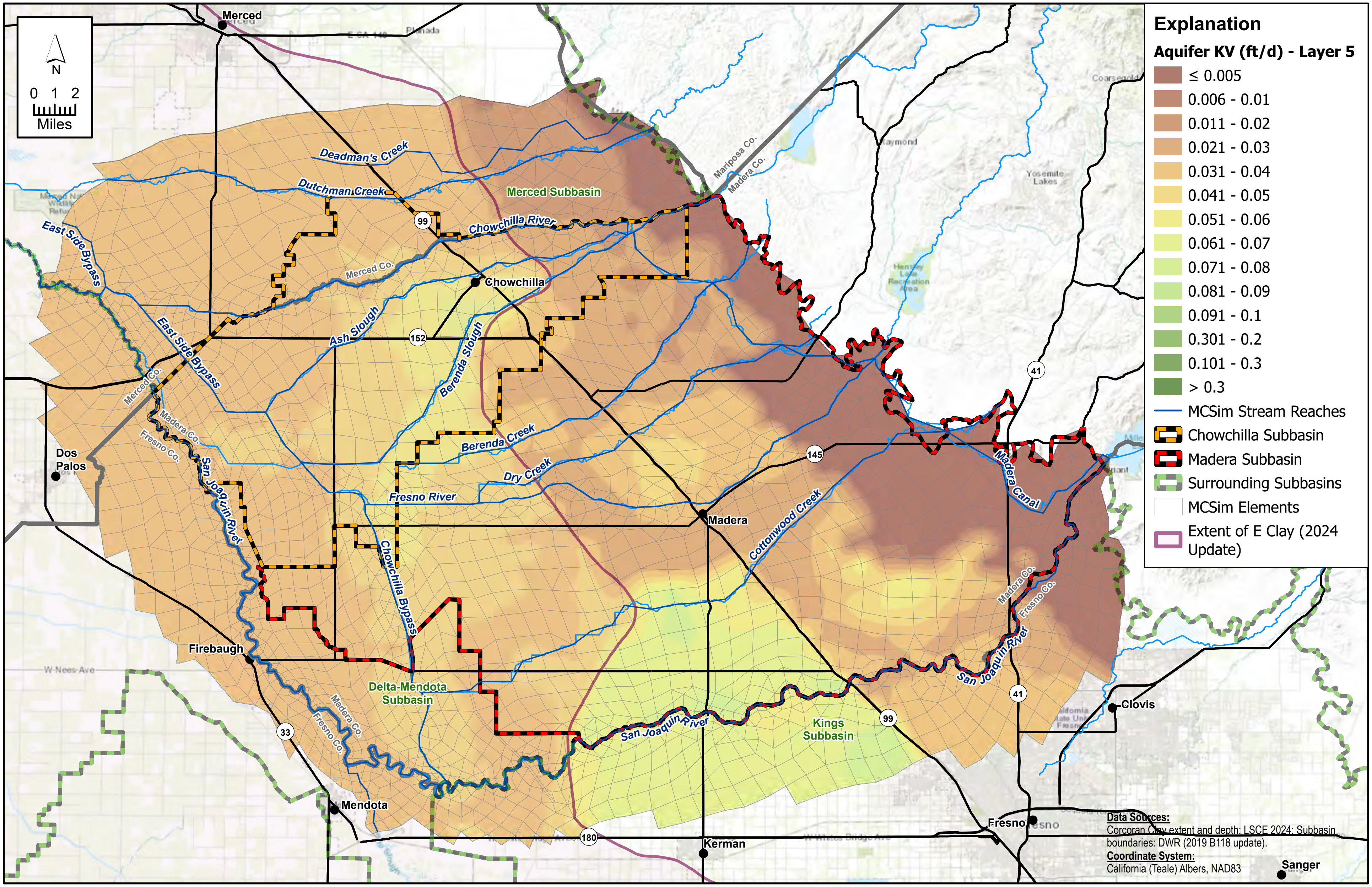
FIGURE 4-18

Calibrated Vertical Hydraulic Conductivity (Kv) - Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_AQFR_KV

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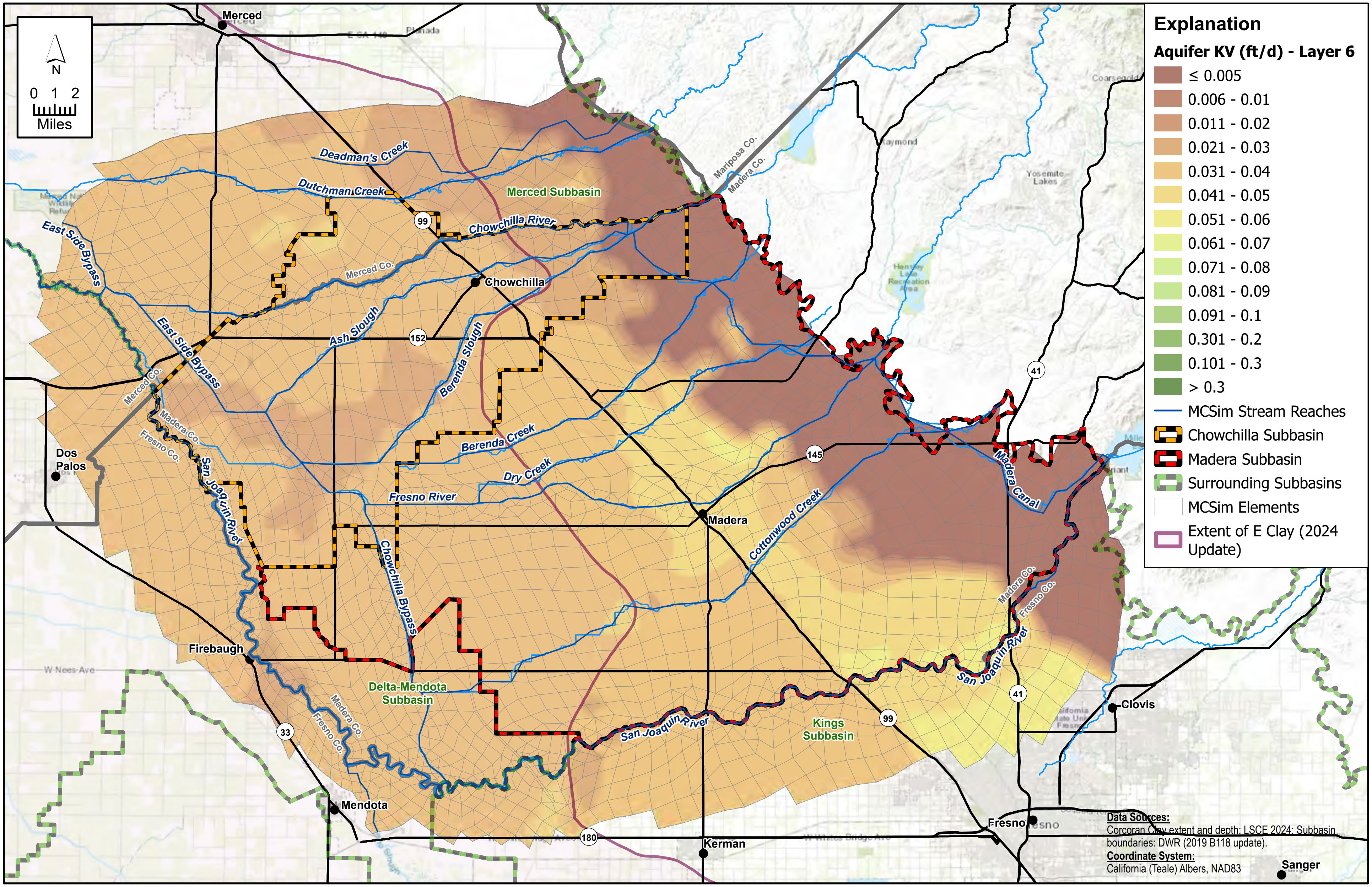
FIGURE 4-19

Calibrated Vertical Hydraulic Conductivity (Kv) - Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_AQFR_KV

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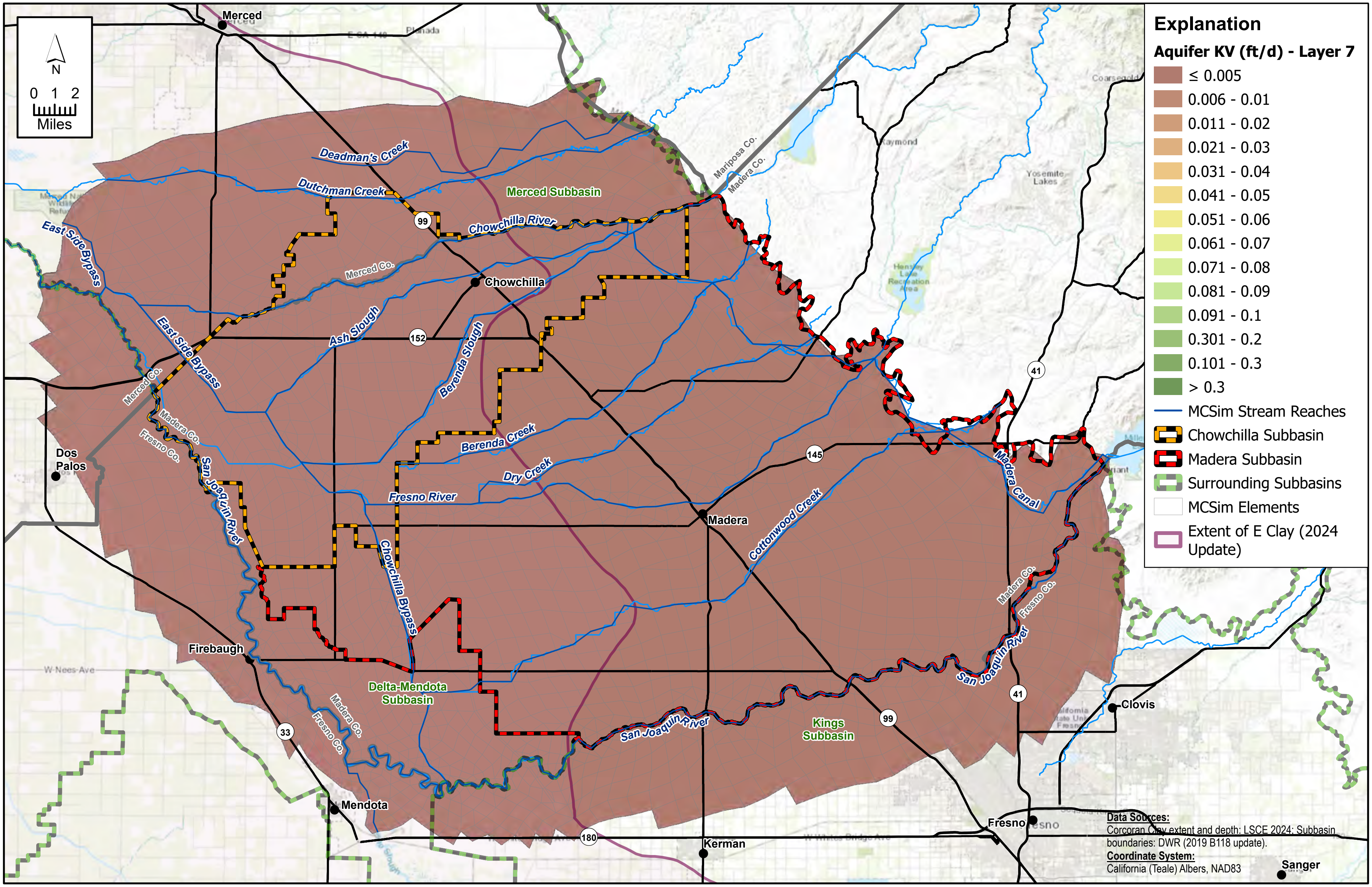
FIGURE 4-20

Calibrated Vertical Hydraulic Conductivity (Kv) - Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_AQFR_KV

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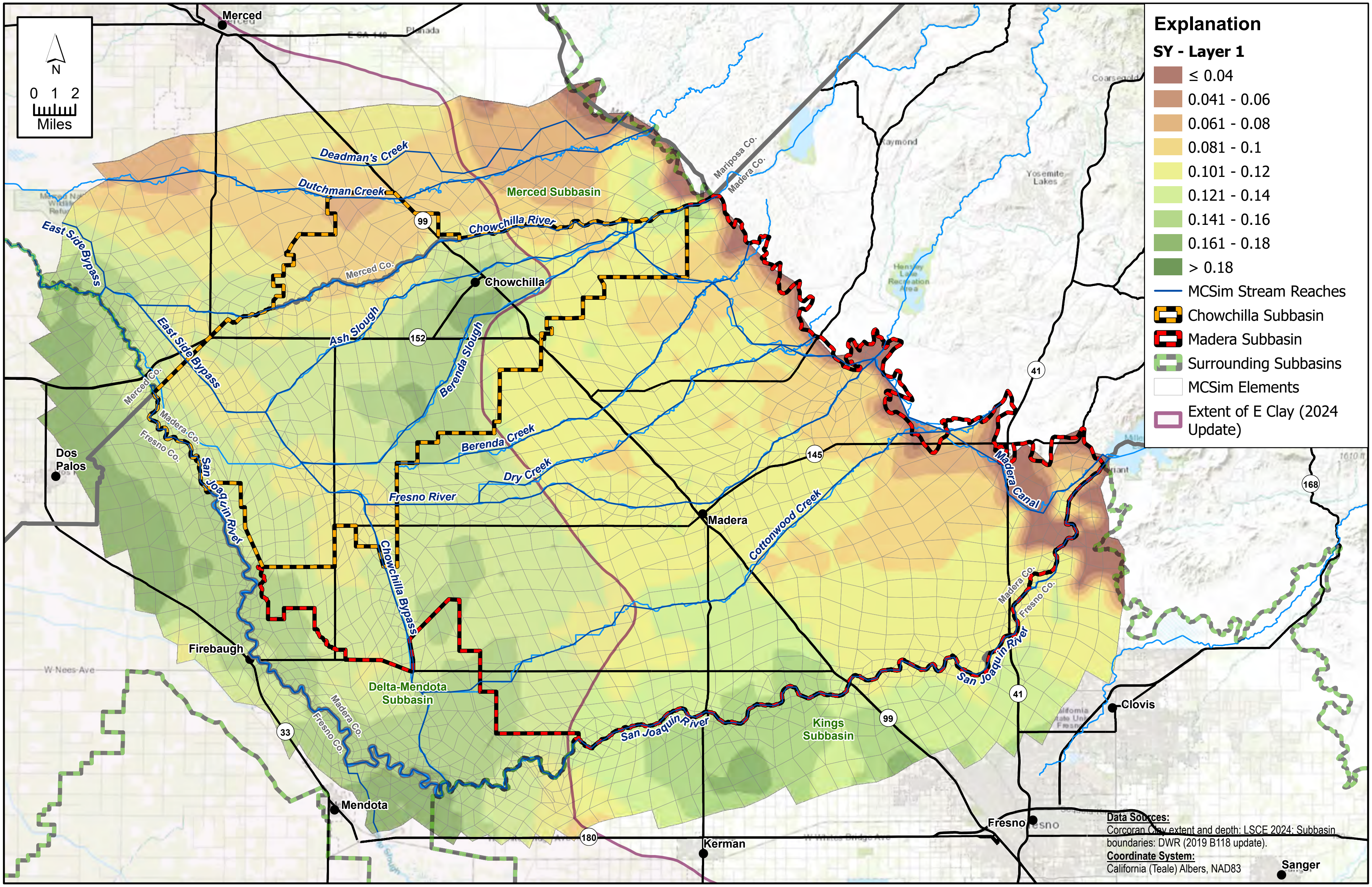
FIGURE 4-21

Calibrated Vertical Hydraulic Conductivity (Kv) - Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SY

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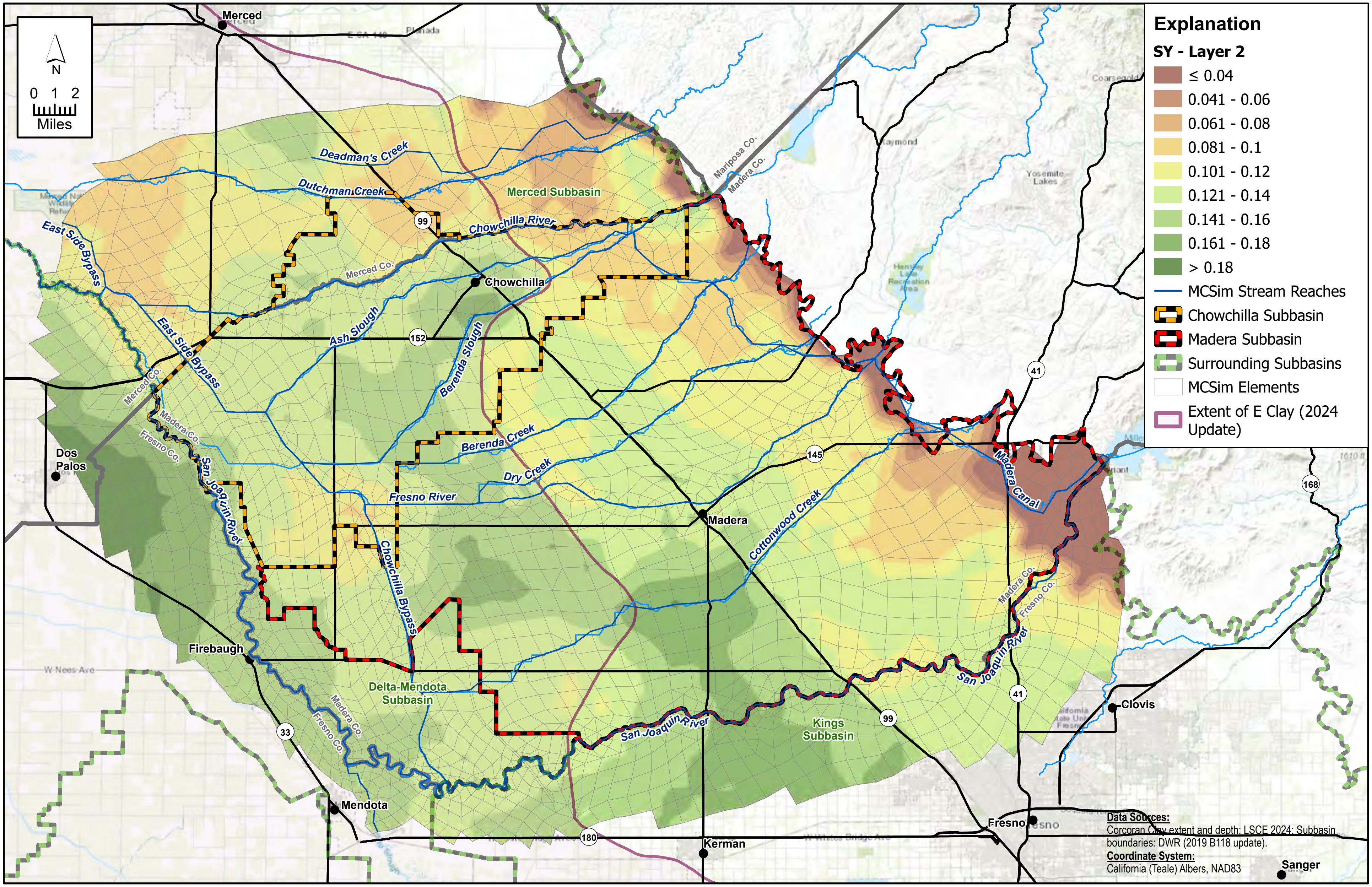
FIGURE 4-22

Calibrated Specific Yield (Sy) - Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SY

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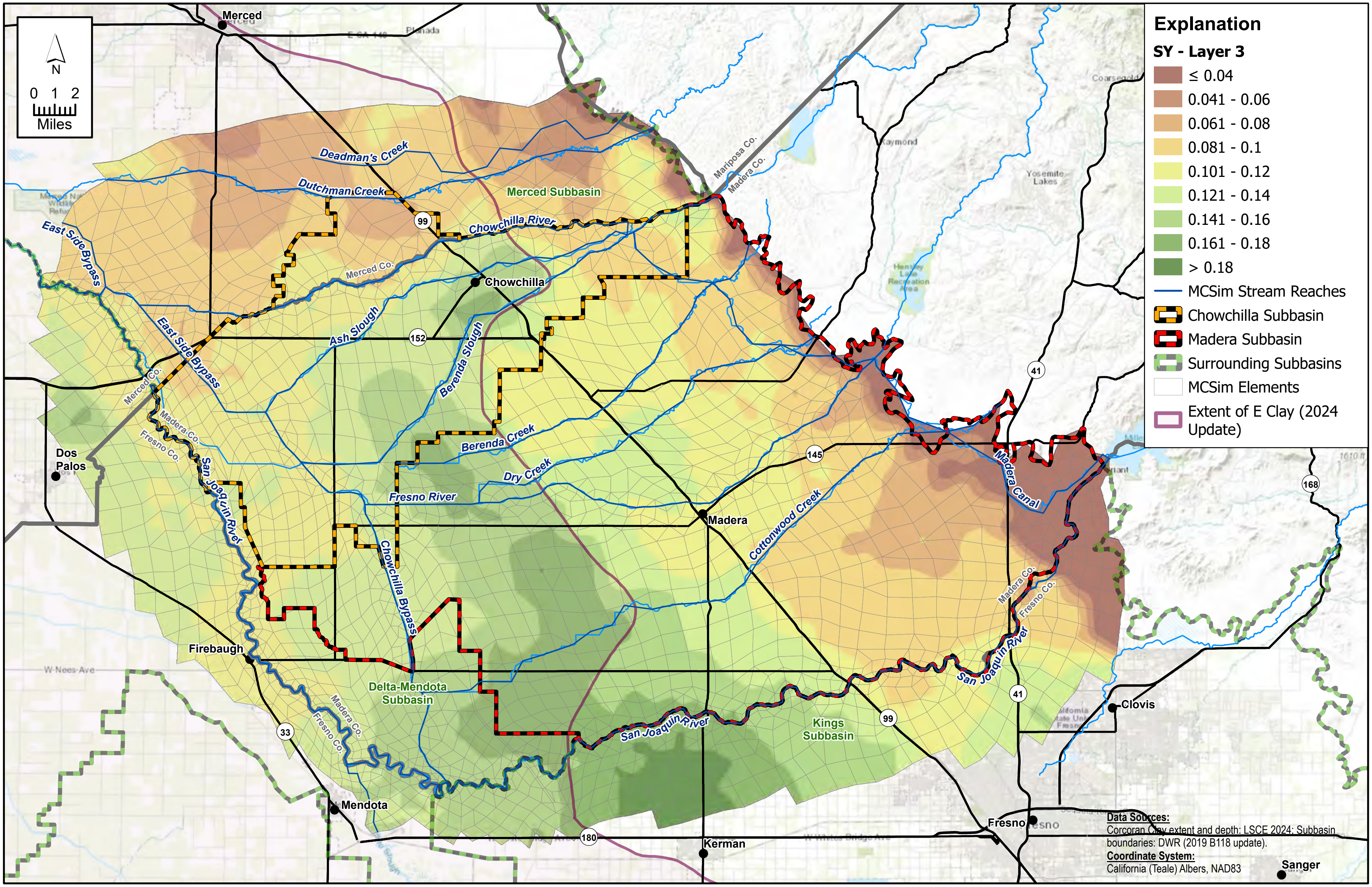
FIGURE 4-23

Calibrated Specific Yield (Sy) - Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SY

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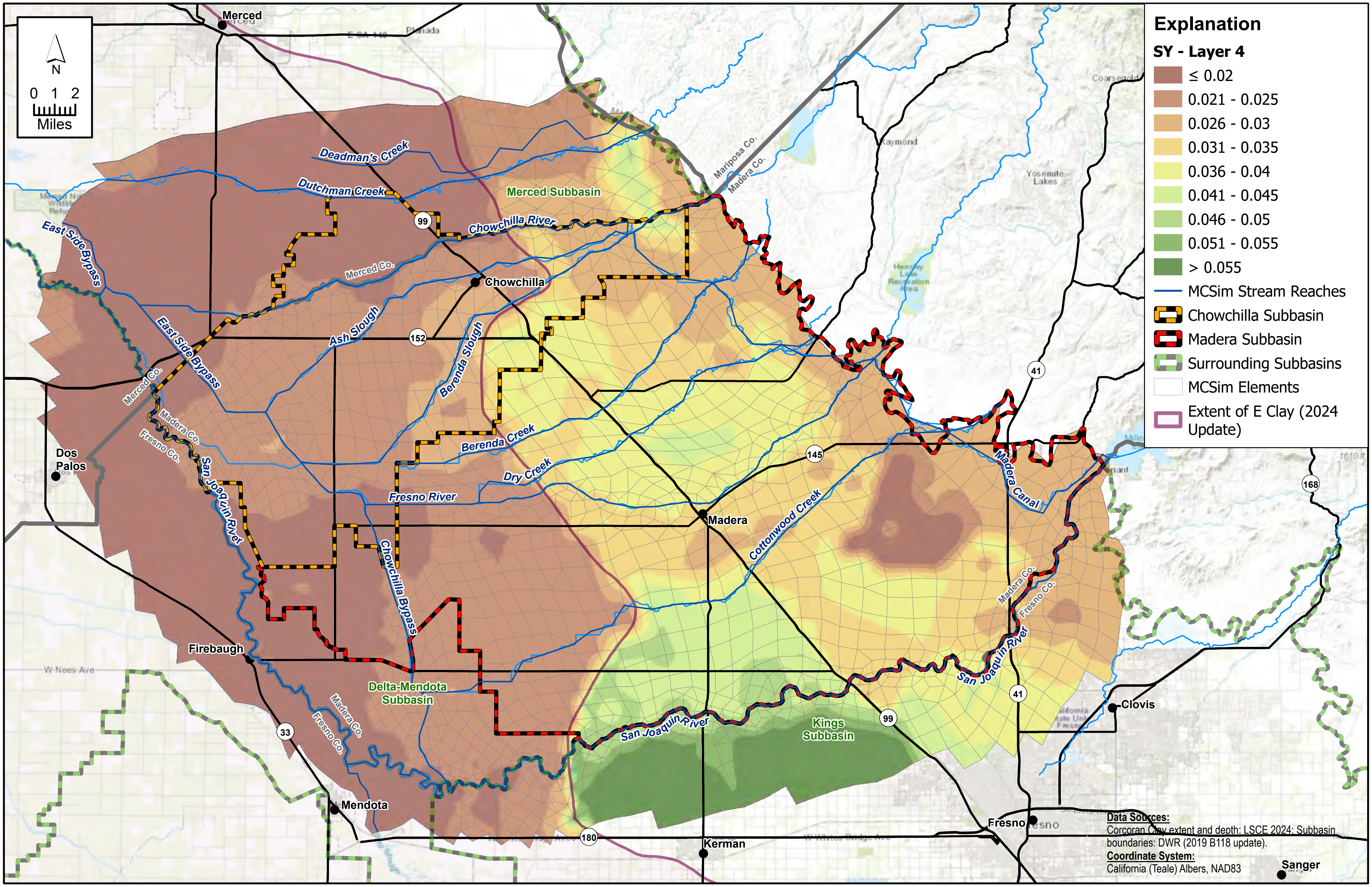
FIGURE 4-24

Calibrated Specific Yield (Sy) - Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SY

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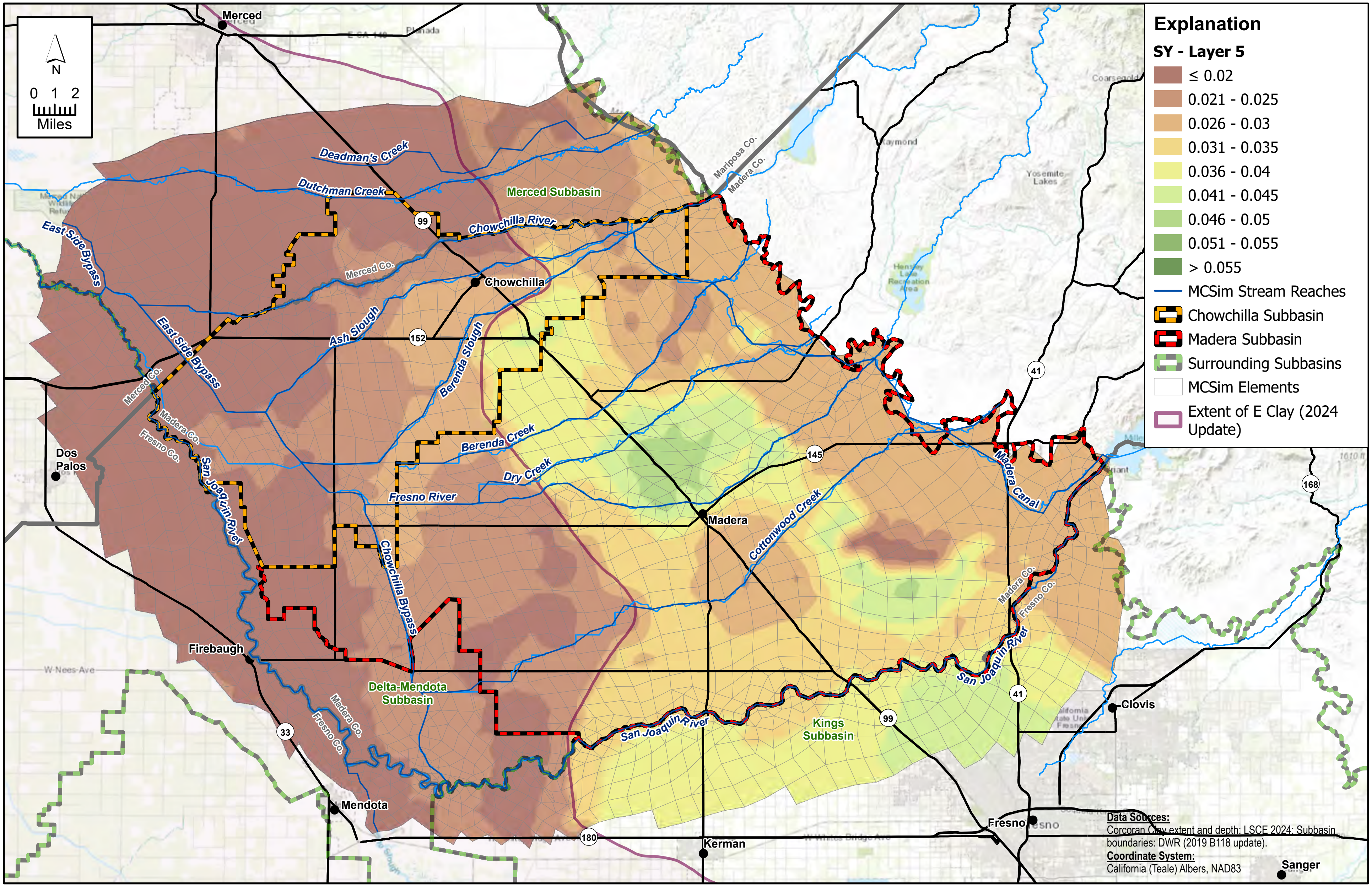
FIGURE 4-25

Calibrated Specific Yield (Sy) - Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SY

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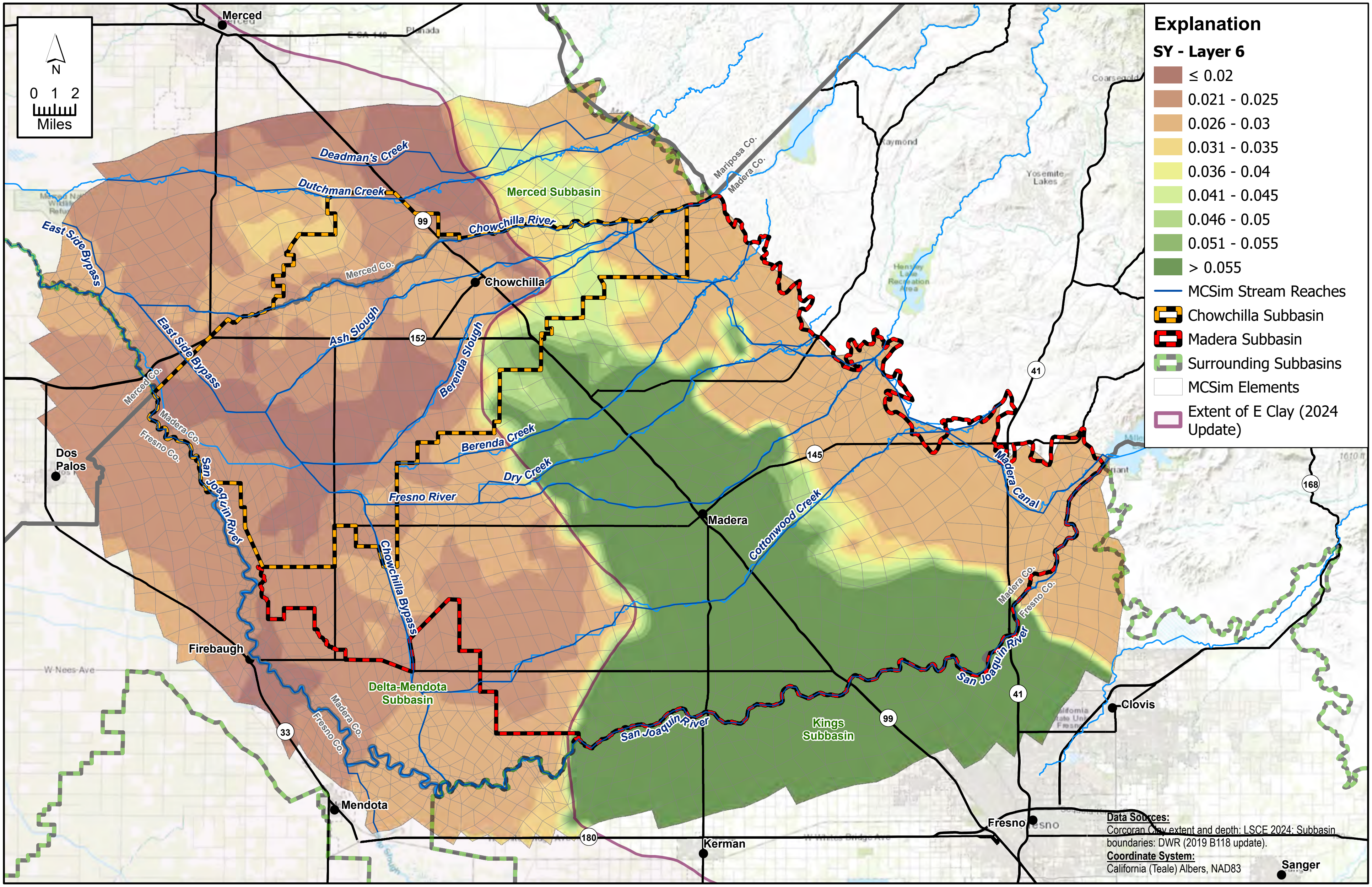
FIGURE 4-26

Calibrated Specific Yield (Sy) - Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SY

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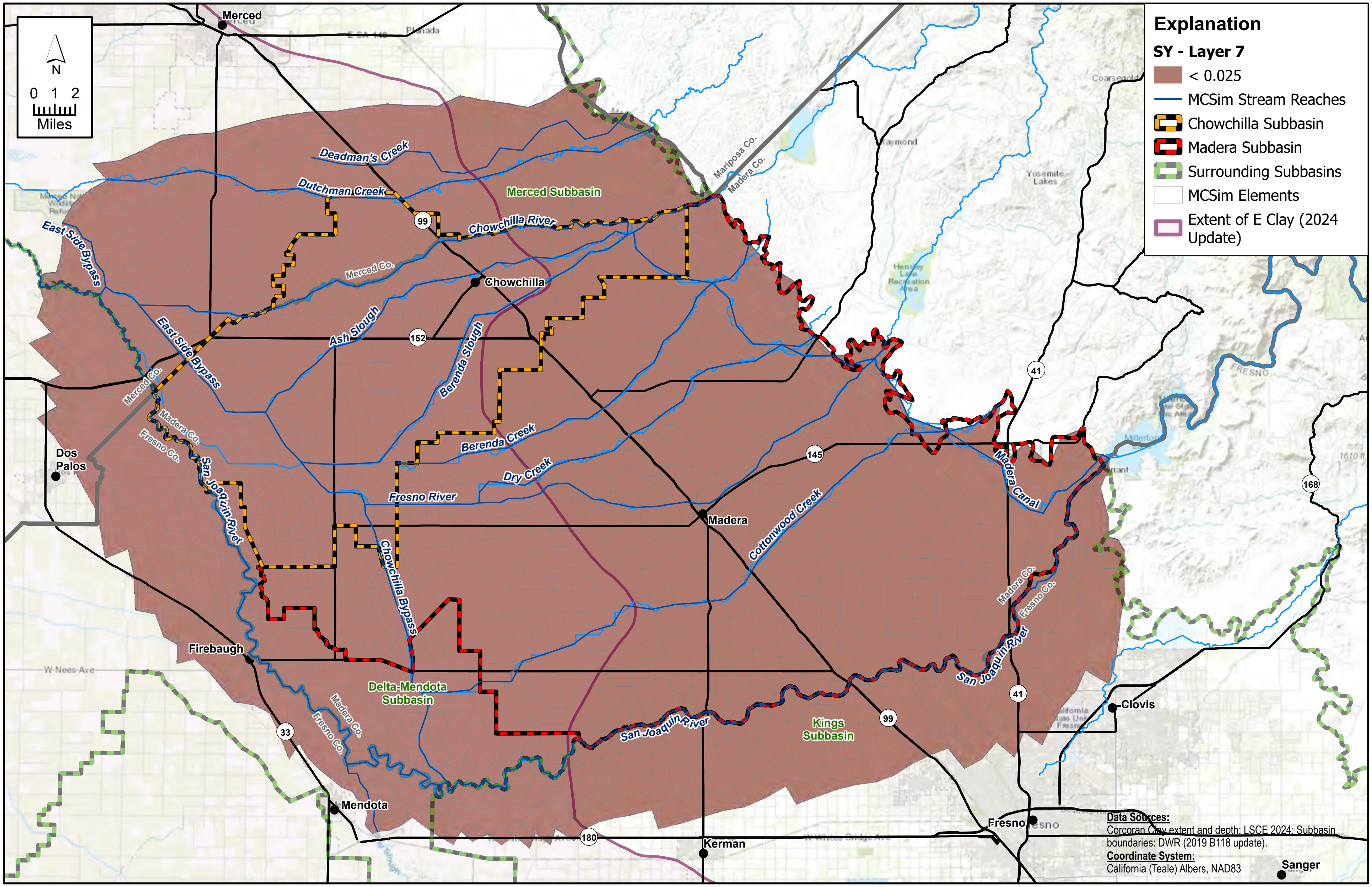
FIGURE 4-27

Calibrated Specific Yield (Sy) - Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SY

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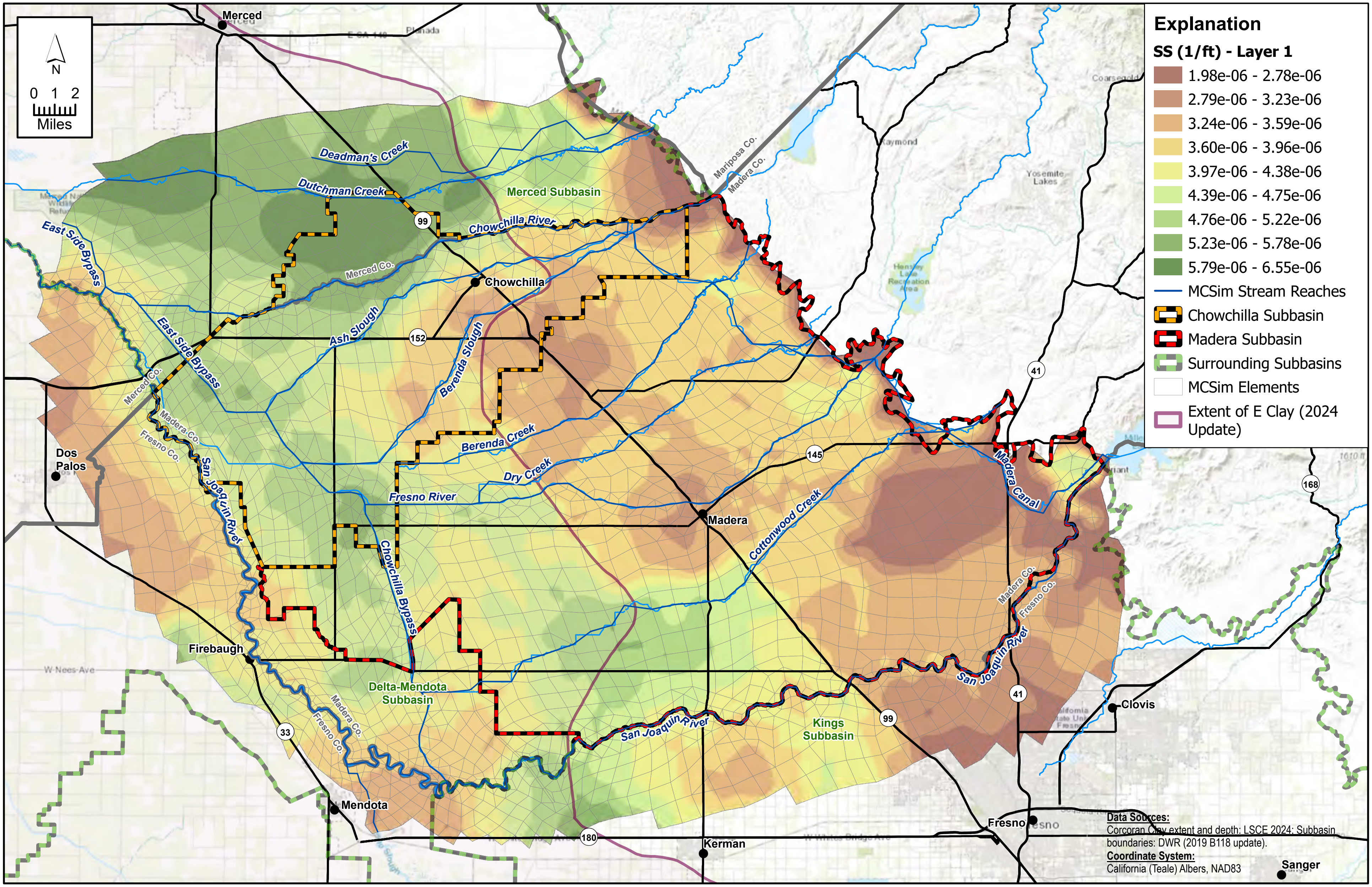
FIGURE 4-28

Calibrated Specific Yield (Sy) - Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SS

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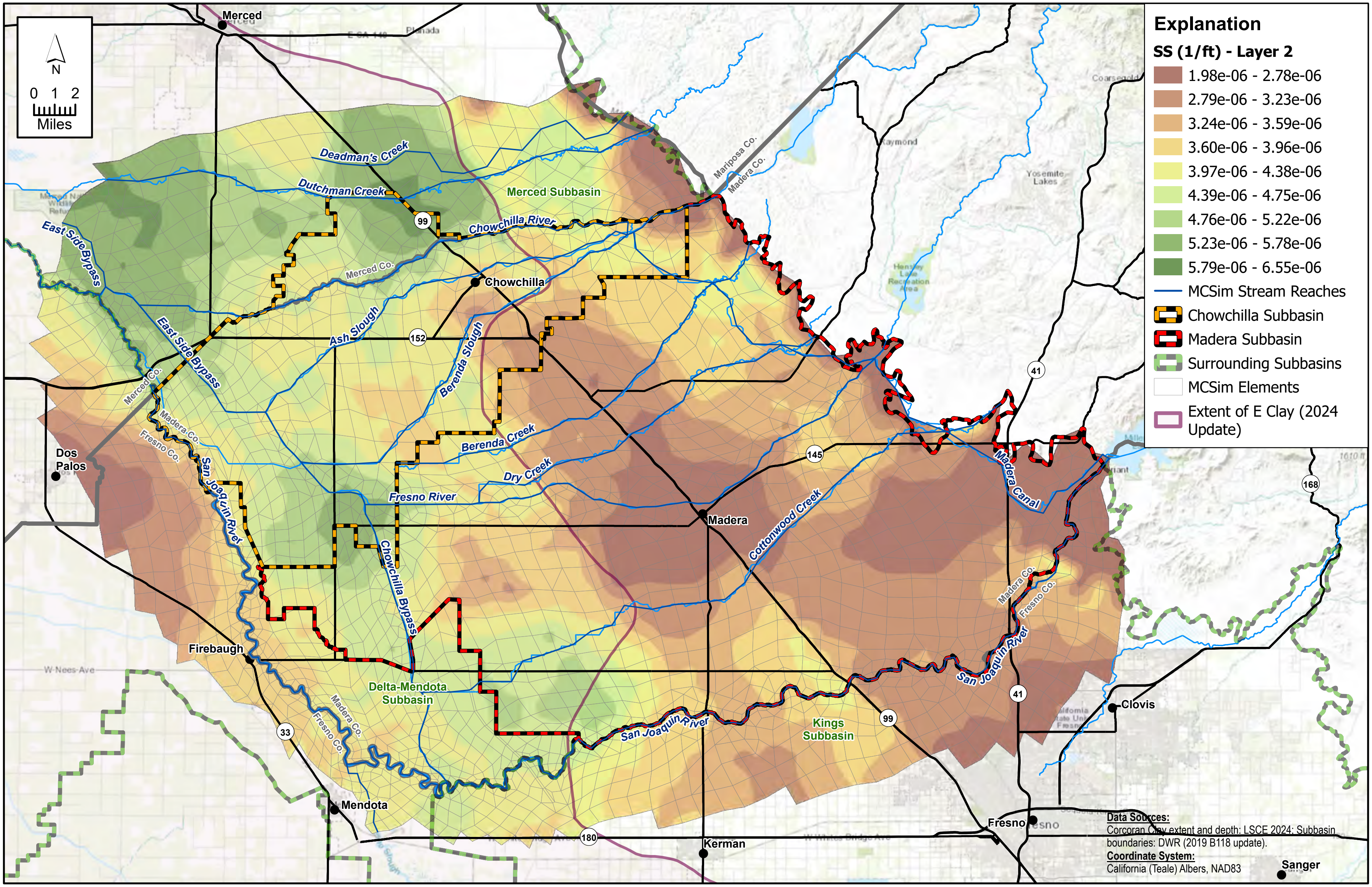
FIGURE 4-29

Calibrated Specific Storage (SS) - Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SS

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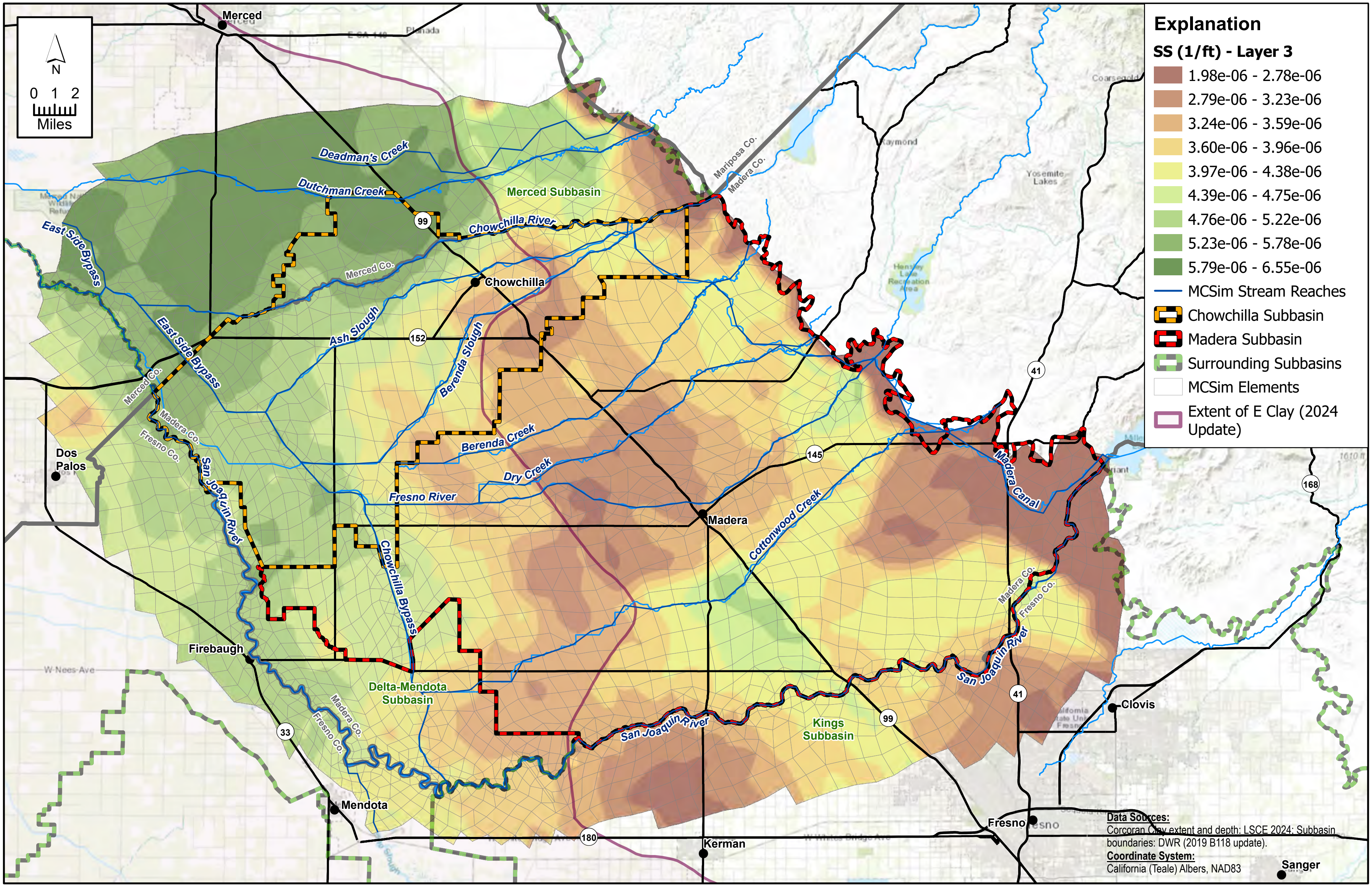
FIGURE 4-30

Calibrated Specific Storage (SS) - Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SS

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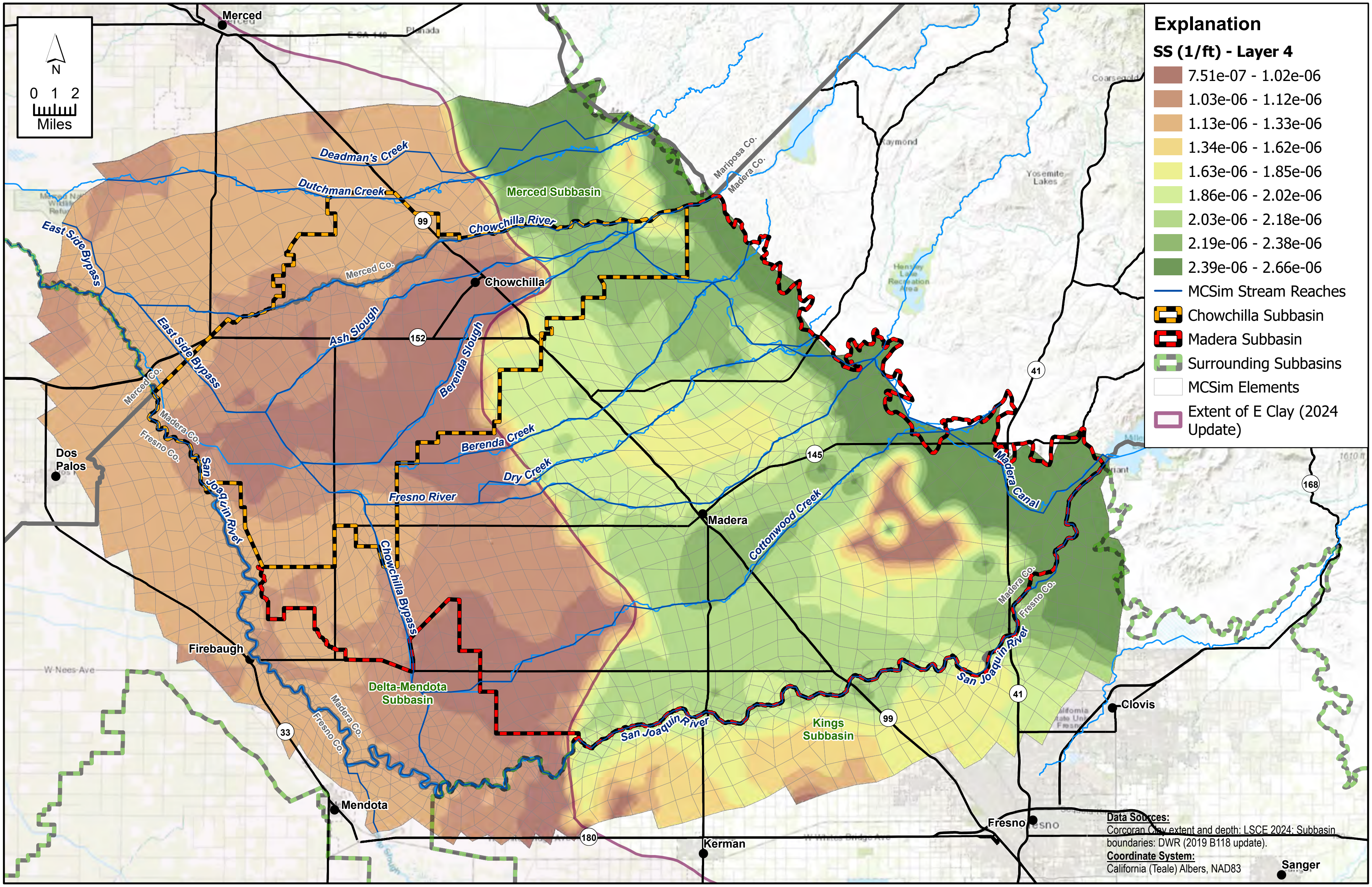
FIGURE 4-31

Calibrated Specific Storage (SS) - Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SS

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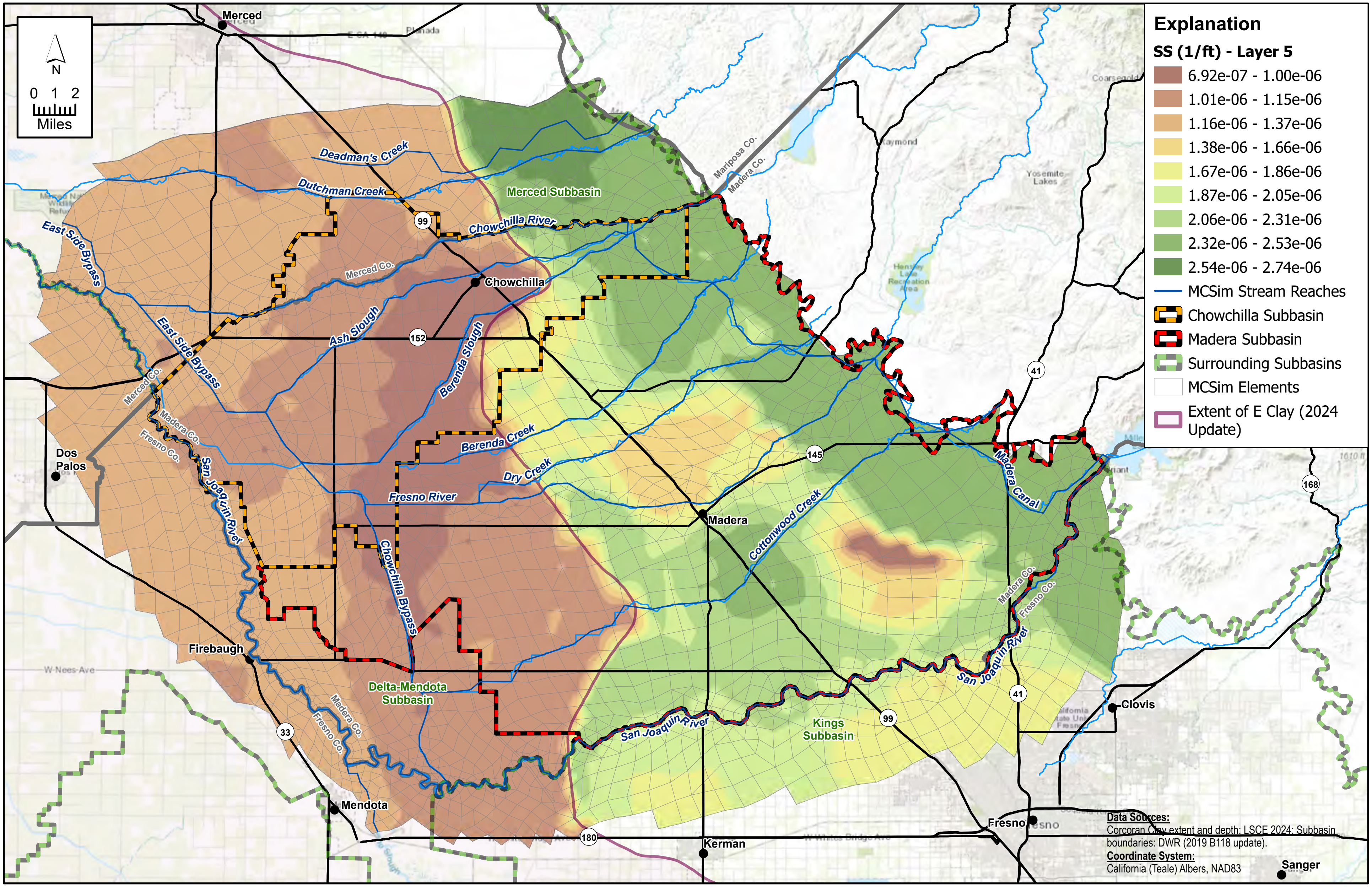
FIGURE 4-32

Calibrated Specific Storage (SS) - Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SS

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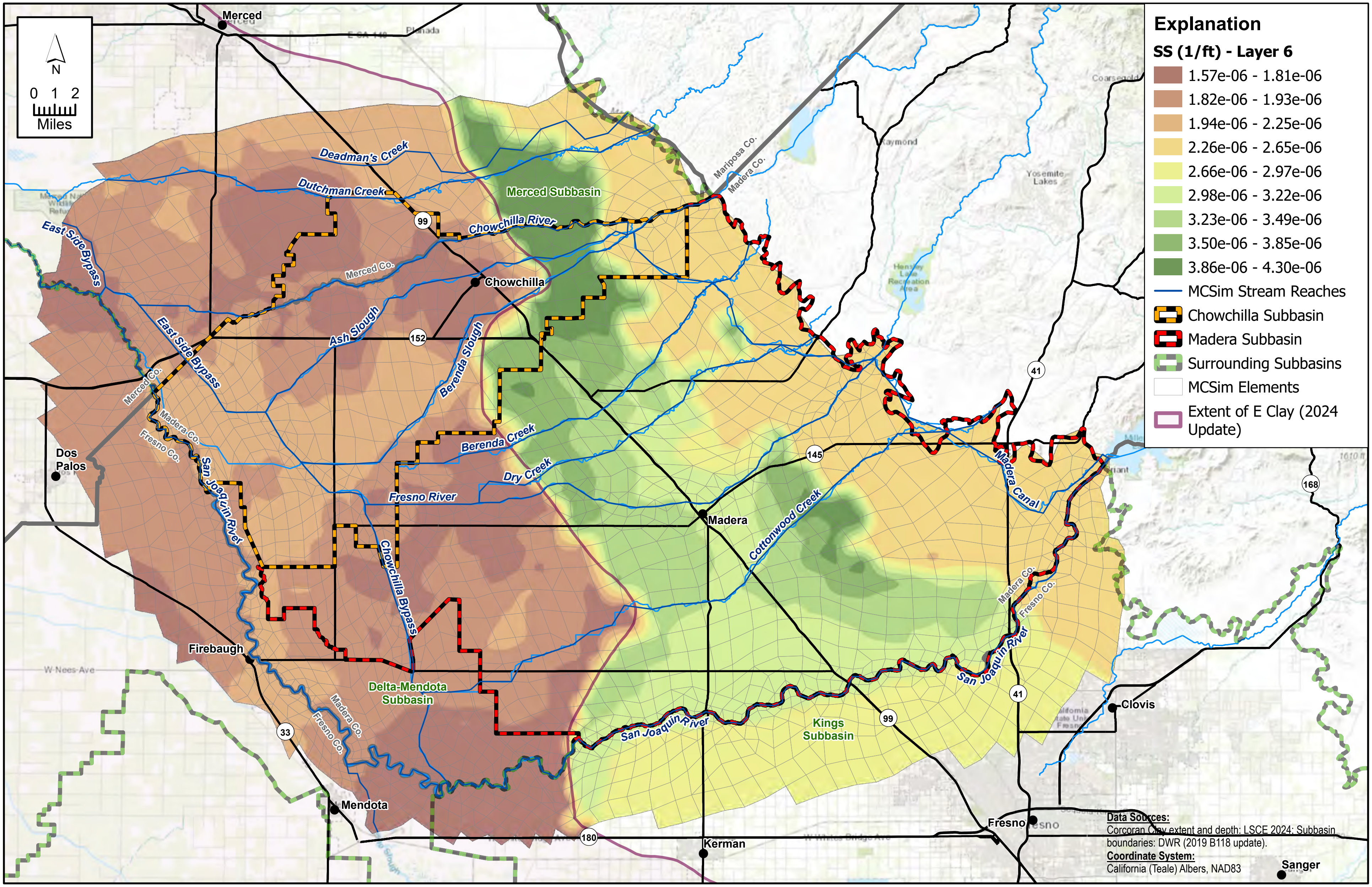
FIGURE 4-33

Calibrated Specific Storage (SS) - Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SS

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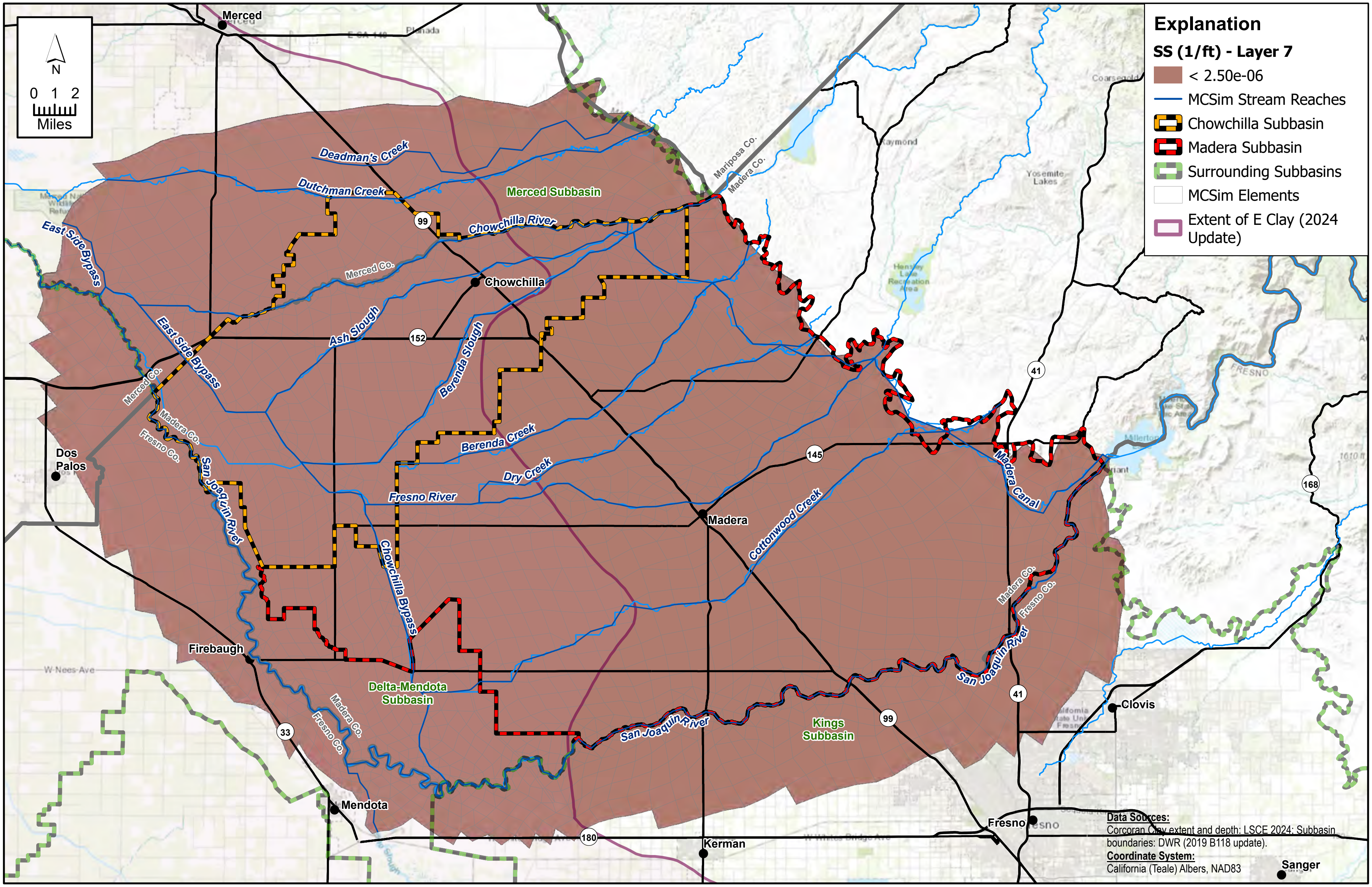
FIGURE 4-34

Calibrated Specific Storage (SS) - Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SS

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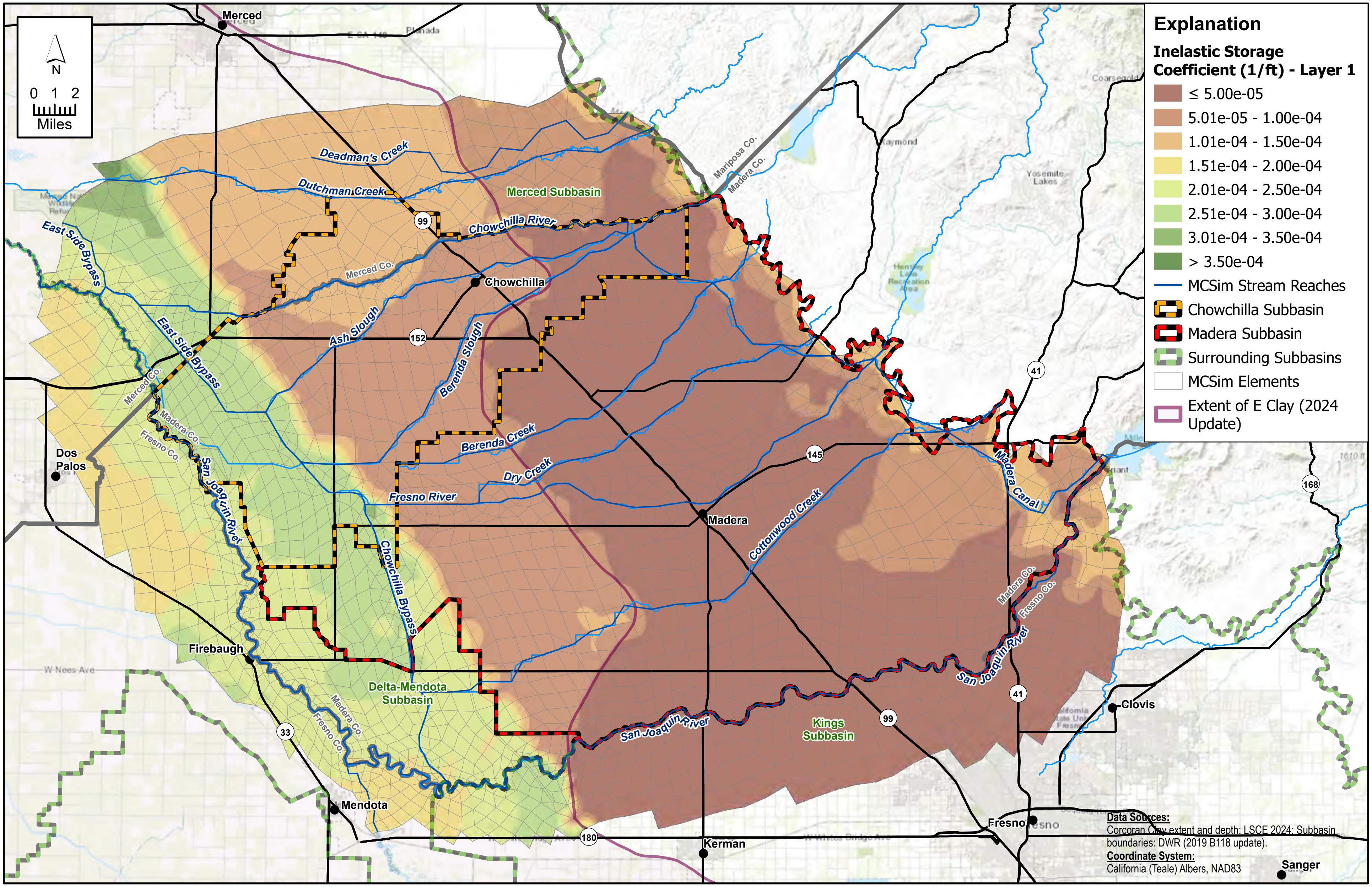
FIGURE 4-35

Calibrated Specific Storage (SS) - Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SCI

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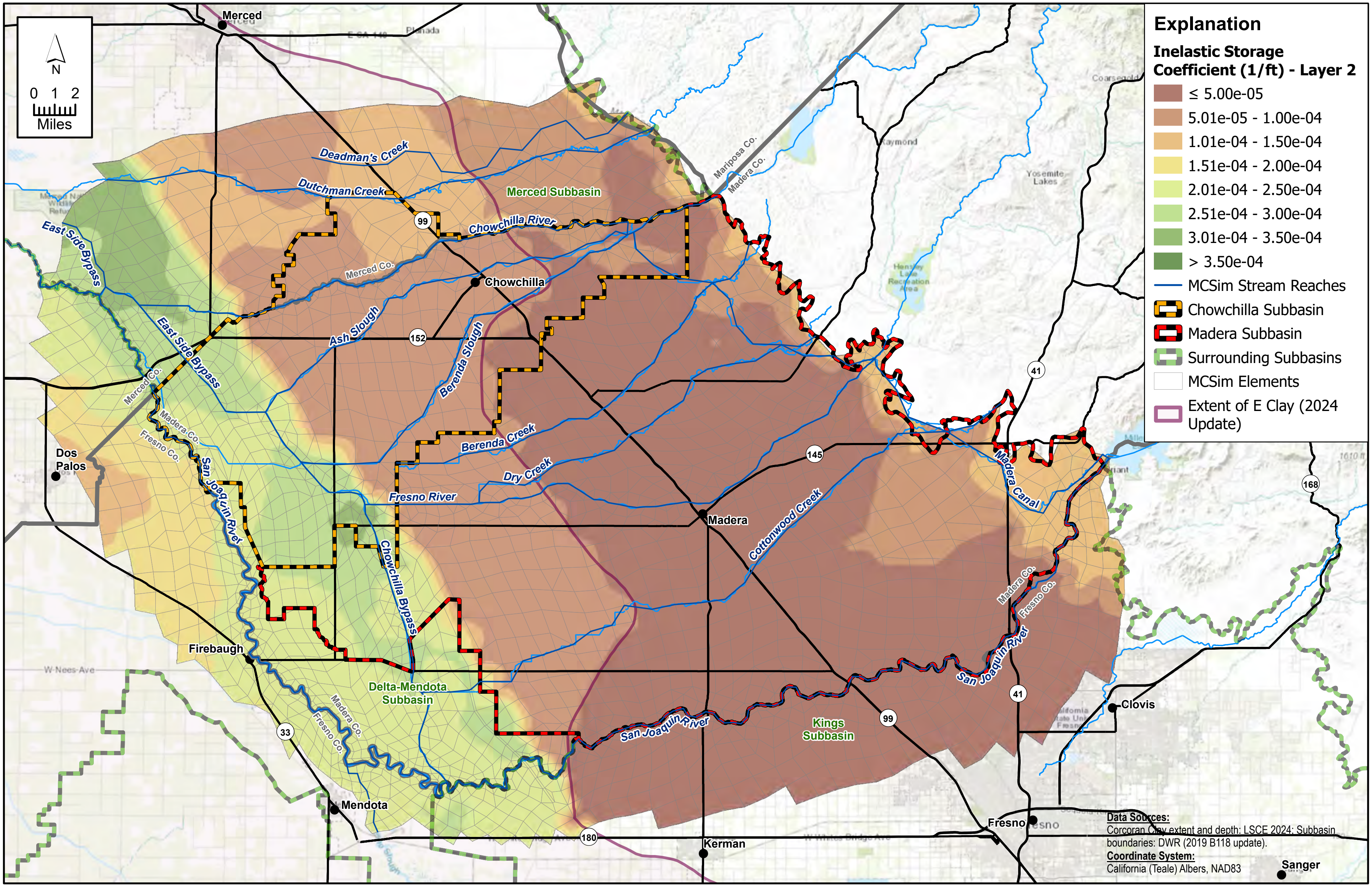
FIGURE 4-36

Calibrated Inelastic Specific Storage (SCI)- Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SCI

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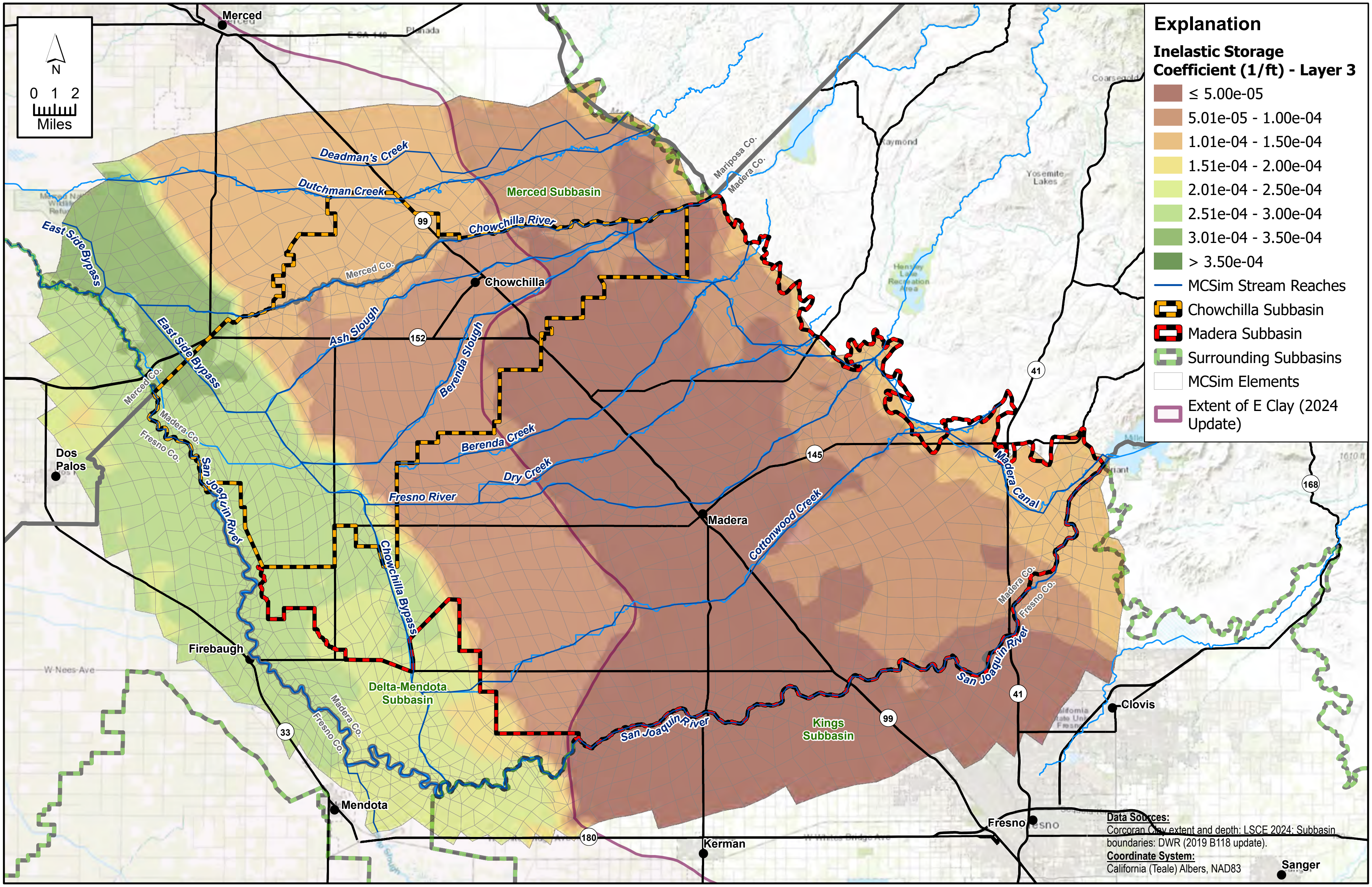
FIGURE 4-37

Calibrated Inelastic Specific Storage (SCI)- Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SCI

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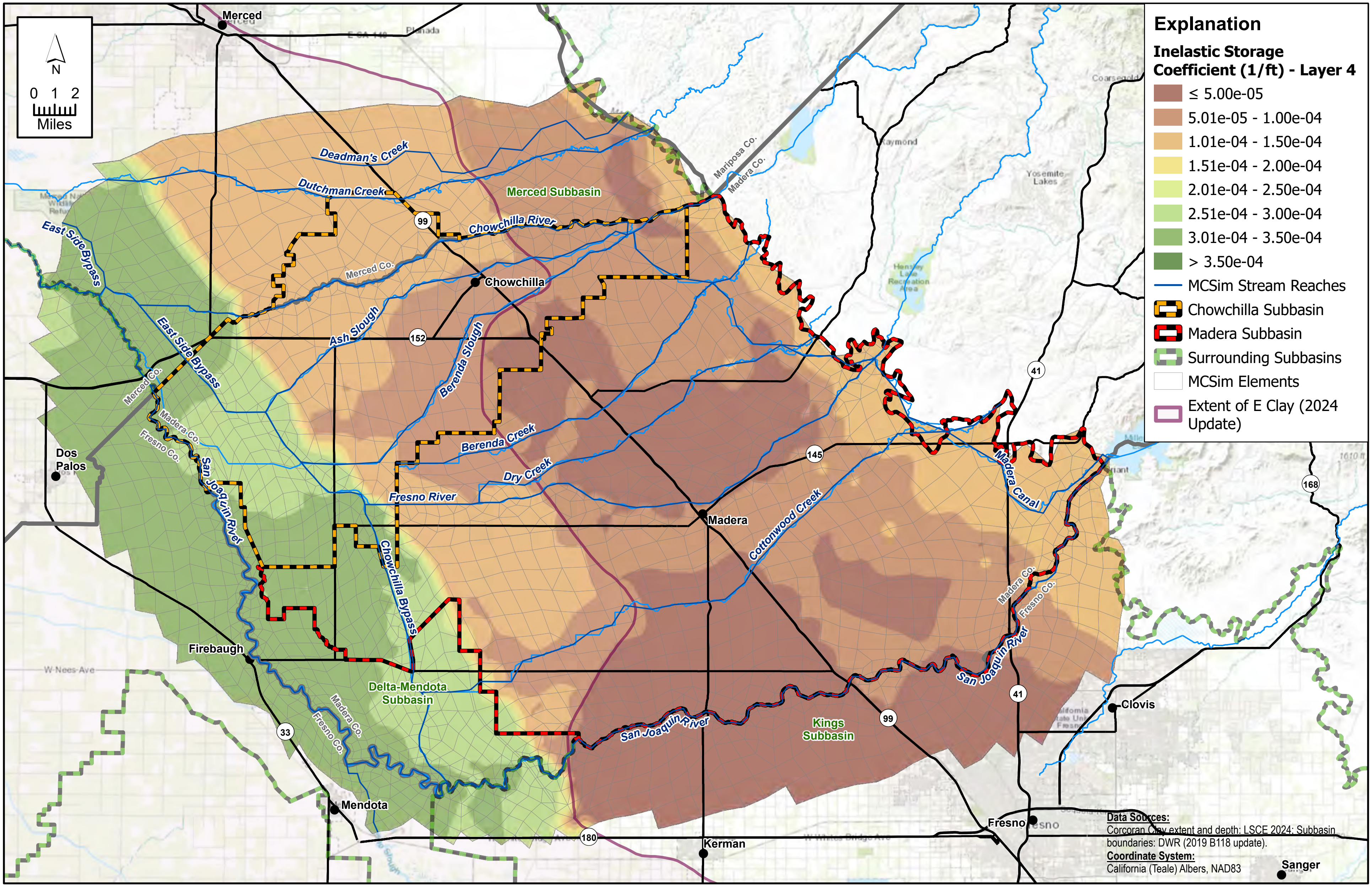
FIGURE 4-38

Calibrated Inelastic Specific Storage (SCI)- Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SCI

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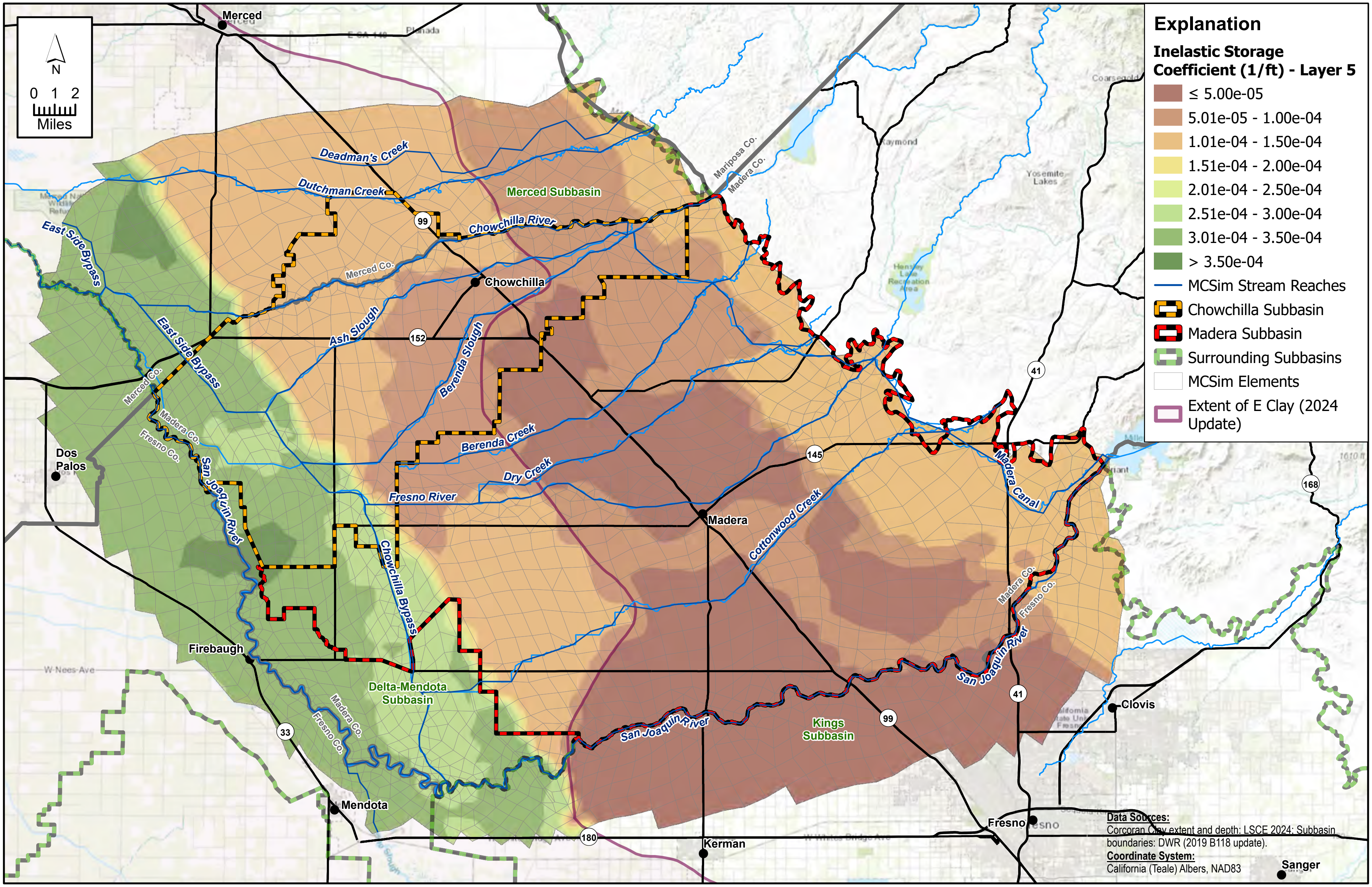
FIGURE 4-39

Calibrated Inelastic Specific Storage (SCI)- Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SCI

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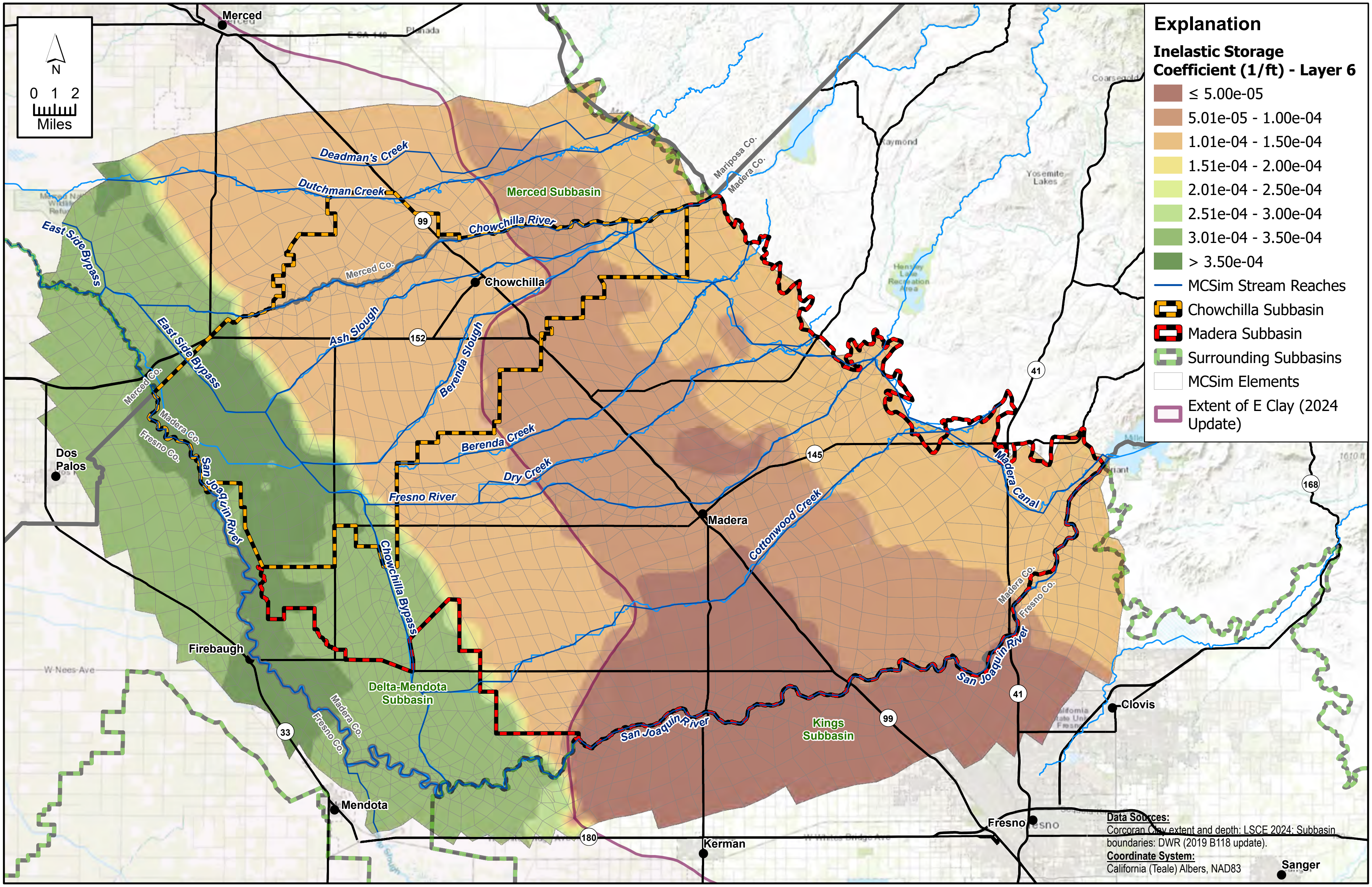
FIGURE 4-40

Calibrated Inelastic Specific Storage (SCI)- Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SCI

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FIGURE 4-41

Calibrated Inelastic Specific Storage (SCI)- Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

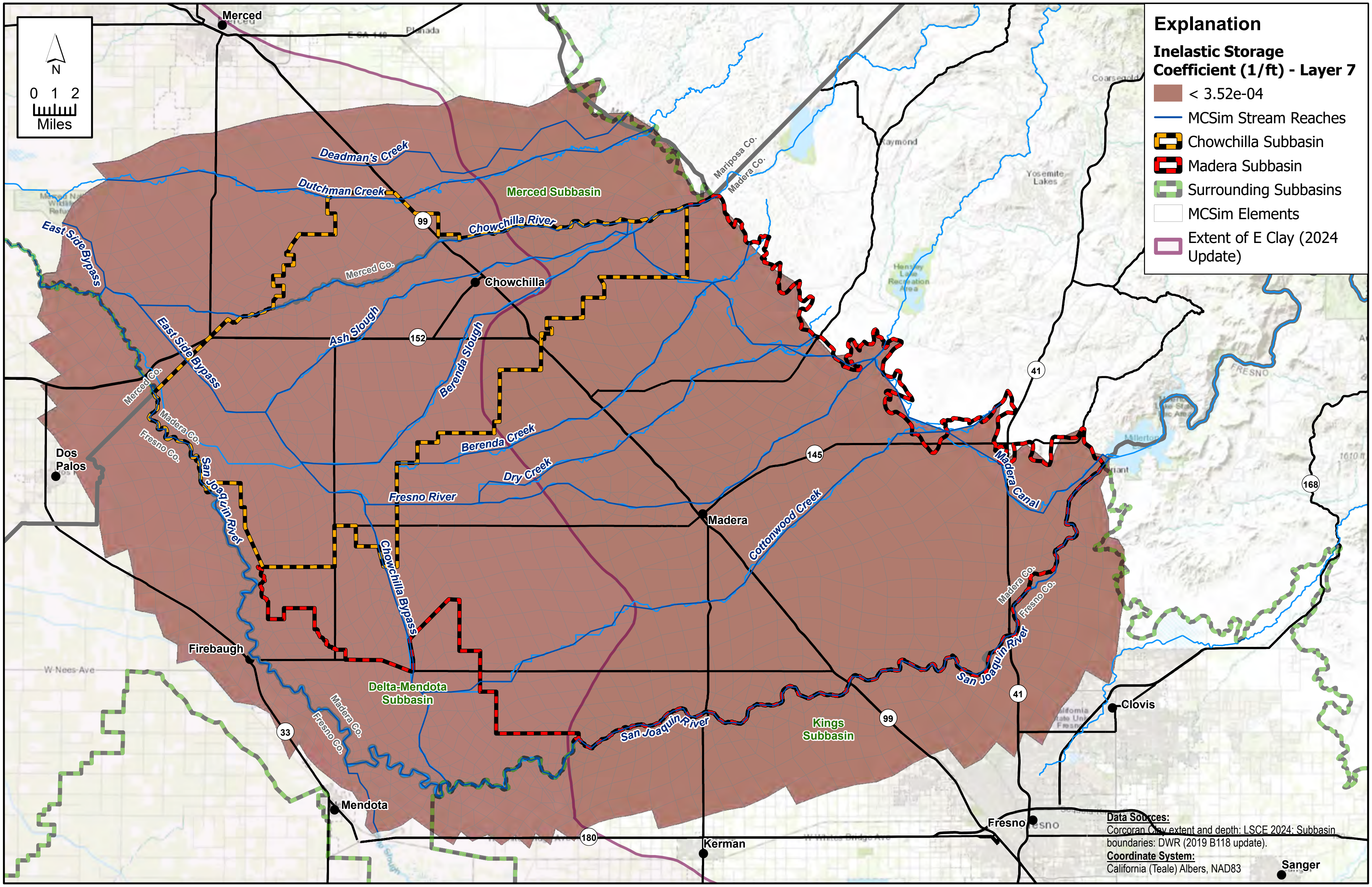

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FIGURE 4-42

Calibrated Inelastic Specific Storage (SCI)- Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

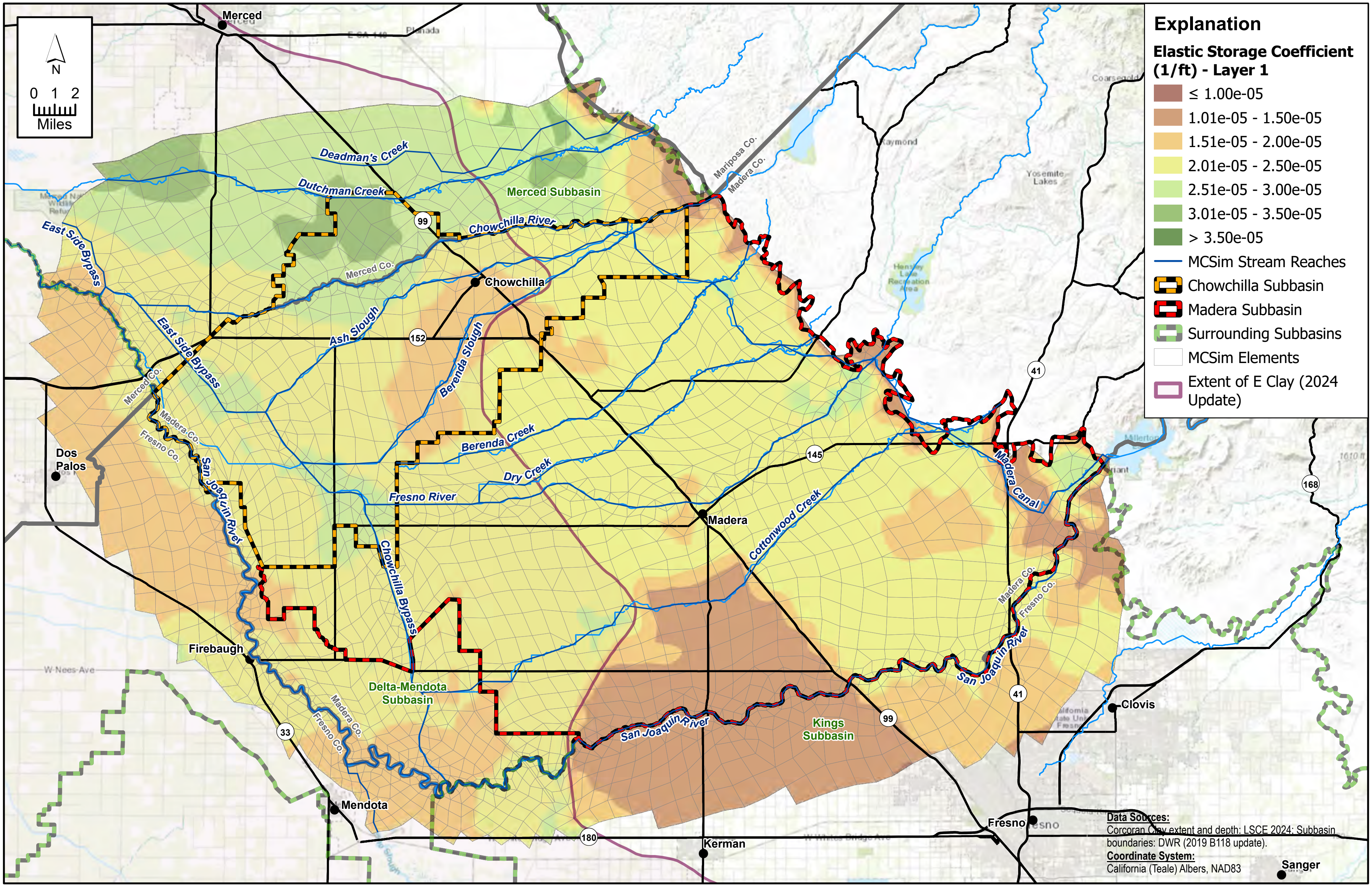

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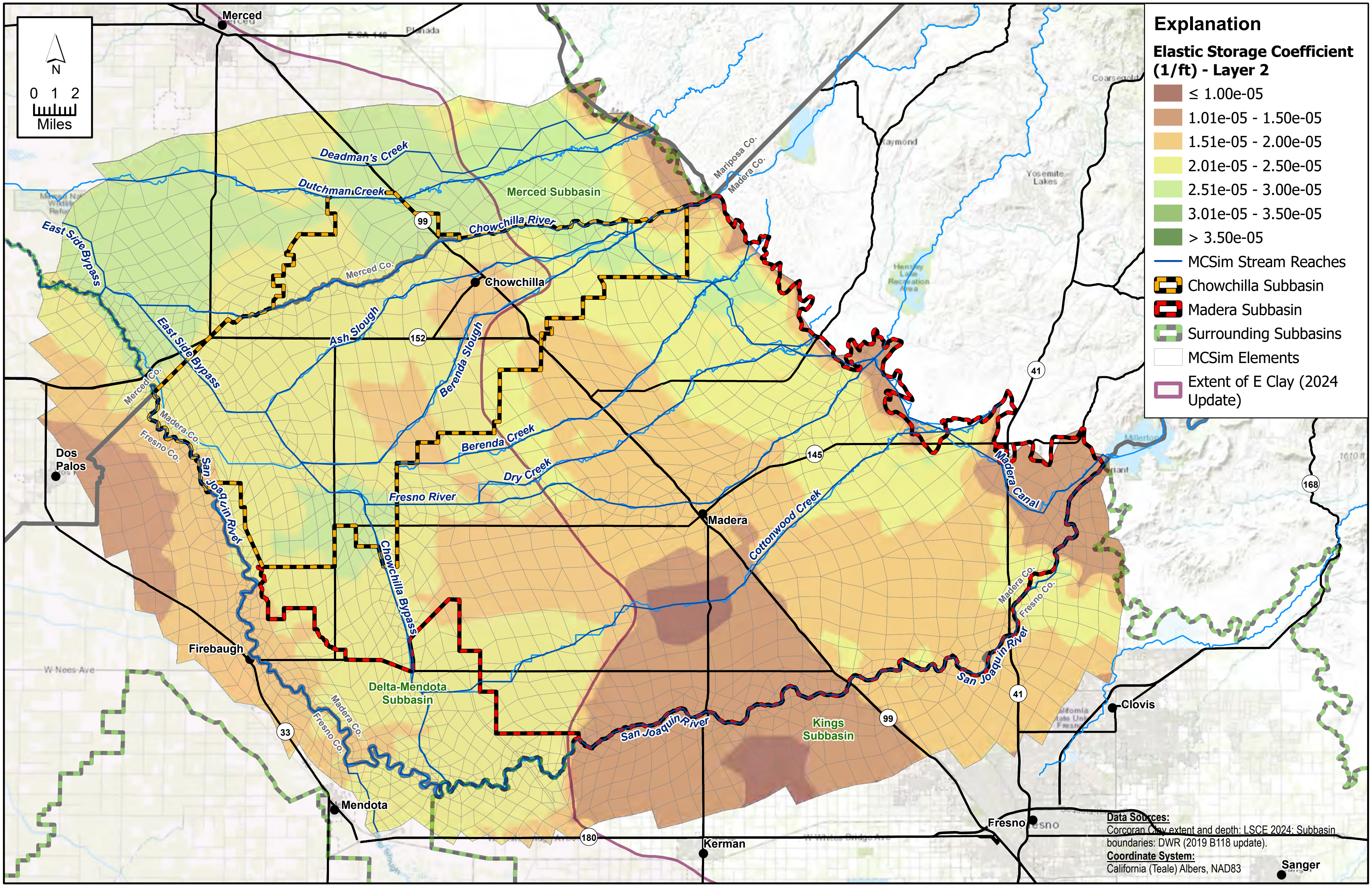
FIGURE 4-43

Calibrated Elastic Specific Storage (SCE)- Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SCE

FIGURE 4-44

Calibrated Elastic Specific Storage (SCE)- Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

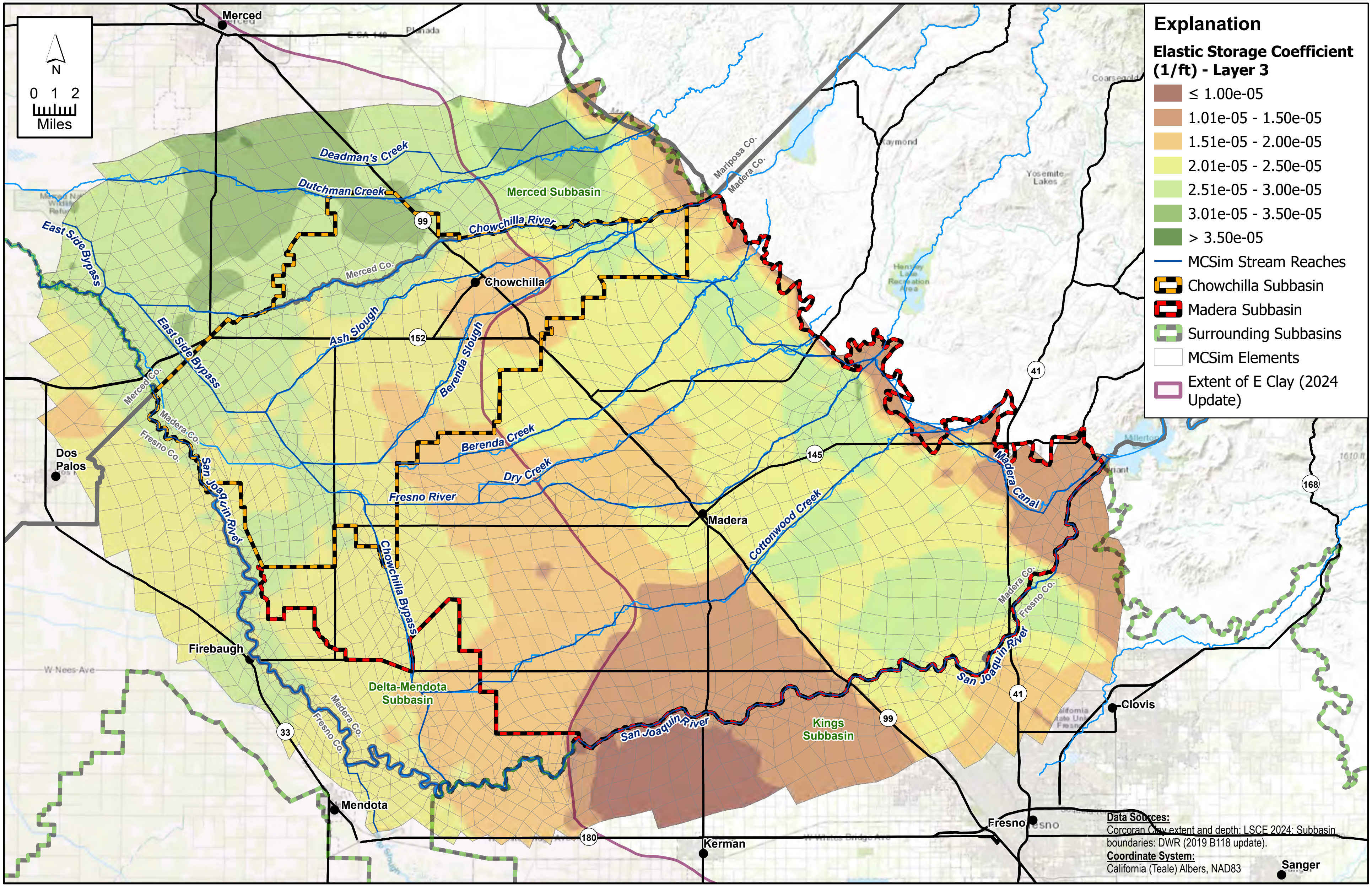


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FIGURE 4-45

Calibrated Elastic Specific Storage (SCE)- Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

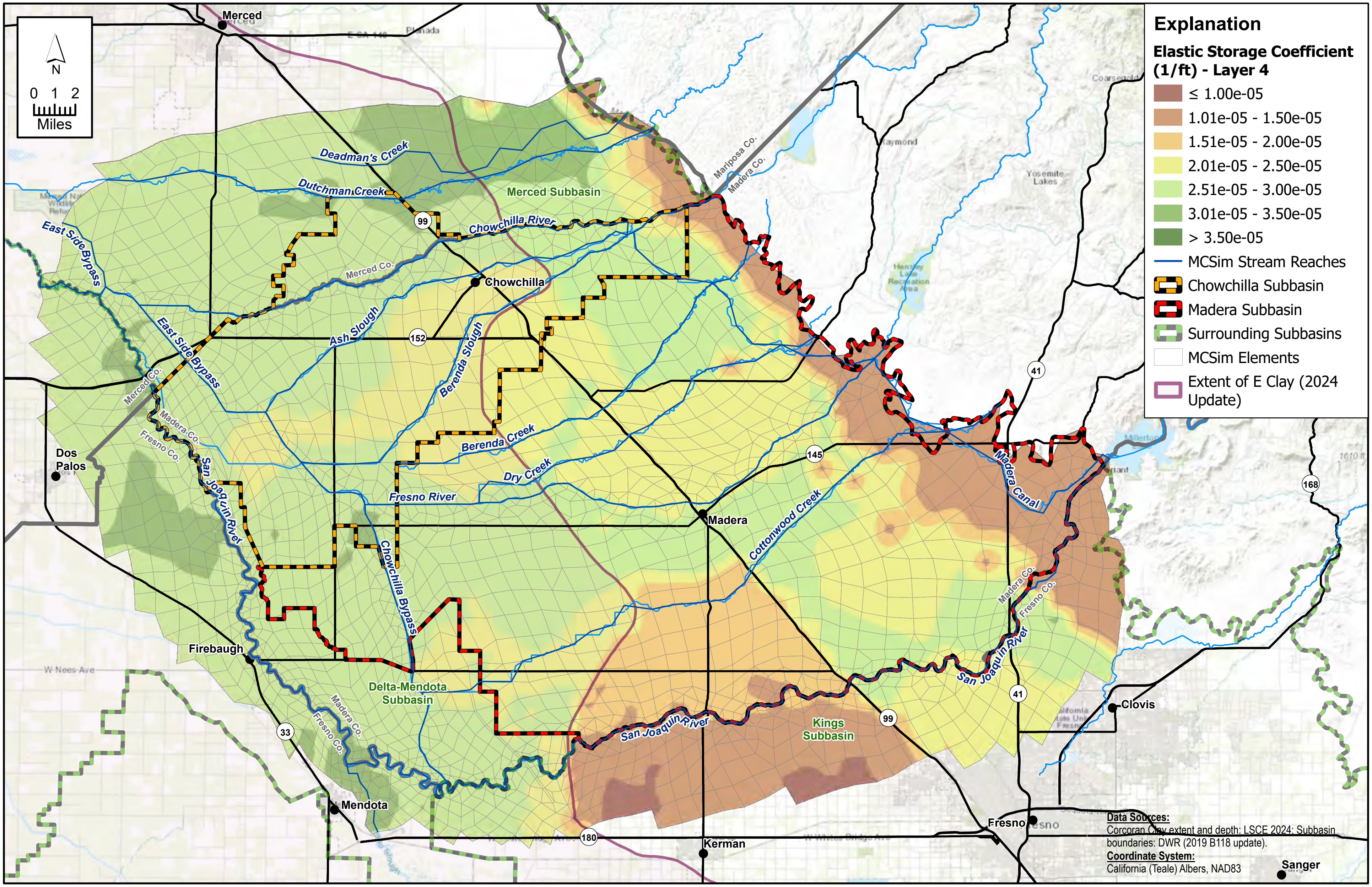

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FIGURE 4-46

Calibrated Elastic Specific Storage (SCE)- Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

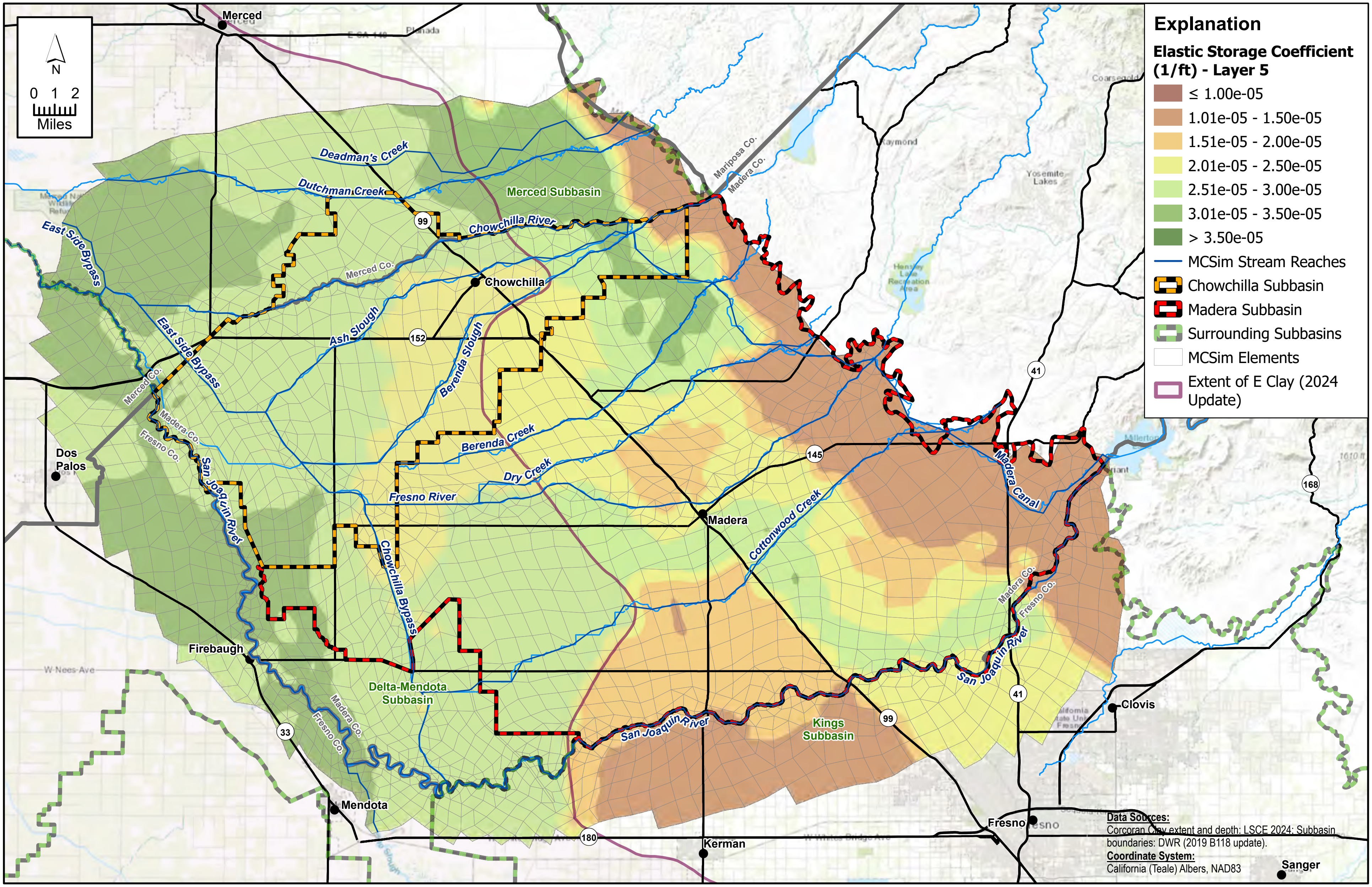

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FIGURE 4-47

Calibrated Elastic Specific Storage (SCE)- Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

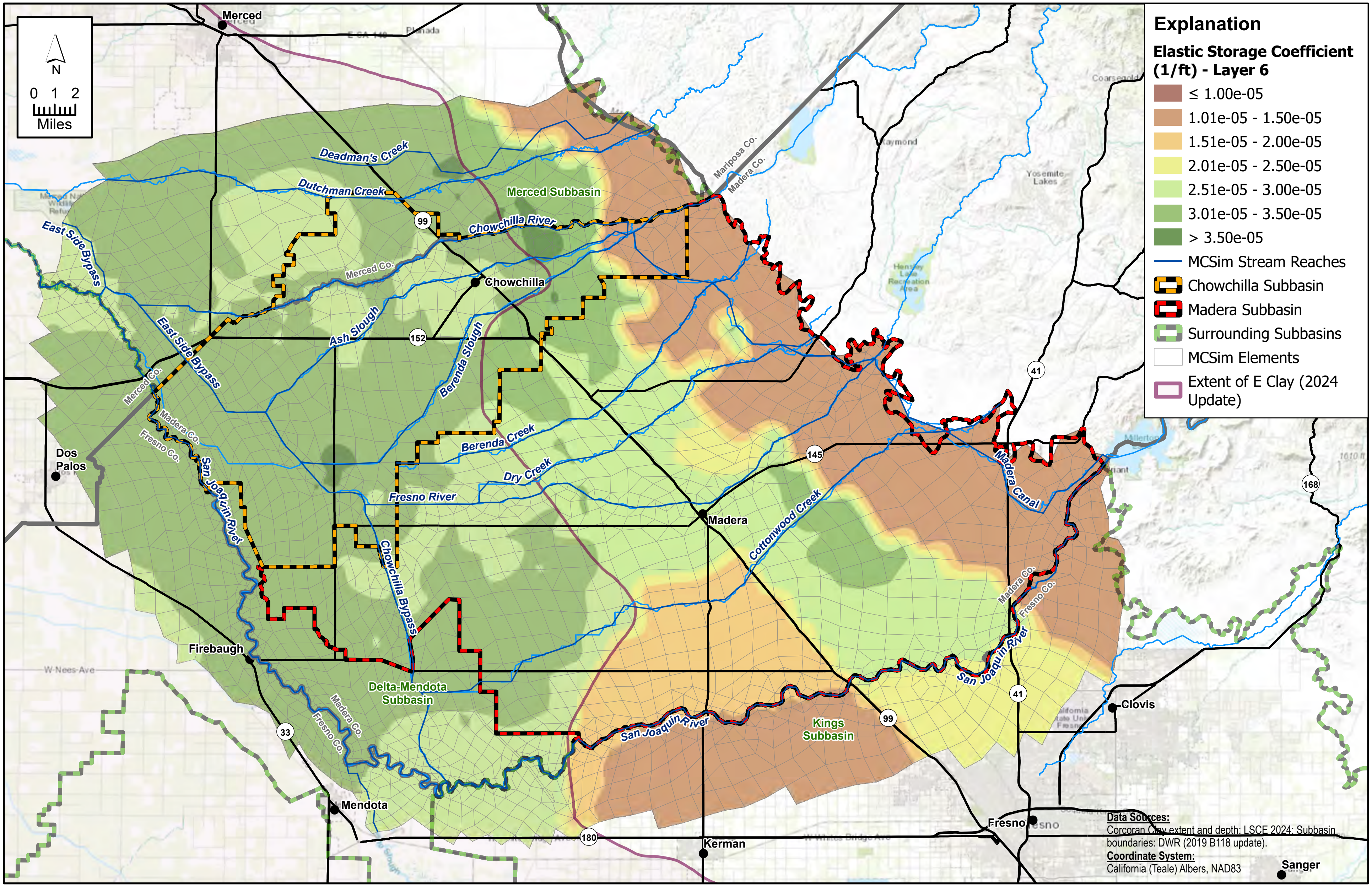

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FIGURE 4-48

Calibrated Elastic Specific Storage (SCE)- Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

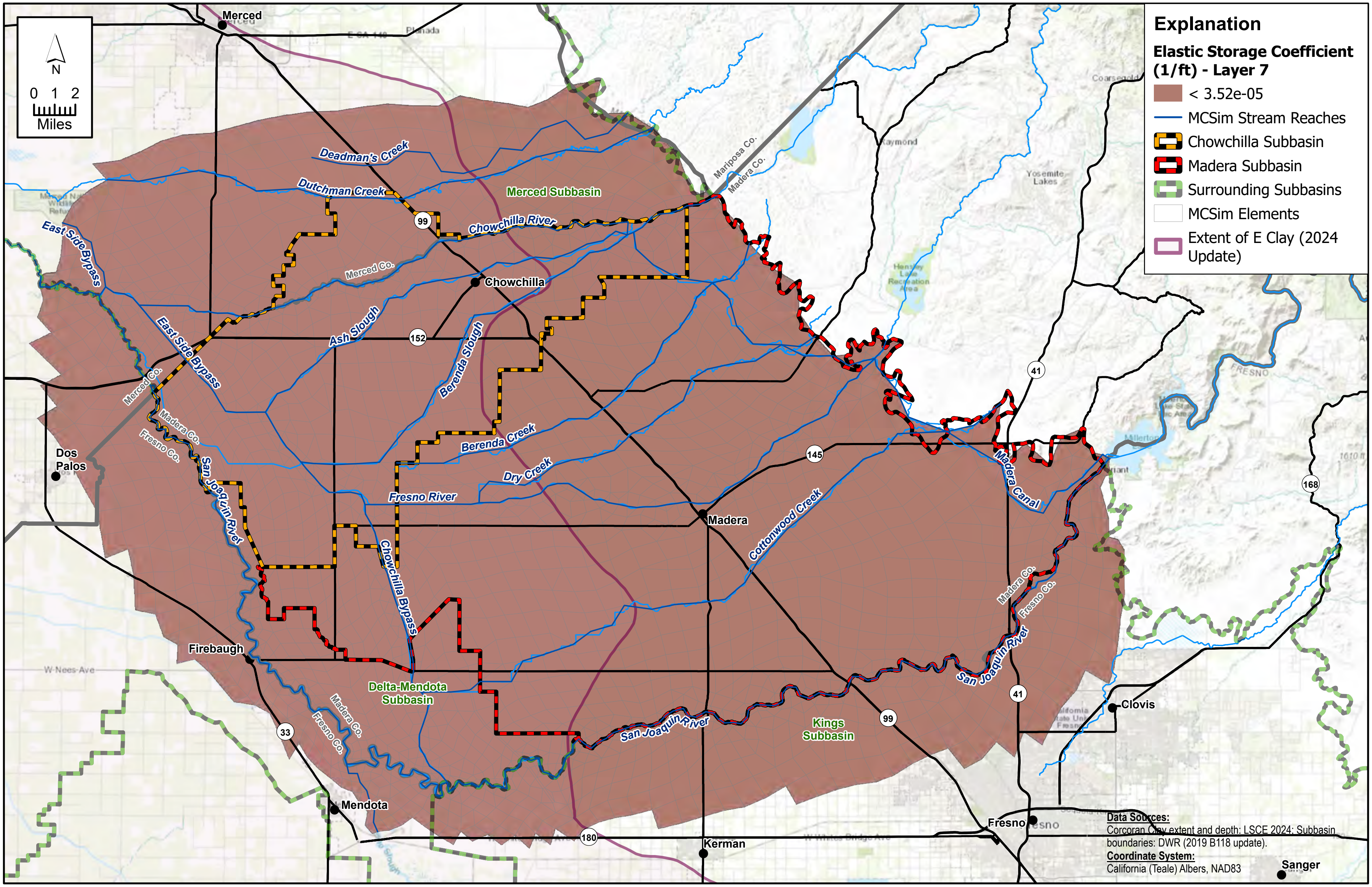

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FIGURE 4-49

Calibrated Elastic Specific Storage (SCE)- Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

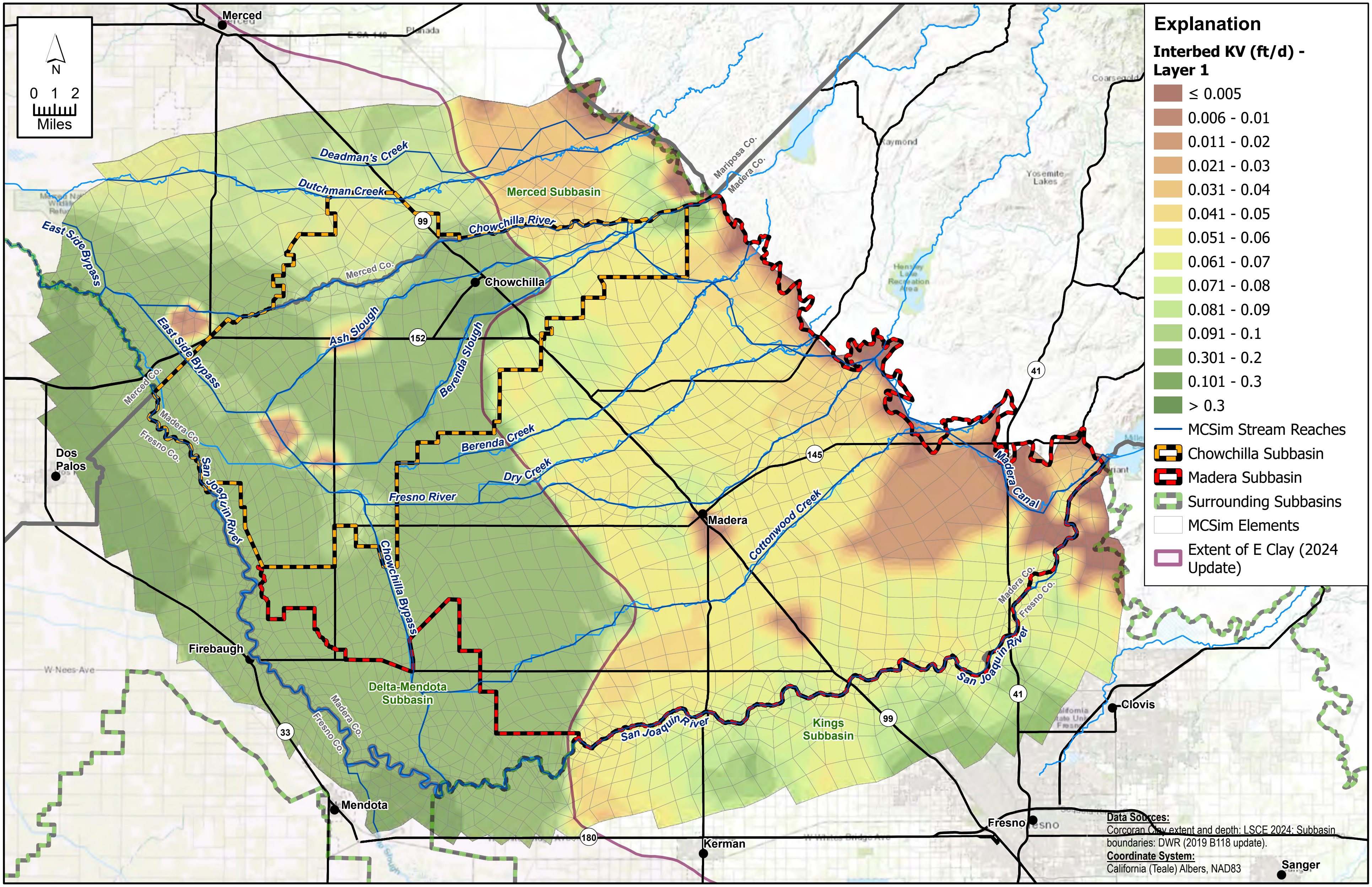

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FIGURE 4-50

Calibrated Interbed Vertical Hydraulic Conductivity- Layer 1

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

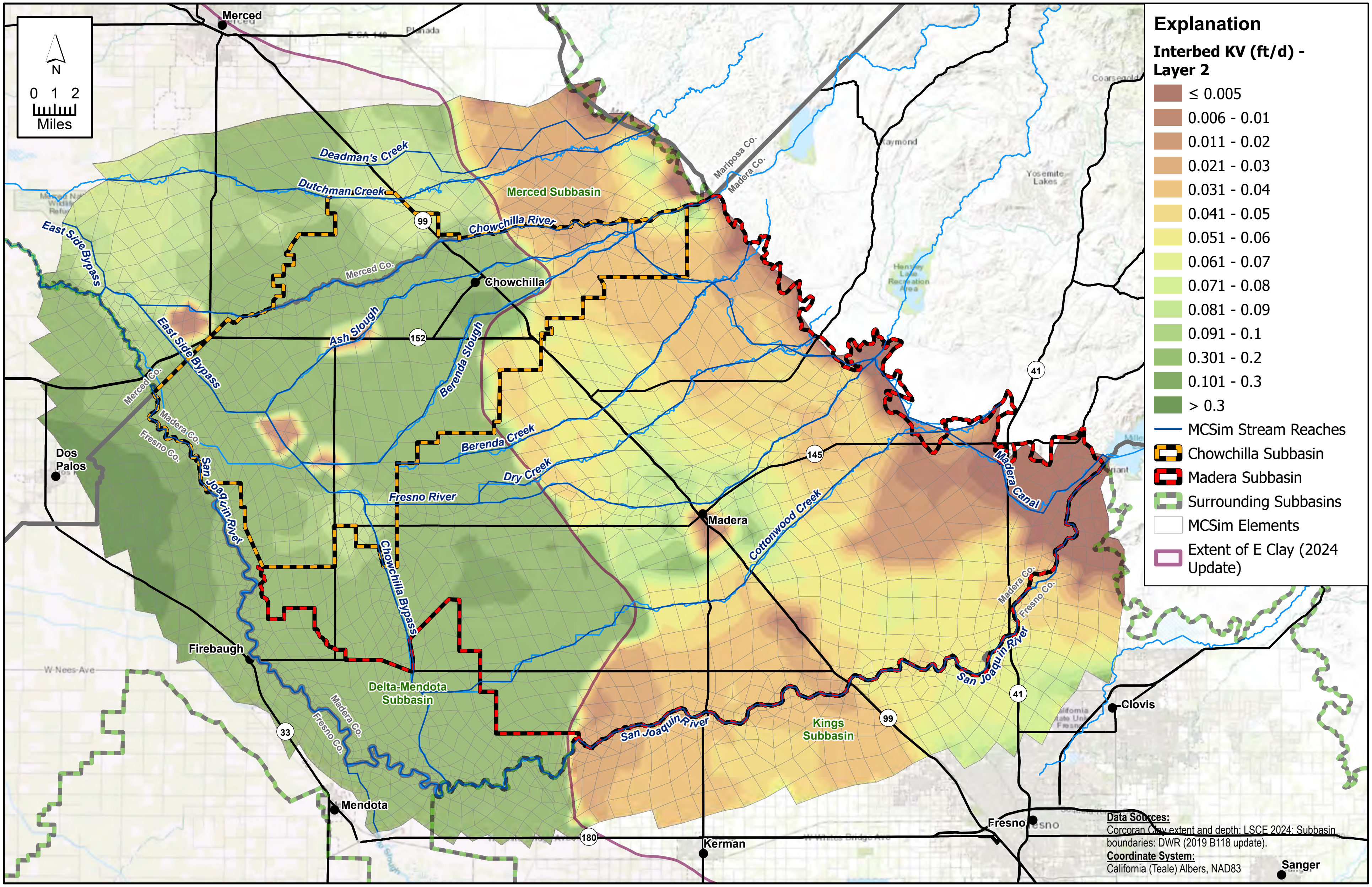

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FIGURE 4-51

Calibrated Interbed Vertical Hydraulic Conductivity- Layer 2

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

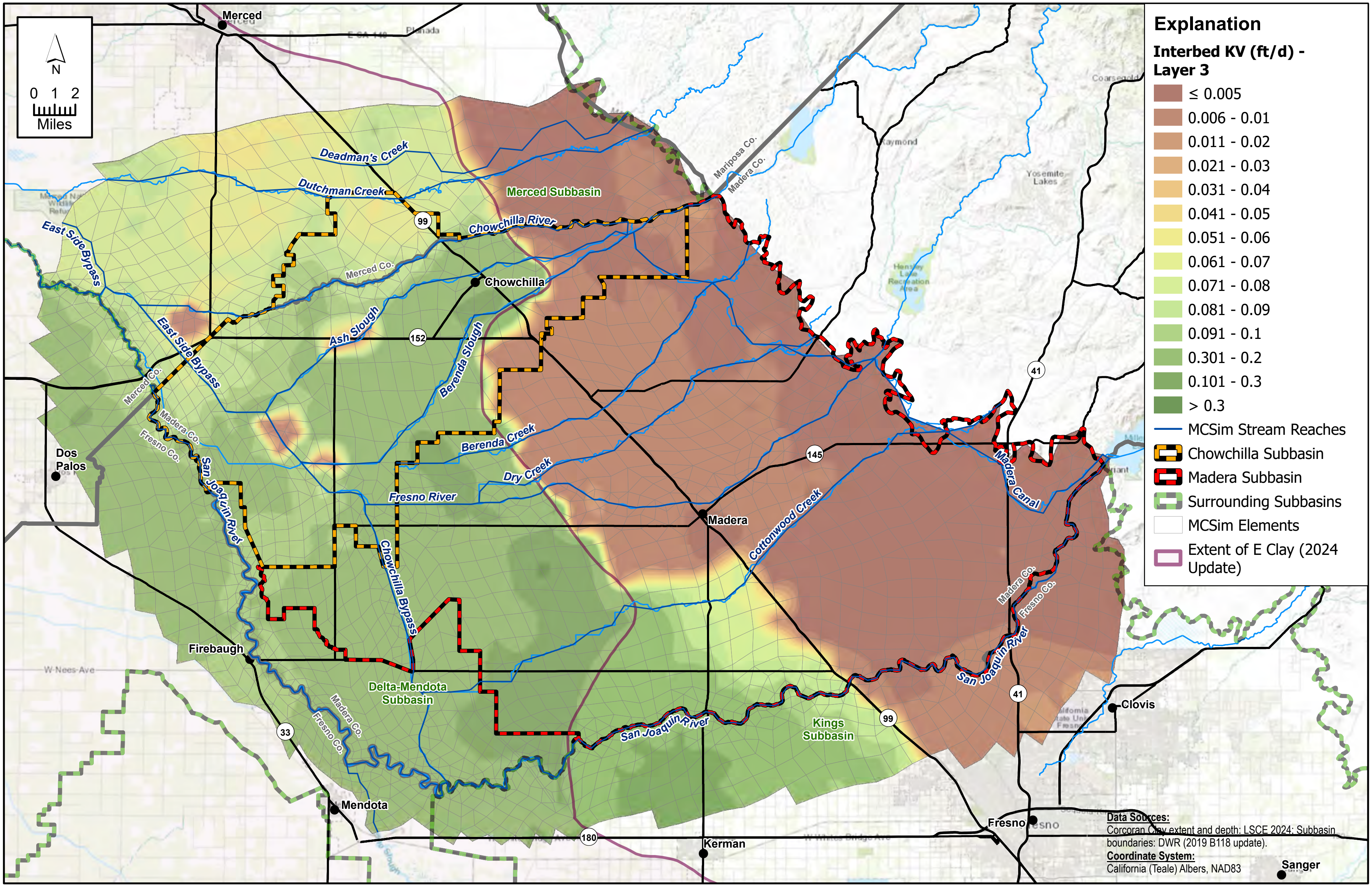

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FIGURE 4-52

Calibrated Interbed Vertical Hydraulic Conductivity- Layer 3

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

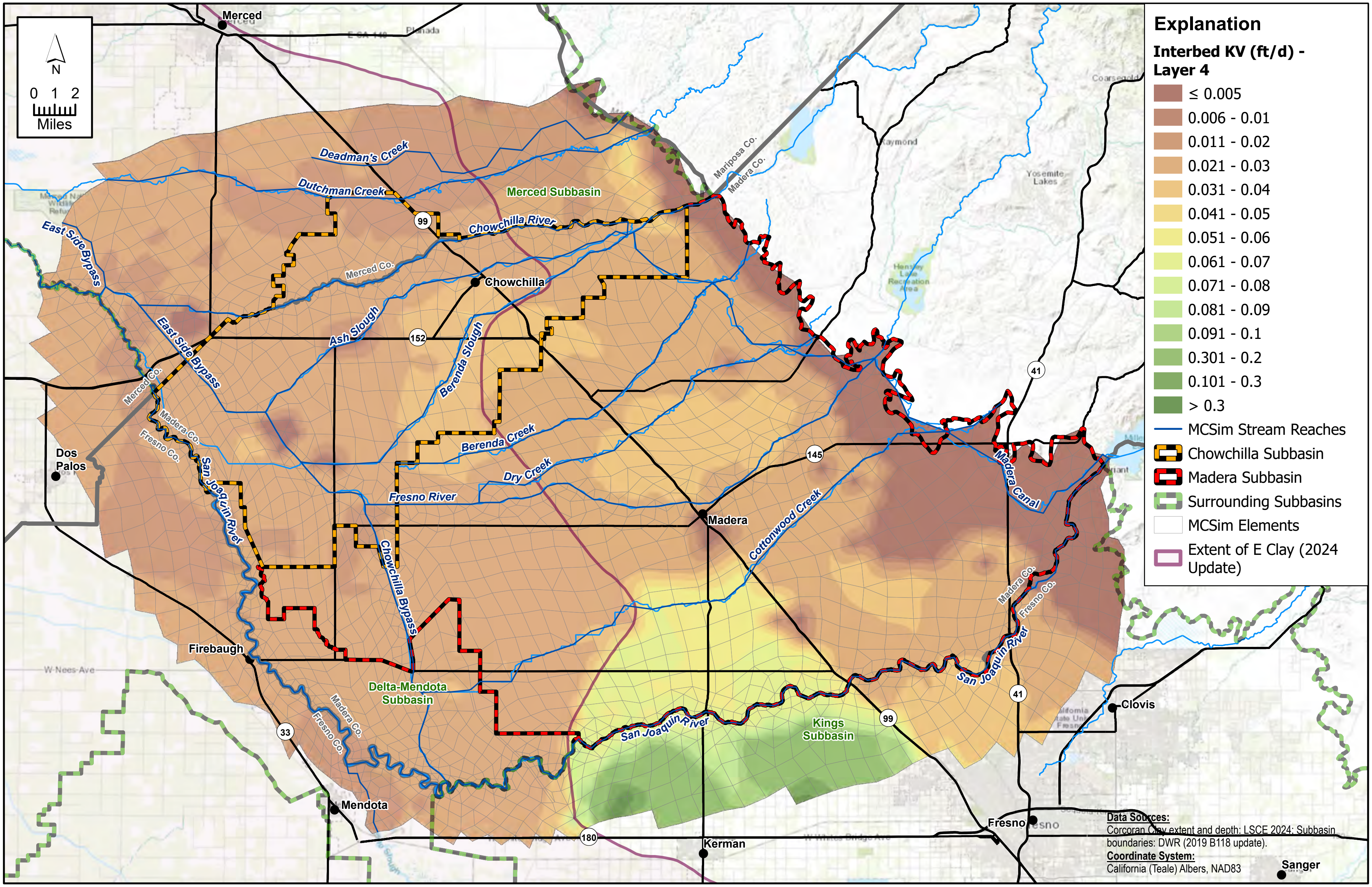

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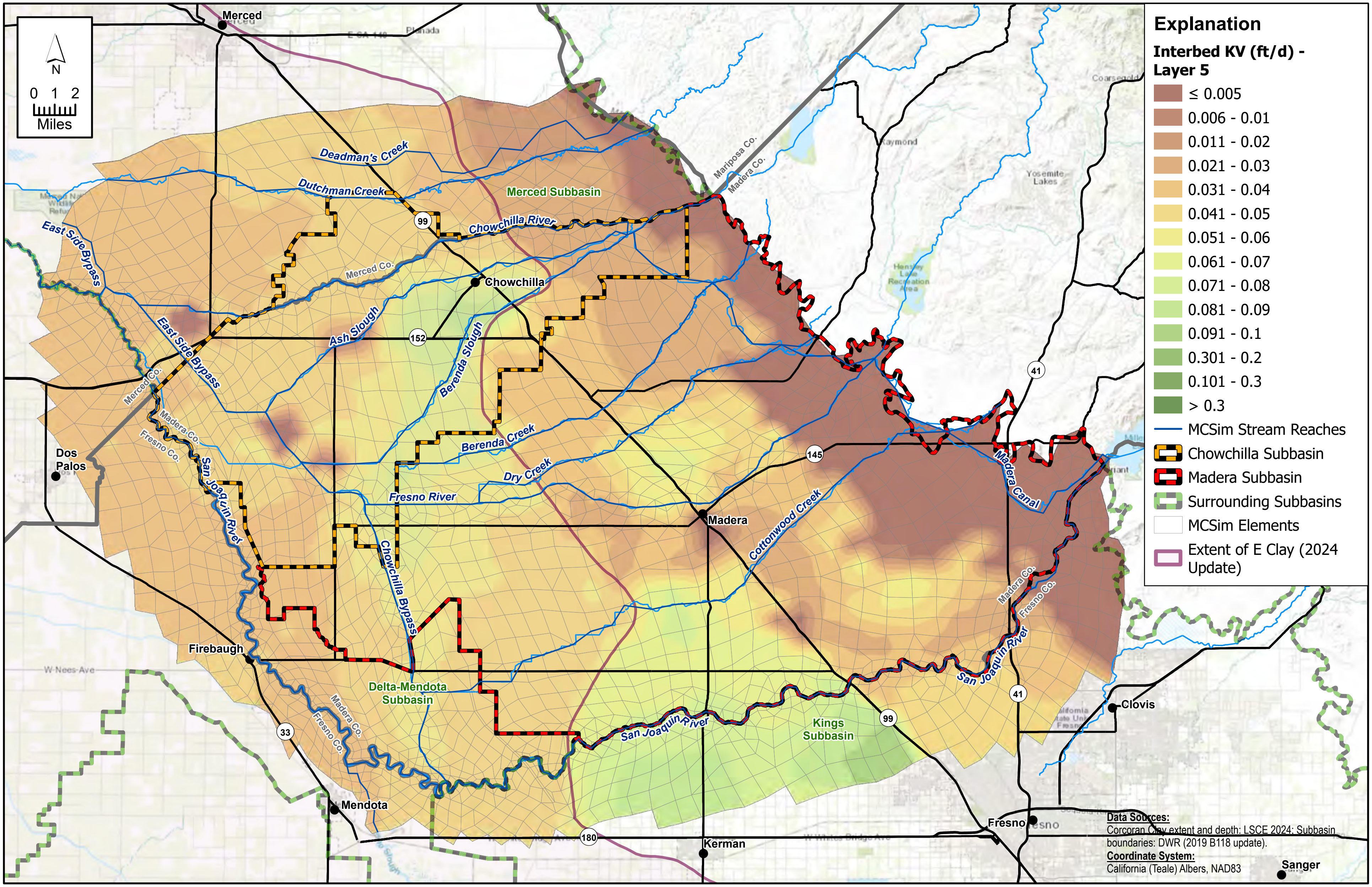
FIGURE 4-53

Calibrated Interbed Vertical Hydraulic Conductivity- Layer 4

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update



X:\2024\24-010 (1) Davids Eng. - Madera Subbasin 5-Year GSP Update\MODEL\MCSim_v2_GIS_20231101\MCSim_v2_20231101.aprx; AQ_PARAM_SUBS_KV

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FIGURE 4-54

Calibrated Interbed Vertical Hydraulic Conductivity- Layer 5

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

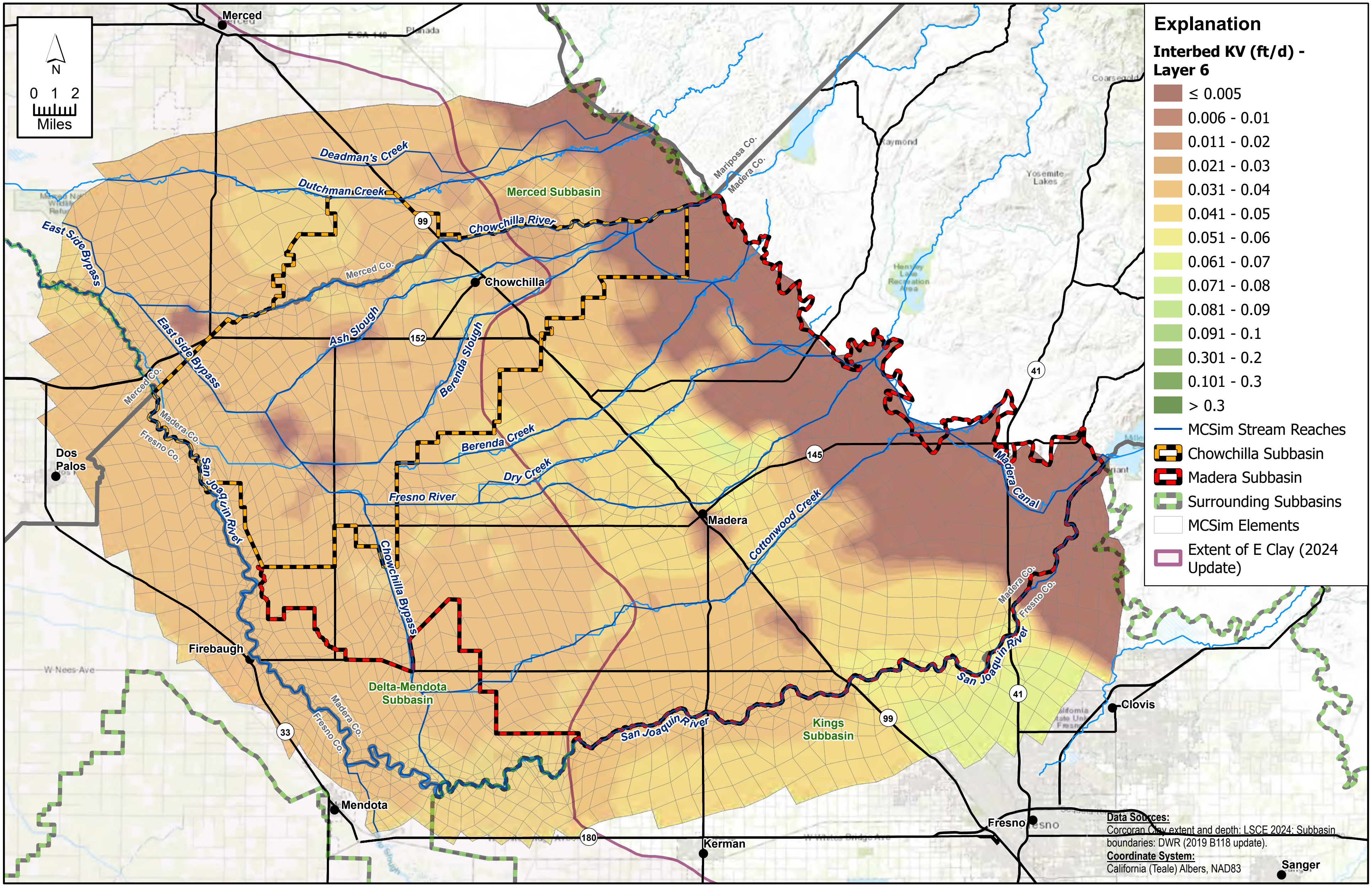

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FIGURE 4-55

Calibrated Interbed Vertical Hydraulic Conductivity- Layer 6

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

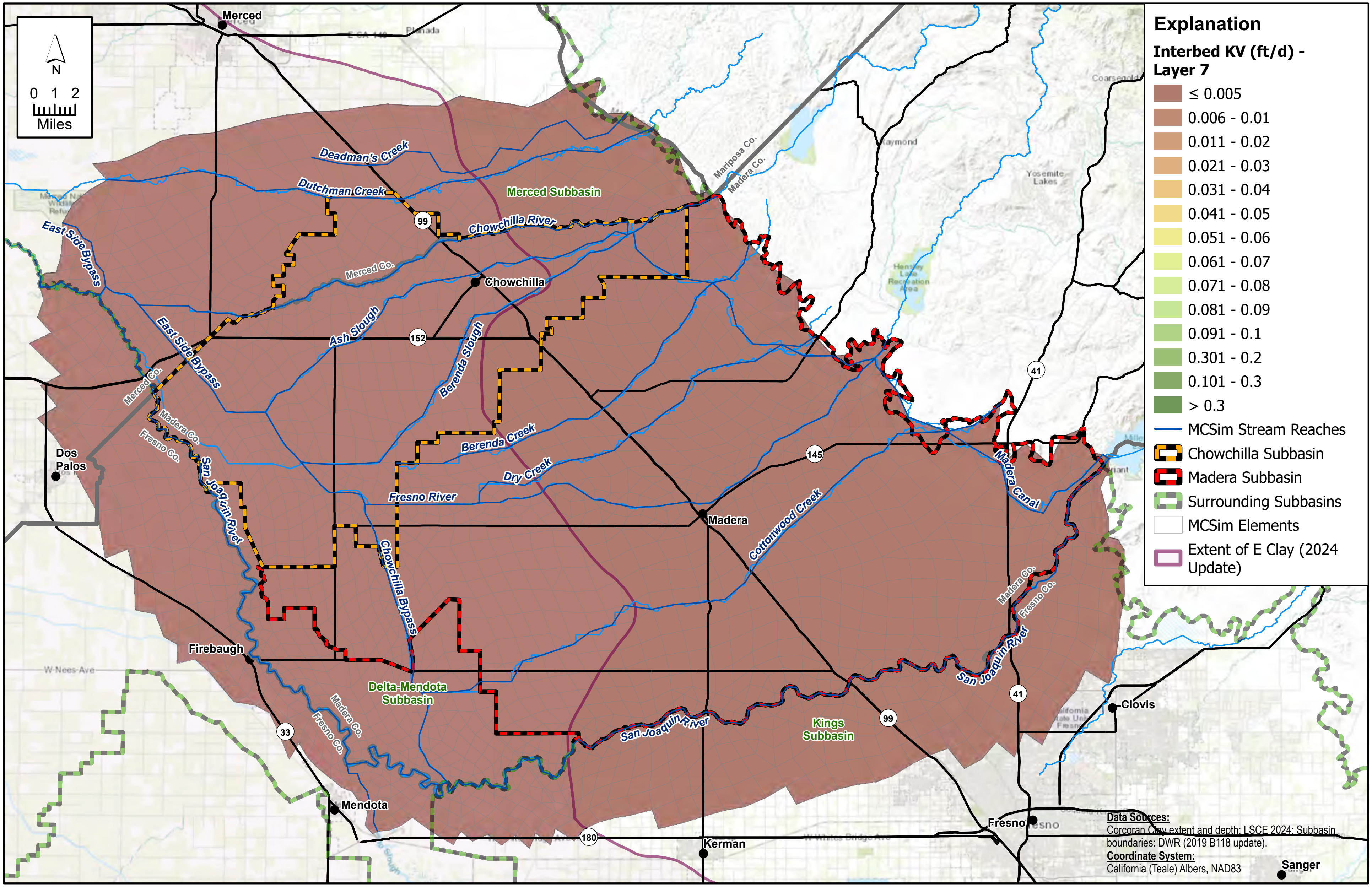

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FIGURE 4-56

Calibrated Interbed Vertical Hydraulic Conductivity- Layer 7

Madera-Chowchilla Groundwater-Surface Water Simulation Model (MCSim) - First Model Update

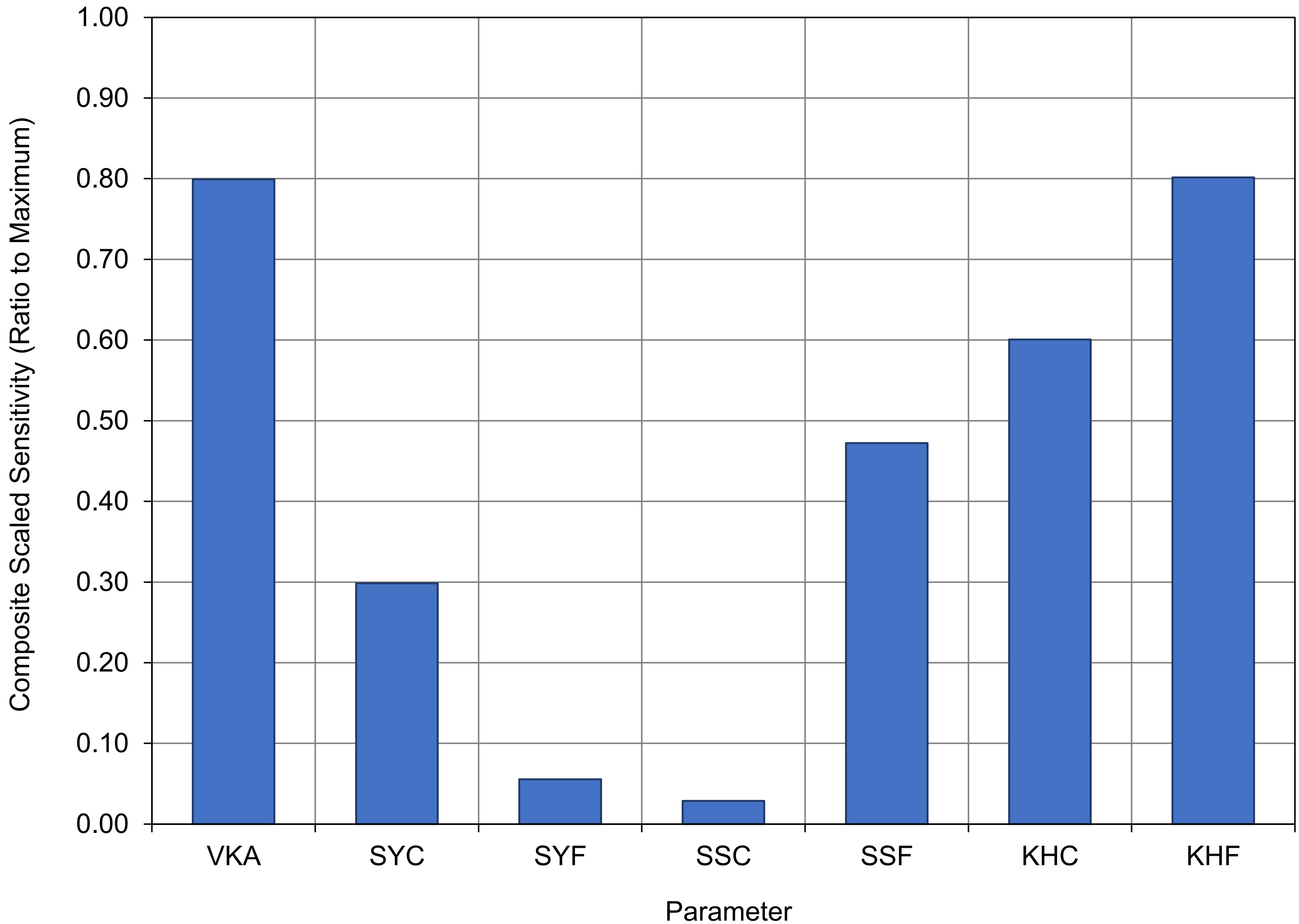

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FIGURE 5-1
Composite Scaled Sensitivity of Simulated Groundwater Elevations to Model Parameter Values

All appendices to this report are included in the Joint GSP 2025 Plan Amendment.

Please see Appendix 6.D of the Joint GSP 2025 Plan Amendment.