MADERA SUBBASIN ANNUAL REPORT

APRIL 2024

Prepared By
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Madera Subbasin Joint Groundwater Sustainability Plan (GSP)

Joint GSP Annual Report

For Water Year 2023
(October 2022 – September 2023)

April 2024

Prepared For

City of Madera GSA
Madera County GSA – Madera
Madera Irrigation District GSA
Madera Water District GSA

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Davids Engineering, Inc
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List of Abbreviations

AF	acre-feet
AMSL	above mean sea level
AN	above normal
BN	below normal
C	critical
CASGEM	California State Groundwater Elevation Monitoring
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
CM	City of Madera
CVP	Central Valley Project
D	dry
DWR	California Department of Water Resources
ETAW	ET of applied water
ET_c	crop ET
eWRIMS	Electronic Water Rights Information Management System
Flood-MAR	Flood Managed Aquifer Recharge
GFWD	Gravelly Ford Water District
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWEL	Groundwater Elevation
GWS	Groundwater system
IM	interim milestone
ISW	interconnected surface water
MC	Madera County
MID	Madera Irrigation District
MO	measurable objective
MT	minimum threshold
MWD	Madera Water District
NOAA NCEI	National Oceanic and Atmospheric Administration National Centers for Environmental Information
NRCS	Natural Resources Conservation Service
NSWD	New Stone Water District
PMAs	projects and management actions
RCWD	Root Creek Water District
RMS	Representative monitoring sites
SCADA	Supervisory Control and Data Acquisition
SEBAL	Surface Energy Balance Algorithm for Land
SGM	Sustainable Groundwater Management
SGMA	Sustainable Groundwater Management Act of 2014
SWRCB	State Water Resources Control Board
SWS	surface water system
USBR	United States Bureau of Reclamation
USDA	U.S. Department of Agriculture
USGS	United States Geological Survey
W	wet

Introduction

The California Code of Regulations Title 23 (23 CCR) §356.2 requires that Annual Reports be submitted to the California Department of Water Resources (DWR) by April 1 of each year following the adoption of the Groundwater Sustainability Plan (GSP). This Annual Report is the fifth Annual Report for the Madera Subbasin Joint GSP (Joint GSP), which is required to be submitted to DWR by April 1, 2024.

This Annual Report has been developed in compliance with the requirements of 23 CCR §356.2, describing efforts made toward implementation of the Joint GSP through April 2024, as well as conditions in the Madera Subbasin (Subbasin) within the area managed pursuant to this Joint GSP. This area is covered by the four groundwater sustainability agencies (GSAs) that prepared the Joint GSP: the City of Madera (CM) GSA, the Madera County (MC) GSA – Madera, the Madera Irrigation District (MID) GSA, and the Madera Water District (MWD) GSA. These GSAs are referred to herein as the Joint GSP GSAs.

This Annual Report does not specifically summarize the conditions within the areas managed by the other GSAs in the Subbasin that elected to develop and implement individual GSPs. Please refer to the Annual Reports prepared by the Gravelly Ford Water District (GFWD) GSA, the New Stone Water District (NSWD) GSA, and the Root Creek Water District (RCWD) GSA for a description of the conditions and GSP implementation efforts within each of their jurisdictional areas.

This Annual Report provides basic information about the Joint GSP plan area and presents technical information from water year 2015 (after the end of the historical water budget period) through the current reporting water year (water year 2023) (23 CCR §356.2.b.5.B), including:

- Groundwater elevation data from monitoring wells
- Contour maps and hydrographs of groundwater elevations
- Total groundwater extraction
- Surface water supply used, including for groundwater recharge or other in-lieu uses
- Total water use
- Change in groundwater storage
- Progress towards implementing the Joint GSP, including implementation of PMAs, and the status of groundwater conditions relative to the SMC for each of the applicable sustainability indicators in the Subbasin.

Groundwater elevation, groundwater extraction, surface water supply, and groundwater storage are summarized for the Joint GSP plan area, while progress towards implementing the GSP is described for each Joint GSP GSA. Additionally, the Joint GSP GSAs have elected to include information on groundwater recharge and evapotranspiration to emphasize the importance of these two data sets. The structure of the Annual Report generally follows the structure of the requirements outlined in 23 CCR §356.2 with consideration of the Annual Report guidelines released by DWR in 2023. The DWR water year ends on September 30th of the named year and begins on October 1st of the previous year; therefore, the period covered by this Annual Report is October 1, 2022, through September 30, 2023.

Also included with this Annual Report are appendices that contain groundwater maps and hydrographs that must be submitted with each Annual Report. The following appendices are located at the end of this Annual Report:

- Appendix A. Contour Maps of the Different Aquifer Units.
- Appendix B. Hydrographs of Time-Series Groundwater Level Data for Groundwater Level RMS Wells.
- Appendix C. Maps of Change in Groundwater Levels and Change in Groundwater Storage in 2016 through 2022, Separated by Principal Aquifer.
- Appendix D. Maps of Annual and Cumulative Subsidence in 2015 through 2023.
- Appendix E. Status of Monitoring Efforts for RMS Wells in Madera Subbasin.
- Appendix F. Interconnected Surface Water Data Gaps Workplan.

Executive Summary (§356.2.a)

The Joint GSP covers the extent of the Madera Subbasin (Subbasin) that is managed by the four Joint GSP GSAs: CM GSA, MC GSA, MID GSA, and MWD GSA (**Table ES-1** and **Figure ES-1**). The four Joint GSP GSAs collectively adopted and submitted the initial Joint GSP in January 2020, and later revised and resubmitted the Joint GSP in March 2023 to address deficiencies identified by DWR and incorporate new information made available since 2020. The revised GSPs in the Madera Subbasin were formally approved by DWR in December 2023.

Coordinated implementation of the Joint GSP is now underway, together with the three individual GSPs adopted by other GSAs in the Subbasin (**Table ES-1**). The full extent of the Madera Subbasin is covered by these four GSPs (**Figure ES-1**). Approximately 94% of the Subbasin area is covered by the Joint GSP GSAs, while the remaining 6% of the Madera Subbasin area is covered by the three individual GSAs[1]. These GSPs will collectively result in sustainable operation of the Subbasin by 2040.

In accordance with 23 CCR §356.2, GSAs must submit Annual Reports to DWR by April 1 each year following GSP adoption to document progress made toward GSP implementation. This Annual Report is the fifth Annual Report for the Joint GSP, which is required to be submitted to DWR by April 1, 2024. This Annual Report summarizes groundwater conditions and water use in the Joint GSP plan area, as well as the progress that has been made to implement projects and management actions (PMAs) and achieve interim milestones established in the Joint GSP. Key data sources and findings of each section are summarized below for the current reporting year (water year 2023) and are described in further detail in the associated Annual Report section.

Table ES-1. Coordination of Madera Subbasin Groundwater Sustainability Plans and Annual Reports.

Groundwater Sustainability Agency	Groundwater Sustainability Agency Abbreviation	Coordinating Body	Groundwater Sustainability Plan and Annual Report Type
City of Madera	CM GSA	Madera Subbasin Coordination Workgroup	Joint GSP and Joint GSP Annual Reports
Madera County	MC GSA		
Madera Irrigation District	MID GSA		
Madera Water District	MWD GSA		
Gravelly Ford Water District	GFWD GSA		Individual GSP and Annual Reports
New Stone Water District	NSWD GSA		Individual GSP and Annual Reports
Root Creek Water District	RCWD GSA		Individual GSP and Annual Reports

[1] In 2020 GFWD annexed 390 acres and removed 412 acres that were annexed to Madera ID.

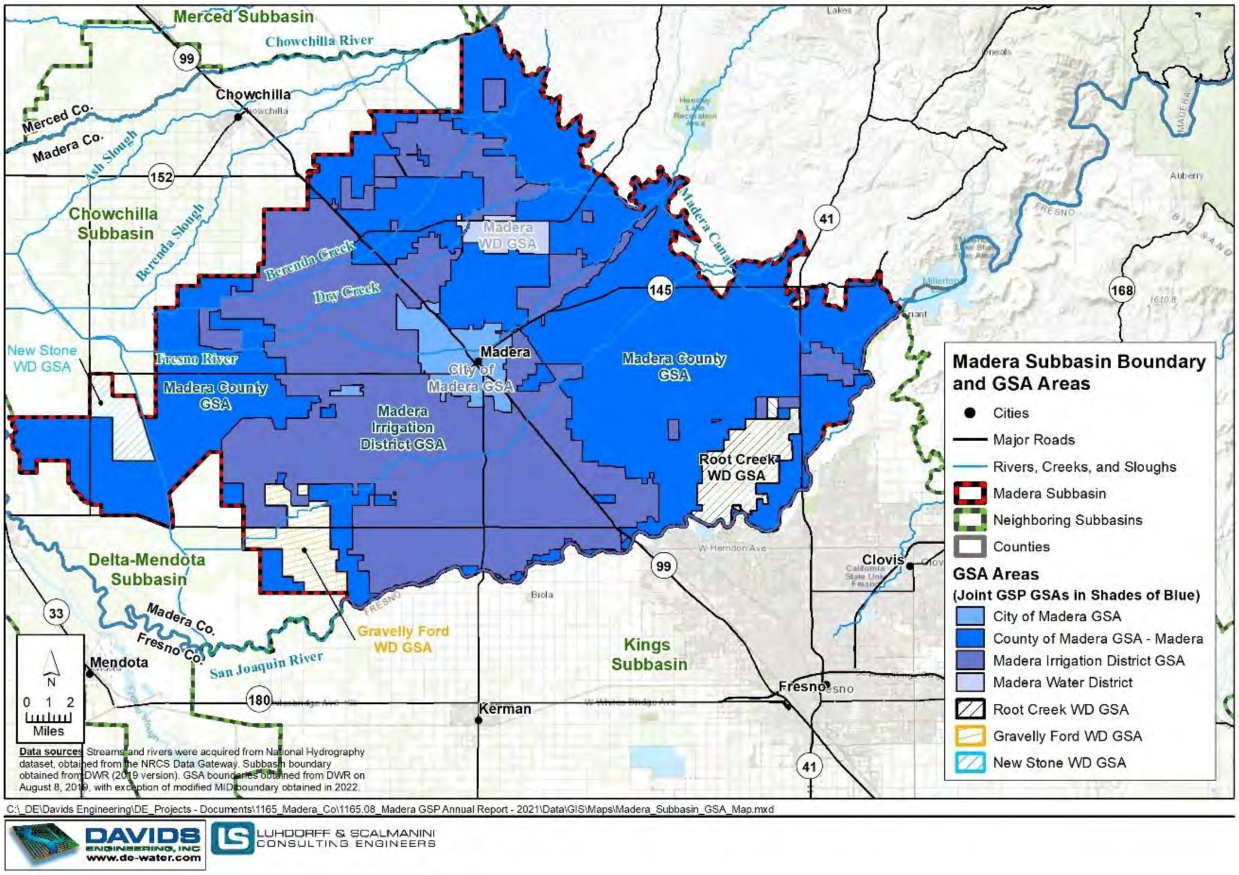

Figure ES-1. Map of Madera Subbasin Joint GSP GSAs.

Groundwater Elevations (§356.2.b.1)

Groundwater level monitoring and groundwater elevations are described in **Section 1.1** of this Annual Report. Groundwater level monitoring data was assembled from publicly available and GSA-related sources for the historical period through water year 2023 and for Fall 2023. Data was collected from various entities, including: MID, MC, CM, MWD, DWR, USBR, GeoTracker, and the California State Groundwater Elevation Monitoring (CASGEM) program (the Madera-Chowchilla Groundwater Monitoring Group).

The GSAs conducted groundwater level monitoring for representative monitoring site (RMS) wells in Spring 2023 and Fall 2023 to evaluate seasonal high and low groundwater level conditions, respectively. During Spring 2023, groundwater elevations at available RMS wells in the Madera Subbasin ranged from -76.2 ft AMSL to 151.5 ft AMSL (mean groundwater elevation of 3.4 ft AMSL). During Fall 2023, groundwater elevations at available RMS wells in the Madera Subbasin ranged from 82.1 ft AMSL to 122.5 ft AMSL (mean groundwater elevation of 0.8 ft AMSL). Despite attempts at measurement, some RMS water level data was not available in 2023 due to continued challenges encountered during implementation of the RMS monitoring program. Additional information on these challenges is provided in **Sections 7.3 and 7.4** and **Appendix E** of this Annual Report.

Groundwater Elevation Contour Maps (§356.2.b.1.A)

Groundwater elevation contour maps are described in **Section 1.2** and shown in **Appendix A** of this Annual Report. Spring and fall groundwater elevation contour maps were prepared for 2023. Spring contours are intended to generally represent seasonal high groundwater levels, while fall contours are intended to represent seasonal low groundwater levels. Data was assembled from all known and available groundwater level information in the Joint GSP area, including from public sources, local GSAs, and other local entities.

In summary, general patterns seen in the Spring 2023 and Fall 2023 groundwater elevation contour maps are similar to patterns observed in earlier spring and fall time periods. In the Upper Aquifer and undifferentiated unconfined groundwater zone, spring and fall contours generally show higher groundwater elevations near the San Joaquin River with groundwater flow to the north-northwest to a broad depression located in the north-central portion of Madera Subbasin. In the Lower Aquifer (within the extent of the Corcoran Clay), spring and fall contours generally show higher groundwater elevations in the southeast and lower groundwater elevations in the northwest. In the Lower Aquifer, the fall groundwater level elevations are generally lower than those observed in the spring.

Groundwater Hydrographs (§356.2.b.1.B)

Groundwater hydrographs are described in **Section 1.3** and shown in **Appendix B** of this Annual Report. All available groundwater level monitoring data was used to prepare groundwater hydrographs for all years spanning the period from January 1, 2015, through the end of 2023. Between 2015 and 2023, the hydrographs for many RMS wells show varying degrees of groundwater level decline, while groundwater levels at other RMS wells remain generally stable. It is noted that a majority of wells recorded an increase in groundwater elevations in Spring and Fall 2023 compared to previous years.

Groundwater Extraction (§356.2.b.2)

Groundwater extraction is summarized in **Section 3** of this Annual Report. Groundwater extraction in the Joint GSP area was either measured directly from flowmeters or estimated using a water budget that provides a complete accounting of all inflows and outflows from the surface water system in each GSA. Flowmeter records were used when available; otherwise, groundwater extraction was estimated using the best available information (sources and methods are summarized below). In total, an estimated 249,000 acre-feet (AF) of groundwater was extracted for use within the Joint GSP area during water year 2023. Of this total, approximately 91% was extracted for agricultural use (approximately 226,600 AF), and approximately 9% was extracted for urban and domestic use (approximately 22,400 AF). The total estimated groundwater recharge from all sources in water year 2023 was approximately 455,000 AF.

Surface Water Supplies (§356.2.b.3)

Surface water supplies used or available for use are summarized in **Section 4** of this Annual Report. Surface water supplies available to certain Joint GSP GSAs include surface water deliveries (CVP supplies from Millerton Reservoir and other supplies from Hidden Dam releases), riparian and water rights diversions, and diversions of natural flows crossing the Joint GSP GSAs' boundaries. In this Annual Report, surface water supplies used or available for use are assumed to be the difference between surface water inflows and surface water outflows in the Joint GSP area. During water year 2023, approximately 162,000 AF of local supplies and approximately 246,000 AF of CVP supplies were used in the Joint GSP area (combined irrigation deliveries, recharge deliveries, infiltration, and evaporation).

Total Water Use (§356.2.b.4)

Total water use is summarized in **Section 5** of this Annual Report. In this Annual Report, total water use is assumed to equal the total applied water from all sources and precipitation in the Joint GSP area, including all consumptive and non-consumptive water use. During water year 2023, total water use in the Joint GSP area is estimated to be approximately 831,000 AF from all sources. Of this total, approximately 31% was from surface water, approximately 30% was from groundwater, and approximately 39% was from precipitation.

Change in Groundwater Storage (§356.2.b.5)

Change in groundwater storage is described in **Section 6** and shown in **Appendix C** of this Annual Report. Consistent with §354.18.b, annual changes in groundwater elevation were calculated for each of the principal aquifers between Spring 2022 and Spring 2023 based on the difference in annual spring groundwater elevation contours (representing seasonal high groundwater conditions). Outside of the delineated confined area, changes in groundwater elevation (in both the Upper and Lower Aquifers) were multiplied by representative specific yield values to estimate change in groundwater storage. Within the delineated confined area in the Lower Aquifer, groundwater potentiometric surface changes in the Lower Aquifer were multiplied by a much smaller storage coefficient value to calculate annual changes in groundwater storage in the Lower Aquifer. The specific yield and storage coefficient values used in the analysis are derived from values in the calibrated integrated groundwater flow model (MCSim) developed and applied during the preparation of the GSP.

In summary, the combined change in groundwater storage for the entire Joint GSP area was approximately 75,000 AF from Spring 2022 to 2023. A positive change in groundwater storage means that the volume of groundwater in storage increased, a negative change in groundwater storage means that the volume of groundwater in storage decreased. Notably, there is uncertainty in this estimate, and there are also other processes that contribute to the net change in groundwater storage besides groundwater pumping (e.g., recharge, subsurface inflows, and outflows). These contributing factors were considered in the MCSim groundwater model used in development of the Joint GSP, and will be further evaluated in future MCSim updates.

Implementation of Projects and Management Actions (§356.2.c)

GSP implementation activities, including projects and management actions (PMAs), are described in **Section 7** of this Annual Report. In the year since the last Annual Report submittal, updates were reported for nearly 30 PMAs developed by the Joint GSP GSAs, with a total combined benefit of approximately 66,000 AF in 2023. Wet conditions in 2023 allowed the GSAs to achieve substantial recharge benefits in the Subbasin. The GSAs have continued to make significant progress in implementing existing PMAs, as well as developing and implementing new PMAs. Details regarding each GSA's PMAs are summarized in **Section 7**.

Interim Milestone Status (§356.2.c)

The status of groundwater conditions relative to interim milestones (IMs) established in the Revised Joint GSP is described in **Section 7.4** of this Annual Report. In the Revised Joint GSP, IMs for sustainability indicators were established at five-year intervals over the Implementation Period from 2020 to 2040 – at years 2025, 2030, and 2035.

Review of the Fall 2023 groundwater level measurements that are available for 18 RMS wells indicates that groundwater elevations are generally below MTs, with two exceptions; however, all of the Fall 2023 RMS groundwater elevations were above the 2025 IMs. Review of December 2021 to December 2022 annual subsidence indicates that all RMS stations are either at or below the 2025 land subsidence IMs. Collection of groundwater quality data to establish baseline conditions over a 3-year monitoring period for RMS wells listed in the GSP are ongoing, and comparison to the MTs and IMs is not currently available. Insufficient data was available to evaluate the interconnected surface water (ISW) sustainability indicator.

1 Groundwater Elevations (§356.2.b.1)

1.1 GROUNDWATER LEVEL MONITORING

The groundwater level monitoring information presented in this Annual Report includes historical and recent monitoring conducted in the Subbasin by various entities, including local GSA-coordinated monitoring conducted as part of the Joint GSP monitoring program and additional monitoring by non-GSA entities that provide useful information for interpreting groundwater conditions. Groundwater level data collected as part of Joint GSP monitoring and additional groundwater level monitoring data available for the period through water year 2023 (plus Fall 2023) are summarized and presented in this Annual Report (**Table 1-1 and Appendices A and B)**. Formal Joint GSP groundwater level monitoring conducted by the Joint GSP GSAs was initiated upon adoption and submittal of the initial Joint GSP in January 2020.

Historically, groundwater level monitoring in the Joint GSP area of the Madera Subbasin has been conducted by a variety of entities including MID, MC, CM, MWD, DWR, USBR, and GeoTracker. The California State Groundwater Elevation Monitoring Program (CASGEM) was initiated in 2011, with the Madera-Chowchilla Groundwater Monitoring Group as the local monitoring entity. This Group includes MID, MC, MWD, GFWD, and RCWD along with entities in the Chowchilla Subbasin. Groundwater levels have been collected and submitted each fall and spring as part of the CASGEM program. Additionally, the Joint GSP GSAs conducted groundwater level monitoring in selected wells prior to adoption and submittal of the initial Joint GSP. Additional groundwater level data collection from newly installed nested monitoring wells (installed as part of a DWR grant) began in water year 2020. Groundwater level monitoring data available from the entities listed above, and all GSAs party to the Joint GSP, were assembled for the period through the end of water year 2023 (plus Fall 2023) and are presented in this Annual Report. **Figure 1-1** includes a map presenting the well locations and most recent monitoring date for historical groundwater level monitoring conducted in the Joint GSP area. Semi-annual groundwater level measurements acquired for groundwater level RMS wells identified in the Joint GSP are submitted through the Monitoring Network Module on the SGMA Portal twice a year. **Figure 1-2** illustrates the groundwater level RMS well network included in the Joint GSP. A summary of RMS well information and recent groundwater level measurements is presented in **Table 1-1**. Despite attempts at measurement, some RMS water level data was not available in 2023 due to continued challenges encountered during implementation of the RMS monitoring program or other access issues. Additional information on these monitoring challenges is provided in **Section 7.3** and **Appendix E** of this Annual Report.

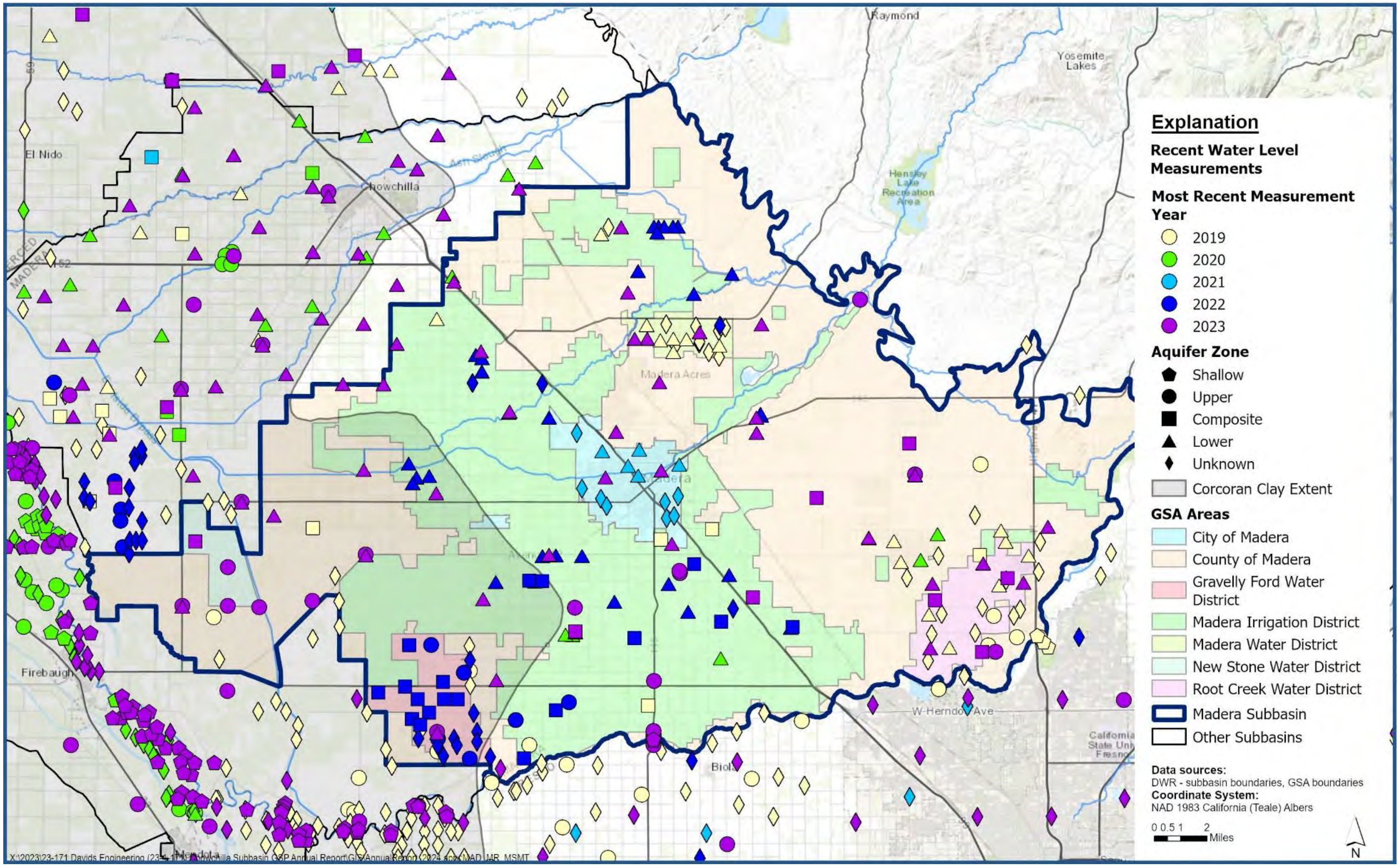

Figure 1-1. Most Recent Groundwater Level Measurement by Well.

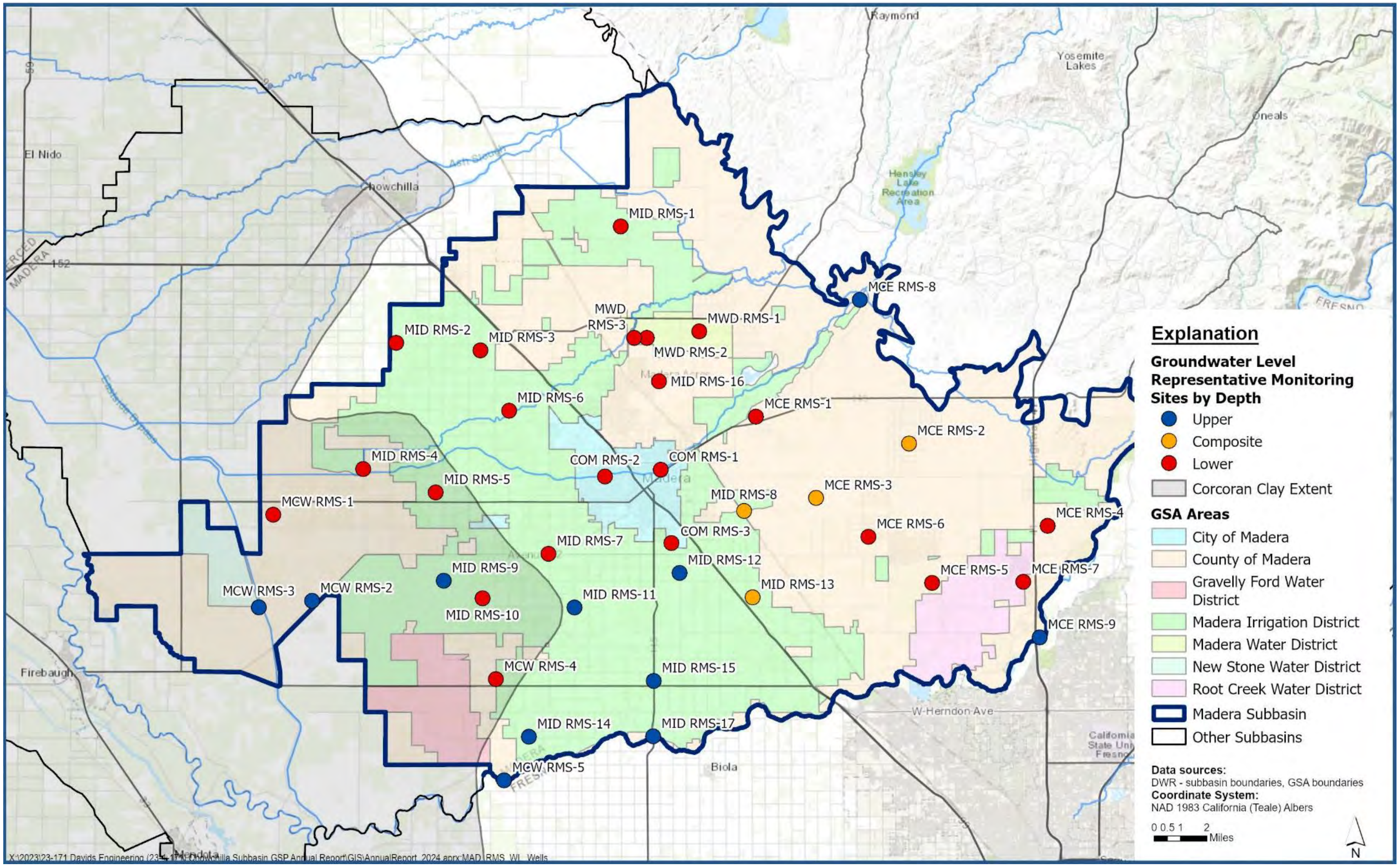

Figure 1-2. Groundwater Levels Sustainable Indicator Well.

Table 1-1. Summary of Groundwater Level RMS Well Information and Measurements During Report Year (2023).

RMS Well I.D.	Estimated Surface Elevation (msl, feet)	Well Depth	Screen Top-Bottom	Aquifer Designation	Spring 2023 GWEL	Date of Spring 2023 GWEL	Fall 2023 GWEL	Date of Fall 2023 GWEL	GSA
COM RMS-1	278	520	210-510	Lower[2]	31.11	4/28/2023[5]	30.11	11/6/2023	CM
COM RMS-2	262	590	370-590	Lower[2]	15.03	5/3/2023[5]	14.03	11/14/2023	CM
COM RMS-3	264	620	310-600	Lower[2]	NM[3]	5/5/2023[5]	NM[3]	11/16/2023	CM
MCE RMS-1	332	500	420-500	Lower[2]	NM[3]	3/29/2023	NM[3]	10/31/2023	MC - East
MCE RMS-2	378	Unknown	Unknown	Composite	151.54	3/29/2023	67.04	10/31/2023	MC - East
MCE RMS-3	327	Unknown	Unknown	Composite	NM[3]	3/29/2023	24.97	10/31/2023	MC - East
MCE RMS-4	404	Unknown	Unknown	Lower[2]	NM[3]	3/29/2023	QM[4]	10/31/2023	MC - East
MCE RMS-5	340	Unknown	Unknown	Lower[2]	NM[3]	3/29/2023	QM[4]	10/31/2023	MC - East
MCE RMS-6	328	550	450-550	Lower[2]	10.5	4/15/2023[5]	-9.5	11/3/2023	MC - East
MCE RMS-7	388	840	370-820	Lower[2]	NM[3]	3/30/2023			MC - East
MCE RMS-8	367	92	32-92	Upper	NM[3]	3/30/2023			MC - East
MCE RMS-9	265	37.1	17-37	Upper					MC - East
MCW RMS-1	169	800	Unknown	Lower[1]	NM[3]	3/30/2023			MC - West
MCW RMS-2	173	216	205-212	Upper	NM[3]	3/28/2023	NM[3]	10/31/2023	MC - West
MCW RMS-3	162	Unknown	Unknown	Upper	NM[3]	3/28/2023	QM[4]	10/31/2023	MC - West
MCW RMS-4	208	580	220-580	Lower[1]	QM[4]	3/29/2023	NM[3]	10/31/2023	MC - West
MCW RMS-5	198	30		Upper					MC - West
MID RMS-1	308	950	320-942	Lower[2]	NM[3]	3/30/2023			MID
MID RMS-2	218	563	298-509	Lower[2]	-76.2	3/7/2023	-82.1	10/16/2023	MID
MID RMS-3	241	516	260-507	Lower[2]	-32.3	3/19/2023	-60.6	10/18/2023	MID
MID RMS-4	190	698	320-667	Lower[1]	-69.3	3/8/2023	-79	10/13/2023	MID
MID RMS-5	207	570	270-570	Lower[1]	-35.02	3/8/2023	-43.02	10/12/2023	MID
MID RMS-6	237	680	320-680	Lower[2]					MID
MID RMS-7	238	656	290-635	Lower[2]	45.13	3/8/2023	36.33	10/11/2023	MID
MID RMS-8	287	Unknown	Unknown	Composite					MID

RMS Well I.D.	Estimated Surface Elevation (msl, feet)	Well Depth	Screen Top-Bottom	Aquifer Designation	Spring 2023 GWEL	Date of Spring 2023 GWEL	Fall 2023 GWEL	Date of Fall 2023 GWEL	GSA
MID RMS-9	202	143	Unknown	Upper					MID
MID RMS-10	213	615	315-615	Lower[1]	46.3	3/9/2023	33	10/23/2023	MID
MID RMS-11	232	Unknown	Unknown	Upper	74.45	3/9/2023	65.85	10/10/2023	MID
MID RMS-12	262	176	Unknown	Upper					MID
MID RMS-13	271	600	228-552	Composite	101.3	3/15/2023	89.5	10/9/2023	MID
MID RMS-14	214	Unknown	Unknown	Upper					MID
MID RMS-15	247	502	160-200	Upper	124.5	5/15/2023[5]	122.5	10/25/2023	MID
MID RMS-16	308	452	348-388	Lower[2]	-32.1	3/7/2023	-42.3	10/23/2023	MID
MID RMS-17	225	47	26.5-46.5	Upper	NM[3]	5/16/2023[5]			MID
MWD RMS-1	330	500	200-500	Lower[2]	-17.95	3/23/2023	-22.16	11/13/2023	MWD
MWD RMS-2	310	537	200-537	Lower[2]	-50.96	3/23/2023	-54.68	11/13/2023	MWD
MWD RMS-3	295	800	380-800	Lower[2]	-60.07	3/23/2023	-69.13	11/13/2023	MWD

[1] Lower Aquifer wells within Corcoran Clay
[2] Lower Aquifer wells outside Corcoran Clay; considered representative of undifferentiated unconfined groundwater zone
[3] NM = no measurement. Measurement attempted on date listed but was unsuccessful. See Appendix E for more information.
[4] QM = questionable measurement. Measurement reported but flagged as questionable. See Appendix E for more information.
[5] Measurement is outside of desired Spring measurement period (March), but is the only measurement available during this time period.

1.2 GROUNDWATER ELEVATION CONTOUR MAPS (§356.2.B.1.A)

Groundwater elevation contours for Spring and Fall 2023 were prepared for this Annual Report. These contours were developed from all known and available groundwater level information in the Joint GSP area, including data from public sources and from local GSAs and other local entities. Annual spring and fall contour maps were prepared for each year and for each of the principal aquifers in the Madera Subbasin: Upper Aquifer and Lower Aquifer. Annual spring contours are intended to generally represent seasonal high groundwater levels, while fall contours are intended to generally represent seasonal low groundwater levels. For the purpose of mapping groundwater elevations, the aquifer system in areas outside the Corcoran Clay was treated as a single undifferentiated unconfined aquifer system and interpretation of groundwater levels in these areas utilized data from wells assigned to both the Upper and Lower depth zones. In areas within the Corcoran Clay, the aquifer system was separated into an Upper Aquifer unconfined system above the Corcoran Clay and a Lower Aquifer below the Corcoran Clay. To evaluate recent groundwater level conditions in the Madera Subbasin, separate groundwater elevation contour maps were prepared for spring and fall of each year for the combined Upper Aquifer and undifferentiated unconfined groundwater zone and also for the Lower Aquifer within the extent of the Corcoran Clay. The groundwater elevation contour maps for the Lower Aquifer represent a combination of potentiometric elevations where the aquifer is under confined conditions and water table surface elevations where the Lower Aquifer is unconfined. Contour maps of the different aquifer units are presented in **Figure 1-3 through 1-6** and are discussed below. For comparison, contour maps for Spring 2016-2022 and Fall 2015-2022, prepared for previous Joint GSP Annual Reports, are included in **Appendix A.**

1.2.1 Upper Aquifer and Undifferentiated Unconfined Groundwater Zone

Seasonal high groundwater elevation contour maps for the Upper Aquifer and undifferentiated unconfined groundwater zone were generated for Spring 2023 (**Figure 1-3**). The Spring 2023 Groundwater Elevation Contour Map (**Figure 1-3**) generally shows higher groundwater elevations near the San Joaquin River with groundwater flow to the north-northwest to a broad depression located in the north-central portion of Madera Subbasin.

Seasonal low groundwater elevation contour maps for the Upper Aquifer and undifferentiated unconfined groundwater zone were generated for Fall 2023 (**Figure 1-4**). Similar to the spring contour maps, the Fall 2023 Groundwater Elevation Contour Map (**Figure 1-4**) generally shows higher groundwater elevations near the San Joaquin River with groundwater flow to the north-northwest towards a broad depression located in the north-central portion of Madera Subbasin.

1.2.2 Lower Aquifer

Seasonal high groundwater elevation contour maps for the Lower Aquifer (within the extent of the Corcoran Clay) were generated for Spring 2023 (**Figure 1-5)**. The Spring 2023 Groundwater Elevation Contour Map for the Lower Aquifer beneath the Corcoran Clay (**Figure 1-5**) included very limited data, but generally shows higher groundwater elevations in the southeast and lower groundwater elevations in the northwestern portion of the Lower Aquifer.

Seasonal low groundwater elevation contour maps for the Lower Aquifer were generated for Fall 2023 (**Figure 1-6**). Similar to the spring contour maps, the Fall 2023 Groundwater Elevation

Contour Map (**Figure 1-6**) included very limited data, but generally shows higher groundwater elevations in the southeast and lower groundwater elevations in the northwestern portions of the Lower Aquifer. As would be expected, the fall groundwater elevations are generally lower than for spring.

1.3 GROUNDWATER HYDROGRAPHS (§356.2.B.1.B)

Hydrographs of time-series groundwater level data for groundwater level RMS wells were prepared with all available groundwater level monitoring data through water year 2023 (plus Fall 2023) and are contained in **Appendix B**. Madera Irrigation District RMS wells (designated MID) generally showed stable to slightly decreasing trends in groundwater elevations between 2015 and 2022, but have shown increases in 2023. Limited measurements are available for Madera County wells in 2023. Madera County East (designated MCE) and Madera County West (designated MCW) RMS wells show variable trends in groundwater elevations over the 2015 to 2023 time period for those wells with measurements, ranging from increasing to stable and decreasing levels. The three City of Madera RMS wells (designated COM) have generally shown stable to slightly decreasing trends since 2015, but showed an increase in 2023. Similarly, the three Madera Water District wells (designated MWD) showed stable to slightly decreasing groundwater elevation trends from 2015 to 2021. It is notable in MWD RMS wells that the sharp declines in groundwater levels that occurred during the 2012 to 2015 drought had largely stabilized between 2015 and 2022. Groundwater elevations in all three MWD wells have increased in 2023.

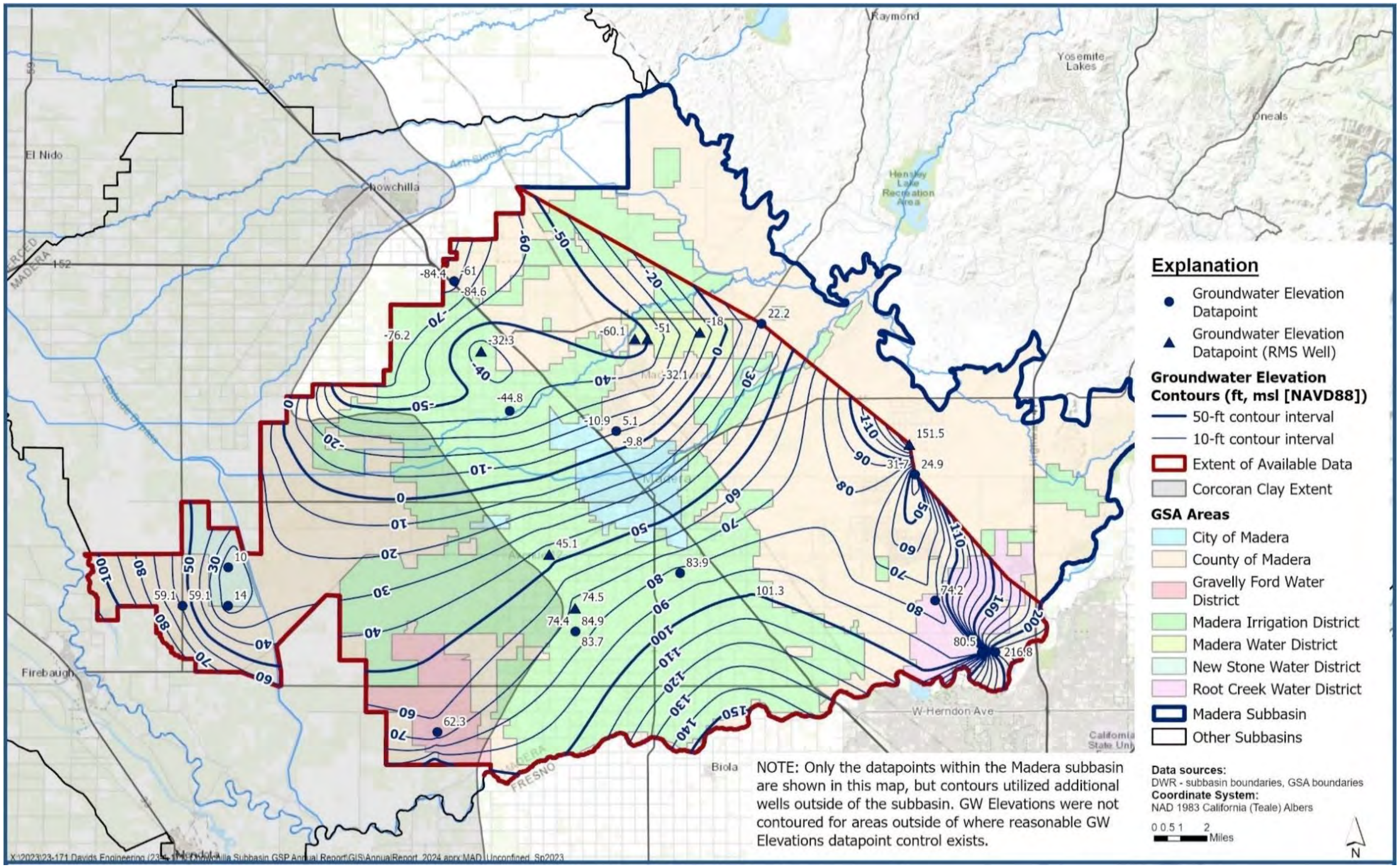

Figure 1-3. Contours of Equal Groundwater Elevation Upper Aquifer/Undifferentiated Unconfined Zone – Spring 2023.

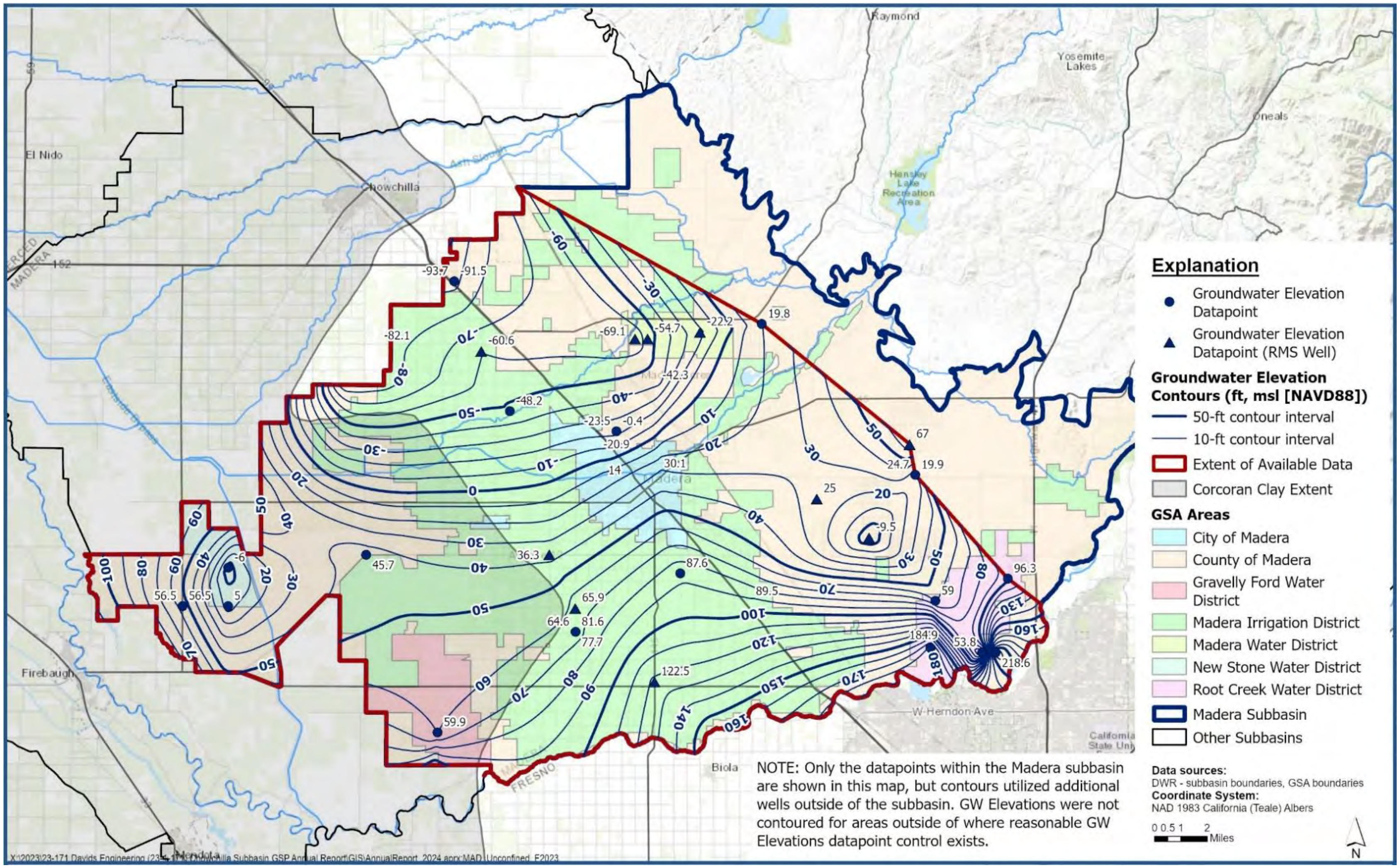

Figure 1-4. Contours of Equal Groundwater Elevation Upper Aquifer/Undifferentiated Unconfined Zone – Fall 2023.

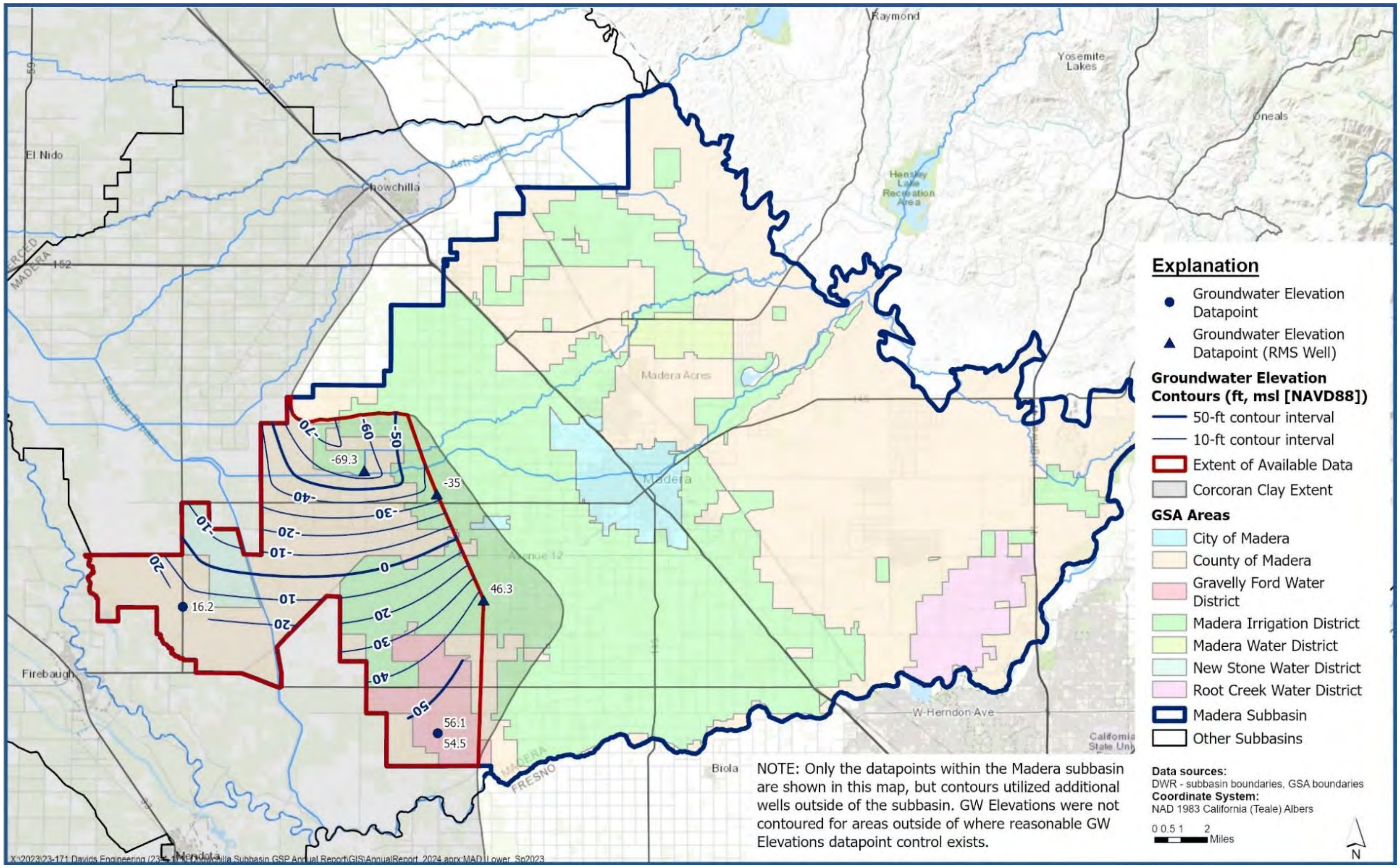

Figure 1-5. Contours of Equal Groundwater Elevation Lower Aquifer – Spring 2023.

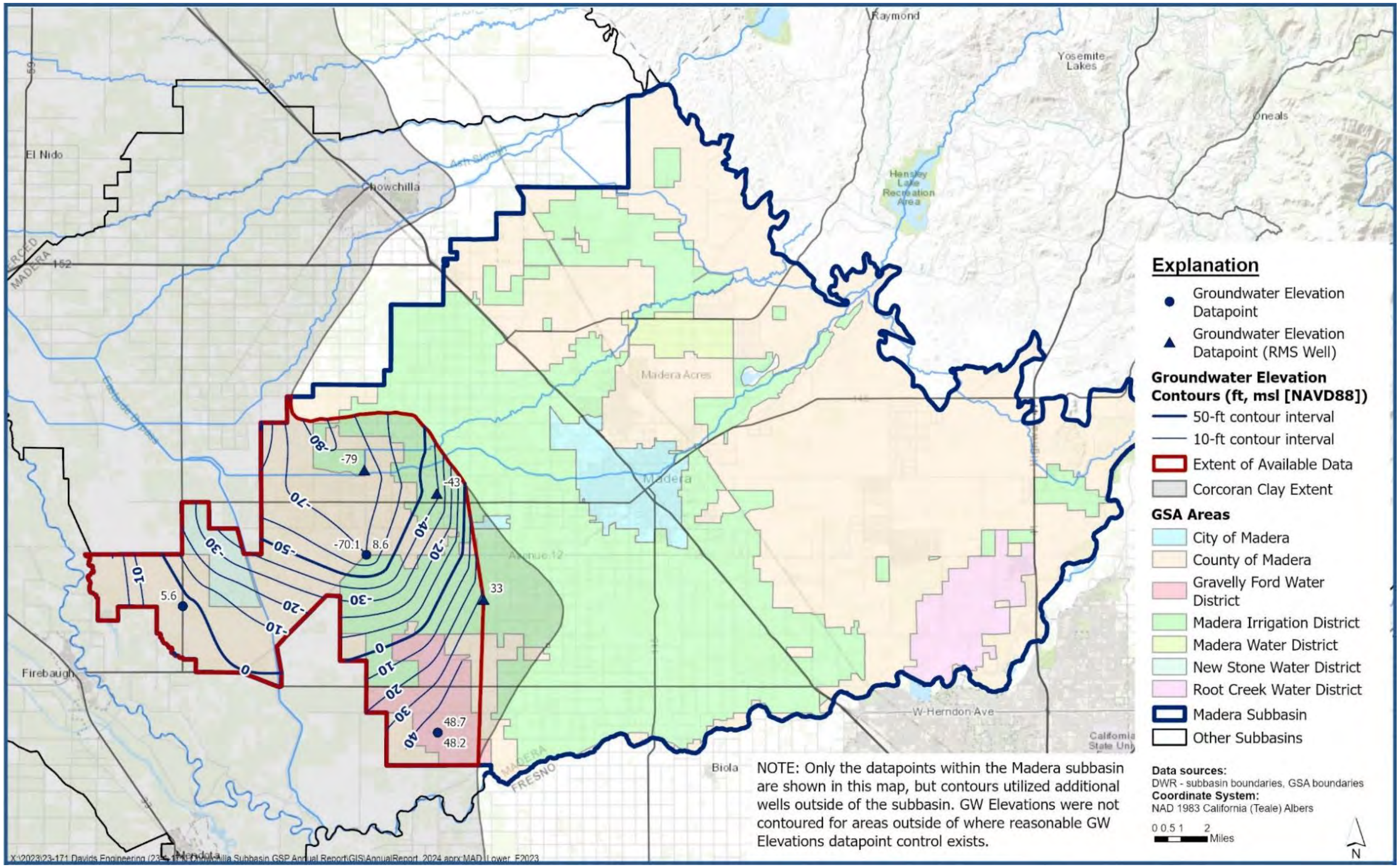

Figure 1-6. Contours of Equal Groundwater Elevation Lower Aquifer – Fall 2023.

2 Water Budget Approach for Quantifying Groundwater Extraction, Surface Water Supplies, and Total Water Use

In fulfillment of the Annual Report requirements, a water budget approach has been used to quantify groundwater extraction, surface water supply availability, and total water use in the Joint GSP area. This section describes the structure and uncertainties of these water budgets.

2.1 WATER BUDGET STRUCTURE

A water budget is defined as a complete accounting of all water flowing into and out of a defined volume[2] over a specified period of time. A schematic of the general water budget accounting structure is provided in **Figure 2-1**.

Water budgets presented in the Joint GSP 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 Joint GSP 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. Separate but related water budgets were prepared for each accounting center that together represent the overall water budget for the Joint GSP plan area.

The SWS water budget accounting center was subdivided further into detailed accounting centers, including the Land Surface System that represents water use in all irrigated and non-irrigated lands. To estimate the water budget components required by the GSP regulations, the Land Surface System was subdivided into accounting centers representing water use sectors.[3] Across the Madera Subbasin and within each subregion, the water use sector accounting centers include agricultural land, urban land (urban, industrial, and semi-agricultural), and native vegetation. Industrial land covers only a small area of the Subbasin, so industrial water uses have been combined with urban and semi-agricultural uses in the Urban land use sector.

During development of the Joint GSP, water budgets were prepared for each GSA in the Madera Subbasin to characterize historical, current, and projected water budget conditions. For this Annual Report, the historical water budgets of the Joint GSP GSAs have been extended through the current reporting year to characterize historical water use through water year 2023. Information about the historical water budget development process is available in Section 2.2.3 of the Revised Joint GSP

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[2] Where 'volume' refers to a space with length, width and depth properties, which for purposes of the GSP means the defined aquifer and associated surface water system.

[3] Identified in the GSP regulations as "categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation" (23 CCR §351(al)).

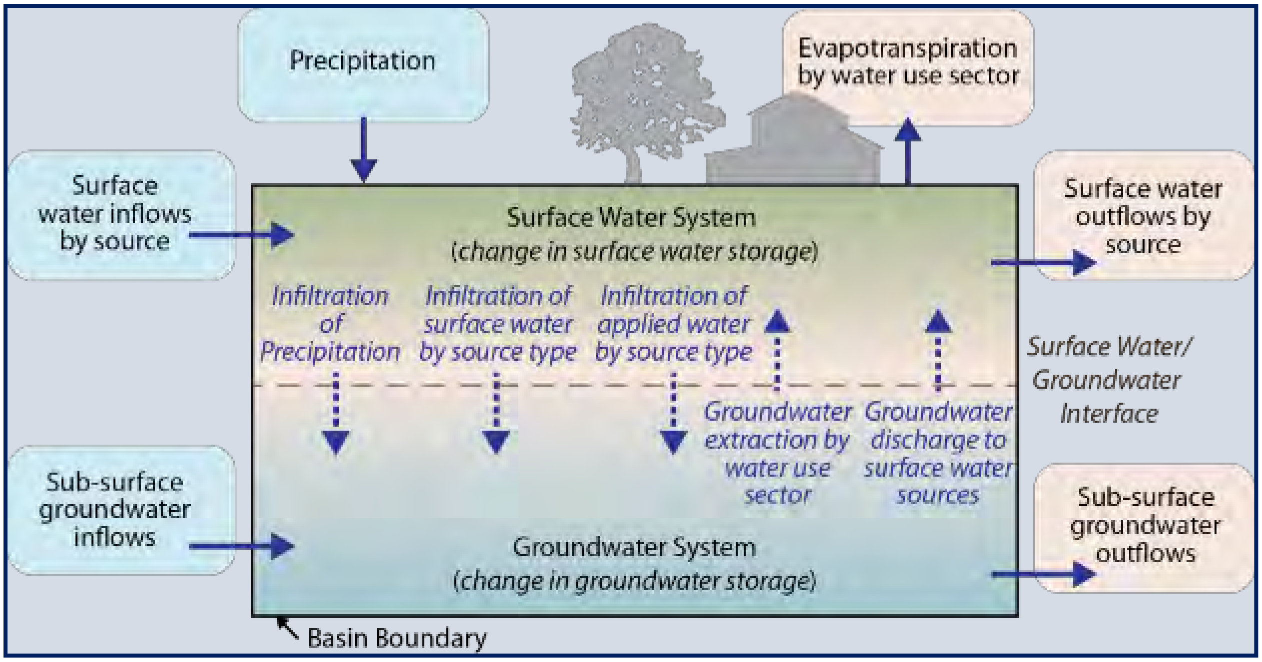


Figure 2-1. Water Budget Accounting Structure (Source: DWR, 2016).

To fulfill the Annual Report requirements, groundwater extraction, surface water supplies, and total water use have been quantified by water use sector and/or water source type. Water budgets for each water use sector were developed individually for each of the Joint GSP GSAs in order to quantify:

- **Groundwater Extraction**: Equal to "Groundwater Extraction"
- **Surface Water Supplies (used, or available for use)**: Assumed to be equal to the difference between "Surface Water Inflows" and "Surface Water Outflows."
- **Total Water Use**: Water use is defined by ASCE (2016) as "water that is used for a specific purpose such as domestic use, irrigation, or industrial processing." This definition includes both consumptive and non-consumptive components. The total consumptive water use (the sum of "Evapotranspiration of Applied Water" and "Evapotranspiration of Precipitation") is also reported as this is the volume of water that is no longer available for use within the Subbasin.

The data sources, calculation procedures, and results pertaining to these key water budget components are described in the sections below. Details about groundwater extraction, surface water supplies, and total water use for the GFWD GSA, NSWD GSA, and RCWD GSA can be found in each of their respective Annual Reports.

2.2 UNCERTAINTIES IN WATER BUDGET COMPONENTS

Uncertainties associated with each water budget component have been estimated as described by Clemmens and Burt (1997), as follows:

1. The uncertainty of each independently-estimated water budget component (excluding the closure term) is calculated or estimated as a percentage that approximately represents a 95% confidence interval. Uncertainties are influenced by the accuracy of available data and the uncertainty of supporting calculations and estimation procedures.
2. Assuming random, normally-distributed error, the standard deviation is calculated for each independently-estimated component as the average uncertainty on a volumetric basis (uncertainty percentage multiplied by the average component volume) divided by two.
3. The variance is calculated for each independently-estimated component as the square of the standard deviation.
4. The variance of the closure term is estimated as the sum of variances of all independently-estimated components.
5. The standard deviation of the closure term is estimated as the square root of the sum of variances.
6. The 95% confidence interval of the closure term is estimated as twice the estimated standard deviation.

Estimated uncertainties were calculated following the above procedure for all Joint GSP GSA water budgets.

3 Groundwater Extraction (§356.2.b.2)

This section summarizes the measurement methods, accuracy, and volumes of groundwater extraction by the Joint GSP GSAs for the current reporting year (water year 2023).

3.1 QUANTIFICATION AND ACCURACY

Groundwater extraction by the Joint GSP GSAs was either measured directly from flowmeters or estimated based on other inflows and outflows from the surface water system. Flowmeter records were used when available (MWD GSA agricultural water use sector and CM GSA urban water use sector); otherwise, groundwater extraction was estimated using the best available information. **Table 3-1** summarizes groundwater extraction in 2022 and the associated measurement methods, by water use sector.

Figure 3-1 provides a map of the 2023 agricultural groundwater extraction volumes and depths in irrigated areas in the Joint GSP area. Notably, the groundwater extraction values shown in MC GSA in **Figure 3-1** are quantified using the IDC root zone water budget methodology used in the Joint GSP. In subsequent Annual Reports, results from the demand measurement program and verification project (described in **Section 7**) may be used to quantify reported groundwater extraction in MC GSA.

Table 3-2 further summarizes the total groundwater extraction by water use sector in the Joint GSP area between 1989 (the beginning of the Joint GSP historical water budget period) and 2023 (the current reporting year).

3.2 DATA SOURCES

3.2.1 Measured Groundwater Extraction

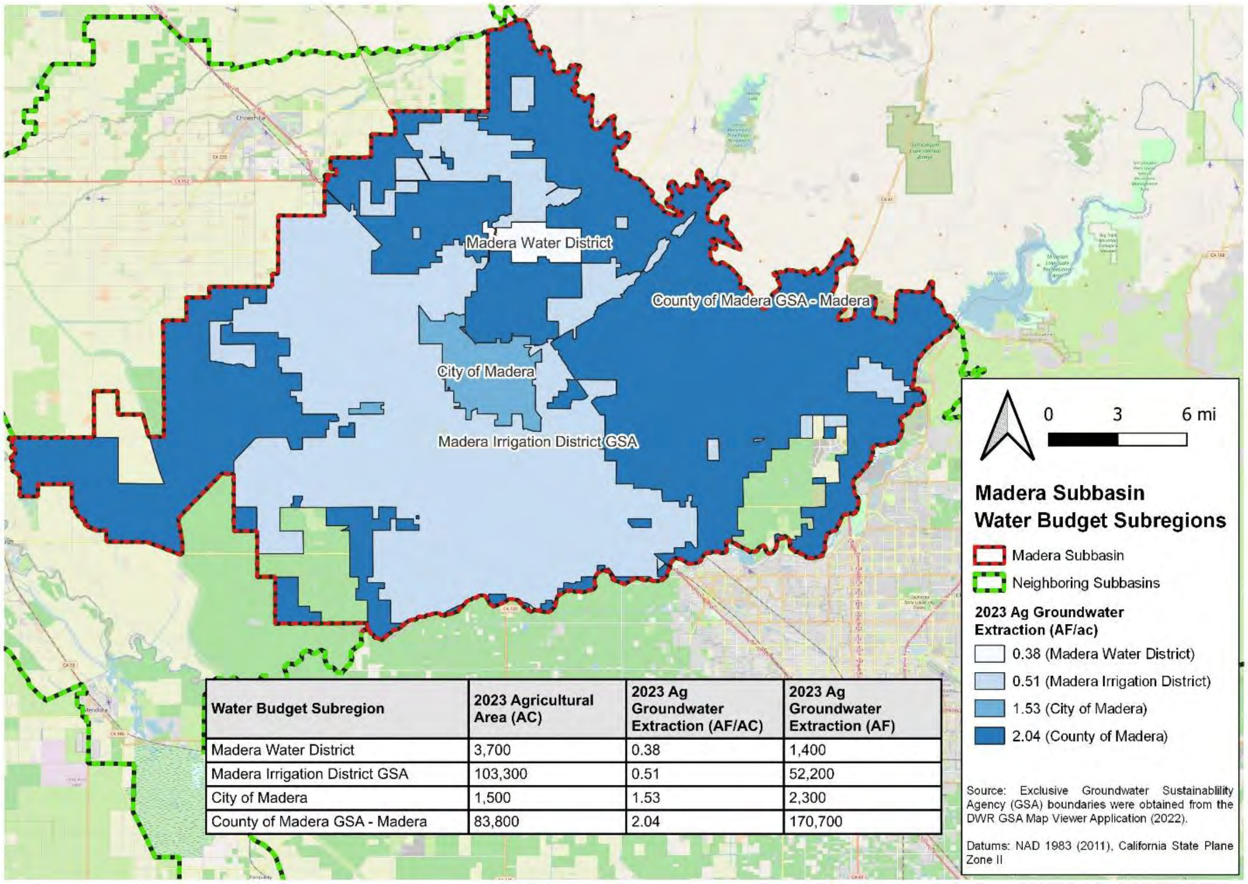
Measured groundwater pumping was available from flowmeter records available from MWD (for agricultural groundwater extraction) and CM (for urban groundwater extraction). MWD pumping records were available from the MWD Groundwater Management Plan for 1993-2014, and MWD metered pumping data was available for 2015-2023. CM SCADA records were available for 2013-2023. Available pumping records from 2023 were used to complete the CM GSA and MWD GSA water budgets.

3.2.2 Estimated Groundwater Extraction

Outside of the MWD GSA agricultural water budget and the CM GSA urban water budget, estimated groundwater extraction was calculated as the Land Surface System water budget "closure" term – the difference between all other estimated or measured inflows and outflows from each water use sector. Groundwater extraction was selected as the closure term because groundwater pumping data has historically been unavailable across the Madera Subbasin (except where indicated in **Table 3-2**). Also, groundwater extraction serves as a relatively large inflow to the Land Surface System, resulting in lower relative uncertainty (as a percent of the total volume) when calculated as a closure term compared to smaller flow paths following the procedure outlined by Clemmens and Burt (1997).

Table 3-1. Groundwater Extraction Volumes and Measurement Methods by Water Use Sector, and Uncertainty (2023).

Joint GSP GSA	Water Use Sector	Groundwater Extraction, 2023 (acre-feet)	Measurement Method	Description
All (except Madera Water District GSA)	Agricultural	225,220	Estimate	Water use sector closure
Madera Water District GSA	Agricultural	1,397	Direct	Flowmeter records
All	Managed Recharge	0	Estimate	No groundwater extraction for managed recharge
All	Native Vegetation	0	Estimate	Water use sector closure
All (except CM GSA)	Urban	13,560	Estimate	Water use sector closure
CM GSA	Urban	8,852	Direct	Flowmeter records
Joint GSP Area		Groundwater Extraction, 2023 (acre-feet)	Average Uncertainty	Uncertainty Source
Total		249,030	20%	Typical uncertainty when calculated for Land Surface System water balance closure, combined with uncertainty of measurement devices for MWD GSA and CM urban sector



Water Budget Subregion	2023 Agricultural Area (AC)	2023 Ag Groundwater Extraction (AF/AC)	2023 Ag Groundwater Extraction (AF)
Madera Water District	3,700	0.38	1,400
Madera Irrigation District GSA	103,300	0.51	52,200
City of Madera	1,500	1.53	2,300
County of Madera GSA - Madera	83,800	2.04	170,700

Figure 3-1. Agricultural Groundwater Extraction, by GSA.*

**Area and volumes rounded to the nearest 100. Data presented in Figure 3-1 is limited to the surface water system and excludes inputs to the groundwater system associated with infiltration of surface water and boundary seepage.*

Table 3-2. Joint GSP Groundwater Extraction, by Water Use Sector (acre-feet, rounded).

Water Year (Type)[1]	Agricultural	Managed Recharge	Native Vegetation	Urban and Industrial	Total
1989 (C)	366,250	0	0	16,920	383,170
1990 (C)	412,050	0	0	17,940	429,990
1991 (C)	405,240	0	0	16,890	422,130
1992 (C)	466,510	0	0	22,400	488,910
1993 (W)	352,910	0	0	17,670	370,580
1994 (C)	387,840	0	0	20,610	408,450
1995 (W)	297,030	0	0	11,070	308,100
1996 (W)	347,820	0	0	16,810	364,630
1997 (W)	408,960	0	0	26,930	435,890
1998 (W)	314,700	0	0	14,510	329,210
1999 (AN)	361,860	0	0	21,220	383,080
2000 (AN)	394,490	0	0	20,100	414,590
2001 (D)	408,070	0	0	18,640	426,710
2002 (D)	448,330	0	0	24,330	472,660
2003 (BN)	424,440	0	0	23,830	448,270
2004 (D)	475,970	0	0	30,860	506,830
2005 (W)	353,550	0	0	19,550	373,100
2006 (W)	348,440	0	0	18,990	367,430
2007 (C)	430,360	0	0	30,260	460,620
2008 (C)	427,160	0	0	30,250	457,410
2009 (BN)	407,860	0	0	29,580	437,440
2010 (AN)	312,280	0	0	17,430	329,710
2011 (W)	326,960	0	0	19,780	346,740
2012 (D)	470,750	0	0	31,200	501,950
2013 (C)	471,430	0	0	32,910	504,340
2014 (C)	529,790	0	0	32,020	561,810
2015 (C)	601,440	0	0	36,810	638,250
2016 (D)	443,550	0	0	31,070	474,620
2017 (W)	402,830	0	0	31,380	434,210
2018 (BN)	457,920	0	0	31,810	489,730
2019 (W)	382,410	0	0	28,620	411,030
2020 (D)	464,220	0	0	36,560	500,780
2021 (C)	596,590	0	0	45,290	641,880
2022 (C)	599,960	0	0	33,640	633,600
2023 (W)	226,620	0	0	22,410	249,030
Average (1989-2014)	398,130	0	0	22,410	420,540
Average (1989-2023)	415,040	0	0	25,150	440,190
W	342,020	0	0	20,700	362,720
AN	356,210	0	0	19,580	375,790
BN	430,070	0	0	28,400	458,470
D	451,820	0	0	28,780	480,600
C	474,550	0	0	28,010	502,560

[1] Water Year Type is classified as C: critical, D: dry, BN: below normal, AN: above normal, and W: wet.

3.3 GROUNDWATER RECHARGE

As required by 23 CCR §354.24, the GSAs within the Madera Subbasin have established a *"sustainability goal for the [Sub]basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline."* The expressed Subbasin sustainability goal is "to implement a package of PMAs that will, by 2040, balance long-term groundwater system inflows with outflows" (Section 3 of the Revised Joint GSP). To track the GSAs' progress toward meeting this sustainability goal, both the GWS inflows and outflows must be quantified.

As shown in **Figure 2-1**, GWS outflows to the SWS include groundwater extraction (quantified above) and groundwater discharge (assumed to be negligible in the Madera Subbasin, given the substantial depth to groundwater). GWS inflows from the SWS include infiltration of precipitation, infiltration of applied water, and infiltration of surface water. While these GWS inflows are not required to be reported in this Annual Report, the Joint GSP GSAs feel that they are necessary to understanding the total contribution of the SWS to sustainability in the Subbasin.

Table 3-3 summarizes the total annual groundwater recharge from the SWS in the Joint GSP area. The components of recharge are useful for understanding and analyzing the combined effects of land surface processes on the underlying GWS. The data sources and calculations used to develop each recharge component are described in Section 2.2.3.3 of the Revised Joint GSP.

Table 3-3. Joint GSP Groundwater Recharge (acre-feet, rounded).[1]

Water Year (Type)	Infiltration of Applied Water	Infiltration of Precipitation	Infiltration of Surface Water[2]	Total Groundwater Recharge
1989 (C)	132,000	88,800	107,000	327,800
1990 (C)	129,100	74,800	93,800	297,700
1991 (C)	143,400	114,000	100,400	357,800
1992 (C)	136,600	57,900	99,900	294,400
1993 (W)	147,300	150,400	249,700	547,400
1994 (C)	129,200	53,800	96,700	279,700
1995 (W)	131,600	199,100	245,800	576,500
1996 (W)	124,500	93,600	199,100	417,200
1997 (W)	173,700	160,600	218,500	552,800
1998 (W)	131,000	161,300	190,200	482,500
1999 (AN)	115,000	39,900	116,700	271,600
2000 (AN)	127,600	69,900	136,500	334,000
2001 (D)	128,200	61,800	108,200	298,200
2002 (D)	134,800	58,000	102,400	295,200
2003 (BN)	119,700	43,400	105,900	269,000
2004 (D)	126,000	33,700	97,500	257,200
2005 (W)	122,700	68,100	154,500	345,300
2006 (W)	115,300	92,800	173,700	381,800
2007 (C)	112,000	26,700	155,000	293,700
2008 (C)	114,600	42,900	113,800	271,300
2009 (BN)	102,200	31,300	93,800	227,300
2010 (AN)	102,400	82,300	120,900	305,600
2011 (W)	116,900	94,200	186,100	397,200
2012 (D)	116,400	26,100	67,000	209,500
2013 (C)	122,400	43,600	95,800	261,800
2014 (C)	105,400	16,700	81,600	203,700
2015 (C)	118,400	22,000	81,600	222,000
2016 (D)	125,900	80,500	133,800	340,200
2017 (W)	126,400	105,900	286,300	518,600
2018 (BN)	119,400	42,200	136,000	297,600
2019 (W)	121,800	61,000	142,300	325,100
2020 (D)	105,600	29,000	125,800	260,400
2021 (C)	107,100	8,400	99,300	214,800
2022 (C)	118,000	9,800	118,000	245,800
2023 (W)	136,300	76,100	242,600	455,000
Average (1989-2014)	125,400	76,400	135,000	336,800
Average (1989-2023)	124,000	69,200	139,300	332,500
W	131,600	114,800	208,100	454,500
AN	115,000	64,000	124,700	303,700
BN	113,800	39,000	111,900	264,700
D	122,800	48,200	105,800	276,800
C	122,300	46,600	103,600	272,500

[1] Values shown in Table 3-3 are representative of infiltration of applied water, infiltration of precipitation, and infiltration of surface water within the entirety of the Joint GSP area. Individual contributions from each GSA are not equal and vary based on the spatial extent and operational characteristics of each GSA.

[2] Infiltration of Surface Water includes infiltration of surface water in the rivers, streams, and canals within the Joint GSP area, plus boundary seepage from the San Joaquin River.

4 Surface Water Supplies (§356.2.b.3)

This section summarizes the annual volumes and data sources for surface water supplies used, or available for use, by the Joint GSP GSAs through the current reporting year (water year 2023).

4.1 QUANTIFICATION BY WATER SOURCE TYPE

Surface water supplies available to the Joint GSP GSAs include surface water deliveries and surface water flowing across the Joint GSP GSA boundaries. In this Annual Report, surface water supplies used or available for use are assumed to be the difference between estimated surface water inflows and estimated surface water outflows through the Joint GSP area.

Per the GSP Regulations, surface water supplies must be reported by water source type. According to the Regulations:

> *"Water source type" represents the source from which water is derived to meet the applied beneficial uses, including groundwater, recycled water, reused water, and surface water sources identified as Central Valley Project, the State Water Project, the Colorado River Project, local supplies, and local imported supplies.*

Table 4-1 summarizes the total surface water supplies used or available for use in the Joint GSP area, by water source type. The supplies included in these totals are described below.

4.1.1 Local Supplies

Local supplies historically available to the Joint GSP GSAs include natural surface water flows along Berenda Creek, Dry Creek, Cottonwood Creek, and Chowchilla Bypass. Much of this water passes through the Madera Subbasin or infiltrates into the GWS. Other local supplies include MID's Pre-1914 water rights, supplies received from Hidden Dam (which in most years are intermingled with CVP supplies from Madera Canal released to the Fresno River), as well as riparian deliveries from the San Joaquin River and the Fresno River to water rights users in MC GSA and MID GSA. This water is applied to irrigated land and is assumed to be completely used within the Madera Subbasin.

4.1.2 CVP Supplies

Agencies with CVP contracts can receive CVP supplies in the Madera Subbasin. CVP supplies received via the Madera Canal include Millerton irrigation releases and flood releases. Outflows of CVP supplies from the Joint GSP area include MID deliveries to growers outside the Joint GSP area (GFWD, RCWD, and Chowchilla Water District), MID conveyance system spillage to the San Joaquin River, MID releases to Cottonwood Creek (for delivery to GFWD), and pass-through flood releases along Fresno River.

4.1.3 Local Imported Supplies

The Joint GSP GSAs do not currently receive local imported supplies, though the Joint GSP GSAs are working on projects to import supplies in the future (see **Section 7**).

4.1.4 Recycling and Reuse

Recycling and reuse are not a significant source of supply within Madera Subbasin. However, urban wastewater treated by the CM, as well as water associated with private septic systems, returns to the groundwater system within the Madera Subbasin and is included in the water budgets.

4.2 SURFACE WATER SUPPLIES AVAILABLE TO EACH GSA

The surface water supplies available to each GSA are summarized below.

4.2.1 City of Madera GSA

The majority of irrigated agricultural lands in CM GSA are located within the boundaries of MID and have the ability to receive surface water in accordance with MID's normal operating practices. Some owners have utilized surface water from MID to meet a portion of their agricultural water needs, while others have chosen to rely solely on groundwater. The CM GSA jointly operates six recharge basins together with MID GSA (including Berry Basin, Golf Course Basin, and four additional City Basins). In total, approximately 1,700 AF of surface water was delivered across the six basins during water year 2023.

4.2.2 Madera County GSA

Surface water supplies available for agriculture in MC GSA primarily include: riparian deliveries to water rights users along the San Joaquin River, the Fresno River, and other minor streams; surface water purchased by irrigators from surface water purveyors; and surface water diverted for recharge in 2023 under Executive Order (EO) N-4-23. Based on reported and estimated diversions from these various sources, approximately 43,000 AF of surface water was used or available for recharge or irrigation in 2023. Additionally, the MC GSA jointly operates the Ellis Basin with the MID GSA, although no water was delivered to the recharge basin during water year 2023.

4.2.3 Madera Irrigation District GSA

The MID GSA receives substantial surface water supplies to support agriculture. MID receives CVP supplies under contract with USBR from the Madera Canal. MID's Friant Class 1 maximum contract amount is 85,000 AF and Class 2 maximum contract amount is 186,000 AF. MID also has access to Hidden Dam contract supplies, Pre-1914 water rights supplies, and other types of surface water made available to the District. Based on estimates from SWRCB eWRIMS records, water rights holders along the San Joaquin River diverted approximately 200 AF from the San Joaquin River in 2023.

4.2.4 Madera Water District GSA

To support agriculture, the MWD GSA receives surface water supplies from MID via Dry Creek. In water year 2023 (October 2022 through September 2023), the MWD GSA received approximately 6,400 AF of surface water at their turnout along Dry Creek.

4.2.5 All GSAs

As defined above, the volume of surface water supplies used or available for use is assumed to be the difference between surface water inflows and outflows from each Joint GSP GSA. This total volume encompasses all surface water that is diverted and applied to land within each Joint GSP GSA (from the water sources described above), as well as all surface water that is lost through seepage and evaporation along the waterways that cross the Joint GSP GSA boundaries.

Table 4-1. Joint GSP Surface Water Supplies Used (Surface Water Inflows – Surface Water Outflows), by Water Source Type (acre-feet, rounded).

Water Year (Type)	Local Supplies	CVP Supplies	Total
1989 (C)	11,700	104,400	116,100
1990 (C)	17,500	62,500	80,000
1991 (C)	14,300	104,600	118,900
1992 (C)	11,700	91,400	103,100
1993 (W)	49,500	253,500	303,000
1994 (C)	9,200	137,400	146,600
1995 (W)	72,900	196,300	269,200
1996 (W)	46,500	238,900	285,400
1997 (W)	89,400	211,900	301,300
1998 (W)	67,300	154,000	221,300
1999 (AN)	12,000	188,000	200,000
2000 (AN)	18,000	175,800	193,800
2001 (D)	11,200	156,600	167,800
2002 (D)	9,900	134,200	144,100
2003 (BN)	12,300	132,400	144,700
2004 (D)	13,400	139,400	152,800
2005 (W)	38,900	161,600	200,500
2006 (W)	60,800	183,300	244,100
2007 (C)	18,500	186,300	204,800
2008 (C)	11,300	148,100	159,400
2009 (BN)	18,100	108,700	126,800
2010 (AN)	15,900	161,800	177,700
2011 (W)	65,300	196,700	262,000
2012 (D)	13,700	95,300	109,000
2013 (C)	10,100	89,600	99,700
2014 (C)	7,900	17,700	25,600
2015 (C)	9,200	8,400	17,600
2016 (D)	17,200	128,300	145,500
2017 (W)	85,500	217,300	302,800
2018 (BN)	4,200	168,800	173,000
2019 (W)	13,700	176,300	190,000
2020 (D)	36,100	92,800	128,900
2021 (C)	23,000	22,400	45,400
2022 (C)	39,300	34,400	73,700
2023 (W)	161,800	246,000	407,800
Average (1989-2014)	28,000	147,300	175,300
Average (1989-2023)	31,900	140,700	172,600
W	68,400	203,300	271,600
AN	15,300	175,200	190,500
BN	11,500	136,600	148,200
D	16,900	124,400	141,400
C	15,300	83,900	99,200

4.3 DATA SOURCES

Table 4-2 summarizes the data sources and estimation procedures for all water budget components that are used to quantify surface water supplies available to the Joint GSP GSAs. Additional details are given below for each water budget component.

The data sources for surface water inflows and outflows along the Fresno River, Chowchilla Bypass and the Berenda, Cottonwood, and Dry Creeks within the Madera Subbasin are described in Section 2.2.3.3 of the Revised Joint GSP. For each waterway, a boundary water budget was computed first by following the procedure described for each waterway in the Joint GSP. Unless otherwise specified, all missing and inaccurate data was replaced by estimates equal to the average monthly value of available data, computed by water year type.

Table 4-2. Rivers and Streams System Water Budget Detailed Components and Estimation Techniques.

Detailed Component	Associated Waterway	Water Source Type	Calculation/Estimation Technique	Information Sources
Surface Inflows	Berenda Creek	Local Supplies	Calculated from MID recorder adjusted upstream to the Madera Subbasin boundary for estimated seepage and evaporation	MID Recorder 13 (available data or estimated), NRCS soil survey, spatial CIMIS data
	Cottonwood Creek	Local Supplies	Calculated from MID recorder adjusted upstream to the Madera Subbasin boundary for estimated seepage and evaporation	MID Recorder 14 (available data or estimated), NRCS soil survey, spatial CIMIS data
	Chowchilla Bypass	Local Supplies	Calculated from SLDMWA CBP station adjusted downstream to the Madera Subbasin boundary for estimated seepage and evaporation	SLDMWA CBP station, NRCS soil survey, spatial CIMIS data
	Dry Creek	Local Supplies	Estimated as equal to Berenda Creek recorder adjusted upstream to the Madera Subbasin boundary for estimated seepage and evaporation	MID Recorder 13 (available data or estimated), NRCS soil survey, spatial CIMIS data
	Fresno River	Local Supplies	Estimated as equal to USGS site along Fresno River below Hidden Dam	USGS Site 11258000 (FRESNO R BL HIDDEN DAM NR DAULTON CA)
Surface Outflows	Berenda Creek	Local Supplies	Calculated from MID recorder adjusted downstream to the Madera Subbasin boundary for estimated seepage and evaporation	MID Recorder 2 (available data or estimated), NRCS soil survey, spatial CIMIS data
	Cottonwood Creek	Local Supplies	Calculated from MID recorder adjusted downstream to the Madera Subbasin boundary for estimated seepage and evaporation	MID Recorder 10 (available data or estimated), NRCS soil survey, spatial CIMIS data
	Chowchilla Bypass	Local Supplies	Calculated from SLDMWA CBP station adjusted downstream to the Madera Subbasin boundary for estimated seepage and evaporation	SLDMWA CBP station, NRCS soil survey, spatial CIMIS data
	Fresno River	CVP Supplies (intermingled with Local Supplies)	Calculated from MID recorder (downstream of convergence with Dry Creek) adjusted downstream to the Madera Subbasin boundary for estimated seepage and evaporation	MID Recorder 4 (available data or estimated), NRCS soil survey, spatial CIMIS data
Riparian Deliveries[1]	San Joaquin River	Local Supplies	Reported riparian deliveries and estimated riparian deliveries (where data missing, based on estimated consumptive use of riparian parcels during streamflow)	eWRIMS, spatial CIMIS data, land use data

Detailed Component	Associated Waterway	Water Source Type	Calculation/Estimation Technique	Information Sources
Madera Canal Releases to Fresno River	Madera Canal	CVP Supplies	Reported in USBR CVP irrigation delivery records at Madera Canal Mile 18.8	USBR CVP delivery records
MID Diversions from Madera Canal	Madera Canal	CVP Supplies	Reported in USBR CVP irrigation delivery records at Madera Canal Miles 6.1, 13.06, 22.95, 24.1, 26.8, 27.5, 28.38, 28.39, 28.64, 30.4, 30.5, 32.2	USBR CVP delivery records
MID Flood Diversions from Madera Canal	Madera Canal	CVP Supplies	Reported in USBR CVP flood delivery records at Madera Canal Miles 6.1, 13.06, 22.95, 24.1, 26.8, 27.5, 28.38, 28.39, 28.64, 30.4, 30.5, 32.2	USBR CVP delivery records
MID Diversions from Fresno River[2]	Fresno River	CVP Supplies (intermingled with Local Supplies)	Closure of Fresno River Balance	USGS Site 11258000 (FRESNO R BL HIDDEN DAM NR DAULTON CA), USBR CVP records, IDC root zone water budget, NRCS soil survey, spatial CIMIS data, MID recorders (available data or estimated)
Spillage[3]	San Joaquin River	CVP Supplies	Measured by MID recorders at spillage sites	MID Recorders 9, 11 (available data or estimated)
MID Conveyance System to Cottonwood Creek	Cottonwood Creek	CVP Supplies	Estimated from MID Recorder 10, GFWD reports	MID Recorder 10 (available data or estimated), GFWD reports (if available)
MID Deliveries to Other Districts	MID Conveyance System	CVP Supplies	Measured by MID, or reported from other districts' records	MID STORM[4] delivery database; GFWD reports, MWD reports, RCWD reports (if available)

[1] Riparian deliveries along Fresno River within the Madera Subbasin are included in the "MID Diversions from Fresno River."

[2] Total diversions from Fresno River includes riparian deliveries from Fresno River.

[3] Spillage to Fresno River (MID Recorders 15-20) are accounted in the Fresno River outflows.

[4] The water ordering and delivery management software used by MID.

5 Total Water Use (§356.2.b.4)

This section summarizes the annual volumes and data sources for total water use by the Joint GSP GSAs through the current reporting year (water year 2023).

5.1 QUANTIFICATION BY WATER USE SECTOR AND WATER SOURCE TYPE

Water use is defined by ASCE (2016) as "water that is used for a specific purpose such as domestic use, irrigation, or industrial processing." This definition includes both consumptive and non-consumptive components.

In the context of agriculture, consumptive water use is defined as "the part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment" (ASCE, 2016). As most field crops dry to a very low moisture content approaching harvest, total consumptive water use is generally equivalent to the combined evaporation and crop transpiration, together referred to as crop evapotranspiration (ET_c). Non-consumptive water use is generally equal to the remaining volume of precipitation and applied water that is not consumptively used.

Accordingly, the total water use reported below is assumed to be equal to the total combined precipitation, agricultural applied water, managed recharge applied water, and urban water use from all sources within the Joint GSP area.

In addition to reporting the total water use in the Joint GSP GSAs, the total consumptive water use (total ET_c) is also reported below, as this represents the volume of water that is no longer available for use within the Joint GSP area (i.e., unavailable for reuse or future groundwater extraction).

Water sources available for use in the Joint GSP area include applied water (surface water and groundwater) and precipitation. **Table 5-1** summarizes the total water use by the Joint GSP GSAs, by water use sector and water source type from 1989 through 2023 (the current reporting year). **Table 5-2** summarizes the consumptive water use by the Joint GSP GSAs, by water use sector and water source type from 1989 through 2023. The methodology and data sources used to develop these tables are provided below.

Table 5-1. Joint GSP Total Water Use, by Water Use Sector and Water Source Type (acre-feet, rounded).

Water Year (Type)	Agricultural				Managed Recharge				Native Vegetation				Urban				Total			
	Total	Surface Water	Ground-water	Precip-itation	Total	Surface Water	Ground-water	Precip-itation	Total	Surface Water	Ground-water	Precip-itation	Total	Surface Water	Ground-water	Precip-itation	Total	Surface Water	Ground-water	Precip-itation
1989 (C)	629,880	68,580	366,250	195,050	0	0	0	0	104,290	0	0	104,290	39,830	0	16,900	22,930	774,010	68,580	383,160	322,270
1990 (C)	647,360	53,310	412,060	181,990	0	0	0	0	96,810	0	-10	96,820	39,570	0	17,940	21,630	783,750	53,310	429,990	300,450
1991 (C)	682,370	86,860	405,250	190,260	0	0	0	0	100,800	0	0	100,800	39,740	0	16,880	22,860	822,920	86,860	422,130	313,930
1992 (C)	691,420	69,150	466,510	155,760	0	0	0	0	81,890	0	0	81,890	41,300	0	22,400	18,900	814,600	69,150	488,910	256,540
1993 (W)	747,760	130,690	352,900	264,170	0	0	0	0	138,140	0	0	138,140	50,030	0	17,670	32,360	935,930	130,690	370,570	434,670
1994 (C)	654,180	116,390	387,840	149,950	0	0	0	0	77,830	0	-10	77,840	39,150	0	20,610	18,540	771,150	116,390	408,440	246,320
1995 (W)	726,610	107,200	297,020	322,390	0	0	0	0	166,160	0	0	166,160	51,300	0	11,060	40,240	944,070	107,200	308,080	528,790
1996 (W)	704,080	159,100	347,820	197,160	0	0	0	0	101,150	0	0	101,150	41,670	0	16,810	24,860	846,910	159,100	364,640	323,170
1997 (W)	798,000	163,590	408,960	225,450	0	0	0	0	115,120	0	0	115,120	55,650	0	26,920	28,730	968,770	163,590	435,890	369,290
1998 (W)	691,980	106,050	314,700	271,230	0	0	0	0	137,850	0	0	137,850	49,410	0	14,500	34,910	879,230	106,050	329,200	443,980
1999 (AN)	607,290	135,340	361,860	110,090	0	0	0	0	55,690	0	0	55,690	35,540	0	21,230	14,310	698,520	135,340	383,090	180,090
2000 (AN)	696,540	122,440	394,500	179,600	0	0	0	0	90,420	0	0	90,420	43,680	0	20,100	23,580	830,640	122,440	414,600	293,600
2001 (D)	688,850	113,100	408,060	167,690	0	0	0	0	84,020	0	0	84,020	40,860	0	18,630	22,230	813,730	113,100	426,690	273,940
2002 (D)	701,760	101,800	448,320	151,640	0	0	0	0	76,220	0	0	76,220	45,010	0	24,320	20,690	822,990	101,800	472,640	248,550
2003 (BN)	661,810	104,630	424,430	132,750	0	0	0	0	66,940	0	0	66,940	42,460	0	23,830	18,630	771,210	104,630	448,260	218,320
2004 (D)	701,220	115,350	475,970	109,900	0	0	0	0	55,600	0	0	55,600	46,720	0	30,870	15,850	803,540	115,350	506,830	181,360
2005 (W)	660,010	117,560	353,540	188,910	0	0	0	0	95,890	0	0	95,890	47,550	0	19,550	28,000	803,460	117,560	373,090	312,810
2006 (W)	682,960	127,150	348,440	207,370	0	0	0	0	105,600	0	0	105,600	50,550	0	18,990	31,560	839,100	127,150	367,420	344,530
2007 (C)	626,540	112,500	430,360	83,680	0	0	0	0	42,760	0	0	42,760	43,320	0	30,250	13,070	712,620	112,500	460,610	139,510
2008 (C)	659,760	105,920	427,160	126,680	0	0	0	0	64,940	0	0	64,940	50,550	0	30,250	20,300	775,260	105,920	457,420	211,920
2009 (BN)	619,610	97,720	407,860	114,030	0	0	0	0	58,650	0	0	58,650	48,320	0	29,580	18,740	726,580	97,720	437,440	191,420
2010 (AN)	634,330	126,940	312,280	195,110	0	0	0	0	100,690	0	0	100,690	50,290	0	17,430	32,860	785,320	126,940	329,720	328,660
2011 (W)	672,870	142,440	326,950	203,480	0	0	0	0	105,350	0	0	105,350	54,890	0	19,780	35,110	833,110	142,440	346,730	343,940
2012 (D)	641,160	100,440	470,750	69,970	0	0	0	0	35,110	0	0	35,110	43,200	0	31,200	12,000	719,460	100,440	501,940	117,080
2013 (C)	667,180	76,330	471,420	119,430	0	0	0	0	58,030	0	0	58,030	53,250	0	32,900	20,350	778,470	76,330	504,330	197,810
2014 (C)	608,670	19,960	529,790	58,920	0	0	0	0	27,730	0	10	27,720	42,000	0	32,020	9,980	678,390	19,960	561,810	96,620
2015 (C)	696,770	13,990	601,430	81,350	0	0	0	0	36,830	0	0	36,830	50,500	0	36,810	13,690	784,100	13,990	638,240	131,870
2016 (D)	742,550	94,670	443,540	204,340	0	0	0	0	90,990	0	0	90,990	71,560	0	31,070	40,490	905,100	94,670	474,610	335,820
2017 (W)	728,640	125,160	402,840	200,640	0	0	0	0	85,930	0	0	85,930	70,870	0	31,380	39,490	885,440	125,160	434,220	326,060
2018 (BN)	712,090	131,670	457,920	122,500	0	0	0	0	50,010	0	0	50,010	55,760	0	31,800	23,960	817,860	131,670	489,710	196,480
2019 (W)	719,280	141,630	382,400	195,250	620	620	0	0	76,360	0	0	76,360	66,490	0	28,610	37,880	862,760	142,250	411,020	309,490
2020 (D)	659,400	95,740	464,220	99,440	310	310	0	0	43,080	0	0	43,080	57,180	0	36,560	20,620	759,980	96,050	500,790	163,140
2021 (C)	652,290	29,860	596,600	25,830	0	0	0	0	11,050	0	0	11,050	50,690	0	45,290	5,400	714,030	29,860	641,890	42,280
2022 (C)	691,600	40,680	599,960	50,960	50	50	0	0	19,970	0	0	19,970	41,430	0	33,640	7,790	753,050	40,730	633,610	78,710
2023 (W)	634,170	214,180	226,620	193,370	41,210	41,210	0	0	100,400	0	-10	100,410	55,120	0	22,410	32,710	830,890	255,390	249,020	326,480
Average (1989-2014)	673,240	106,940	398,120	168,180	0	0	0	0	86,300	0	0	86,300	45,610	0	22,410	23,200	805,140	106,940	420,520	277,680
Average (1989-2023)	678,300	104,800	415,000	158,500	1,200	1,200	0	0	78,800	0	0	78,800	48,700	0	25,100	23,600	807,100	106,000	440,200	260,900
W	706,000	139,500	342,000	224,500	3,800	3,800	0	0	111,600	0	0	111,600	54,000	0	20,700	33,300	875,400	143,300	362,700	369,400
AN	646,000	128,200	356,200	161,600	0	0	0	0	82,300	0	0	82,300	43,200	0	19,600	23,600	771,500	128,200	375,800	267,500
BN	664,500	111,300	430,100	123,100	0	0	0	0	58,500	0	0	58,500	48,800	0	28,400	20,400	771,900	111,300	458,500	202,100
D	689,100	103,500	451,800	133,800	100	100	0	0	64,200	0	0	64,200	50,800	0	28,800	22,000	804,200	103,600	480,600	220,000
C	659,000	66,100	474,600	118,300	0	0	0	0	60,200	0	0	60,200	44,300	0	28,000	16,300	763,500	66,100	502,500	194,900

Table 5-2. Joint GSP Consumptive Water Use, by Water Use Sector and Water Source Type (acre-feet, rounded).

Water Year (Type)	Agricultural				Managed Recharge				Native Vegetation				Urban				Total			
	Total	Surface Water	Ground-water	Precip-itation	Total	Surface Water	Ground-water	Precip-itation	Total	Surface Water	Ground-water	Precip-itation	Total	Surface Water	Ground-water	Precip-itation	Total	Surface Water	Ground-water	Precip-itation
1989 (C)	432,040	44,970	266,490	120,580	0	0	0	0	78,270	0	10	78,260	26,890	0	12,340	14,550	537,210	44,970	278,840	213,400
1990 (C)	456,420	34,280	296,630	125,510	0	0	0	0	75,960	0	0	75,960	28,280	0	12,970	15,310	560,670	34,280	309,610	216,780
1991 (C)	445,400	55,960	288,830	100,610	0	0	0	0	68,210	0	0	68,210	24,890	0	12,000	12,890	538,490	55,960	300,820	181,710
1992 (C)	509,580	46,920	351,930	110,730	0	0	0	0	81,570	0	0	81,570	30,750	0	15,220	15,530	621,890	46,920	367,150	207,820
1993 (W)	488,170	87,200	255,780	145,190	0	0	0	0	80,740	0	0	80,740	29,860	0	13,010	16,850	598,760	87,200	268,780	242,780
1994 (C)	484,450	80,810	296,120	107,520	0	0	0	0	63,440	0	0	63,440	29,410	0	15,480	13,930	577,290	80,810	311,600	184,880
1995 (W)	458,010	72,010	217,220	168,780	0	0	0	0	78,300	0	0	78,300	27,450	0	9,400	18,050	563,760	72,010	226,620	265,130
1996 (W)	510,640	111,180	261,000	138,460	0	0	0	0	81,240	0	0	81,240	29,670	0	10,750	18,920	621,540	111,180	271,740	238,620
1997 (W)	515,660	108,230	293,800	113,630	0	0	0	0	70,950	0	0	70,950	31,890	0	15,430	16,460	618,500	108,230	309,230	201,040
1998 (W)	453,130	71,300	231,190	150,640	0	0	0	0	67,960	0	0	67,960	28,040	0	11,990	16,050	549,130	71,300	243,180	234,650
1999 (AN)	470,150	96,900	283,410	89,840	0	0	0	0	58,790	0	0	58,790	28,260	0	14,160	14,100	557,200	96,900	297,570	162,730
2000 (AN)	513,160	87,580	307,820	117,760	0	0	0	0	66,840	0	0	66,840	30,640	0	15,630	15,010	610,640	87,580	323,450	199,610
2001 (D)	513,980	79,790	316,570	117,620	0	0	0	0	71,910	0	0	71,910	30,280	0	13,850	16,430	616,170	79,790	330,420	205,960
2002 (D)	525,190	70,900	346,980	107,310	0	0	0	0	68,010	0	0	68,010	33,560	0	17,630	15,930	626,750	70,900	364,600	191,250
2003 (BN)	512,100	75,460	336,410	100,230	0	0	0	0	54,710	0	0	54,710	33,040	0	18,920	14,120	599,850	75,460	355,330	169,060
2004 (D)	553,000	83,810	381,790	87,400	0	0	0	0	60,290	0	0	60,290	37,780	0	22,890	14,890	651,070	83,810	404,680	162,580
2005 (W)	492,880	85,130	278,040	129,710	0	0	0	0	67,490	0	0	67,490	33,610	0	16,380	17,230	593,980	85,130	294,420	214,430
2006 (W)	499,450	91,200	272,850	135,400	0	0	0	0	72,850	0	0	72,850	34,750	0	15,570	19,180	607,050	91,200	288,410	227,440
2007 (C)	501,580	82,430	348,320	70,830	0	0	0	0	54,170	0	0	54,170	35,260	0	20,180	15,080	591,010	82,430	368,500	140,080
2008 (C)	513,180	77,480	343,900	91,800	0	0	0	0	57,330	0	0	57,330	39,100	0	23,380	15,720	609,600	77,480	367,280	164,840
2009 (BN)	496,220	72,350	335,090	88,780	0	0	0	0	47,170	0	0	47,170	38,890	0	24,460	14,430	582,270	72,350	359,540	150,380
2010 (AN)	482,710	94,570	252,260	135,880	0	0	0	0	66,560	0	0	66,560	35,460	0	15,970	19,490	584,730	94,570	268,230	221,930
2011 (W)	497,250	105,340	258,950	132,960	0	0	0	0	72,250	0	0	72,250	36,580	0	14,670	21,910	606,070	105,340	273,620	227,110
2012 (D)	508,280	72,540	376,710	59,030	0	0	0	0	41,240	0	0	41,240	33,800	0	20,300	13,500	583,330	72,540	397,020	113,770
2013 (C)	520,270	55,610	382,590	82,070	0	0	0	0	51,980	0	0	51,980	40,440	0	25,080	15,360	612,680	55,610	407,670	149,400
2014 (C)	497,980	14,380	431,090	52,510	0	0	0	0	26,860	0	0	26,860	34,150	0	24,670	9,480	558,990	14,380	455,760	88,850
2015 (C)	564,390	10,320	493,460	60,610	0	0	0	0	29,940	0	0	29,940	38,950	0	28,680	10,270	633,260	10,320	522,130	100,810
2016 (D)	562,270	69,030	356,740	136,500	0	0	0	0	67,530	0	0	67,530	48,350	0	24,370	23,980	678,150	69,030	381,110	228,010
2017 (W)	544,570	91,990	325,400	127,180	0	0	0	0	59,440	0	0	59,440	44,290	0	19,950	24,340	648,300	91,990	345,350	210,960
2018 (BN)	559,620	97,820	373,090	88,710	0	0	0	0	42,780	0	0	42,780	39,820	0	22,110	17,710	642,230	97,820	395,200	149,210
2019 (W)	577,490	109,220	320,930	147,340	440	440	0	0	60,440	0	0	60,440	48,150	0	21,920	26,230	686,510	109,660	342,850	234,000
2020 (D)	544,620	72,970	389,810	81,840	130	130	0	0	42,650	0	0	42,650	43,950	0	25,110	18,840	631,340	73,100	414,910	143,330
2021 (C)	550,160	22,580	502,890	24,690	0	0	0	0	19,470	0	0	19,470	41,730	0	32,470	9,260	611,360	22,580	535,370	53,410
2022 (C)	582,970	32,230	515,180	35,560	0	0	0	0	12,430	0	0	12,430	32,350	0	26,820	5,530	627,750	32,230	542,000	53,520
2023 (W)	497,970	168,230	190,460	139,280	0	0	0	0	63,780	0	0	63,780	35,510	0	17,980	17,530	597,240	168,230	208,430	220,580
Average (1989-2014)	494,260	75,320	308,140	110,800	0	0	0	0	64,810	0	0	64,810	32,410	0	16,630	15,780	591,480	75,320	324,770	191,390
Average (1989-2023)	509,570	75,220	327,990	106,360	20	20	0	0	59,530	0	0	59,530	34,740	0	18,620	16,120	603,850	75,240	346,610	182,000
W	503,200	100,090	264,150	138,960	40	40	0	0	70,490	0	0	70,490	34,520	0	15,180	19,340	608,250	100,130	279,330	228,790
AN	488,670	93,020	281,160	114,490	0	0	0	0	64,070	0	0	64,070	31,460	0	15,260	16,200	584,200	93,020	296,420	194,760
BN	522,640	81,870	348,200	92,570	0	0	0	0	48,220	0	0	48,220	37,250	0	21,830	15,420	608,110	81,870	370,020	156,220
D	534,560	74,840	361,430	98,290	20	20	0	0	58,600	0	0	58,600	37,950	0	20,690	17,260	631,130	74,860	382,120	174,150
C	504,870	46,500	376,450	81,920	0	0	0	0	51,630	0	0	51,630	33,510	0	20,770	12,740	590,020	46,500	397,230	146,290

5.2 DATA SOURCES

ET_c volumes were calculated by water use sector and water source type using a root zone water balance model as described in Section 2.2.3.3 of the Revised Joint GSP.

Daily ET_o values were computed based on weather and climate data in the study area (**Table 5-3**) and were provided as inputs to the root zone model for calculating crop consumptive use requirements. Daily precipitation inflows to each Land Surface System water use sector were calculated as the daily precipitation depth derived from weather station data (**Table 5-3**) applied over the total area of each water use sector within the Joint GSP area (in acres). Daily precipitation depths were provided as inputs to the root zone model to compute the fraction of ET_c that results from precipitation.

Table 5-3. Madera Subbasin Weather and Climate Data Sources.

Station/Source	Station Type	Start Date	End Date	Comment
Fresno State	CIMIS	Oct. 2, 1988	May 12, 1998	CIMIS Station #80. Used before Madera CIMIS station was installed.
Madera	CIMIS	May 13, 1998	Apr. 2, 2013	CIMIS Station #145. Moved eastward 2 miles in 2013 and renamed "Madera II."
Madera II	CIMIS	Apr. 3, 2013	Jun. 23, 2018	CIMIS Station #188.
Spatial CIMIS	Spatial CIMIS	Jun. 24, 2018	Sep. 30, 2023	Used for developing ET_0 time series after CIMIS station data was available.
Madera	NOAA NCEI	Jun. 24, 2018	Sep. 30, 2023	Used for developing precipitation time series after CIMIS station data was available.

6 Change in Groundwater Storage (§356.2.b.5)

6.1 CHANGE IN GROUNDWATER STORAGE MAPS

Consistent with §354.18.b, based on a comparison of the annual spring groundwater elevation contour maps representing seasonal high groundwater conditions, changes in groundwater elevation were calculated for individual aquifers between Spring 2022 and Spring 2023. To calculate annual change in groundwater storage from the groundwater level contour maps, the difference in groundwater elevation between annual spring contour maps was calculated for each of the principal aquifers (Upper and Lower Aquifers). Both confined and unconfined groundwater conditions occur within the Madera Subbasin. To accurately estimate the change in groundwater storage from changes in groundwater levels, it is important to differentiate areas of confined groundwater conditions from unconfined conditions. Accordingly, the groundwater elevation data were reviewed to estimate an area over which the Lower Aquifer exhibits confined conditions and where the groundwater levels are representative of a potentiometric surface. This was done by comparing groundwater elevations to the elevation of the bottom of the Corcoran Clay confining geologic unit. The extent of the area where groundwater elevations in the Lower Aquifer occur above the bottom of the Corcoran Clay was delineated as the area of confined groundwater conditions for the purpose of calculating change in groundwater storage.

Outside of the delineated confined area, changes in groundwater levels (in both the Upper and Lower Aquifers) were multiplied by representative specific yield values to estimate change in groundwater storage. Within the delineated area of confinement in the Lower Aquifer, groundwater potentiometric surface changes in the Lower Aquifer were multiplied by a much smaller storage coefficient value to calculate annual changes in groundwater storage in the Lower Aquifer. The specific yield and storage coefficient values used in the analysis are derived from values in the calibrated integrated groundwater flow model (MCSim) developed and applied during the preparation of the Joint GSP. The specific yield values in MCSim are lower than previous values estimated for the Madera Subbasin; however, recent test hole drilling and associated subsurface geologic and geophysical logging conducted at nine monitoring well sites across the Madera Subbasin indicate a high fraction of fine-grained sediments in many parts of the Madera Subbasin, which is consistent with the relatively low specific yield values in MCSim.

Figures 6-1 and 6-2 show the spatial distribution of calculated annual change in groundwater level for the most recent reporting year between Spring 2022 and Spring 2023 for the Upper Aquifer/undifferentiated unconfined groundwater zone and the Lower Aquifer. Maps of change in groundwater levels for each of the years between Spring 2016 and 2022, separated by principal aquifer, are presented in **Appendix C**. Because there was incomplete spatial coverage of groundwater elevation data within the Joint GSP area, it was not deemed appropriate to extend groundwater elevation contours into some parts of the Joint GSP area. In these areas without contour data, the average change in groundwater elevation value calculated for the area with data was applied to areas without data to estimate change in storage amounts for the entire Joint GSP area. **Tables 6-1 through 6-3** summarize the calculated annual change in groundwater storage volumes for 2023 by principal aquifer for the Joint GSP area. The discussion of estimated change in storage values presented below is based on the aquifer parameter values derived from MCSim as presented in **Tables 6-1 through 6-3**. The change in storage value in the Upper Aquifer/undifferentiated unconfined groundwater zone is presented in **Table 6-1**. Maps of the spatial distribution of change in storage in the principal aquifers for the most recent period from Spring 2022 to Spring 2023 are presented in **Figures 6-3 and 6-4**. All maps of change in groundwater storage utilize specific yield and storage coefficient values derived from MCSim. Maps of change in groundwater storage for each of the years between Spring 2016 and 2022, separated by aquifer, are presented in **Appendix C**.

Using representative aquifer parameter values derived from the calibrated groundwater flow model MCSim, the calculated changes in groundwater levels in the combined Upper Aquifer and undifferentiated unconfined zone translate to annual change in groundwater storage of about 76,749 AF from Spring 2022 to 2023 (**Table 6-1**). Negative change in storage values indicate depletion of groundwater storage, whereas positive change in storage values represent accretion of groundwater in storage. In the Lower Aquifer, changes in groundwater levels translated to substantially smaller changes in groundwater storage where confined conditions exist due to the smaller overall area and application of a storage coefficient value in these areas. The portion of the Lower Aquifer treated as unconfined, while smaller in overall areal extent, can result in greater storage changes due to application of a specific yield value. Between Spring 2022 and Spring 2023, the change in groundwater storage in the Lower Aquifer was about -1,522 AF (**Table 6-2**), with the majority of that decrease occurring in the unconfined portion of the Lower Aquifer. The combined change in groundwater storage for the entire Joint GSP area was an increase of about 75,228 AF from Spring 2022 to 2023, indicating a net recharge of groundwater storage (**Table 6-3**). Notably, there is uncertainty in this estimate, and there are also other processes that contribute to the net change in groundwater storage besides groundwater pumping (e.g., recharge, subsurface inflows, and outflows). These contributing factors were considered in the MCSim groundwater model used in development of the Joint GSP, and will be further evaluated in future updates to the MCSim model.

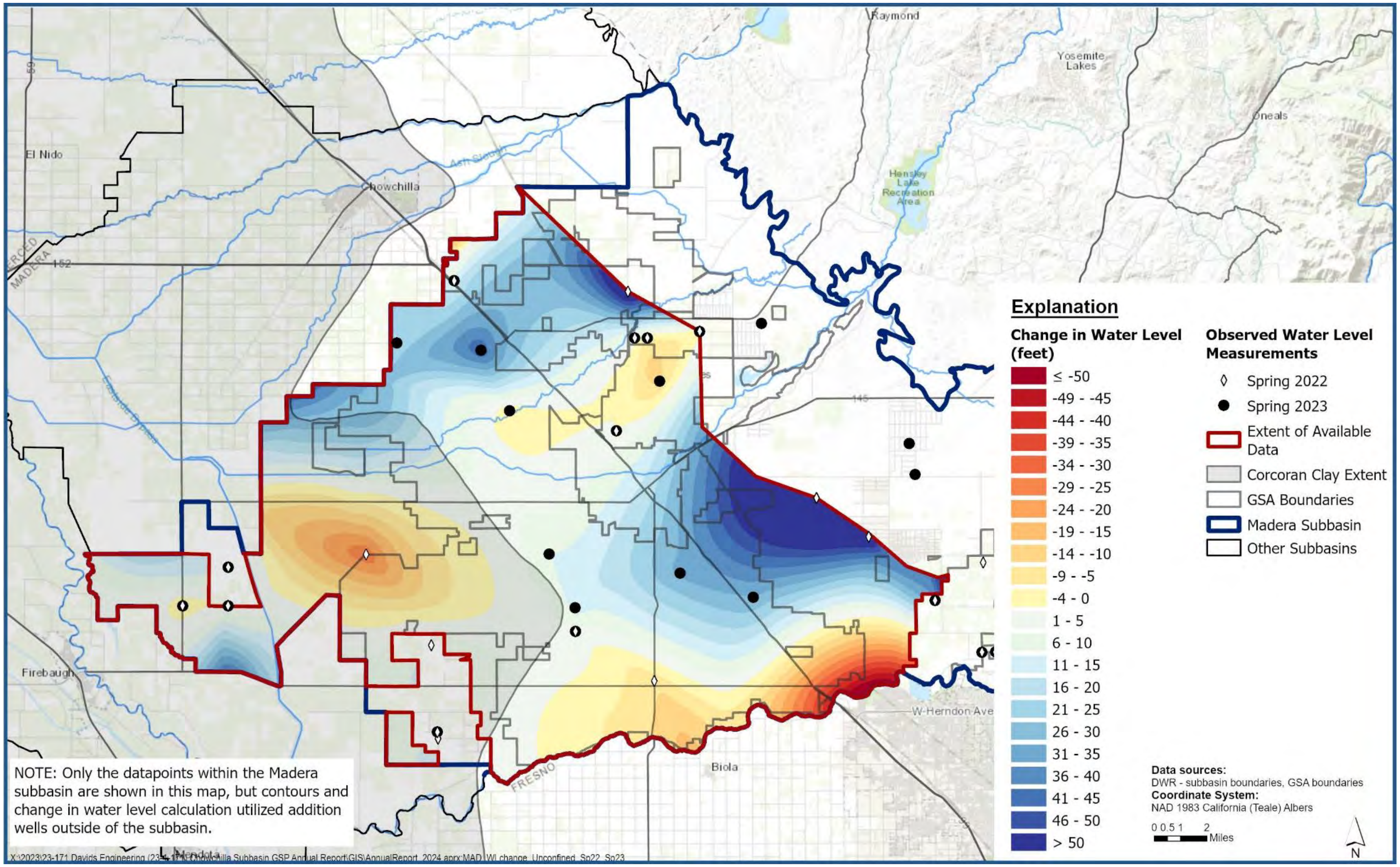


Figure 6-1. Change in Groundwater Level in the Upper Aquifer/Undifferentiated Unconfined Zone – Spring 2022 through Spring 2023.

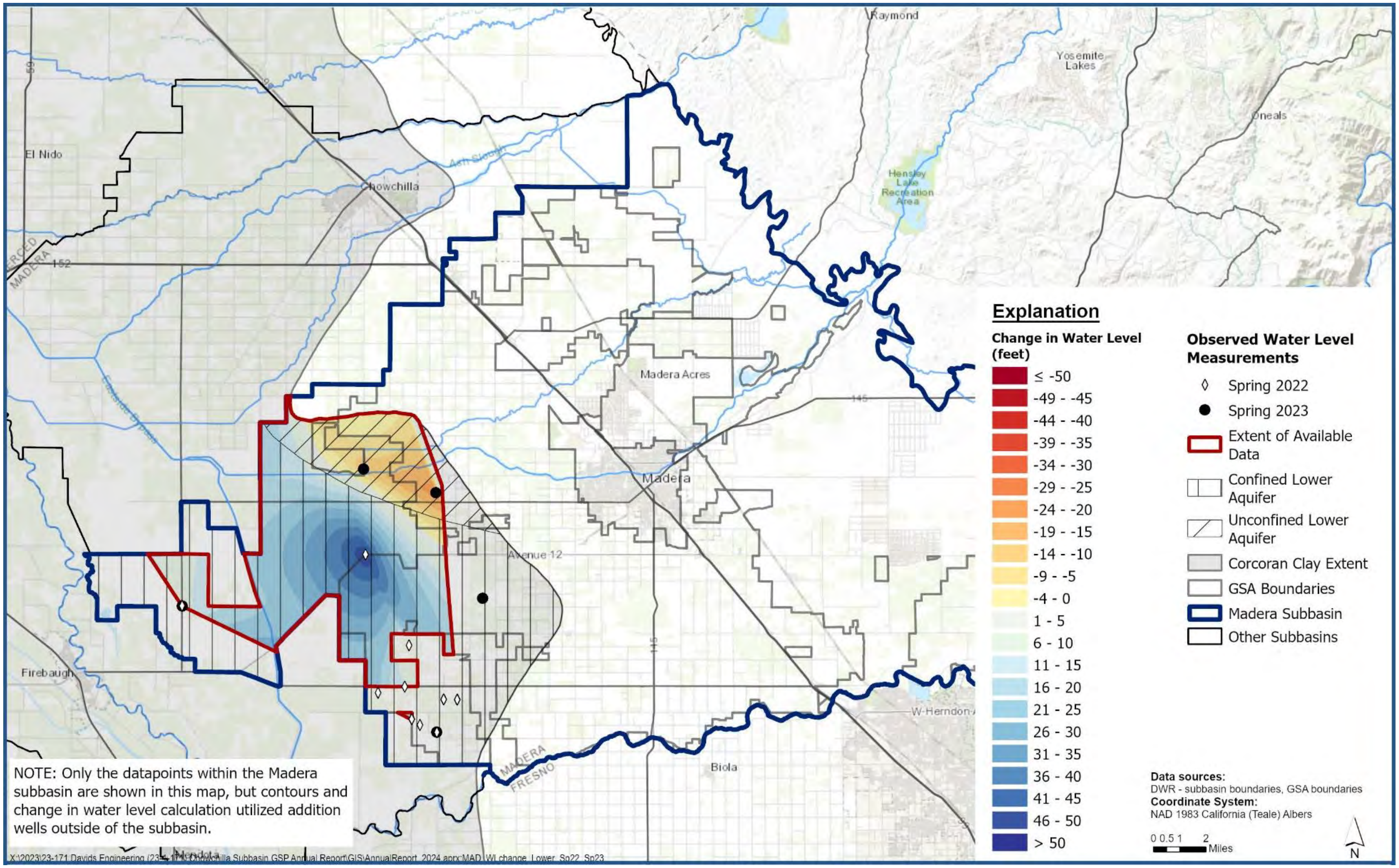


Figure 6-2. Change in Groundwater Level in the Lower Aquifer – Spring 2022 through Spring 2023.

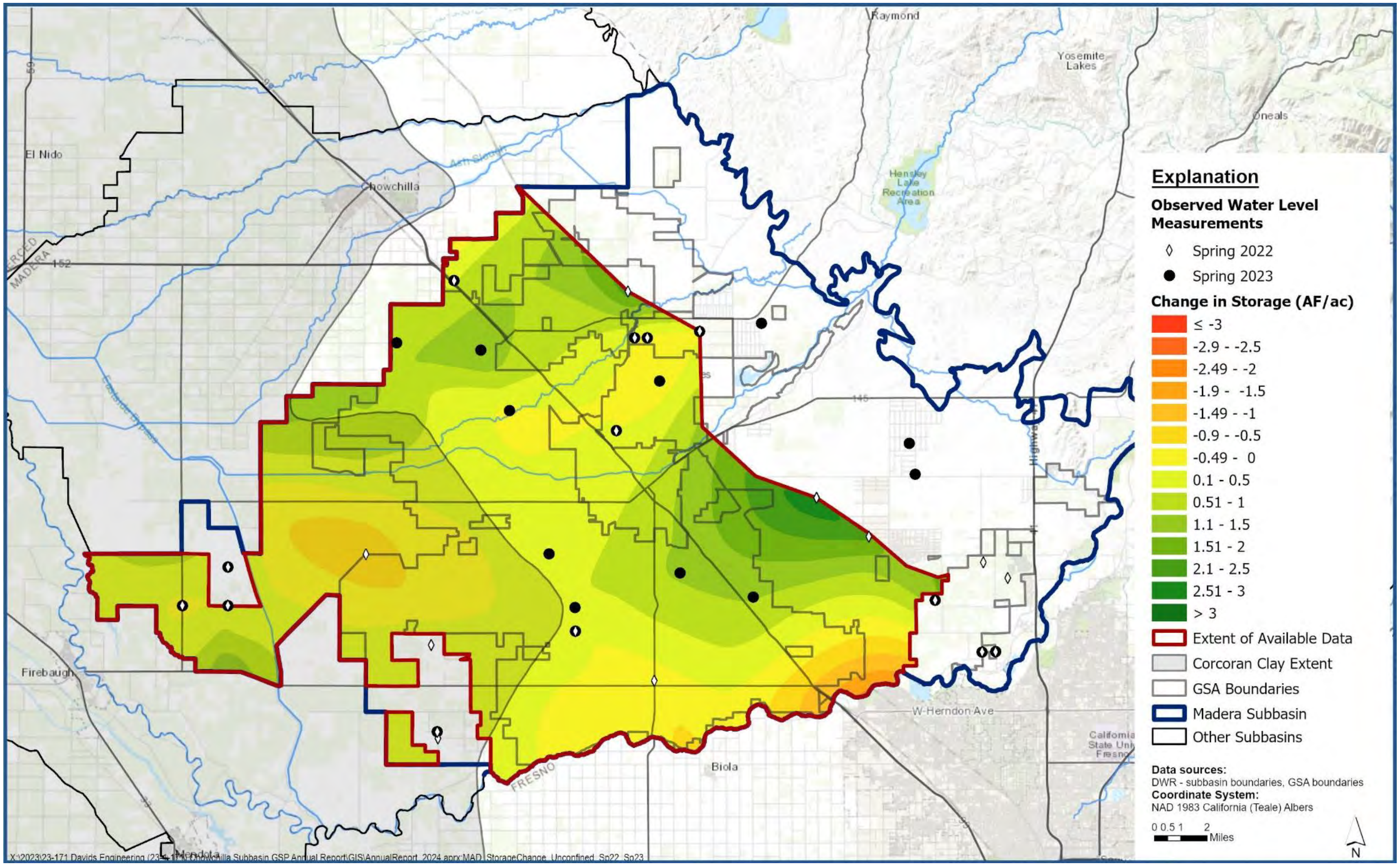


Figure 6-3. Change in Groundwater Storage in the Upper Aquifer/Undifferentiated Unconfined Zone – Spring 2022 through Spring 2023.

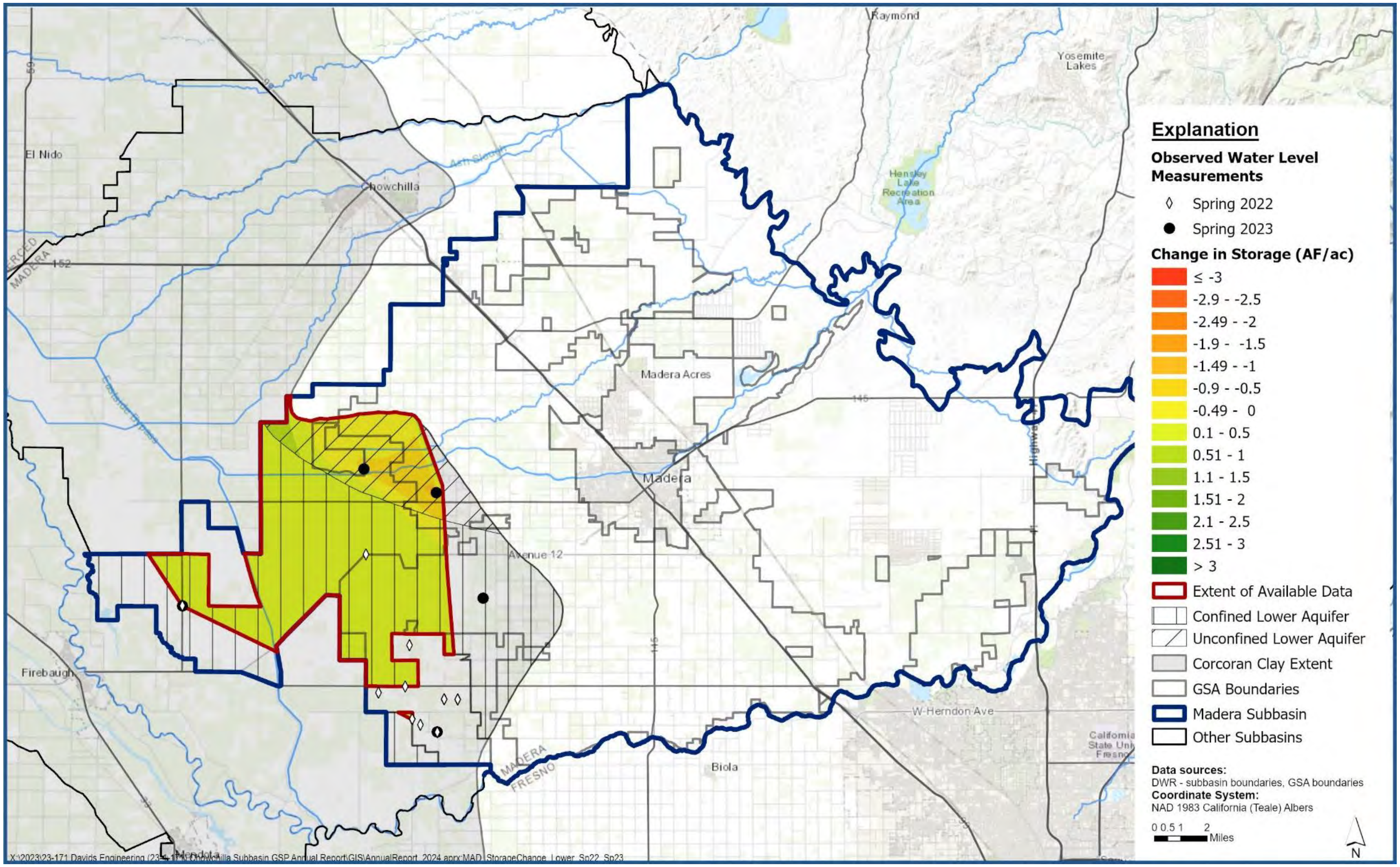


Figure 6-4. Change in Groundwater Storage in the Lower Aquifer – Spring 2022 through Spring 2023.

Table 6-1. Calculated Change in Groundwater Storage in the Combined Upper Aquifer and Undifferentiated Unconfined Zone.

Analysis Time Period	Specific Yield	Average Groundwater Elevation Change (ft)	Average Groundwater Storage Change Per Acre (AF/acre)	Area Applied for Estimating Groundwater Storage Change (acres)	Total Groundwater Storage Change in Joint GSP Area (AF)[1]	Notes on Specific Yield Basis
Spring 2022-2023	0.04	6.69	0.24	325,834	76,749	Representative value from MCSim model

[1] Total Upper Aquifer and Undifferentiated Unconfined Zone within Joint GSP area is 325,834 acres and includes only those areas of the Madera Subbasin outside of RCWD GSA, GFWD GSA, and NSWD GSA.

Table 6-2. Calculated Change in Groundwater Storage in the Lower Aquifer Zone.

Analysis Time Period	Lower Aquifer Zone	Storage Coefficient[1]	Specific Yield[2]	Average Change in Groundwater Elevation Surface (ft)	Average Groundwater Storage Change Per Acre (AF/acre)	Area Used for Estimating Groundwater Storage Change (acres)	Total Groundwater Storage Change in Joint GSP Area (AF)[3]	Notes on Storage Coefficient Basis
Spring 2022-2023	Confined	1.24E-03		21.56	0.03	56,545	1,507	Representative value from MCSim model
	Unconfined		0.049	-4.95	-0.24	12,474	-3,028	
	TOTAL				-0.02	69,019	-1,522	

[1] Storage Coefficient value applies to those areas under the Corcoran Clay considered to be confined (56,545 acres).
[2] Specific Yield value applies to those areas under the Corcoran Clay considered to be unconfined (12,474 acres).
[3] Total Lower Aquifer within Joint GSP area is 69,019 acres and includes only those areas of the Madera Subbasin outside of RCWD GSA, GFWD GSA, and NSWD GSA.

Table 6-3. Total Calculated Change in Groundwater Storage in the Joint GSP Area.

Analysis Time Period	Average Groundwater Storage Change Per Acre (AF/acre)	Total Joint GSP Area (acres)	Total Groundwater Storage Change in Joint GSP Area (AF)[1]
Spring 2022-2023	0.23	325,834	75,228

[1] Total Joint GSP area is 325,834 acres and includes only those areas of the Madera Subbasin outside of RCWD GSA, GFWD GSA, and NSWD GSA.

6.2 GROUNDWATER USE AND CHANGE IN GROUNDWATER STORAGE

Annual groundwater extraction and change in groundwater storage in the Joint GSP area are shown in **Figure 6-5** for water years 2015 to 2023. Groundwater extraction is estimated or directly measured following the procedures described in Section 3. Change in groundwater storage is estimated based on an annual comparison of spring groundwater elevations following the procedure described in Section 6.1. Change in groundwater storage is not provided for water years 2015 and 2016, as there was insufficient historical data to accurately calculate change in storage those years. Historical groundwater extraction in water years 1989 through 2014 are shown in Section 2.2.3.4 of the Revised Joint GSP. Historical annual changes in groundwater storage and cumulative changes in storage are also shown in the Joint GSP (Revised Joint GSP Appendix D.1.b, pages A6.D-D-15 and A6.D-D-16). Historical changes in groundwater storage between 1989 and 2014 were calculated based on a water balance of the Madera Subbasin groundwater system using the MCSim numerical groundwater flow model (described in the Joint GSP). Total annual groundwater extraction decreases in wet years and increases in dry years, while the annual change in groundwater storage has fluctuated between approximately 75,000 AF and -186,000 AF since water year 2017 (**Figure 6-5**).

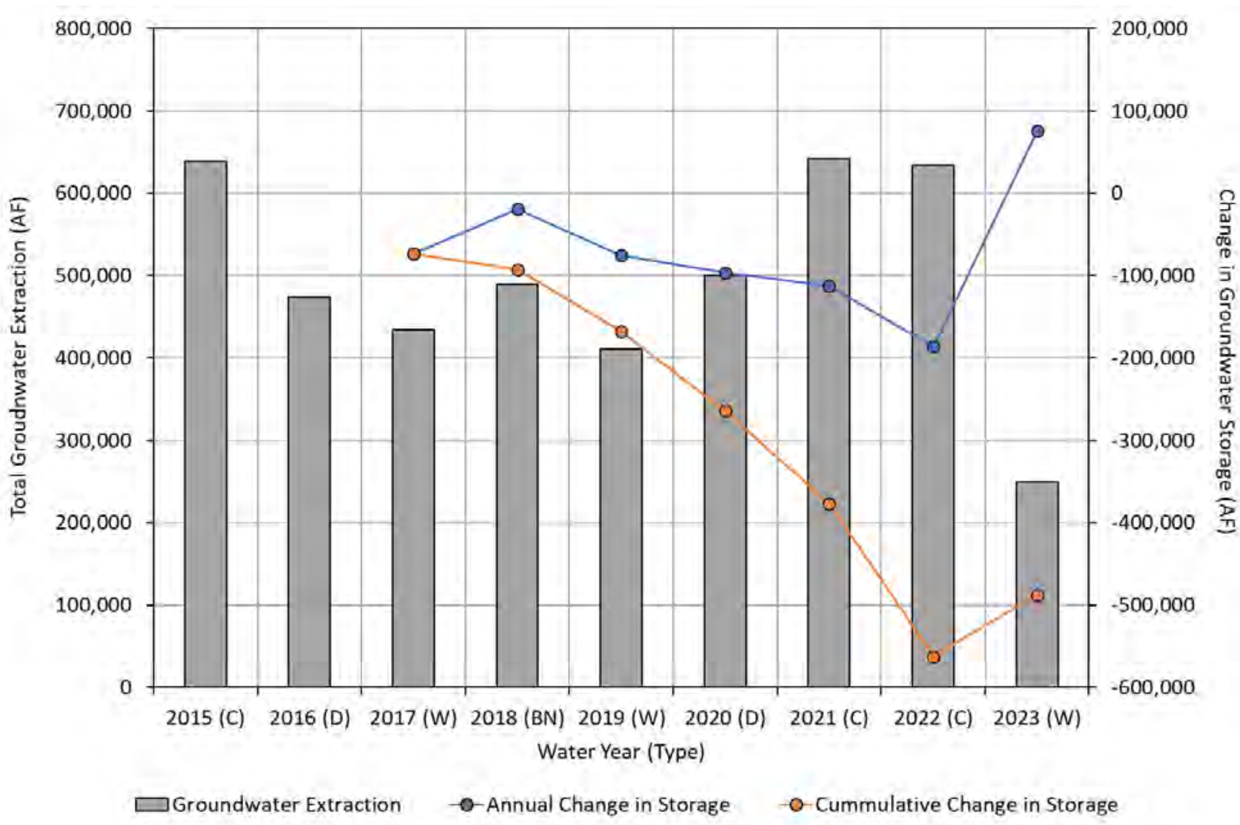


Figure 6-5. Annual Change in Groundwater Storage and Total Groundwater Extraction in the Joint GSP Area*.

**Information in 2023 is summarized from Table 6-3 (Total Groundwater Storage Change in Joint GSP Area) and Table 3-2 (Total Groundwater Extraction). Cumulative change in storage is calculated from 2023 data and information from earlier years, documented in prior Annual Reports.*

7 Groundwater Sustainability Plan Implementation Progress (§356.2.c)

7.1 IMPLEMENTATION OF PROJECTS AND MANAGEMENT ACTIONS (§356.2.C)

The implementation of projects and management actions (PMAs) is critical for achieving and maintaining groundwater sustainability, as described in the Joint GSP. PMAs are scheduled for implementation throughout the 2020 through 2040 GSP Implementation Period, with different timelines anticipated for implementation of each PMA. The estimated annual costs and benefits (i.e., increased groundwater recharge or reduced groundwater use) of PMAs proposed by the Joint GSP GSAs vary across the GSP Implementation Period, as described in the Joint GSP.

This section describes progress that has been made toward implementation of the Joint GSP and specific PMAs since the previous Annual Report. First, a brief overview is given regarding the progress toward implementation of the Domestic Well Mitigation Program as of early 2024. The remainder of this section describes the progress made in implementation of PMAs proposed by each of the Joint GSP GSAs.

7.1.1 Domestic Well Mitigation Program

A key element included and described in the Revised Joint GSP approved by DWR in December 2023 is a Domestic Well Mitigation Program 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 PMAs to achieve and maintain sustainability.

Between 2019-2022, the GSAs successfully completed an inventory of the domestic wells in the Madera Subbasin as a first step toward development of the Domestic Well Mitigation Program. The GSAs applied for and were awarded a Proposition 68 grant from DWR to conduct a domestic well inventory and install six new monitoring wells at two sites in the Madera Subbasin. The MC GSA applied for the grant on behalf of the Madera Subbasin and has led the project since its inception. After issuing a request for proposals and selecting a consultant, the domestic well inventory was conducted in 2021-2022 and final documentation of the inventory was completed in spring 2022 (Revised Joint GSP Appendix 2.G). The new nested monitoring wells were installed in 2022. In addition to an updated and more accurate domestic well inventory, information collected during this project from the drilling, geologic and geophysical logging, groundwater quality sampling, and automated groundwater level monitoring will continue to aid the GSAs in filling data gaps in the monitoring and conceptualization of the Madera Subbasin hydrogeology. The project will also improve understanding and management of groundwater in the Subbasin.

During and since the GSP revisions process, the GSAs within the Subbasin have proceeded with coordination and focused planning efforts to develop a Domestic Well Mitigation Program in the Subbasin. The Domestic Well Mitigation Program would provide assistance to domestic and municipal wells adversely impacted by declining groundwater levels that interfere with groundwater production or quality in the Subbasin, and would be coordinated with the Madera County SB 552 Drought Plan that is also under development. It is expected that the Domestic Well Mitigation Program would be implemented during the GSP Implementation Period, as needed, and continue until groundwater sustainability is achieved. After 2040, groundwater levels will stabilize at historical levels, avoiding undesirable results for groundwater users. As of early 2024, the GSAs are developing the Domestic Well Mitigation Program eligibility criteria, terms, and conditions and are preparing to move forward with implementation, as needed, no later than 2025. MC GSA has also secured grant funding to support the program. Additional information about the Domestic Well Mitigation Program is provided in the previous Annual Report. Further updates on program implementation will be reported in subsequent Annual Reports.

7.1.2 Summary of Projects and Management Actions

PMAs described in the GSP and in previous Annual Reports are listed and described in **Tables 7-1 through 7-4**, followed by a more detailed description of individual PMAs being implemented by each Joint GSP GSA. **Tables 7-1 and 7-2** provide an overview of each PMA from the Joint GSP, its implementation status, a description of activities planned to occur as part of that PMA, and updates on actual activities and actual benefits since implementation. The status of PMAs is generally defined as follows:

- **Implemented**: Active efforts to operate the project or management action have begun, though benefits may or may not have been achieved to date.
- **In Progress**: Active efforts needed to initiate the project or management action 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 project or management action have not begun.

Tables 7-3 and 7-4 summarize the actual project costs incurred through the current reporting year (water year 2023) and the estimated overall project costs. All estimated benefits and costs are summarized from the Joint GSP, while actual benefits and costs are presented only for those PMAs already in implementation. These tables provide a comparison of the actual and estimated costs and benefits of PMAs, as well as a measure of the degree of implementation for PMAs that will take multiple years to fully implement. It should be noted that the estimated benefits and costs were developed for full project implementation, not partial implementation.

Since GSP adoption, the GSAs have considered additional PMAs that may be implemented during the GSP Implementation Period. All additional PMAs will support the GSP sustainability goal and align with other GSP implementation efforts. Additional PMAs that are not described in the GSP or previous Annual Reports will be described in **Section 7.2** as they are identified.

This Annual Report covers the fourth full year of project implementation under the GSP. Wet conditions in 2023 allowed the GSAs to achieve substantial recharge benefits in the Subbasin. The GSAs have continued to make significant progress in implementing existing PMAs, as well as developing and implementing new PMAs.

The GSAs in the Madera Subbasin are committed to adaptive management of groundwater resources through this suite of identified PMAs. As PMAs are implemented and monitored, the project timelines and volume of demand management necessary will be reviewed. If adjustments are needed to meet the sustainability goal for the Subbasin, project timelines will be evaluated and adjusted. In addition to continuous monitoring and review of PMA implementation, each Annual Report represents an important milestone and opportunity to review the status of Joint GSP implementation efforts.

Table 7-1. Projects and Management Actions: Summary.

Groundwater Sustainability Agency (GSA)	Project / Management Action Name	Mechanism	First Year Implemented	Status	General Description
MID	Rehab Recharge Basins	Increase Recharge	2016	Implemented	Rehabilitate and upgrade recharge facilities, including metering.
MID/MC	Ellis Basin	Increase Recharge	2016	Implemented	Cooperatively operate Ellis Basin for recharge.
MID/CM	Berry Basin	Increase Recharge	2018	Implemented	Cooperatively operate Berry Basin for recharge.
MID	Allende Basin	Increase Recharge	2019	Implemented	Operate Allende Basin for recharge.
MID/CM	Additional Recharge Basins with City of Madera[1]	Increase Recharge	2021	Implemented	Cooperatively operate additional basins for recharge, including Golf Course Basin and Airport Basin.
MID	Additional Recharge Basins Phase 1	Increase Recharge	2021	Implemented	Construct and operate additional recharge basins.
MID	Additional Recharge Basins Phase 2	Increase Recharge	2023	In Progress	Construct and operate 260 acres of additional recharge basins.
MID	On-Farm Recharge	Increase Recharge	2015	Implemented	Deliver available flood water to agricultural or other suitable land for recharge.
MID	Phase 2 On-Farm Recharge	Increase Recharge	2023	Implemented	Expand delivery of available flood water to agricultural or other suitable land for recharge.
MID	MID Pipeline	Reduce evaporation and GW Pumping	2016	Implemented	Rehabilitate aging pipelines to reduce losses.
MID	WaterSMART Pipeline	Reduce evaporation and GW Pumping	2019	Implemented	Rehabilitate additional pipelines to reduce losses and allow MID to deliver water later in the irrigation season.
MID	WaterSMART SCADA	Reduce evaporation and GW Pumping	2019	Implemented	Expand SCADA to improve MID water management, reduce losses, and allow MID to deliver water later in the irrigation season.
MID	Water Supply Partnerships	Purchase water from willing partners outside of the basin to increase recharge or reduce GW pumping	2022	In Progress	Identify and purchase or exchange additional water supplies from partnering districts.
MID	Incentive Program	Encourage more use of district SW; Reduce GW pumping	2022	Implemented	Develop incentive structures to encourage growers to utilize surface water supplies instead of groundwater.
MID	Demand Reduction[1]	Reduce demand	2019	Implemented	Detach from MID or remove agricultural land from production.
MID	Grazing Land Annexation[1]	Increase Sustainable Yield	2020	Implemented	Annexation of grazing land to increase sustainable yield for the MID GSA.
MID	Water User Software Platform (UI)[1]	Education / Outreach	2020	Implemented	Software platform for MID landowners that provides information on current and historic water use.
MID	Intensive Groundwater Use Policy[1]	Reduce GW Pumping	2019	Implemented	Policy related to intensive groundwater use for a purpose other than agriculture.
MWD	Expanded Surface Water Purchase	Purchase water from willing partners in the basin to reduce GW pumping	2023	In Progress	Expand ability to purchase additional surface water supply, including upgrades to conveyance infrastructure.
CM	Meters and Volumetric Pricing	Reduce evaporation and GW Pumping	2015	Implemented	Install water meters and implement volumetric billing for single-family users to promote water conservation.
CM/MID	Berry Basin	Increase Recharge	2018	Implemented	Cooperatively operate Berry Basin for recharge.
CM/MID	Additional Recharge Basins[1]	Increase Recharge	2021	Implemented	Operate additional recharge basins in coordination with MID, including Golf Course Basin and Airport Basin. *This PMA was added to CM since adoption of the Joint GSP, although it is part of MID's planned PMAs.*
MC/MID	Ellis Basin	Increase Recharge	2016	Implemented	Cooperatively operate Ellis Basin for recharge.
MC	Water Imports Purchase	Purchase water from willing partners outside of the basin to increase recharge or reduce GW pumping	2025	In Progress	Develop partnerships and import additional water into Madera County for direct or in-lieu recharge.
MC	Millerton Flood Release Imports	Purchase water from willing partners outside of the basin to increase recharge or reduce GW pumping	2025	In Progress	Request CVP Section 215 flood water when available for recharge.
MC	Chowchilla Bypass Flood Flow Recharge Phase 1	Increase Recharge	2025	In Progress	Construct and operate diversion and conveyance facilities/basins to recharge an average of 12,700 AF/year.
MC	Chowchilla Bypass Flood Flow Recharge Phase 2	Increase Recharge	2040	In Progress	Construct and operate diversion and conveyance facilities/ basins to recharge an average of 25,000 AF/year.
MC	Demand Management	Reduce demand by limiting groundwater pumping	2020	In Progress	Reduce consumptive water use through actions such as water-stressing crops, shifting to lower water-using crops, reducing evaporation losses, and reducing irrigated acreage.
GFWD	Recharge Basin and Canals	Increase Recharge	2020	Implemented	Operate an existing basin to recharge surface water, from either purchased supplies or available as excess flow.
NSWD	Water Right Utilization	Divert flood flow from Chowchilla Bypass, existing water right	2020	Implemented	Utilize existing appropriative water right on Chowchilla Bypass to divert up to 15,700 AF/year of surface water.
RCWD	Purchase Water for In-Lieu Storage	Purchase water from in-basin partners to reduce GW pumping	2019	Implemented	Construct and operate conveyance facilities to import purchased surface water for irrigation.
RCWD	Holding Contracts	Divert flood flow from San Joaquin River, existing water right	2020	Implemented	Utilize holding contract right to divert an average of 9,840 AF of surface water per year from San Joaquin River.

Notes: 1. This PMA was added since adoption of the Joint GSP. It is expected that updates to this PMA will be moved to Section 7.2 in future Annual Reports.

Table 7-2. Projects and Management Actions: Implementation Updates and Benefits.

Groundwater Sustainability Agency (GSA)	Project / Management Action Name	First Year Implemented	Updates	2023 Annual Benefit (acre-feet/year)	Average Annual Benefit in Years with Benefits (acre-feet/year)	Estimated Average Annual Benefit at 2040[1] (acre-feet/year)
MID	Rehab Recharge Basins	2016	Recharged nearly 5,300 AF of water in 2023.	5,277	2,310	5,030
MID/MC	Ellis Basin	2016	MC completed recharge basin improvements and maintenance in 2022-2023. Continued operation is expected, although no recharge occurred in 2023.	0	150	240
MID/CM	Berry Basin	2018	Recharged more than 400 AF of water in 2023 (benefits are split between MID and CM).	221	340	20
MID	Allende Basin	2019	Recharged 4,967 AF of water in 2023.	4,967	2,700	1,050
MID/CM	Additional Recharge Basins with City of Madera	2021	More than 1,200 AF of water was recharge in 2023 in basins jointly operated by MID and CM (benefits are split between MID and CM).	632	632	632
MID	Additional Recharge Basins Phase 1	2021	Recharged more than 6,700 AF of water in 2023 using recharge basins developed in 2022.	6,753	6,750	5,470
MID	Additional Recharge Basins Phase 2	2023	Two parcels were acquired for a new recharge facility, totaling approximately 45 acres.	-	-	21,890
MID	On-Farm Recharge	2015	Wet conditions in 2023 allowed MID to offer landowners on-farm recharge opportunities throughout the year. Water was available at $10/AF and $0/AF to promote on-farm recharge (benefits are split between Phase 1/2).	19,161	11,080	510
MID	Phase 2 On-Farm Recharge	2023	MID has expanded the on-farm recharge program. Many more MID landowners are taking advantage of this opportunity when it is available. MID has also partnered with the NRCS for funding of projects related to on-farm recharge (benefits are split between Phase 1/2).	19,161	19,161	1,690
MID	MID Pipeline	2016	Ongoing implementation.	420	420	420
MID	WaterSMART Pipeline	2019	Ongoing implementation.	880	880	880
MID	WaterSMART SCADA	2019	Ongoing implementation.	1,230	1,230	1,230
MID	Water Supply Partnerships	2022	MID is currently working with other districts with Friant contracts to develop water supply partnerships.	0	50	3,990
MID	Incentive Program	2022	MID has continued implementing the Incentive Program as part of the On-Farm Recharge Program. In 2023, MID continued outreach and education to encourage use of available surface water. MID has also continued the pilot program with the NRCS, through which $1.5 million 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. MID has also offered an additional financial incentive of 15% of the project costs for basins as a future water purchase offset to incentivize landowners to recharge water. More than 25 parcels in MID have participated in recharge activities.	0	22,900	5,010
MID	Demand Reduction[2]	2019	MID acquired approximately 45 acres of irrigated parcels and took those out of production for conversion to recharge basins in 2023.. Benefits of the detachment of 320 acres from MID GSA and of conversion of 73 acres to recharge basins in earlier years are ongoing.	1,260	1,130	1,020
MID	Grazing Land Annexation[2]	2020	Benefits are ongoing.	206	206	206
MID	Water User Software Platform (UI)[2]	2020	Ongoing implementation.	-	-	-
MID	Intensive Groundwater Use Policy[2]	2019	Ongoing implementation.	-	-	-
MWD	Expanded Surface Water Purchase	2023	MWD purchased approximately 6,400 AF of surface water in 2023. MWD continues to pursue the required permits for the Madera Lake project.	4,283	2,370	2,810
CM	Meters and Volumetric Pricing	2015	CM proceeded with installation of 46 automatic meter reading (AMR) meters ranging from 3 to 10 inches.	250	3,400	3,350

Groundwater Sustainability Agency (GSA)	Project / Management Action Name	First Year Implemented	Updates	2023 Annual Benefit (acre-feet/year)	Average Annual Benefit in Years with Benefits (acre-feet/year)	Estimated Average Annual Benefit at 2040[1] (acre-feet/year)
CM/MID	Berry Basin	2018	Recharged more than 400 AF of water in 2023 (benefits are split between MID and CM).	221	343	20
CM/MID	Additional Recharge Basins[2]	2021	More than 1,200 AF of water was recharge in 2023 in basins jointly operated by MID and CM (benefits are split between MID and CM).	632	632	632
MC/MID	Ellis Basin	2016	MC completed recharge basin improvements and maintenance in 2022-2023. Continued operation is expected, although no recharge occurred in 2023.	0	153	240
MC	Water Imports Purchase	2025	Madera County requested a change in place of use in 2019 and has had multiple meetings with USBR.	-	-	3,610
MC	Millerton Flood Release Imports	2025	Madera County requested a change in place of use in 2019 and has had multiple meetings with USBR. Madera County has written a separate letter requesting Section 215 water to be available.	-	-	7,060
MC	Chowchilla Bypass Flood Flow Recharge Phase 1[3]	2025	Grant-funded work continued in 2023 to support planning and design of infrastructure for diversions, deliveries, and recharge of flood water from Millerton Reservoir and purchased water, although delays in CEQA and permitting occurred. MC GSA plans to move forward with permitting and CEQA-related efforts in 2024, followed by completion of design documents and initiation of the construction bid process. The MC GSA is also planning to submit a request for a grant agreement extension to support project completion.	-	-	3,900
MC	Chowchilla Bypass Flood Flow Recharge Phase 2[3]	2040	Grant-funded work continued in 2023 to support 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 plans to proceed with 30% and 60% designs in 2024, and initiate the permitting process thereafter.	-	-	36,500
MC	Demand Management	2020	MC GSA completed numerous actions toward implementation of demand management in 2023, including: development and enforcement of groundwater allocations and penalties; implementation of a demand measurement program and verification project; and development of land repurposing strategies, rules, and criteria through LandFlex funding. Initial data shows promising reductions in ETAW from actions in 2023. However, the precise costs and benefits of these demand management efforts are still being quantified and will be given in future reports.	-	-	90,000
GFWD	Recharge Basin and Canals	2020	*See GFWD Annual Report*			2,620
NSWD	Water Right Utilization	2020	*See NSWD Annual Report*			5,540
RCWD	Purchased Water for In-Lieu Storage	2019	*See RCWD Annual Report*			4,380
RCWD	Holding Contracts	2020	*See RCWD Annual Report*			9,840
Total				65,553	76,837	219,790

Notes:

1. Estimates developed for full project implementation. For PMAs described in the Joint GSP, the estimated average annual benefit at 2040 is summarized from the Joint GSP. Some PMAs have been modified since the Joint GSP was adopted, so these totals may not equal the totals reported in the GSP.
2. This PMA was added since adoption of the Joint GSP. It is expected that updates to this PMA will be moved to Section 7.2 in future Annual Reports.
3. Since the 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.

Table 7-3. Projects and Management Actions: Cost Summary, 2023.

Groundwater Sustainability Agency (GSA)	Project	First Year Implemented	Status	2023 Capital Cost ($)	Capital Cost to Date ($)	2023 Annual Operating Cost ($)
MID	Rehab Recharge Basins	2016	Implemented		$60,000	
MID/MC	Ellis Basin	2016	Implemented		$20,000	
MID/CM	Berry Basin	2018	Implemented		$20,000	
MID	Allende Basin	2019	Implemented		$200,000	
MID/CM	Additional Recharge Basins with City of Madera[1]	2021	Implemented			
MID	Additional Recharge Basins Phase 1	2021	Implemented		$2,158,000	
MID	Additional Recharge Basins Phase 2	2023	In Progress	$1,600,000	$1,600,000	
MID	On-Farm Recharge	2015	Implemented			
MID	Phase 2 On-Farm Recharge	2023	Implemented			
MID	MID Pipeline	2016	Implemented		$640,000	
MID	WaterSMART Pipeline	2019	Implemented			
MID	WaterSMART SCADA	2019	Implemented			
MID	Water Supply Partnerships	2022	In Progress			
MID	Incentive Program	2022	Implemented	$89,000	$151,000	
MID	Demand Reduction[1]	2019	Implemented		$12,000	
MID	Grazing Land Annexation[1]	2020	Implemented			
MID	Water User Software Platform (UI)[1]	2020	Implemented			
MID	Intensive Groundwater Use Policy[1]	2019	Implemented			
MWD	Expanded Surface Water Purchase	2023	In Progress			
CM	Meters and Volumetric Pricing	2015	Implemented	$972,046	$1,253,906	
CM/MID	Berry Basin	2018	Implemented			
CM/MID	Additional Recharge Basins[1]	2021	Implemented		$50,000	-[2]
MC/MID	Ellis Basin	2016	Implemented			
MC	Water Imports Purchase	2025	In Progress			
MC	Millerton Flood Release Imports	2025	In Progress			
MC	Chowchilla Bypass Flood Flow Recharge Phase 1	2025	In Progress		$257,000	
MC	Chowchilla Bypass Flood Flow Recharge Phase 2	2040	In Progress			
MC	Demand Management	2020	In Progress			
GFWD	Recharge Basin and Canals		Implemented	*See GFWD Annual Report*		
NSWD	Water Right Utilization		Implemented	*See NSWD Annual Report*		
RCWD	Purchased Water for In-Lieu Storage		Implemented	*See RCWD Annual Report*		
RCWD	Holding Contracts		Implemented	*See RCWD Annual Report*		

Notes:

1. This PMA was added since adoption of the Joint GSP. It is expected that updates to this PMA will be moved to Section 7.2 in future Annual Reports.
2. Capital costs reported by MID. CM will maintain the Golf Course Basin, which will be reported in future annual operating costs.

Table 7-4. Projects and Management Actions: Cost Summary, Estimated Total.

Groundwater Sustainability Agency (GSA)	Project	First Year Implemented	Status	Estimated Capital Cost[1] ($)	Estimated Average Annual Operating Cost[1] ($/year)
MID	Rehab Recharge Basins	2016	Implemented	$60,000	$430,000
MID/MC	Ellis Basin	2016	Implemented	$20,000	$20,000
MID/CM	Berry Basin	2018	Implemented	$20,000	$0
MID	Allende Basin	2019	Implemented	$200,000	$70,000
MID/CM	Additional Recharge Basins with City of Madera[2]	2021	Implemented	-	-
MID	Additional Recharge Basins Phase 1	2021	Implemented	$1,000,000	$240,000
MID	Additional Recharge Basins Phase 2	2023	In Progress	$14,200,000	$3,750,000
MID	On-Farm Recharge	2015	Implemented	$0	$50,000
MID	Phase 2 On-Farm Recharge	2023	Implemented	$0	$190,000
MID	MID Pipeline	2016	Implemented	$560,000	$0
MID	WaterSMART Pipeline	2019	Implemented	$1,300,000	$0
MID	WaterSMART SCADA	2019	Implemented	$1,200,000	$0
MID	Water Supply Partnerships	2022	In Progress	$0	$2,500,000
MID	Incentive Program	2022	Implemented	$0	$3,080,000
MID	Demand Reduction[2]	2019	Implemented	$12,000	$110,000
MID	Grazing Land Annexation[2]	2020	Implemented	-	-
MID	Water User Software Platform (UI)[2]	2020	Implemented	-	-
MID	Intensive Groundwater Use Policy[2]	2019	Implemented	-	-
MWD	Expanded Surface Water Purchase	2023	In Progress	$14,900,000	$900,000
CM	Meters and Volumetric Pricing	2015	Implemented	$11,000,000	$0
CM/MID	Berry Basin	2018	Implemented	$20,000	$0
CM/MID	Additional Recharge Basins[2]	2021	Implemented	$50,000	-
MC/MID	Ellis Basin	2016	Implemented	$20,000	$20,000
MC	Water Imports Purchase	2025	In Progress	$300,000	$2,490,000
MC	Millerton Flood Release Imports	2025	In Progress	$31,900,000	$450,000
MC	Chowchilla Bypass Flood Flow Recharge Phase 1[3]	2025	In Progress	$6,600,000[3]	$800,000[3]
MC	Chowchilla Bypass Flood Flow Recharge Phase 2[3]	2040	In Progress	$103,600,000[3]	$700,000[3]
MC	Demand Management	2020	In Progress	$0	$53,900,000[4]
GFWD	Recharge Basin and Canals	2020	Implemented	*See GFWD Annual Report*	
NSWD	Water Right Utilization	2020	Implemented	*See NSWD Annual Report*	
RCWD	Purchased Water for In-Lieu Storage	2019	Implemented	*See RCWD Annual Report*	
RCWD	Holding Contracts	2020	Implemented	*See RCWD Annual Report*	
Total				$186,962,000	$69,700,000

Notes:

1. Estimates developed for full project implementation. These totals may not equal the totals reported in the Joint GSP, as certain projects have been added or revised since initial GSP development. The Joint GSP GSAs remain committed to adaptive management of PMAs to ensure long-term sustainable management of the Subbasin. The estimated costs of new PMAs are estimated to be equal to the costs in the Annual Report, if specified.
2. This PMA was added since adoption of the Joint GSP. It is expected that updates to this PMA will be moved to Section 7.2 in future Annual Reports.
3. Since the Joint GSP was adopted, the Chowchilla Bypass Flood Flow Recharge Project Phases 1 and 2 have been reconfigured 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 total capital cost of $6.6 million and an estimated annual operating cost of $800,000. Phase 2 now corresponds to Projects 2 through 5, with a revised total capital cost of $103.6 million and an estimated annual operating cost of $700,000. The total combined capital cost of these projects is $110.2 million, which is the cost that is being considered during development of the rate study. These costs have been refined from the initial costs identified during GSP development.
4. Costs represent the estimated average annual direct economic costs of demand management, based on the economic impact analysis of the demand management program (see Section 4.4.4.5 of the Joint GSP).

7.1.3 Madera Irrigation District GSA Projects and Management Actions

MID GSA has implemented the majority of the PMAs it planned in the Joint GSP since January 2020, and has begun implementing additional PMAs identified since initial GSP adoption to support groundwater sustainability. The average annual benefits of PMAs currently implemented by MID are shown in **Table 7-2** for water year 2023. In total, MID's PMAs resulted in approximately 61,000 AF of benefits to the Subbasin in 2023.

7.1.3.1 Recharge Basins and On-Farm Recharge

Sixteen dedicated recharge basins are now being utilized by MID, including those operated in partnership with other GSAs. Of this total, six are operated together with the CM GSA (Berry Basin, Golf Course Basin, and four additional City Basins) and one is operated together with the MC GSA (Ellis Basin). MID operates the remaining basins, including the Allende Basin, Madera Lake, and other dedicated recharge facilities developed since GSP adoption. Among the new facilities are recharge basins developed in 2022 on three parcels that MID acquired and took out of agricultural production in 2021, totaling approximately 73 acres. These basins were successfully used for recharge in 2023. In 2023, MID also acquired an additional two parcels for a new recharge facility, totaling approximately 45 acres and costing approximately $1.6 million. The new recharge facility is a component of MID's "Additional Recharge Basins Phase 2" project, which MID is beginning to implement ahead of schedule (implementation was expected by 2040 in the GSP).

Wet conditions in 2023 facilitated substantial recharge in fifteen of the recharge basins in 2023. In total, approximately 18,700 AF of surface water was delivered across all fifteen basins in 2023, including 1,705 AF of surface water in CM-partner basins (benefits are split equally between MID GSA and CM GSA). MID pays for the water recharged as well as the O&M of the MID-owned and operated recharge facilities. MID plans to continue operating all recharge basins in future years when surface water is available.

In years when sufficient water is available, MID continues to administer an on-farm recharge program. Wet conditions in 2023 allowed MID to offer landowners on-farm recharge opportunities throughout the year. Water was available at $10/AF and $0/AF to promote on-farm recharge. The estimated benefits of on-farm recharge in 2023 was approximately 38,000 AF. MID has already begun implementation of phase 2 of the on-farm recharge program. Many more MID landowners are taking advantage of on-farm recharge opportunities when they are available.

MID has also partnered with the Natural Resources Conservation Service (NRCS), which has made pilot program funds available in MID for recharge projects such as on-farm recharge, recharge basins, or other supporting practices (described further below, see Incentive Program). These efforts are two years ahead of schedule. Updates on these efforts will be reported in future Annual Reports.

7.1.3.2 Infrastructure Upgrades

MID's WaterSMART SCADA and WaterSMART pipeline projects continued to be implemented in 2023. Both projects are helping to improve MID's water management, reduce system losses, and enhance flexibility of surface water deliveries to growers who would otherwise use groundwater. Since 2021, MID has also benefitted from the replacement of 5,350 feet of aging pipelines within the district's system. Infrastructure improvements have resulted in cumulative average annual benefits to date of more than 2,500 AF per year.

MID has also continued its partnership with the NRCS and U.S. Department of Interior's WaterSMART Initiative, which designated MID as a priority area in the western U.S. Funding has been made available to MID landowners through the program, including $1.5 million in 2022 and another $2.4 million in fall 2023. Landowners in MID can apply for these funds through the NRCS to support conservation practices and infrastructure improvements such as irrigation water management, irrigation pipelines, structures for water control, pumps, micro irrigation systems, cover crops, and additional practices. Updates on these efforts will be reported in future Annual Reports.

7.1.3.3 Water Supply Partnerships

MID has also continued work to develop water supply partnerships with partners outside of the Madera Subbasin. Efforts to import surface water supplies are being coordinated with other districts that have contracts for supplies from Friant Dam. Updates on these efforts will be reported in future Annual Reports.

7.1.3.4 Demand Reduction

In addition to these PMAs, MID has continued with demand reduction by: annexing rangeland into MID; acquiring more than 110 acres of irrigated land for conversion to new recharge basins (described above), effectively removing those lands from production; and detaching 320 acres from the GSA.

7.1.3.5 Incentive Program

As part of the on-farm recharge program, MID has also continued implementing an incentive program to encourage growers to use surface water when it is available. Outreach remains a major component of the incentive program. MID has encouraged landowners to continue installing and using turnouts by educating and explaining the benefits of surface water use.

As described above, MID has partnered with the NRCS 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. MID has conducted public outreach and workshops to promote program participation within MID. MID has also continued its support of the program by offering an additional financial incentive of 15% of the project costs for basins as a future water purchase offset to incentivize landowners to participate and utilize surface water in the future. The program has been a success, with more than 25 parcels in MID participating in recharge activities. Approximately $89,000 in program costs have been incurred by MID.

7.1.3.6 Other Activities

In 2023, MID continued implementing the intensive groundwater use policy that supports the goals of the incentive program and the overall sustainability goal established in the Joint GSP.

Other tools and policies reported in previous Annual Reports, including the Water User Software Platform, are still in effect with ongoing benefits.

7.1.4 Madera Water District GSA Projects and Management Actions

MWD GSA has continued work to implement the expanded surface water purchase project proposed in the Joint GSP. In 2023, MWD purchased and delivered more than 6,400 AF of surface water to its customers, offsetting groundwater demand and providing recharge benefits. As surface water is available, MWD plans to continue purchasing additional surface water each year to facilitate in-lieu recharge and preserve groundwater supplies.

As part of the expanded surface water purchase project, MWD also continues to move forward on the Madera Lake Project. MWD has circulated California Environmental Quality Act (CEQA) documents and has initiated the various permitting processes required for project implementation through the USACE, Regional Water Quality Control Board, the California Department of Fish & Wildlife. Permitting processes have continued in 2023.

7.1.5 City of Madera GSA Projects and Management Actions

The CM GSA has continued efforts on a project to install water meters and implement a volumetric billing process for single-family users to promote water conservation. Following approval of Madera's Proposition 1 Round 1 Integrated Regional Water Management (IRWM) grant agreement in 2021, the CM has proceeded with actions to install meters on the remaining unmetered services and to replace failing meters on higher volume services. In 2021-2022, the CM GSA identified 646 residential, industrial, commercial, and institutional locations to be metered and prepared plans, specifications, and estimates (PS&Es) for installation. In 2023, the CM GSA proceeded with installation of 46 automatic meter reading (AMR) meters ranging from 3 to 10 inches. In addition to the average annual project benefits to the Madera Subbasin of 3,350 AF per year, project implementation in 2023 has achieved an estimated 250 AF of additional benefits, resulting in total estimated benefits of 3,600 AF. The capital cost incurred for project implementation in 2023 was approximately $972,000.

As described above, MID and the CM have also continued working cooperatively to operate and develop several recharge basins. As of 2023, six recharge basins are operated cooperatively by MID and the CM, including the Berry Basin, the Golf Course Basin, and four additional City Basins. Wet conditions in spring 2023 facilitated substantial recharge in the basins, totaling 1,705 AF in water year 2023 (benefits are split equally between MID GSA and CM GSA).

7.1.6 Madera County GSA Projects and Management Actions

Since adoption of the 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 initiated work to support the implementation and enforcement of a substantial demand management program. Adaptive implementation of PMAs will collectively support achievement of the Subbasin sustainability goal over the GSP Implementation Period. Progress that has been made in each of these efforts is described below.

7.1.6.1 Funding for GSP Implementation

The MC GSA collects an administrative fee of approximately $24 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.

In 2022, a Proposition 218 process was completed that led to approval of an acreage-based rate for extraction of groundwater within the MC GSA in the Subbasin (under Madera County Resolution 2022-086). The rate was intended to fund implementation of PMAs. However, following a preliminary injunction issued by the Madera County Superior Court in December 2022, the MC GSA is ordered to restrain from imposing and/or collecting any fees, rates, and/or GSP project fees enacted under Madera County Resolution 2022-086 against landowners in the Madera Subbasin. The preliminary injunction remains in place as of early 2024. Updates regarding the injunction will be provided in future Annual Reports.

In 2022, the MC GSA also approved a penalty for groundwater extraction above the allocation that is being imposed as of 2023 (described below). Funds generated from these penalties are also available to support GSP implementation moving forward, as directed by the GSA Board.

In addition to these efforts, the MC GSA continues to utilize Proposition 68 funding for PMA implementation through two grants. This funding is currently being used to support design, permitting, and construction of a portion of the Chowchilla Bypass Flood Flow Recharge Program (described below). The MC GSA in the Madera Subbasin also received a grant for $9.3 million from DWR for LandFlex, in coordination with the California Department of Food and Agriculture. This funding is being used to support the Voluntary Land Repurposing Program (described below).

7.1.6.2 Recharge Projects

Since 2016, the MC GSA has operated the Ellis Basin for recharge in partnership with MID GSA. MC has worked on various site improvements since 2022 to improve future operation of the Ellis Basin. CM conducted maintenance in 2023 to remove sediment and improve drainage. Site improvements are ongoing, and MC plans to continue operation of the Ellis Basin project for recharge, although no recharge occurred in 2023.

MC has also continued work on a recharge planning study to refine the costs, benefits, and schedule for recharge projects described in the GSP. The recharge planning study has refined the costs and schedule for constructing additional basins and to conduct additional flood managed aquifer recharge (Flood-MAR) of winter floodwater. This study has resulted in the development of the Chowchilla Bypass Flood Flow Recharge Program. A description of the recharge study and planned recharge efforts is available at: https://www.maderacountywater.com/recharge/. In 2023, the MC GSA continued public outreach and engagement for the recharge program, including outreach regarding Executive Order (EO) N-4-23 which allows for flood waters to be used for groundwater recharge in certain circumstances. Planned recharge efforts are coordinated together with the emergency recharge plan (described in **Section 7.2**, below).

Since 2020, the MC GSA has continued design efforts, permitting, and construction for portions of the Chowchilla Bypass Flood Flow Recharge Program. These efforts are being funded by two Proposition 68 grants from DWR, which were based on work developed through the recharge planning study.

In 2021, the first grant proposal was awarded more than $4 million total from Proposition 68 funds. As of early 2024, those funds are being used toward planning, design, and construction of diversion, conveyance, and recharge infrastructure that will supply flood water for Flood-MAR activities on farmland in MC GSA. The recharge sites were surveyed in early 2022, and 60% designs were completed and reviewed by participating landowners in mid- to late-2022. CEQA and permitting efforts were slated to begin in 2023, following successful completion of the necessary field work and permit preparation work. However, the project was ultimately delayed during coordination efforts between the participating GSAs. As of early 2024, MC GSA plans to continue moving forward with the project. CEQA and permitting applications are expected to be submitted in 2024, shortly after the project is re-initiated. The MC GSA is pursuing a CEQA exemption in accordance with EO N-7-22 Action 13, and will coordinate permitting efforts with the California Department of Fish and Wildlife (CDFW), the National Marine Fisheries Service (NMFS), the United States Fish and Wildlife Service (USFWS), the Lower San Joaquin Levee Control District, and others as applicable. Following successful completion of all required permitting, the MC GSA anticipates completing the 100% design documents and initiating the construction bid process. The MC GSA is also planning to submit a request for a grant agreement extension to support project completion. This project has been developed in close coordination with RCWD GSA and landowners in the MC GSA who offered their farmland for recharge. When completed, this project will utilize flood flows from Millerton Reservoir and purchased water to provide direct or in-lieu recharge benefits to the Madera Subbasin.

In 2022, the second grant proposal was awarded approximately $500,000 from Proposition 68 funds as part of Round 1 of the 2022 SGMA Implementation Grant program. Those funds are being used to plan, design, and construct additional recharge facilities along the Chowchilla Bypass, expanding on work being developed through the first grant. As of early 2024, conceptual plans have been developed for a new project location, after earlier efforts to coordinate with landowners on the Chowchilla Bypass stalled and led MC GSA to pivot and re-design the recharge project downstream of the initial project location. The project approach remains the same despite the relocation, and is anticipated to include a recharge basin and infrastructure to support Flood-MAR. The MC GSA plans to proceed with 30% and 60% designs in 2024, and initiate the permitting process thereafter.

The rate study that the MC GSA completed and approved in 2022 is also intended to fund implementation of the recharge program, among other GSP PMAs, over the GSP Implementation Period. However, due to the injunction, local funding to implement the PMAs in the GSP is currently on hold.

In addition to the recharge efforts above, MC GSA is also currently working on the Fairmead Groundwater Resilience Project and has received approximately $180,000 in grant funding as part of the California Resilience Challenge to support that effort. As of early 2024, concept plans for recharge projects have been developed, including options for direct recharge, in-lieu recharge, and a multi-benefit recharge project incorporating a recharge basin into community recreational facilities. A monitoring framework is currently in development. MC GSA has held several meetings with the community throughout this process to collect feedback and to guide project development.

7.1.6.3 Water Imports

In addition to the recharge efforts described above, the MC GSA is also in the process of developing partnerships to import additional water into Madera County and to acquire CVP Section 215 flood water when it is available for recharge. MC GSA requested a change in place of use in 2019 and has since had multiple meetings with USBR. MC GSA has written a separate letter requesting Section 215 water to be available.

7.1.6.4 Demand Management

As a primary element of its efforts to achieve groundwater sustainability, MC GSA has 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. By 2040, this program is expected to result in approximately 50% reduction of estimated current consumptive use quantities as of 2015. The precise costs and benefits of these demand management efforts are still being quantified and are expected to be reported in the 2025 Joint GSP evaluation and updates, as well as future Annual Reports.

To implement this overall demand management program, MC GSA has:

- Conducted a water market study (completed in 2021),
- Implemented a Voluntary Land Repurposing Program (VLRP),
- Developed an allocation framework, and
- Continued implementing a demand measurement program and verification project.

The following sections briefly describe the VLRP, the allocation framework, and the demand measurement program and verification project.

Voluntary Land Repurposing Program (VLRP). Since initial GSP development, the MC GSA received grant funding to explore the feasibility of adopting a sustainable agricultural land conservation (SALC) easement program within the MC GSA. The SALC program has since been referred to as the Voluntary Land Repurposing Program (VLRP). 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.

MC has developed the VLRP through a stakeholder-driven process in 2020-2022, involving multiple public workshops and meetings, stakeholder interviews, and outreach with conservation groups. Details about this process are documented in previous 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.

As described above, the MC GSA in the Madera Subbasin was awarded a $9.3 million grant from DWR in 2022 for LandFlex, in coordination with the California Department of Food and Agriculture. This funding is being used to support implementation of the VLRP, and has already resulted in removal of nearly 70 acres of irrigated agricultural land from production. The MC GSA is working to incorporate this information into implementation of the allocation framework (described below) to ensure that participating landowners are receiving credit for land fallowing under the VLRP. As of early 2024, MC is also completing a plan for land repurposing projects through the Multi-Benefit Land Repurposing Program.

The rate study that the MC GSA completed and approved in 2022 was intended to fund implementation of the VLRP, among other GSP PMAs over the GSP Implementation Period. However, due to the injunction, local funding to implement the PMAs in the GSP is currently on hold.

Additional information about the VLRP and the Multi-Benefit Land Repurposing Program is available on the Madera County website: https://www.maderacountywater.com/multibenefit-land-repurposing-program/.

Allocation Framework. Since initial GSP development, the MC GSA has developed a groundwater allocation framework. The allocation framework was developed primarily by MC GSA staff through a series of public meetings with the MC GSA Advisory Committee. Following discussions in these meetings, the MC GSA Board of Directors adopted resolutions in December 2020, June 2021, and August 2021 that describe "per-acre" allocations and rules for credits. The MC GSA Board of Directors approved penalties for groundwater use in excess of these allocations in 2022. Links to the resolution documents are provided in the previous Annual Report.

Beginning in calendar year 2023, the allocations and associated penalties are being enforced in the MC GSA (within the Chowchilla, Madera, and Delta-Mendota Subbasins) through measurements of groundwater use by approved measurement methods (described in the following section). MC GSA has included certain refinements to the framework, allowing “farm units” (i.e., fields irrigated from the same well that are grouped and considered together in enforcement of the allocation) to be changed at the end of the calendar year, and allowing never-irrigated lands to opt-in in November of each year. MC GSA is in the process of developing a recharge policy that would credit recharge benefits to the allocation of areas where recharge occurred. As of early 2024, MC GSA has also developed recharge credit policies that would credit recharge benefits to the allocation of areas where recharge occurred. MC GSA recently approved two policies: one related to recharge with surface water that is purchased, and one related to recharge with water taken under EO N-4-23. 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. Additional information about the allocation enforcement process is described as part of the demand measurement program and verification project, below.

The penalties for exceeding the allocation begin at $100 per AF for farm units in calendar year 2023, potentially increasing by $100 per AF per year if exceedance continues, up to a maximum of $500 per AF for the total volume extracted in excess of the authorized amount.

Demand Measurement Program and Verification Project. MC GSA has continued to implement the demand measurement program in partnership with 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.

The main objective of the demand measurement program is to use the IrriWatch program to track ETAW against an allocation established in the MC GSA area (described in the previous section). Through the IrriWatch program portal, both the MC GSA and individual growers can track ETAW against the allocation. IrriWatch provides additional benefits to growers by providing information about the irrigation status of fields and irrigation recommendations, which can also be accessed remotely through a cell phone application. This information, together with the allocation, supports grower decision-making on the timing and amounts of irrigation.

Between 2020-2022, the MC GSA hosted trainings to inform growers about the program and then conducted two test years with IrriWatch. All irrigated parcels in the MC GSA have been auto-enrolled in the program.

Since 2023, the MC GSA is tracking groundwater use to enforce the approved allocations (described in the previous section). Three approved demand measurement options are available to growers in the MC GSA for allocation enforcement:

- IrriWatch approach
- Land IQ approach (similar to the IrriWatch approach, quantifying ETAW from land use and satellite imagery)
- Use of approved flowmeters

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 flowmeters. MC GSA expects to reevaluate measurement options for the program moving forward in 2025.

As of early 2024, MC GSA has developed and approved recharge credit policies that would credit recharge benefits to the allocation of areas where recharge occurred. MC GSA is also working to incorporate information from the VLRP (described above) into enforcement of the allocation to ensure that participating landowners are receiving credit for land fallowing under the VLRP. Enforcement of the allocation is incorporating adjustments to account for recharge credits, land fallowing credits, and successful appeals in the future.

In 2022-2023, the MC GSA also conducted the Madera Verification Project to analyze the consistency of applied water measurements from flowmeters to the ETAW 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 provided in the previous Annual Report.

Additional information on the demand measurement program is available on the Madera County website: https://www.maderacountywater.com/measurement/.

Demand Management. Through these many interrelated efforts, the MC GSA is in the process of implementing the planned demand management program described in the GSP. This management action is expected to result in a large reduction in groundwater pumping at the cost of reduced crop production and related economic activities in Madera County. MC GSA has observed landowner responses to the demand management program thus far, and initial data is showing promising reductions in ETAW from actions in 2023. However, the precise costs and benefits of these demand management efforts are still being quantified and are expected to be reported in the 2025 Joint GSP evaluation and updates as well as future Annual Reports.

7.1.6.5 Additional Roles

Although neither projects nor management actions, there are number of actions that the MC GSA has taken towards sustainability of the Madera Subbasin:

1. MC GSA staff serves as the plan manager for the Joint GSP;
2. MC GSA serves as the grantee and administrator for several active grants, including Proposition 1 and Proposition 68 grants (RCWD GSA serves as the grantee and administrator for the Proposition 68 grant awarded in early 2022); and
3. MC GSA serves as the contractor with the consultant for the data management system, the Annual Report, the GSP revisions process, and the basin point of contact.

7.1.7 Other Projects and Management Actions in the Madera Subbasin

GFWD, NWSD, and RCWD are implementing PMAs in the Madera Subbasin with aggregated gross average annual benefits estimated in their respective GSP Annual Reports. More information about the costs and implementation status of these PMAs can be found in each of their Annual Reports.

7.2 ADDITIONAL PROJECTS AND MANAGEMENT ACTIONS IDENTIFIED SINCE GSP ADOPTION

Since GSP adoption, the Joint GSP GSAs have also developed additional PMAs to support GSP efforts.

7.2.1 Jointly Implemented Projects

In addition to the ongoing development of recharge projects proposed in the Joint GSP, the MC GSA has initiated work on an emergency recharge plan to achieve more immediate recharge benefits from flood flows available on the Chowchilla Bypass. Under this plan, MC GSA has worked collaboratively with others in the Subbasin to secure temporary water rights and develop a plan for installation of temporary infrastructure to divert flood flows off the Chowchilla Bypass to the extent they are available ahead of construction of permanent infrastructure. In winter 2021-2022, MC GSA initiated the environmental permitting for the points of diversion available for use as part of the emergency recharge plan. In 2022, Madera County continued development of the plan, including development of a draft technical memorandum to provide guidance for landowners participating in groundwater recharge through diversion of water from the Chowchilla Bypass, whether under the emergency recharge program or other efforts. In 2023, substantial recharge occurred under the provisions of Executive Order N-4-23 and Senate Bill 122, which have opened the door to implementing recharge of flood waters in certain circumstances, in absence of an approved water right.

In addition to these GSA-led efforts, multiple recharge efforts are being led in the Subbasin by private entities. The GSAs will continue collaborating and working with locals in the Subbasin to implement recharge efforts in the future.

7.2.2 Other GSA Projects and Management Actions

Additional information about other GSA PMAs will be added to future Annual Reports as they are identified.

7.3 IMPLEMENTATION OF MONITORING AND ADDRESSING DATA GAPS

During the period of GSP development and since the GSP adoption and submittal in January 2020, the GSAs have been conducting monitoring of RMS wells, including coordination with well owners and other monitoring entities. Despite multiple attempts at measurement, some RMS water level data were not available in 2023 due to continued challenges encountered during implementation of the RMS monitoring program. Loss of access to certain RMS sites has persisted for a variety of reasons, such as owners' unwillingness to participate in monitoring, or replacement of a site with another well having slightly different characteristics. The GSAs have worked to resolve these issues where possible, and are continuing to work to resolve these access issues during 2024. In addition, a comprehensive review and update of the RMS network has been planned as part of the 5-Year Update of the Joint GSP (see **Appendix E**).

The GSAs have also begun work to install new dedicated nested monitoring wells that may be added to the monitoring network. As part of a Proposition 1 DWR Sustainable Groundwater Management grant award to the Madera Subbasin for the installation of dedicated monitoring wells in the Madera Subbasin, a total of 21 new monitoring wells at seven different sites were constructed in 2019 and 2020. Some additional funds from Proposition 68 were allocated toward installation of additional monitoring wells, which were installed at two new sites in 2022. Information collected from the drilling, geologic and geophysical logging, groundwater quality sampling, and automated groundwater level monitoring is filling data gaps in the monitoring and conceptualization of the hydrogeology and will improve understanding and management of groundwater in the Madera Subbasin. Groundwater level data from these monitoring wells were incorporated into groundwater elevation contour maps prepared for this Annual Report.

Although the various new dedicated monitoring wells are not yet formally included in the Joint GSP RMS well monitoring network, the GSAs may add those new dedicated nested monitoring wells to the Joint GSP monitoring network once more data is collected and site-specific sustainable management criteria can be appropriately established. If added to the monitoring network, these sites may be added in addition to current RMS wells or may be added in place of sites with access issues.

7.4 INTERIM MILESTONE STATUS (§356.2.C)

7.4.1 Chronic Lowering of Groundwater Levels

In the Revised Joint GSP, interim milestones (IMs) for chronic lowering of groundwater levels were established at five-year intervals over the Implementation Period from 2020 to 2040, at years 2025, 2030, and 2035. IMs for groundwater levels were established through review and evaluation of measured groundwater level data and future projected fluctuations in groundwater levels utilizing the numerical groundwater flow model, which simulated implementation of PMAs. The lowest interim milestone was set for 2030 based on the lowest model groundwater elevations expected to occur during the GSP implementation period, while accounting for a small amount of hydrologic variability and operational flexibility with a 10-foot buffer. Where necessary, adjustments were made to account for occasional offsets between historically observed and modeled data.

MOs for groundwater levels were established in accordance with the sustainability goal and to provide estimates of the expected groundwater level variability due to climatic and operational variability. MOs for groundwater levels were set at Fall 2010 groundwater levels based on observed data when available. If observed data were not available, the Fall 2010 groundwater level was based on modeled results, modified if necessary, to account for offset between historically observed and modeled groundwater levels.

The 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 minimum thresholds (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” (354.28.c.1). Chronic lowering of groundwater levels in the Plan area is determined in the Joint GSP 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 use(s) where alternative means of obtaining sufficient groundwater resources are not technically or financially feasible.

Table 7-5 and **Figures 7-1 and 7-2** present the status of groundwater level RMS wells in relation to the 2025 IMs, MOs, and MTs defined in the GSP. Note that there are some RMS wells that do not have Fall 2023 measurements to compare with IMs, MOs, and MTs. GSA efforts to bring in the remaining RMS wells listed in the GSP are ongoing; the status of monitoring efforts to date is provided in **Appendix E**. Review of the Fall 2023 groundwater level measurements that are available for 18 RMS wells (measurements were available for 22 RMS wells, but 3 were flagged as questionable) indicates that groundwater elevations are generally below MTs, with the exceptions of MCE RMS-3 and MWD RMS-1, while all groundwater elevations are above the 2025 IMs. The IMs developed in the Joint GSP are dependent on the future assumed climatic and surface water hydrology conditions that started with the 2019 water year. Groundwater levels are a function of the sequence and magnitude of wet and dry years applied as part of the projected/future hydrology leading up to 2025 as well as the gradual implementation of PMAs. Thus, it is important to understand that groundwater elevations are anticipated to fluctuate above and below the IMs in the years leading up to 2025; and no conclusions should be drawn regarding comparison to 2025 IMs based on only the current year of data. It is notable that 2020 through 2022, the first three years of the Joint GSP implementation period, were very dry years in the Madera Subbasin, while 2023 was a very wet year. Dry conditions have impacted groundwater levels relative to IMs in some areas. Additionally, some measurements may be impacted by local pumping occurring at the time the measurement is collected. A more detailed analysis of observed groundwater levels vs. IMs will be performed for the five-year update report that coincides with the first five-year IMs established in the Joint GSP.

Table 7-5. Summary of RMS Well Groundwater Levels Relative to Interim Milestones, Minimum Thresholds, and Measurable Objectives.

RMS Well I.D.	Estimated Surface Elevation[1] (msl, feet)	Aquifer Designation	2025 Interim Milestone GWEL (feet, AMSL)	MT GWEL (feet, AMSL)	MO GWEL (feet, AMSL)	Fall 2023 GWEL (feet, AMSL)	Date of Fall Measurement	2025 IM Status (feet)	MT Status (feet)
COM RMS-1	278	Lower	-9	37	66	30.11	11/6/2023	+39.11	-6.89
COM RMS-2	262	Lower	-33	36	36	14.03	11/14/2023	+47.03	-21.97
COM RMS-3	264	Lower	-22	10	74	NM[2]	11/16/2023		
MCE RMS-1	332	Lower	-31	26	82	NM[2]	10/31/2023		
MCE RMS-2	378	Composite	49	105	117	67.04	10/31/2023	+18.04	-37.96
MCE RMS-3	327	Composite	-43	7	64	24.97	10/31/2023	+67.97	+17.97
MCE RMS-4	404	Lower	122	144	165	QM[3]	10/31/2023		
MCE RMS-5	340	Lower	12	38	63	QM[3]	10/31/2023		
MCE RMS-6	328	Lower	-27	20	57	-9.5	11/3/2023	+17.5	-29.5
MCE RMS-7	388	Lower	68	86	107				
MCE RMS-8	367	Upper	325	334	349				
MCE RMS-9	265	Upper	244	252	254				
MCW RMS-1	169	Lower	-64	30	66				
MCW RMS-2	173	Upper	-1	34	55	NM[2]	10/31/2023		
MCW RMS-3	162	Upper	0	55	79	QM[3]	10/31/2023		
MCW RMS-4	208	Lower	49	67	90	NM[2]	10/31/2023		
MCW RMS-5	198	Upper	171	178	180				
MID RMS-1	308	Lower	-67	-23	25				
MID RMS-2	218	Lower	-129	-65	40	-82.1	10/16/2023	+46.9	-17.1
MID RMS-3	241	Lower	-116	-32	25	-60.6	10/18/2023	+55.4	-28.6
MID RMS-4	190	Lower	-127	-64	13	-79	10/13/2023	+48	-15
MID RMS-5	207	Lower	-83	-27	20	-43.02	10/12/2023	+39.98	-16.02
MID RMS-6	237	Lower	-65	-27	52				
MID RMS-7	238	Lower	-10	50	89	36.33	10/11/2023	+46.33	-13.67
MID RMS-8	287	Composite	-21	30	65				
MID RMS-9	202	Upper	16	58	85				
MID RMS-10	213	Lower	20	42	85	33	10/23/2023	+13	-9
MID RMS-11	232	Upper	55	89	114	65.85	10/10/2023	+10.85	-23.15
MID RMS-12	262	Upper	60	98	128				
MID RMS-13	271	Composite	69	93	114	89.5	10/9/2023	+20.5	-3.5
MID RMS-14	214	Upper	109	115	140				
MID RMS-15	247	Upper	112	130	144	122.5	10/25/2023	+10.5	-7.5
MID RMS-16	308	Lower	-98	-10	30	-42.3	10/23/2023	+55.7	-32.3
MID RMS-17	225	Upper	190	198	200				
MWD RMS-1	330	Lower	-122	-30	40	-22.16	11/13/2023	+99.84	+7.84

RMS Well I.D.	Estimated Surface Elevation[1] (msl, feet)	Aquifer Designation	2025 Interim Milestone GWEL (feet, AMSL)	MT GWEL (feet, AMSL)	MO GWEL (feet, AMSL)	Fall 2023 GWEL (feet, AMSL)	Date of Fall Measurement	2025 IM Status (feet)	MT Status (feet)
MWD RMS-2	310	Lower	-116	-37	5	-54.68	11/13/2023	+61.32	-17.68
MWD RMS-3	295	Lower	-148	-60	-8	-69.13	11/13/2023	+78.87	-9.13

[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.

[3] QM = questionable measurement. Measurement reported but flagged as questionable.

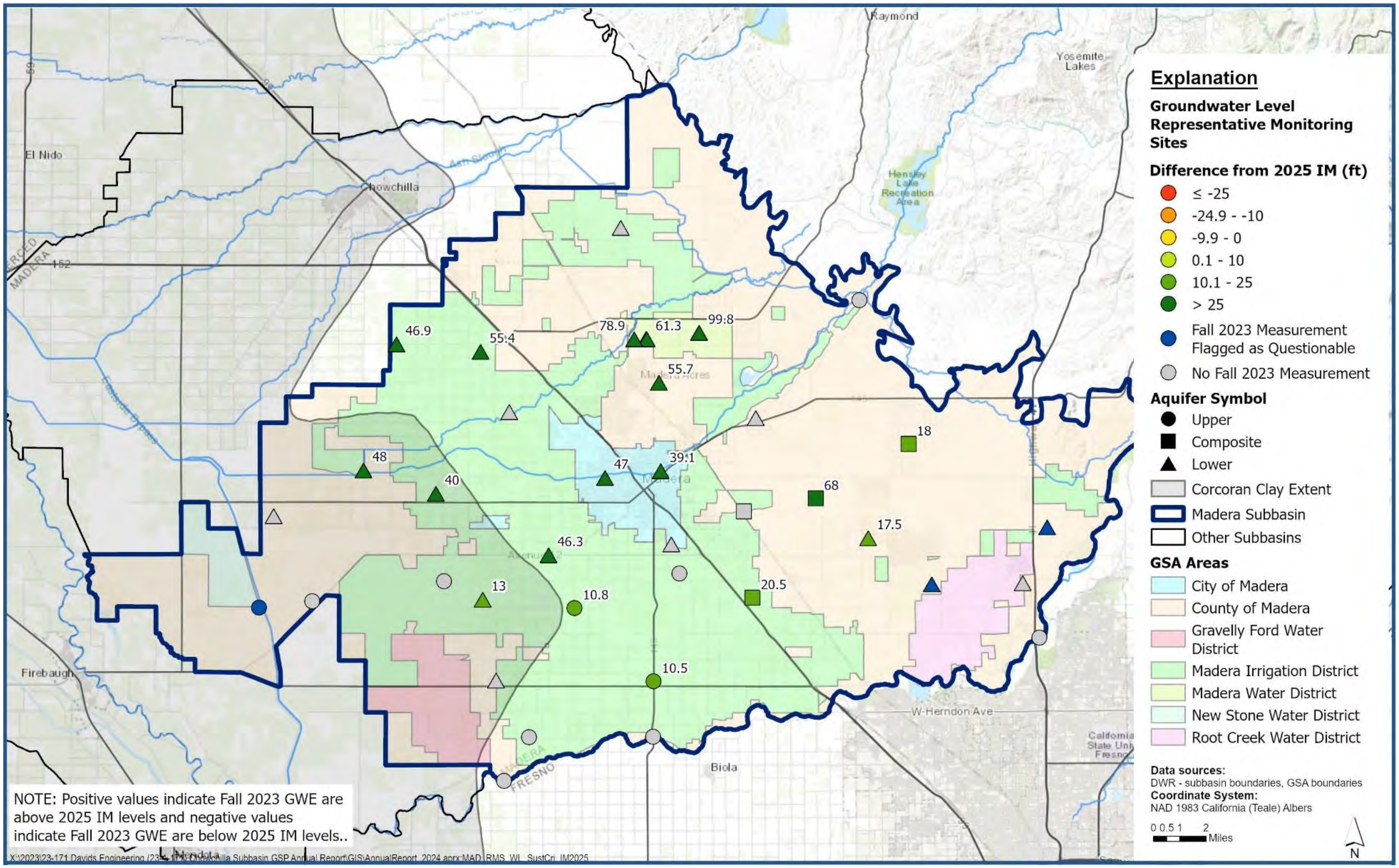


Figure 7-1. Fall 2023 Groundwater Level Measurements at RMS Wells Compared to 2025 Interim Milestone.

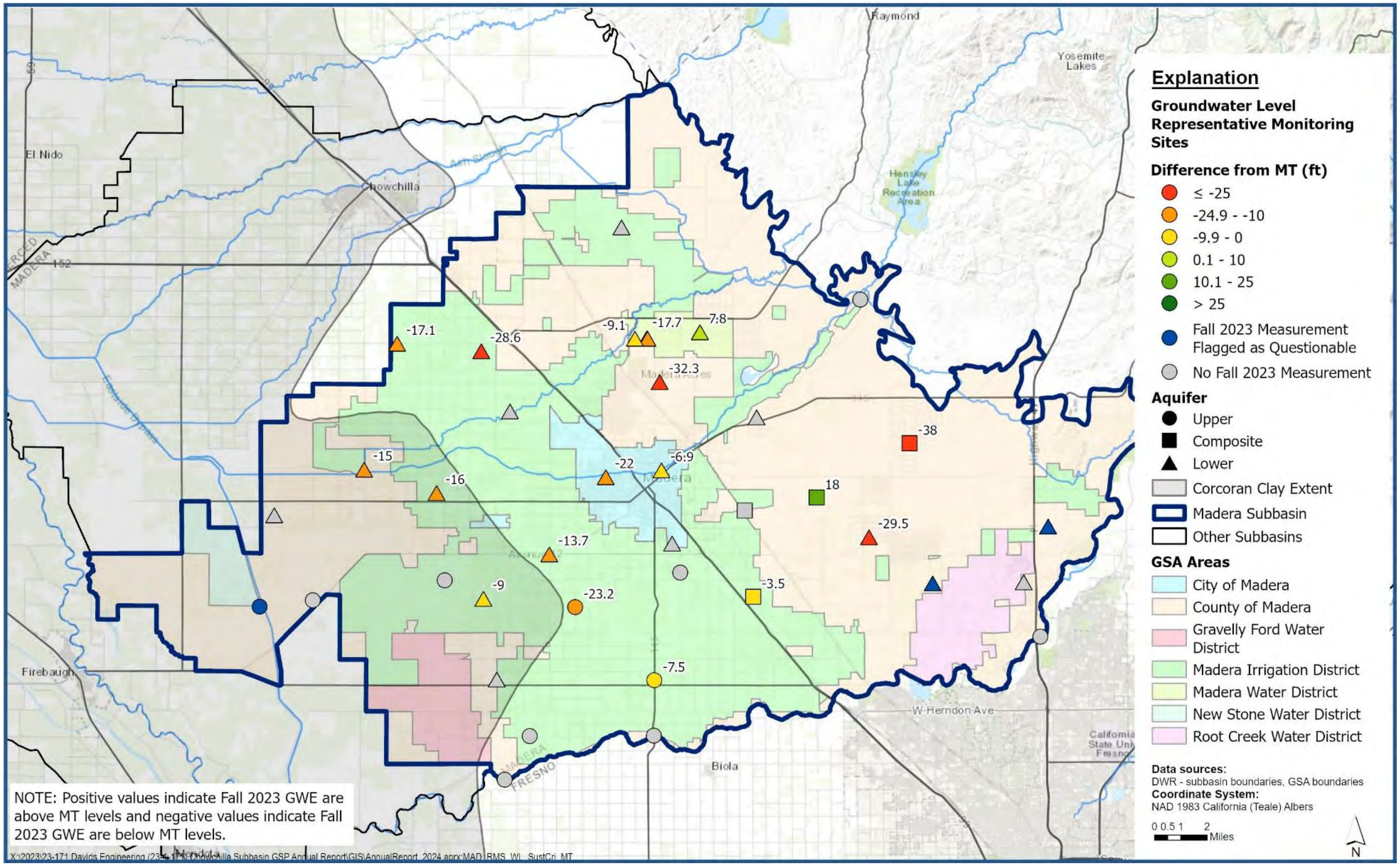


Figure 7-2. Fall 2023 Groundwater Level Measurements at RMS Wells Compared to Minimum Threshold.

7.4.2 Land Subsidence

In the Revised Joint GSP, interim milestones (IMs) for land subsidence were established at five-year intervals over the Implementation Period from 2020 to 2040, at years 2025, 2030, and 2035. IMs for Land subsidence were established through review of historical elevation monitoring through benchmark surveys and continuous GPS monitoring. RMS stations have been separated into two groups for the purpose of establishing interim milestones for land subsidence: stations within the area of greater subsidence concern and stations within the general subsidence monitoring area (i.e., areas of lesser concern). Within each group, the initial land subsidence interim milestone for 2025 was set at a rate slightly higher than the maximum rate that had been observed between 2011 and 2016. The subsequent interim milestones have reduced subsidence rates as PMAs are implemented to address groundwater levels and subsidence. 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 7-6 and **Figure 7-3** present the status of land subsidence RMS stations in relation to the 2025 IMs, MOs, and MTs defined in the GSP. In the area of subsidence concern, the annual rates of subsidence at all three RMS stations are significantly below the 2025 IM. In the general subsidence monitoring area, the four RMS stations are either at or below the 2025 IM. Additional annual and cumulative subsidence maps are presented in **Appendix D**.

Table 7-6. Summary of RMS Stations Land Subsidence Rates Relative to Interim Milestones, Minimum Thresholds, and Measurable Objectives.

RMS ID	Dataset	SMC Group	MO (feet/year)	2025 IM (feet/year)	Observed Annual Rate (feet/year)	Annual Timing
SJRRP_29	SJRRP	Area of Subsidence Concern	0.0	-0.6	-0.29	Dec 2021 to Dec 2022
SJRRP_127	SJRRP	Area of Subsidence Concern	0.0	-0.6	-0.28	Dec 2021 to Dec 2022
SJRRP_1007R	SJRRP	Area of Subsidence Concern	0.0	-0.6	-0.28	Dec 2021 to Dec 2022
SJRRP_141	SJRRP	Subsidence Monitoring	0.0	-0.2	-0.19	Dec 2021 to Dec 2022
SJRRP_142	SJRRP	Subsidence Monitoring	0.0	-0.2	-0.14	Dec 2021 to Dec 2022
SJRRP_160R	SJRRP	Subsidence Monitoring	0.0	-0.2	-0.05	Dec 2021 to Dec 2022
P307	PBO	Subsidence Monitoring	0.0	-0.2	-0.2	Dec 2021 to Dec 2022

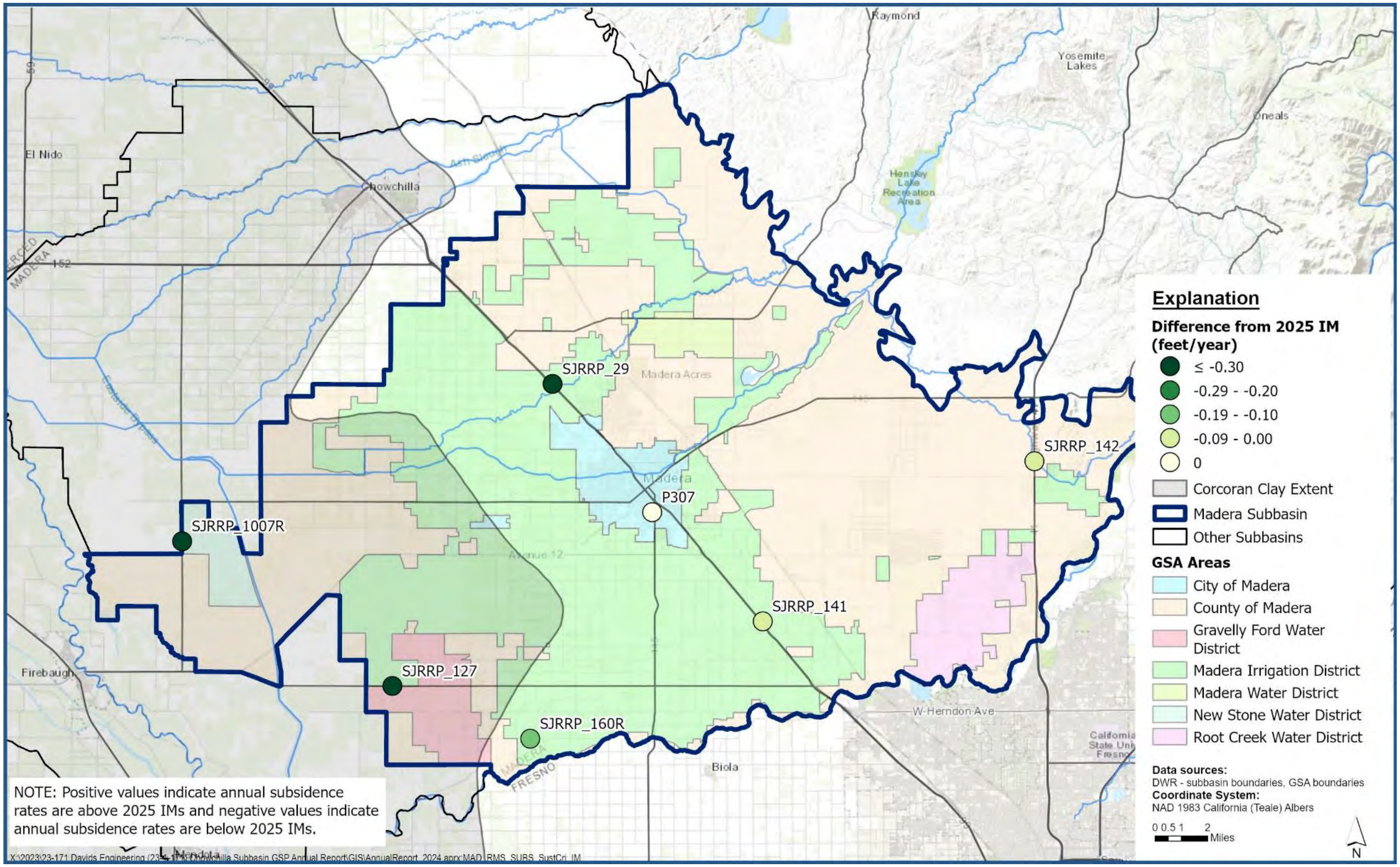


Figure 7-3. December 2021 to December 2022 Annual Subsidence Rates at Land Subsidence RMS Stations compared to 2025 Interim Milestone.

7.4.3 Degraded Groundwater Quality

In the Revised Joint GSP, interim milestones (IMs) for degraded groundwater quality were established at five-year intervals over the 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 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 representative groundwater quality indicator wells (RMS) 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 also include maintaining existing or historical groundwater quality conditions over the implementation period for wells in which the existing or historical conditions already exceed the MCL. The GSP does not include any plan or milestones specifically intended to improve groundwater quality conditions in wells with existing or historical MCL exceedances.

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 representative monitoring sites and is the direct result of projects or management actions 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 related to GSP actions. As part of the planned 5-Year Update to the GSP, groundwater quality SMC will be confirmed or adjusted as needed based on historical sampling.

Table 7-7 presents a summary of groundwater quality monitoring activities to date. Sampling is currently being conducted to establish a baseline concentration to confirm and/or adjust SMC that were presented in the Revised GSP, and will be discussed in greater in the Five-Year Update. GSA efforts to bring in the remaining RMS wells listed in the GSP are ongoing; the status of monitoring efforts to date is provided in **Appendix E**.

Table 7-7. Summary of RMS Well Groundwater Quality Monitoring Activities.

		Arsenic		Nitrate as N		Total Dissolved Solids	
	RMS ID	Most Recent Sampling Date	Sample Count	Most Recent Sampling Date	Sample Count	Most Recent Sampling Date	Sample Count
GSA-Current	MCE RMS-1						
	MCE RMS-3	6/20/2023	3	6/20/2023	3	6/20/2023	3
	MCW RMS-1						
	MCW RMS-2						
	MCW RMS-4						
	MID RMS-13*						
	MID RMS-4*						
	MID RMS-5*						
	MID RMS-6*	7/12/2022	1	7/12/2022	1	7/12/2022	1
	MID RMS-7*	7/12/2022	1	7/12/2022	1	7/12/2022	1
	MID RMS-9*			4/6/1966	1		
	MWD RMS-1	8/19/2022	4	8/19/2022	4	8/19/2022	4
GSA-Future	MSB03A	6/13/2023	5	6/13/2023	2	6/13/2023	5
	MSB03B	6/28/2023	4	6/28/2023	3	6/28/2023	4
	MSB03C	6/13/2023	4	6/13/2023	3	6/13/2023	4
	MSB04A	6/15/2023	4	6/15/2023	3	6/15/2023	4
	MSB04B	6/15/2023	4	6/15/2023	3	6/15/2023	4
	MSB04C	6/15/2023	4	6/15/2023	3	6/15/2023	4
	MSB05A	6/13/2023	5	6/13/2023	2	6/13/2023	5
	MSB05B	6/13/2023	3	6/13/2023	2	6/13/2023	3
	MSB05C	6/13/2023	3	6/13/2023	2	6/13/2023	3
	MSB06A	6/14/2023	6	6/14/2023	3	6/14/2023	6
	MSB06B	6/14/2023	5	6/14/2023	4	6/14/2023	5
	MSB06C	6/28/2023	5	6/28/2023	4	6/28/2023	5
	MSB09A	6/13/2023	6	6/13/2023	3	6/13/2023	6
	MSB09B	6/13/2023	4	6/13/2023	3	6/13/2023	4
	MSB09C	6/13/2023	4	6/13/2023	3	6/13/2023	4
	MSB10A						
	MSB10B	6/15/2023	6	6/15/2023	3	6/15/2023	6
	MSB10C	6/15/2023	4	6/15/2023	3	6/15/2023	4
	MSB11A	2/11/2020	1			2/11/2020	1
	MSB11B	2/11/2020	1			2/11/2020	1
	MSB11C	6/21/2022	2	6/21/2022	1	6/21/2022	2
Non-GSA	2000507-001	5/11/2023	4	5/11/2023	9		
	2000553-001	1/13/2021	5	10/9/2023	32	1/13/2021	7
	2000682-002	8/23/2023	4	8/23/2023	17	5/20/2008	1

		Arsenic		Nitrate as N		Total Dissolved Solids	
	RMS ID	Most Recent Sampling Date	Sample Count	Most Recent Sampling Date	Sample Count	Most Recent Sampling Date	Sample Count
Non-GSA (continued)	2000727-001	1/6/2021	7	3/6/2023	22	1/6/2021	7
	2000846-002						
	2000938-001	8/23/2022	6	1/17/2023	21		
	2010002-014	5/22/2023	13	5/22/2023	34	5/22/2023	15
	2010002-032	11/10/2021	11	2/27/2023	22	11/10/2021	11
	2010008-005	1/6/2021	7	3/1/2023	35	1/6/2021	9
	2010009-002	7/15/2013	7	1/26/2017	20	7/15/2013	7
	2010010-007	9/9/2022	7	2/23/2023	20	9/9/2022	7
	2010801-001	12/5/2023	139	8/15/2023	30	8/5/2021	11
	2801077-001	4/3/2002	1	4/20/2023	21		
	ESJ12	7/27/2021	1			8/4/2020[1]	1 [1]
	ESJ17	7/27/2021	1			8/4/2020[1]	1 [1]

[1] Monitoring for the Irrigated Lands Regulatory Program annual monitoring includes specific conductance (SC), TDS is tested every five years; SC will be used as proxy for TDS in years in which TDS is not tested.
* MID contracted to have these wells tested, however due to unforeseen circumstances, the wells were not tested by the third party testing entity.

7.4.4 Depletion of Interconnected Surface Water

In the Revised Joint GSP, interim SMC for the depletion of interconnected surface water (ISW) were established due to limited data available to quantify the relationship between groundwater and the San Joaquin River. A workplan was developed to improve understanding of ISW in the Subbasin (**Appendix F**), but in the meantime the interim SMC will be used to evaluate this sustainability indicator.

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.

8 References

American Society of Civil Engineers (ASCE). 2016. Evaporation, Evapotranspiration and Irrigation Water Requirements. Manual 70. Second Edition. M. E. Jensen and R. G. Allen (eds). Am. Soc. Civ. Engrs.

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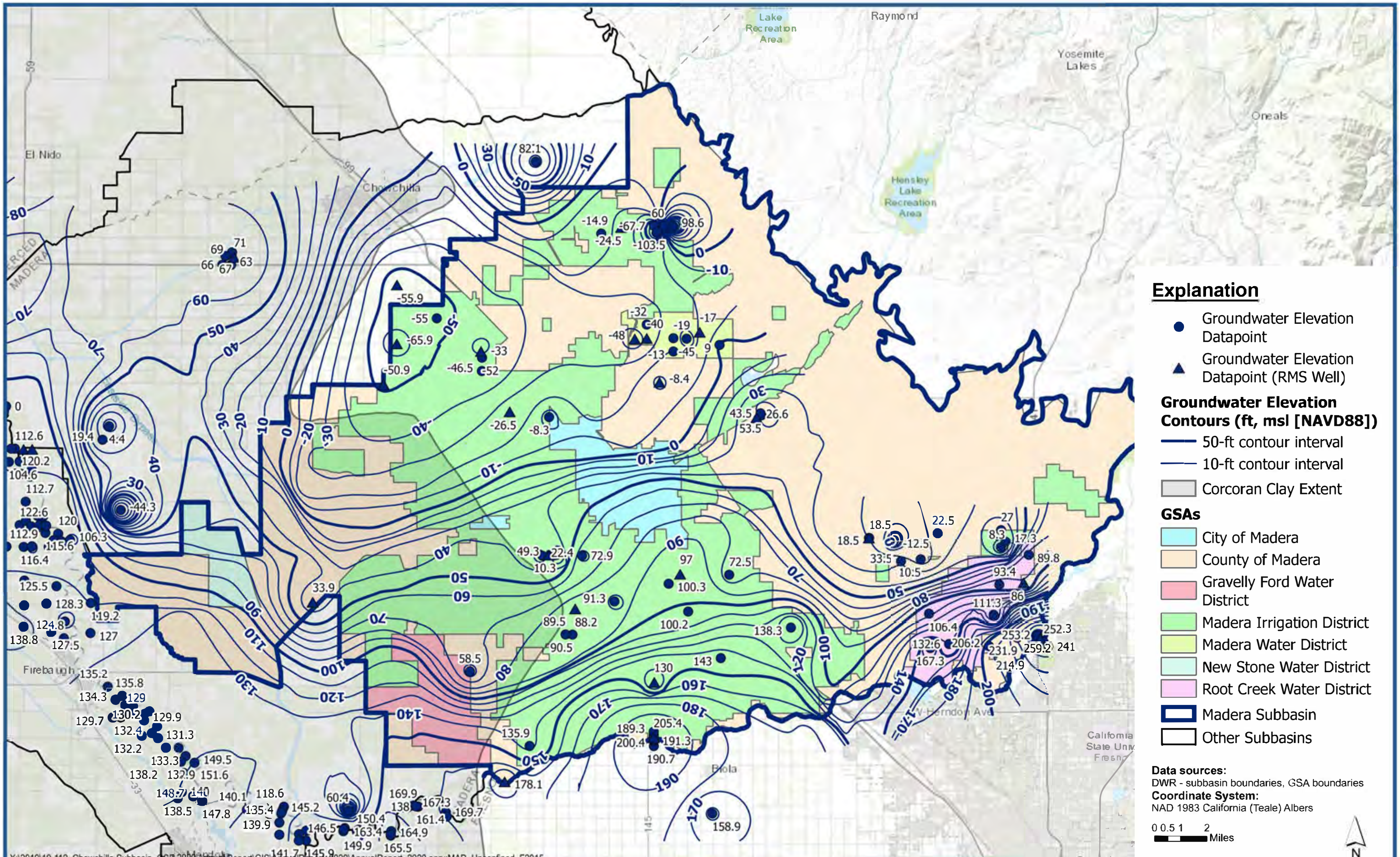
Clemmens, A. J. and C. M. Burt. 1997. Accuracy of irrigation efficiency estimates. J. Irrig. and Drain. Engng. 123(6): 443-453.

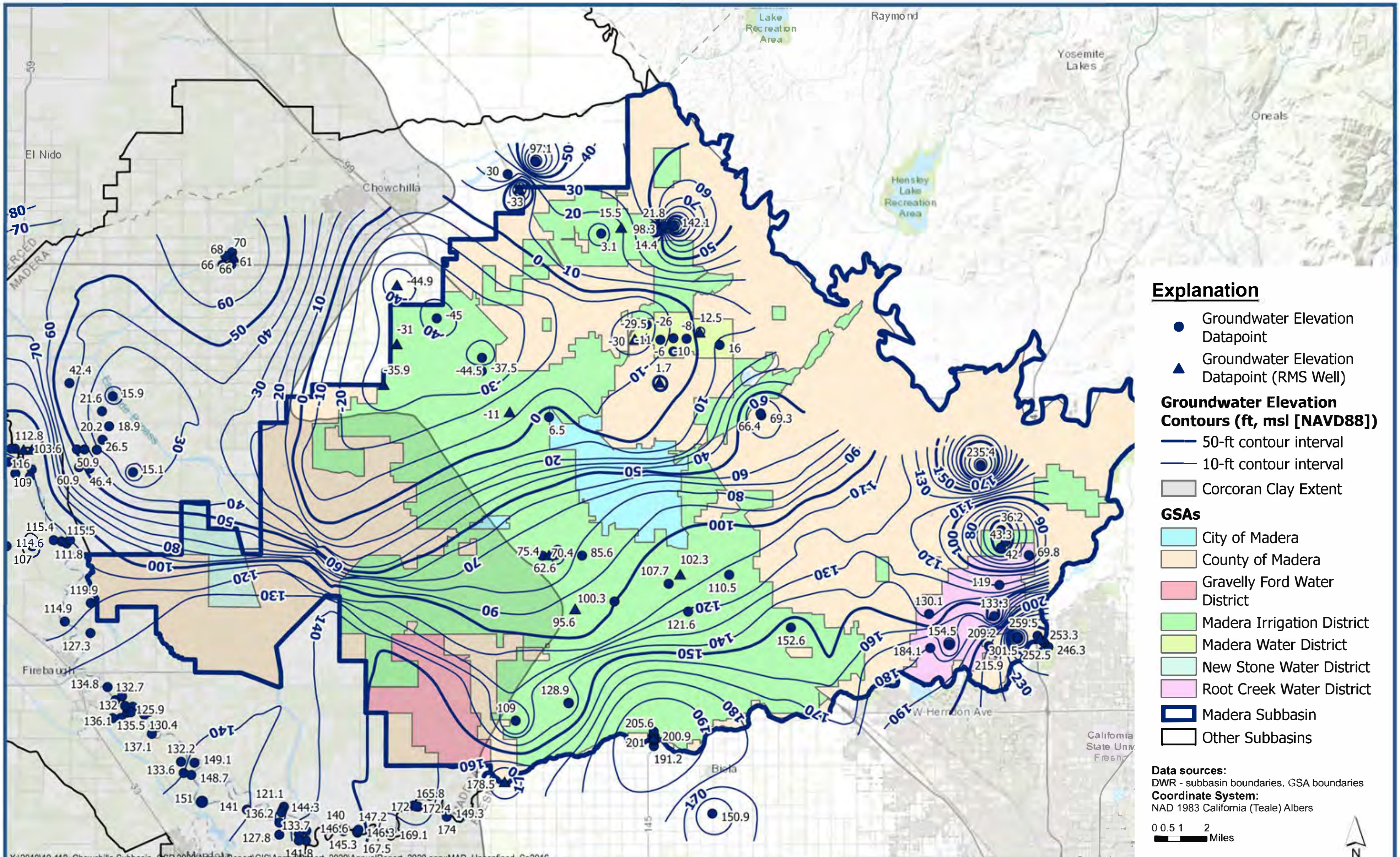
Appendix A. Contour Maps of the Different Aquifer Units.



Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Fall 2015

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-1



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Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2016

Figure A-2

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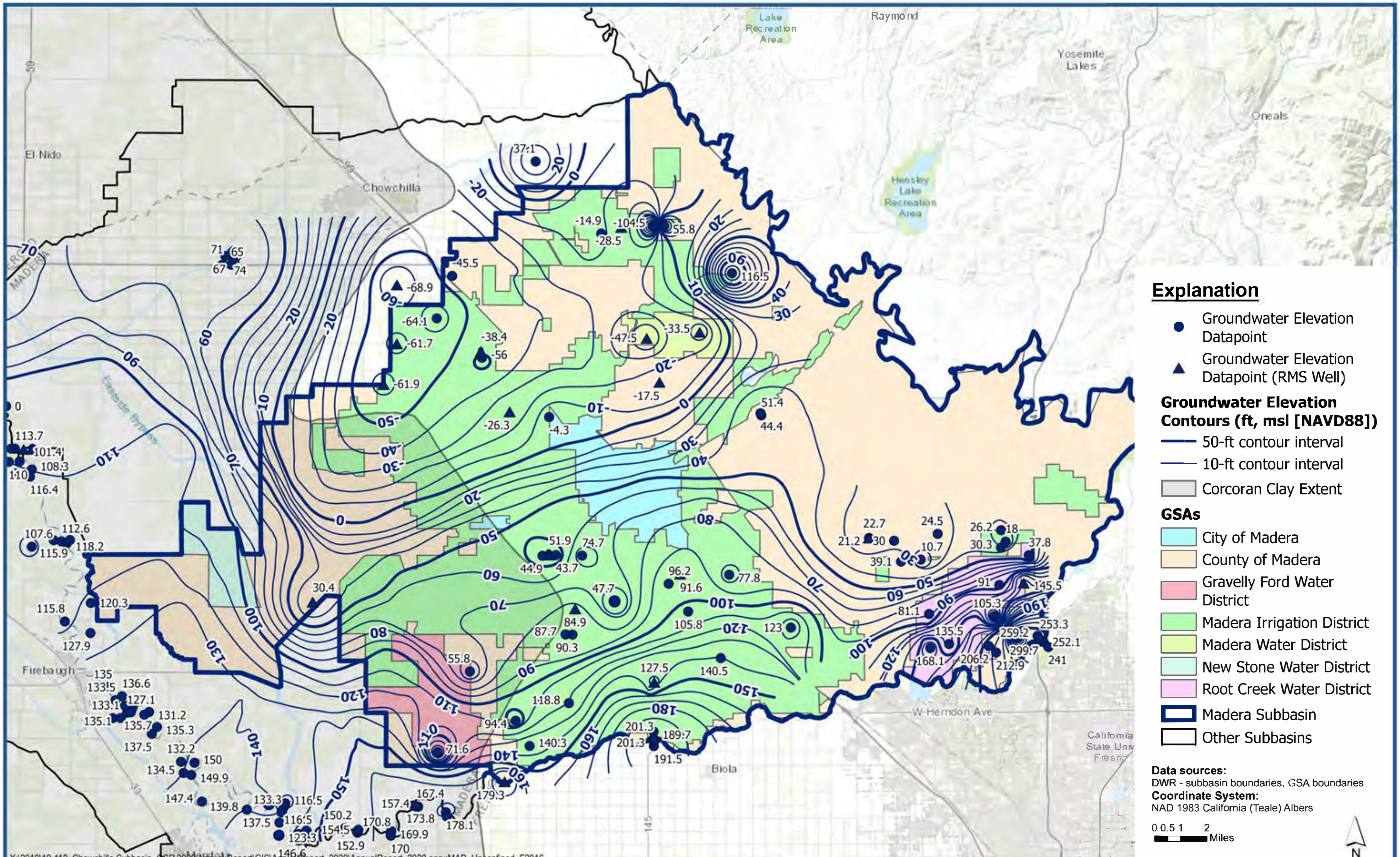

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Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Fall 2016

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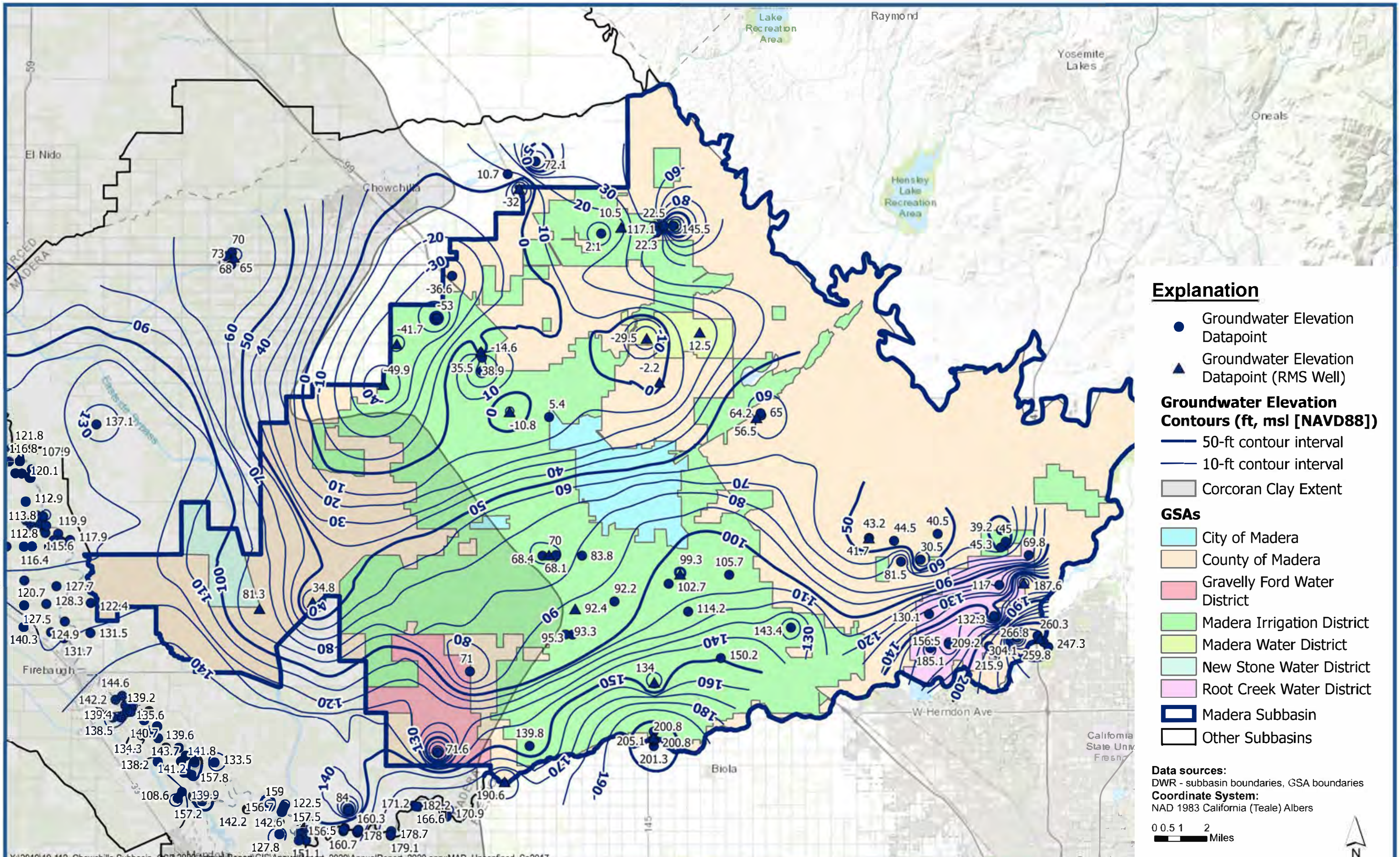
Groundwater Sustainability Plan 2024 Annual Report

Figure A-3



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Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2017

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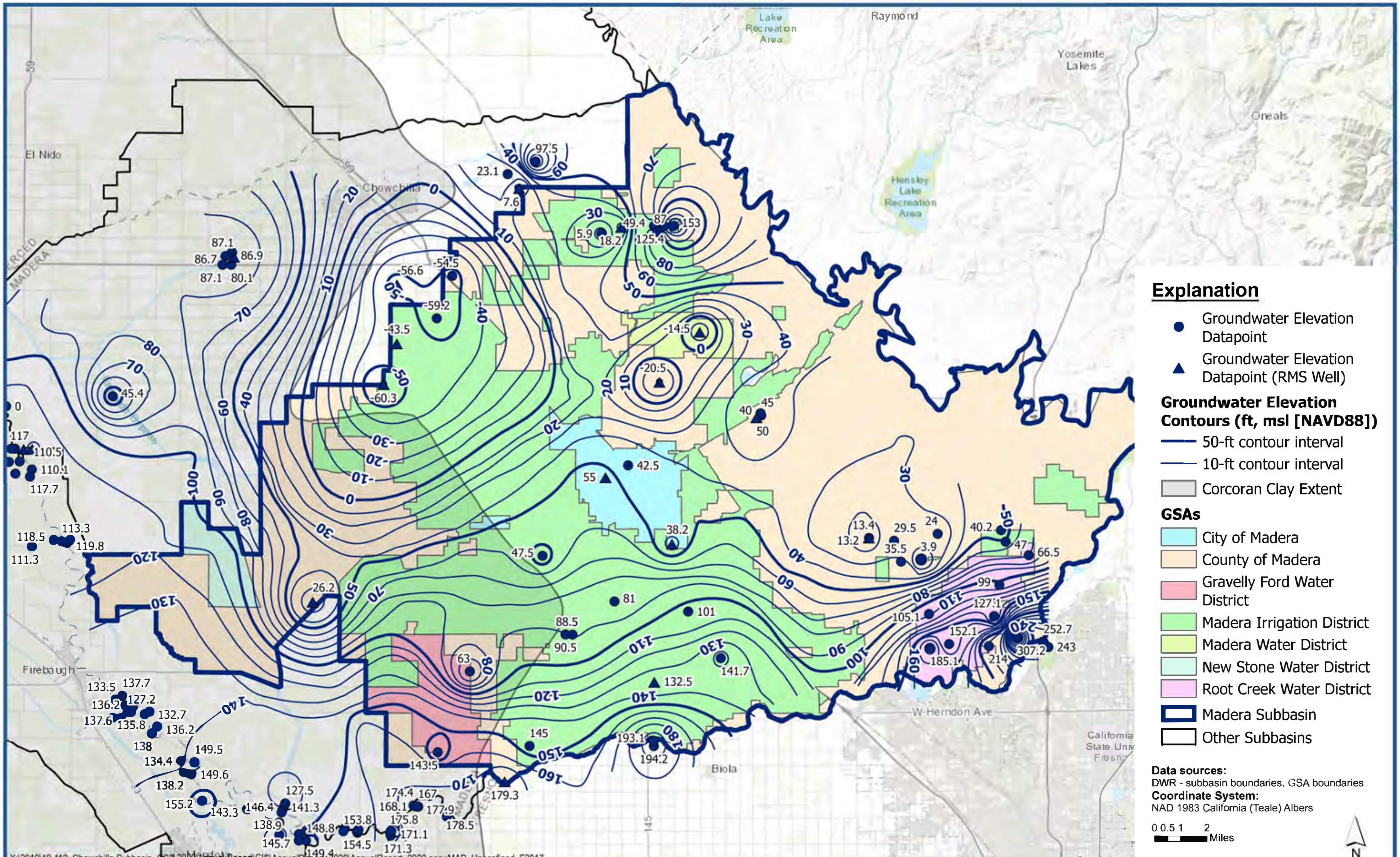
Groundwater Sustainability Plan 2024 Annual Report

Figure A-4



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Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Fall 2017

Figure A-5

Madera Subbasin
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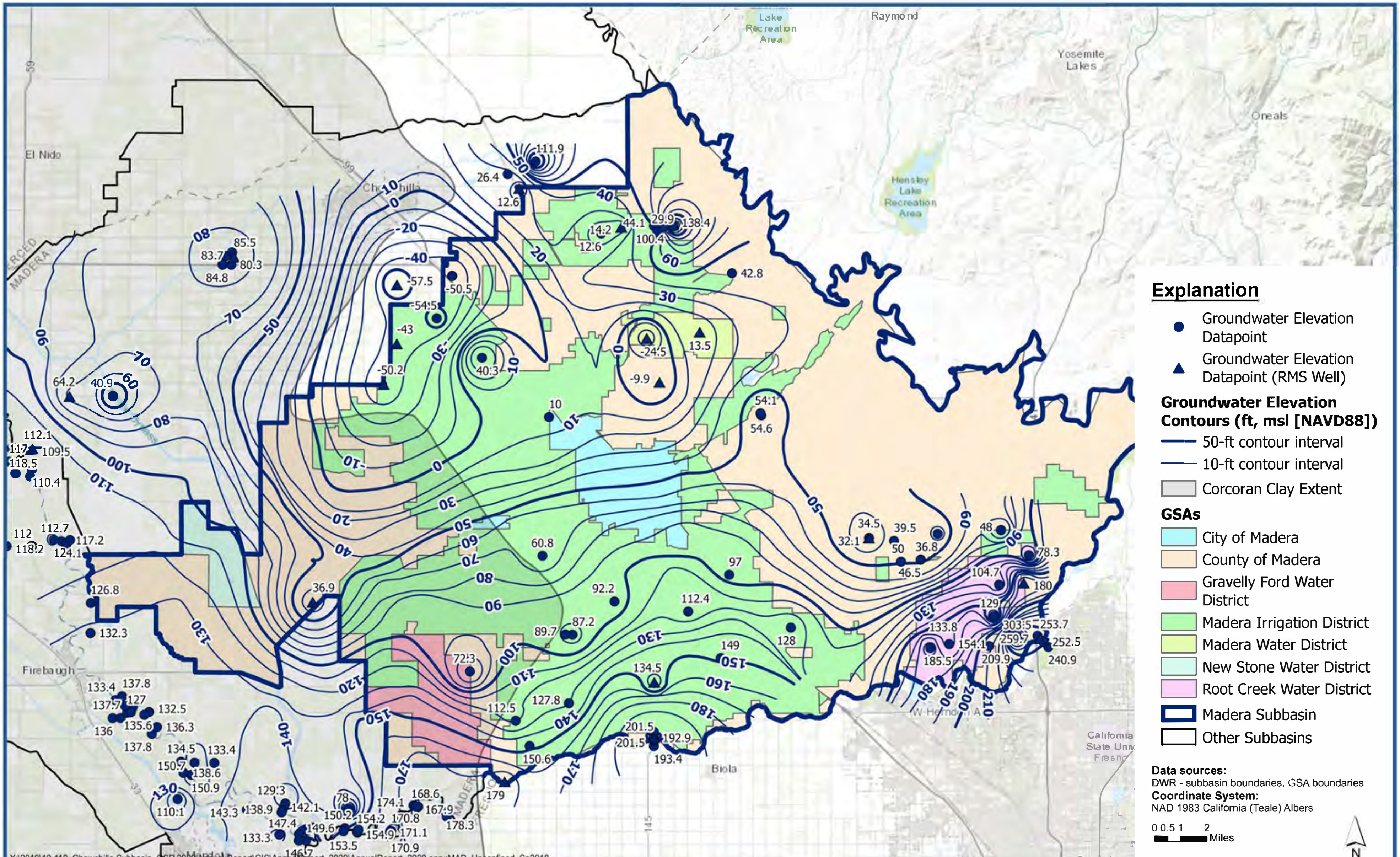

Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2018

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-6

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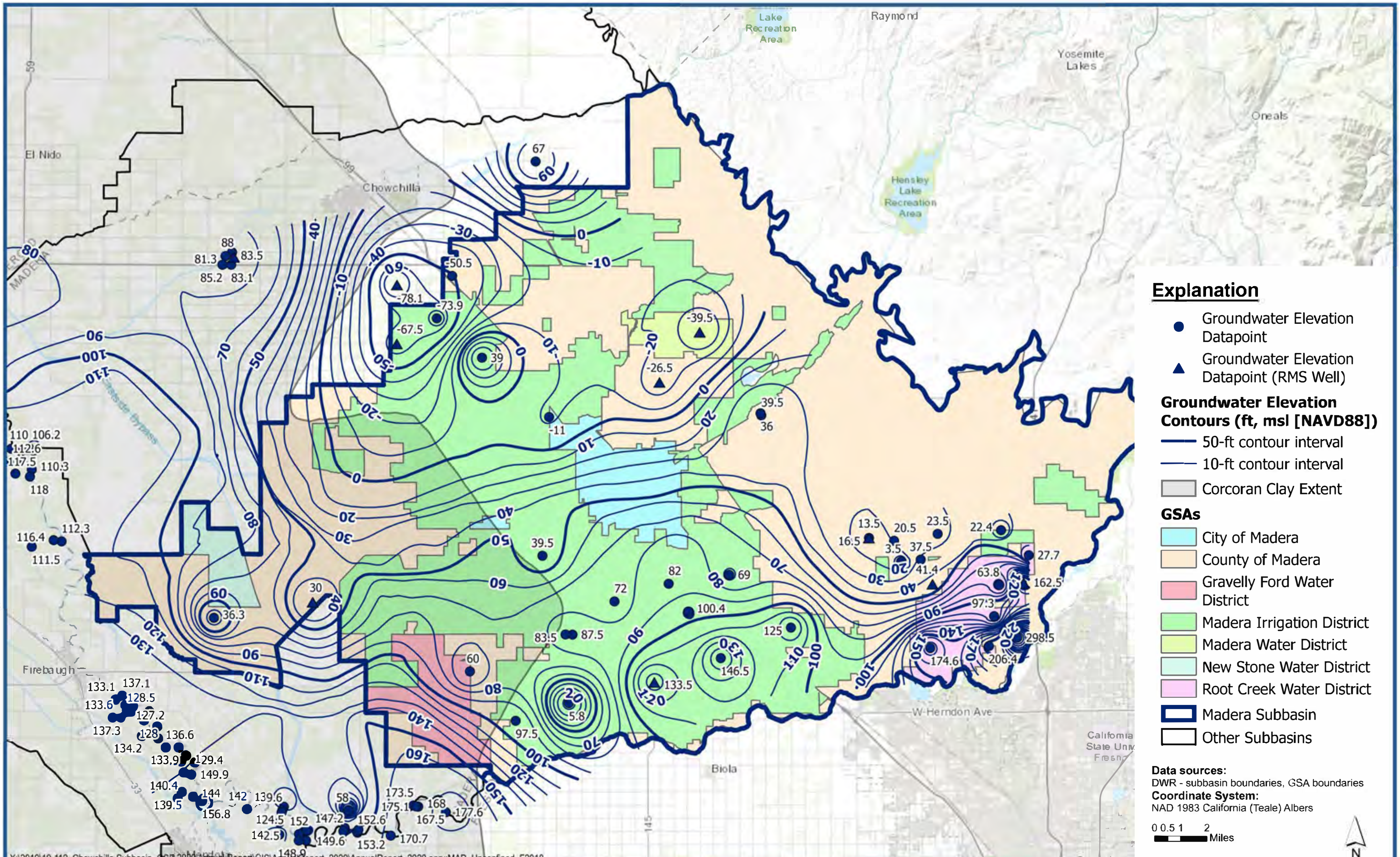

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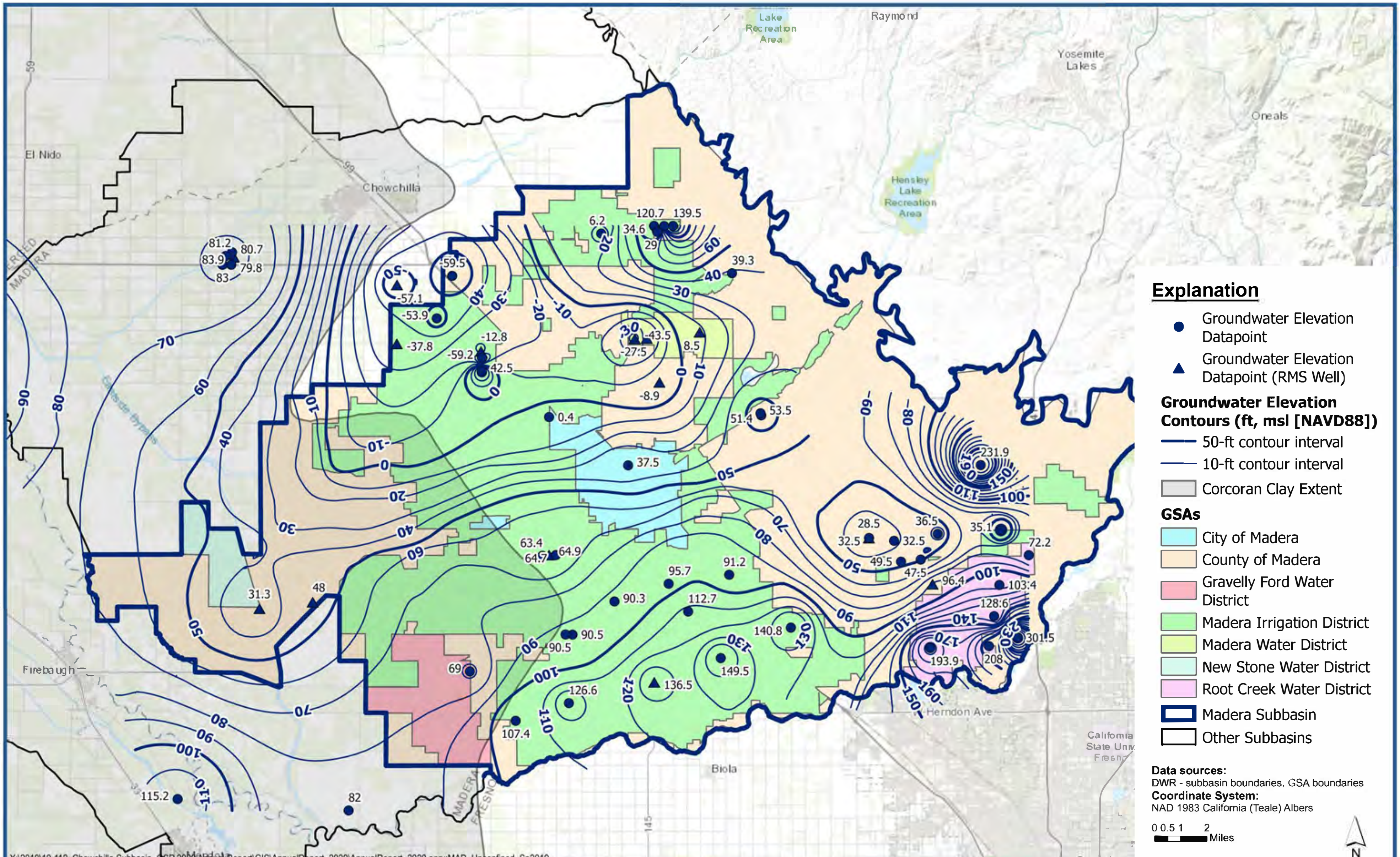
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Fall 2018

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-7



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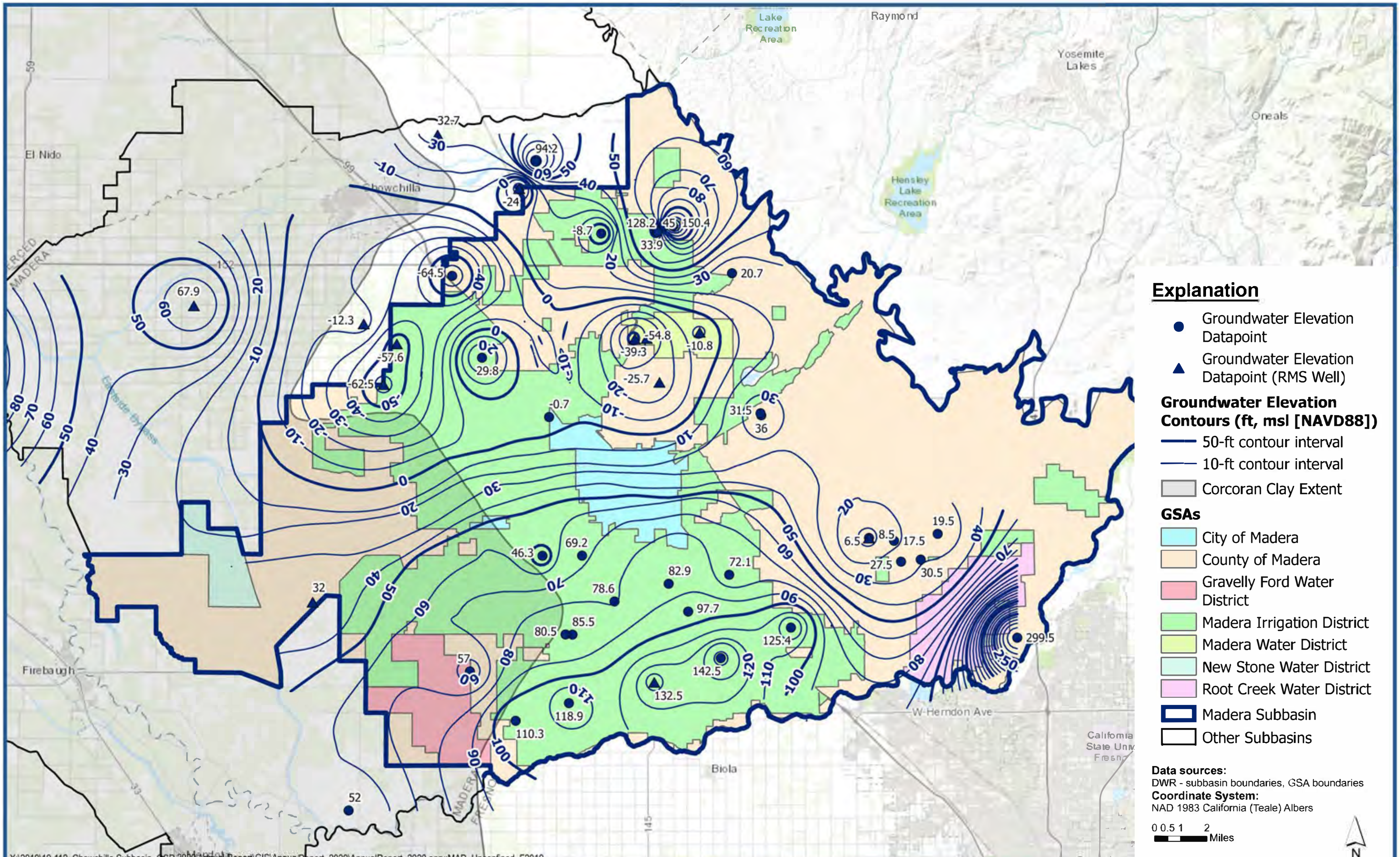
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2019

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-8



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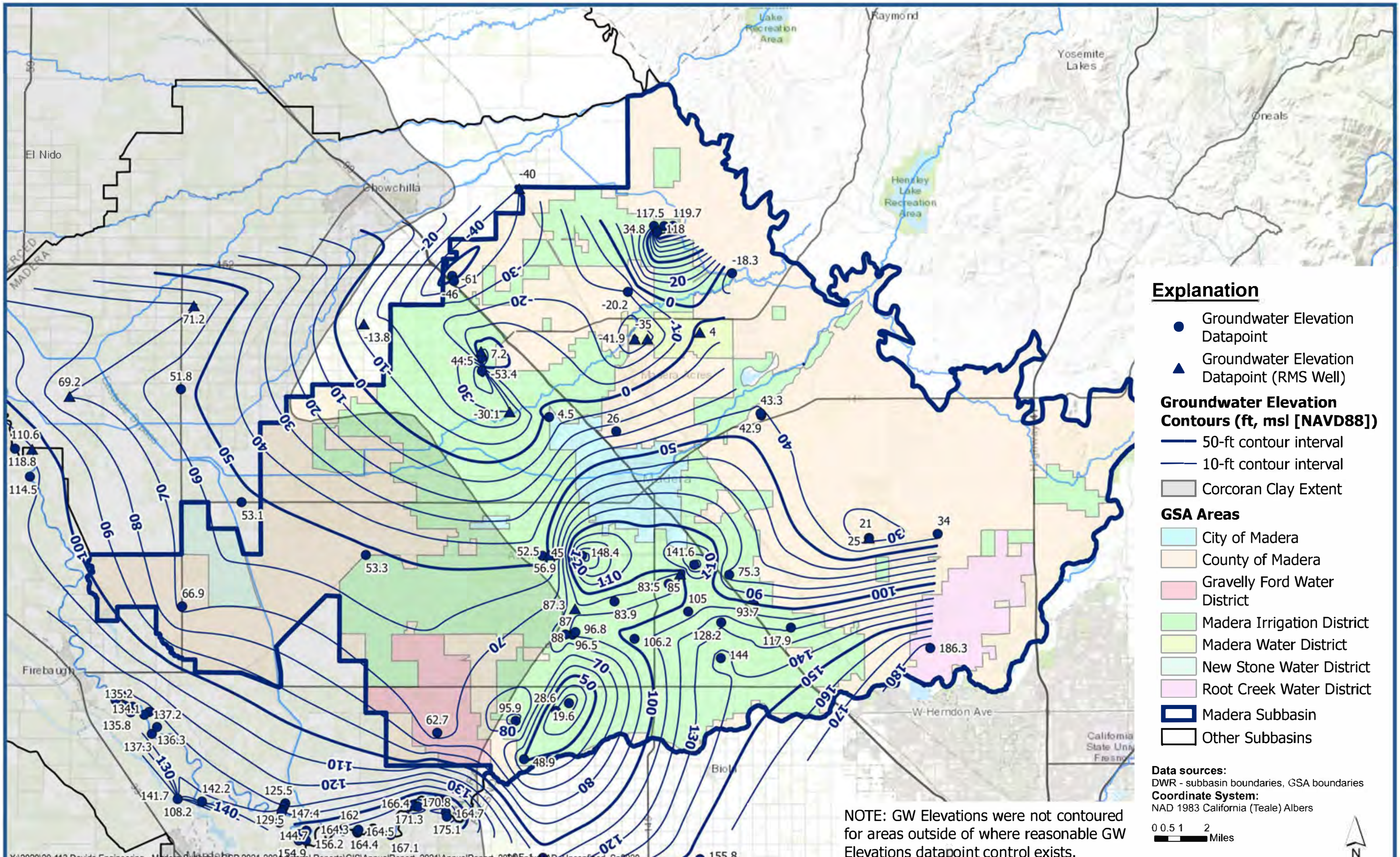
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Fall 2019

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-9



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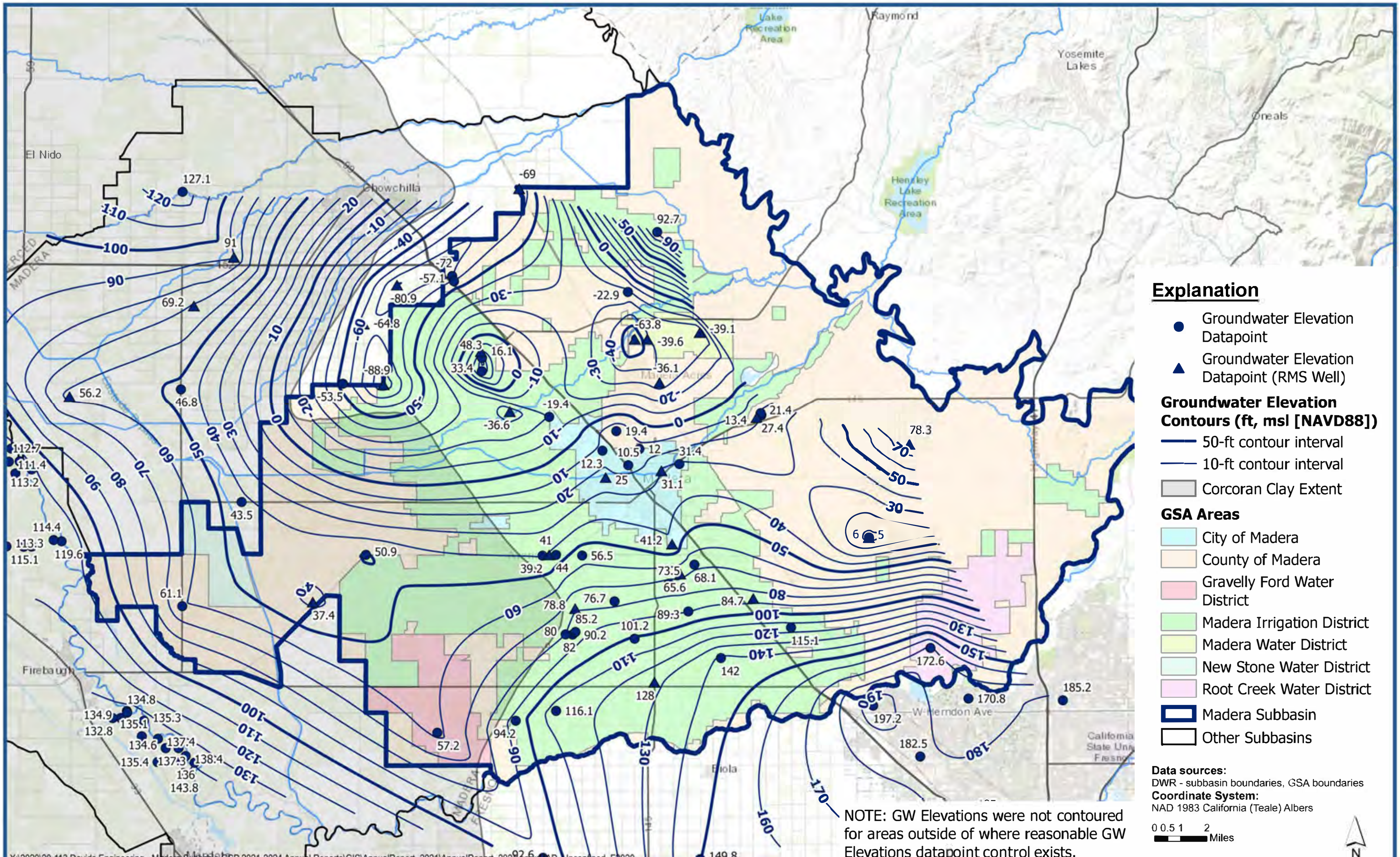
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2020

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-10



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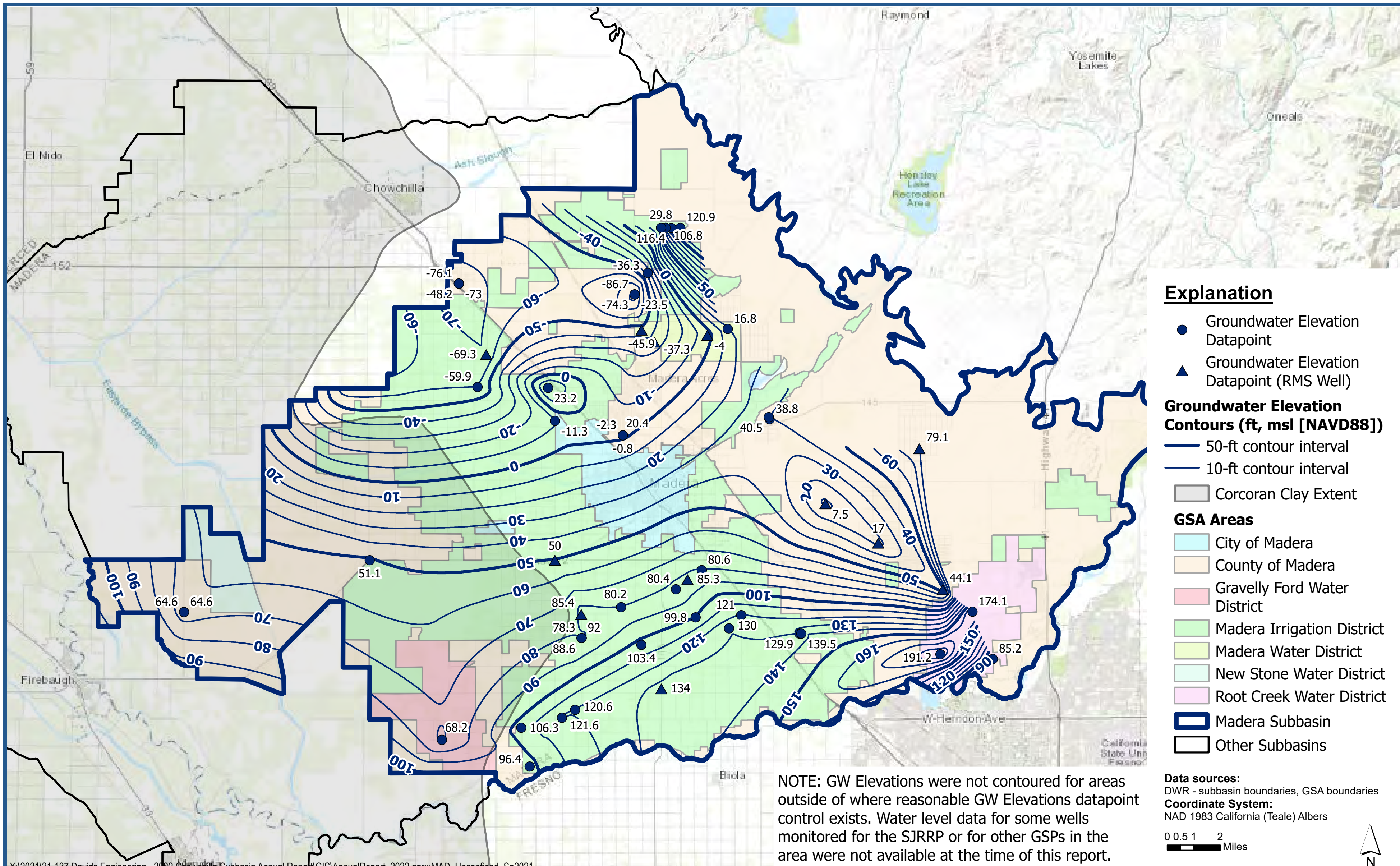
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Fall 2020

Figure A-11

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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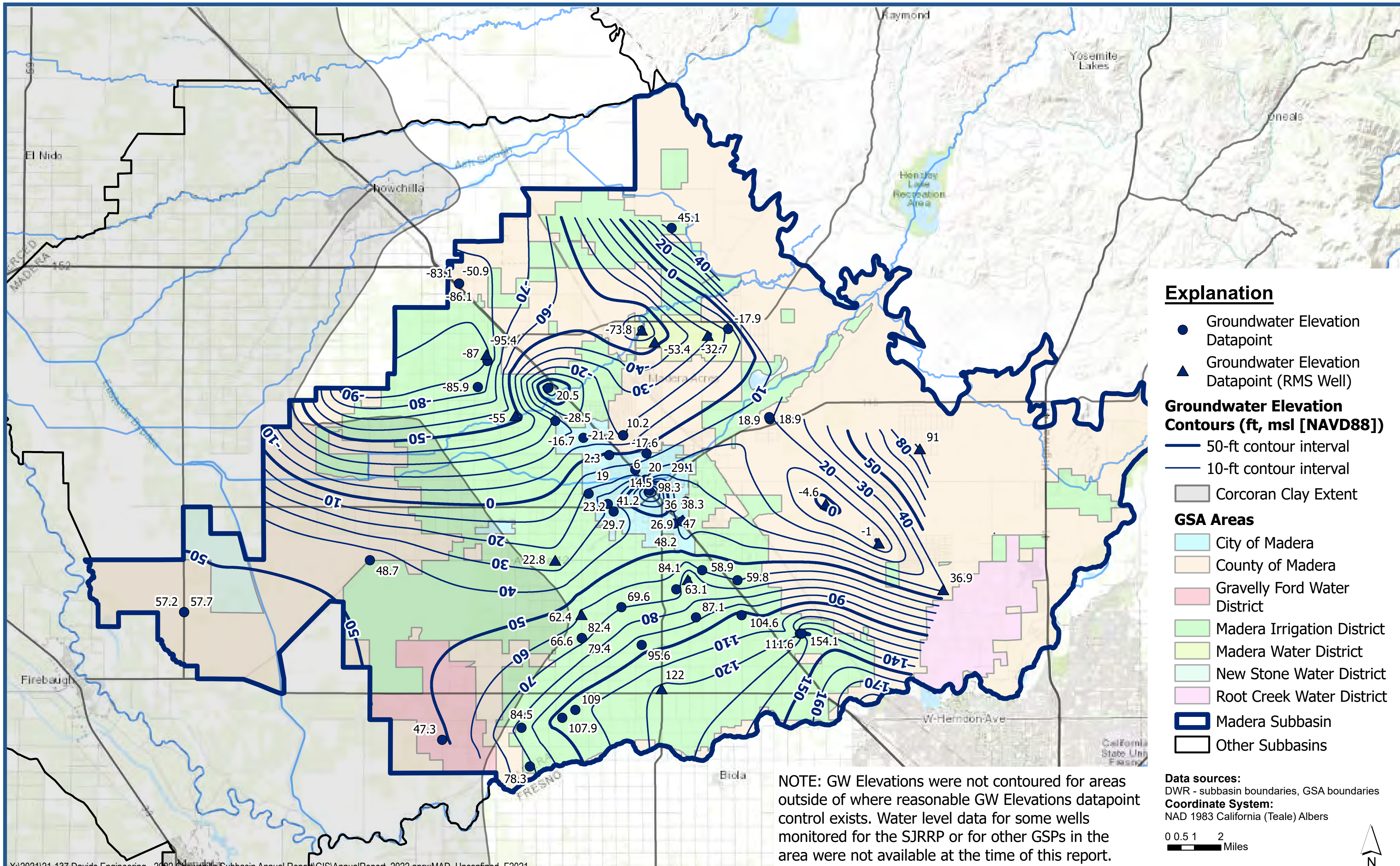
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2021

Figure A-12

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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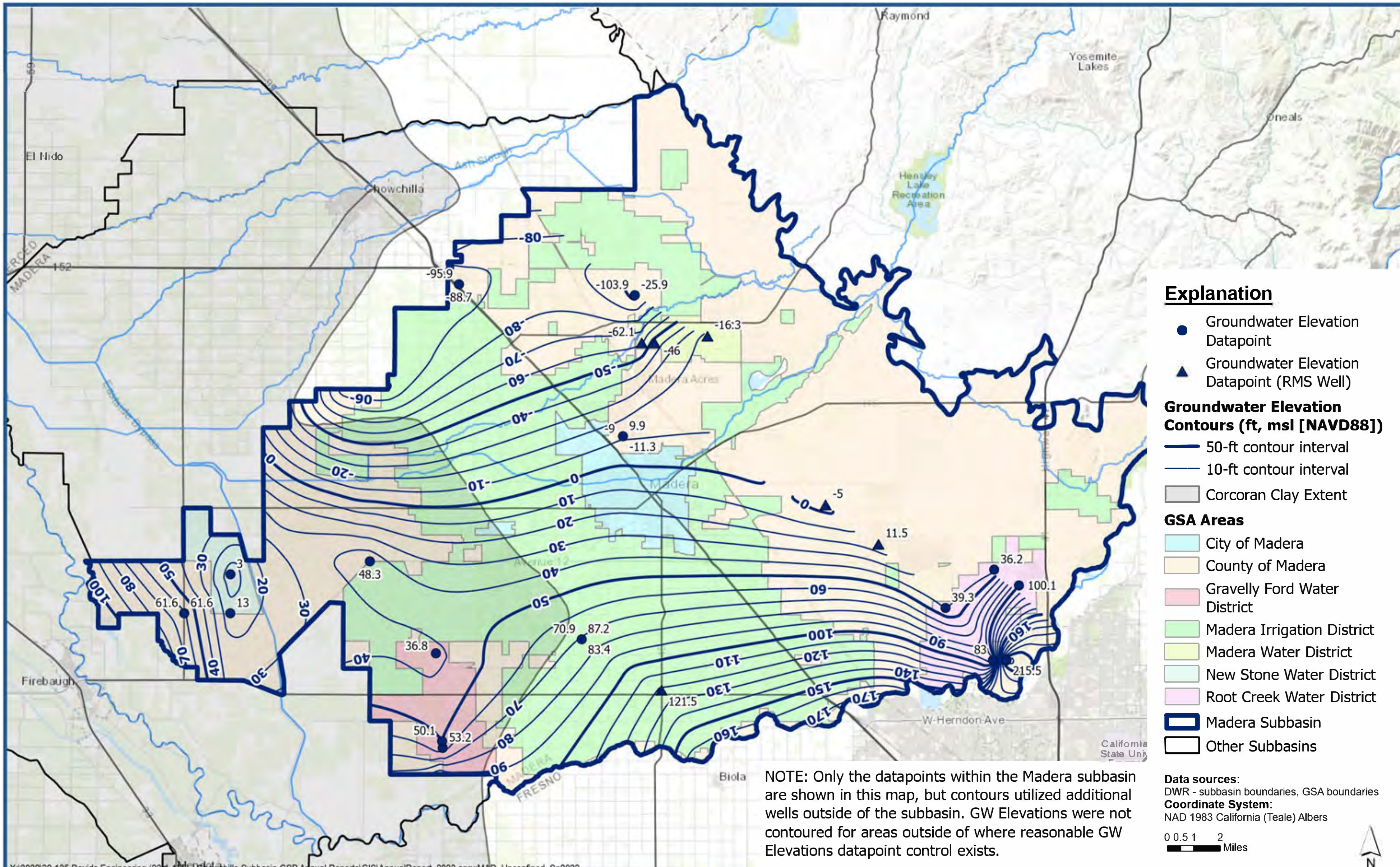
Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Fall 2021

Figure A-13

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2022

Figure A-14

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

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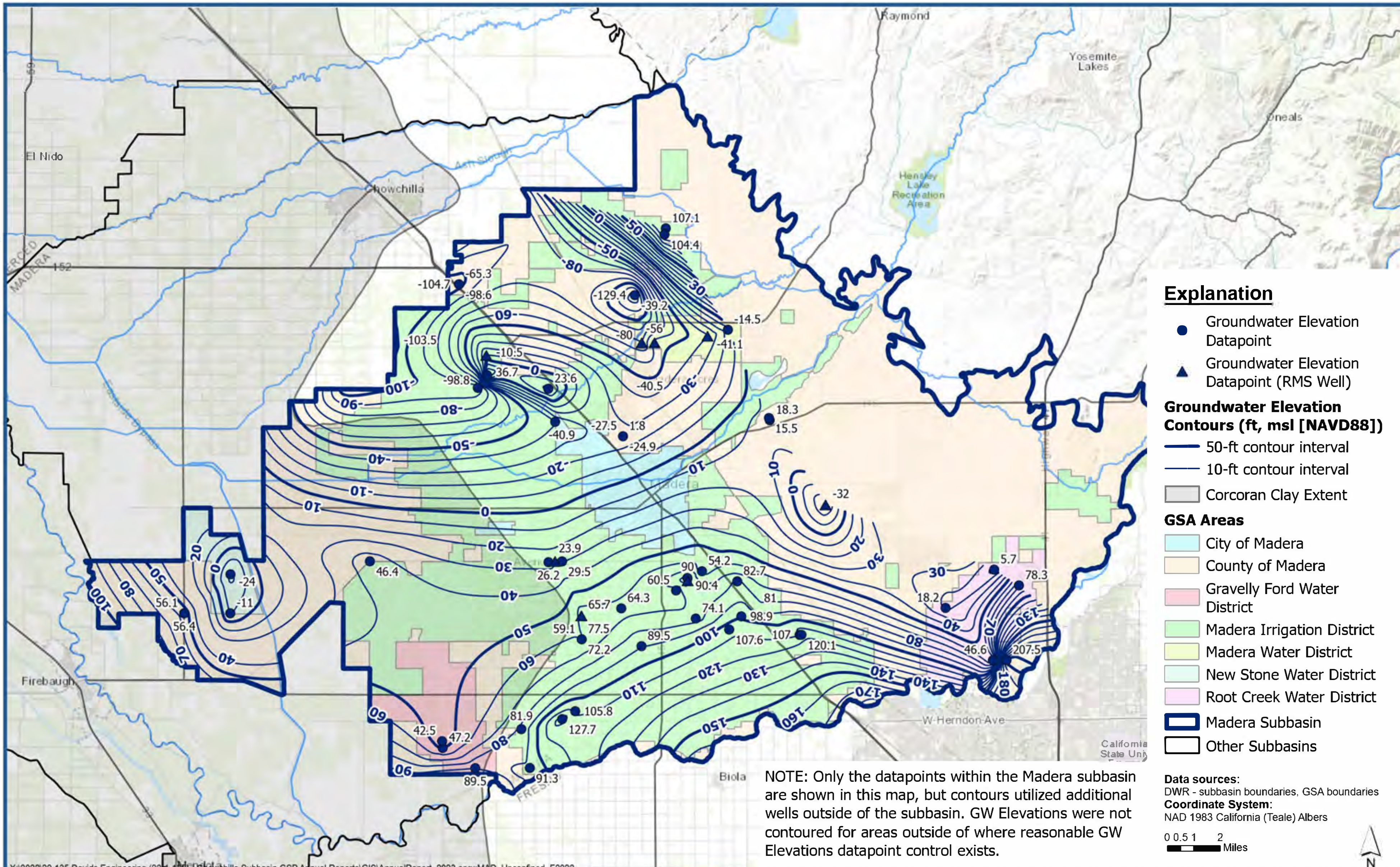
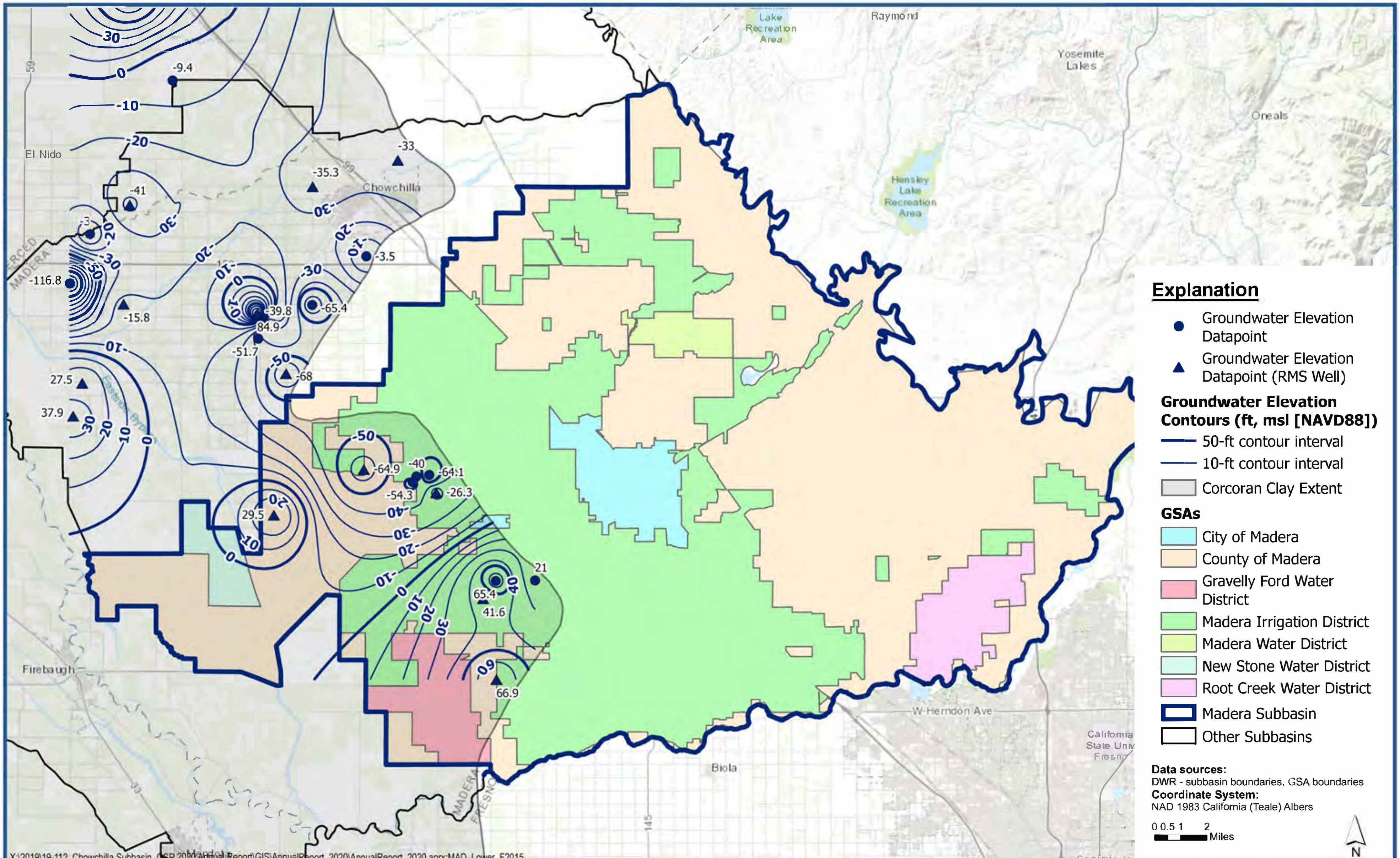


Contours of Equal Groundwater Elevation
Upper Aquifer/Undifferentiated Unconfined Zone - Fall 2022

Figure A-15

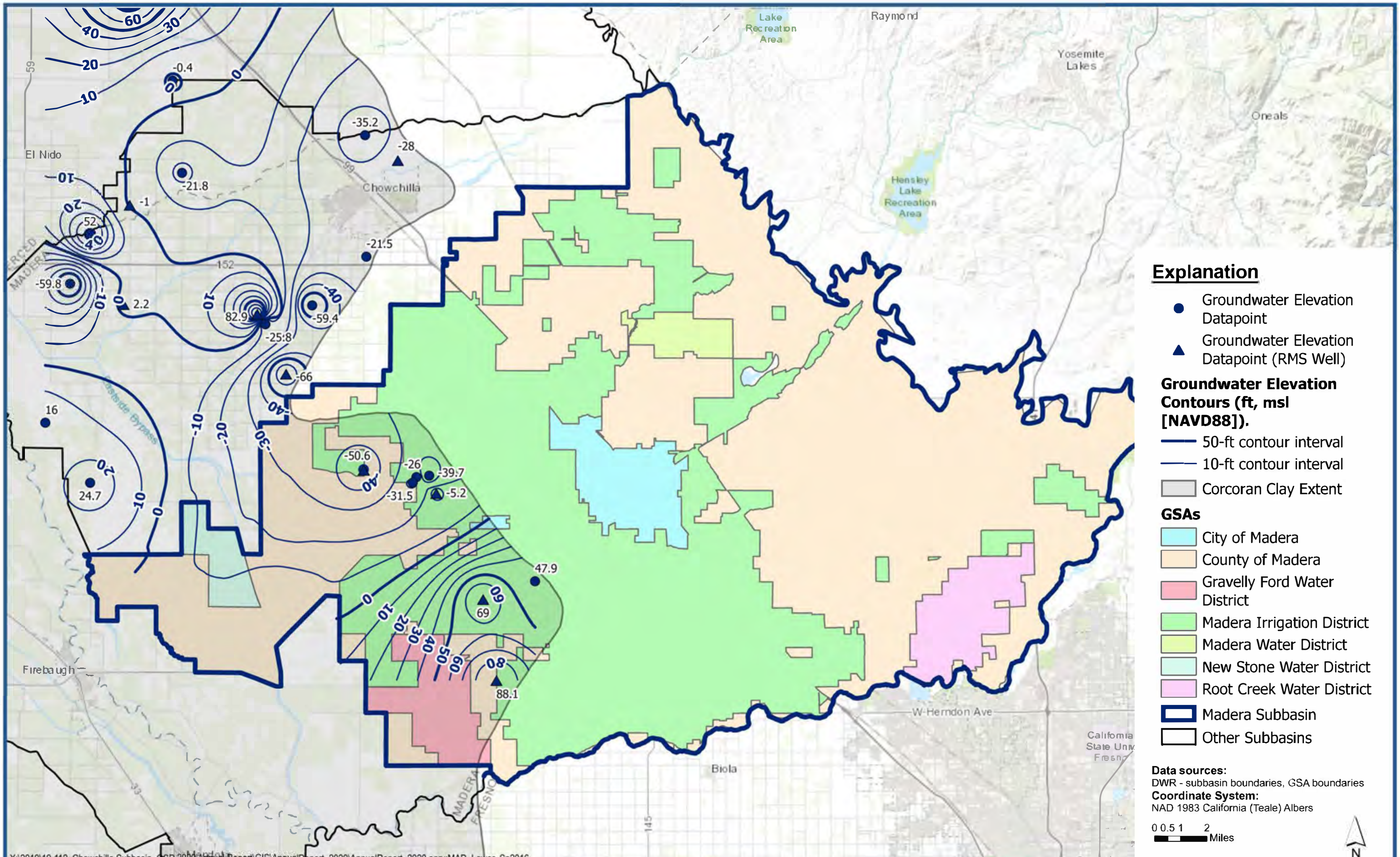
Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



Contours of Equal Groundwater Elevation
Lower Aquifer - Fall 2015

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-16



Contours of Equal Groundwater Elevation
Lower Aquifer - Spring 2016

Figure A-17

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

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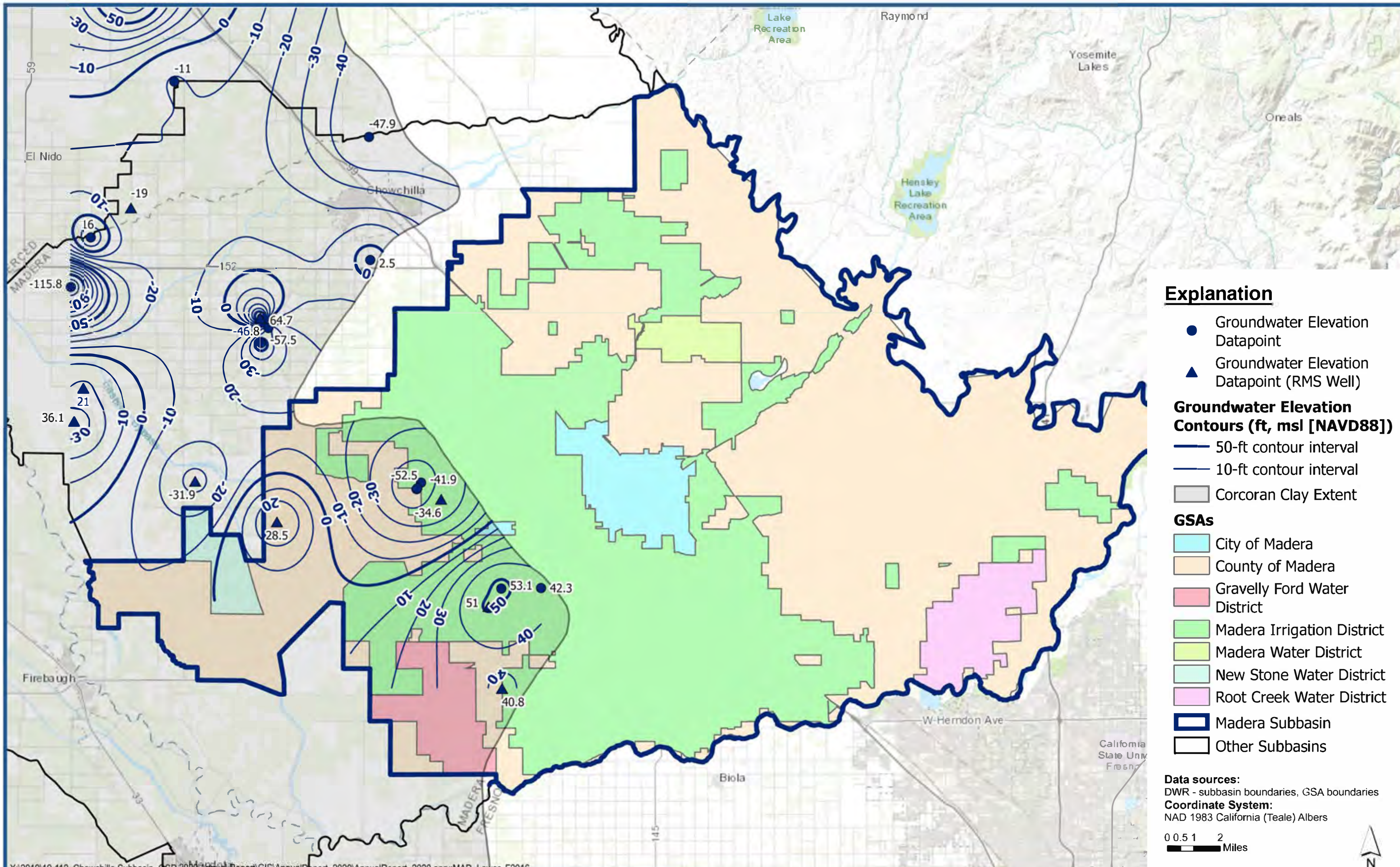

X:\2019\19-112_Chowchilla Subbasin_GSP 2020\Annual Report\GIS\AnnualReport_2020\AnnualReport_2020.aprx:MAD_Lower_F2016

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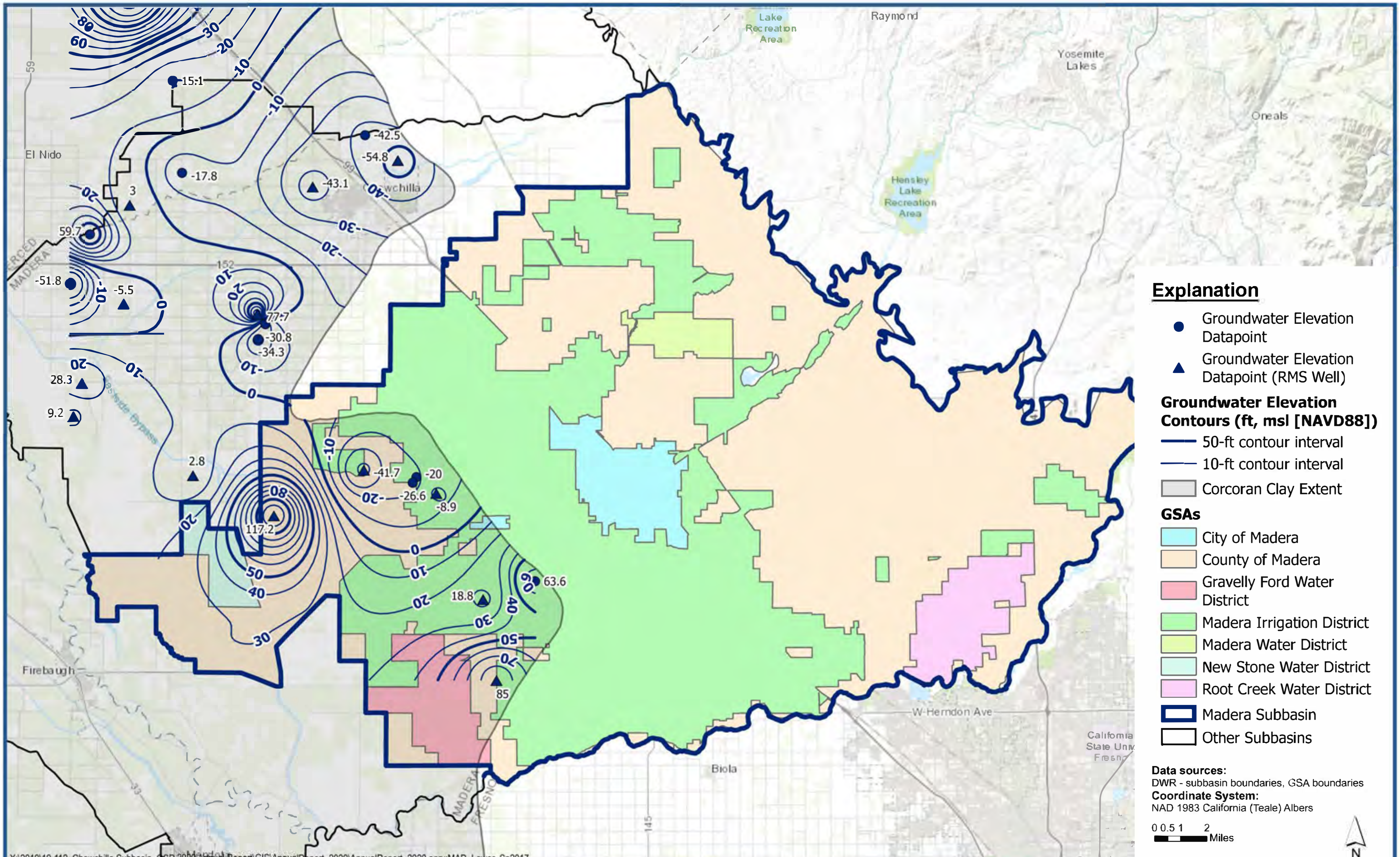
Contours of Equal Groundwater Elevation
Lower Aquifer - Fall 2016

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-18



X:\2019\19-112 Chowchilla Subbasin GSP 2020\Annual Report\GIS\AnnualReport_2020\AnnualReport_2020.aprx:MAD_Lower_Sp2017

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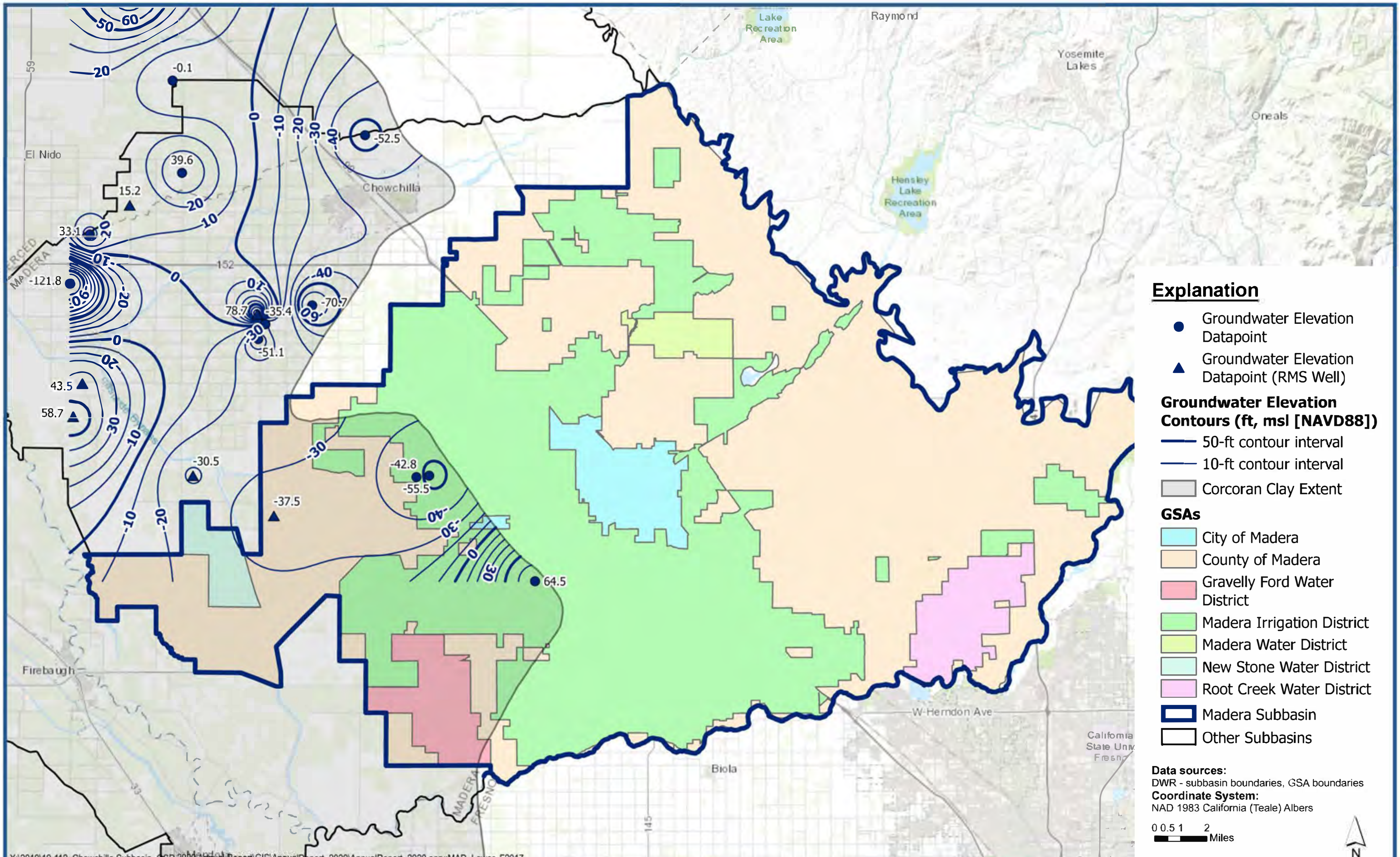
Contours of Equal Groundwater Elevation
Lower Aquifer - Spring 2017

Figure A-19

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



Contours of Equal Groundwater Elevation
Lower Aquifer - Fall 2017

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-20

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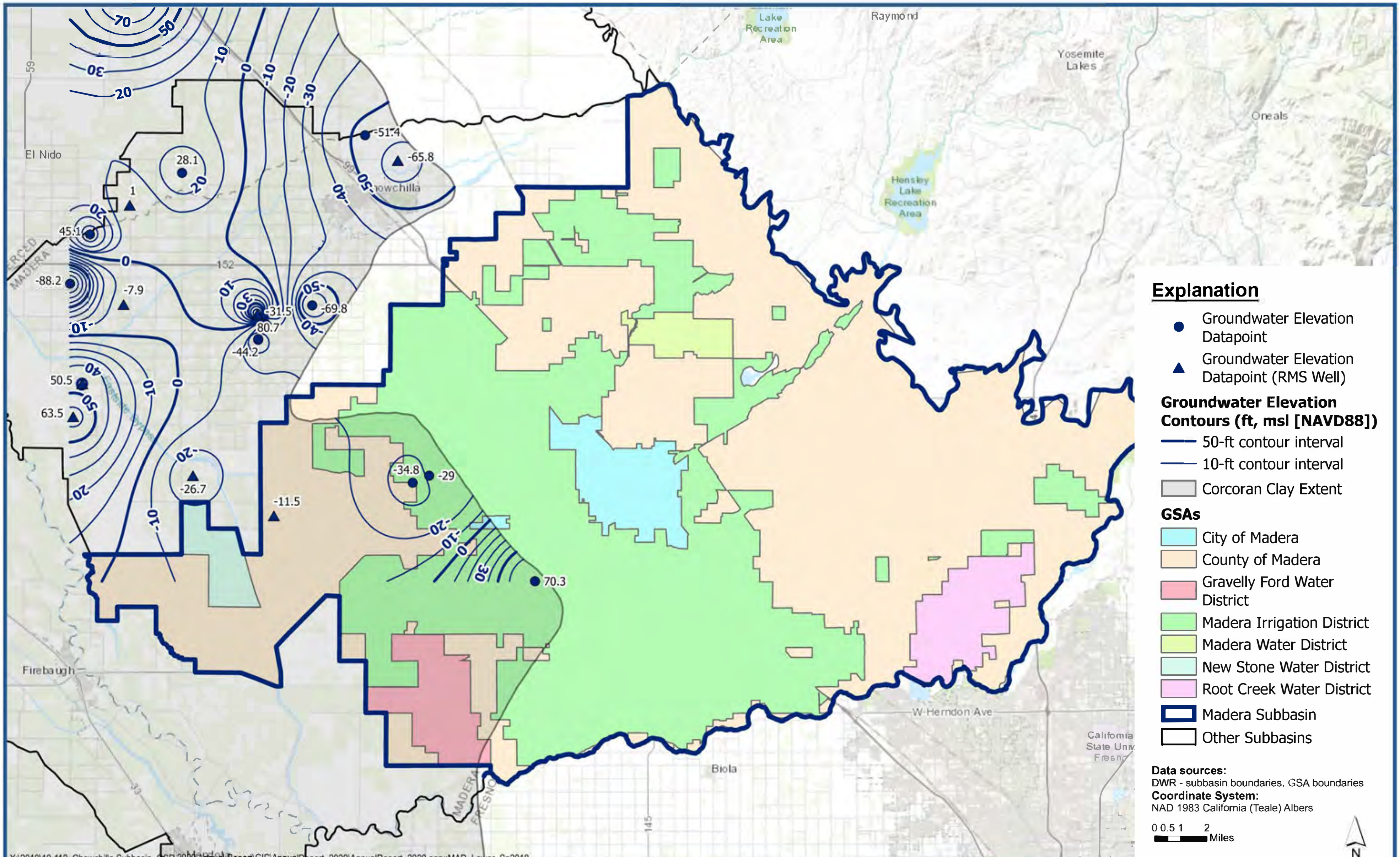

Contours of Equal Groundwater Elevation
Lower Aquifer - Spring 2018

Figure A-21

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

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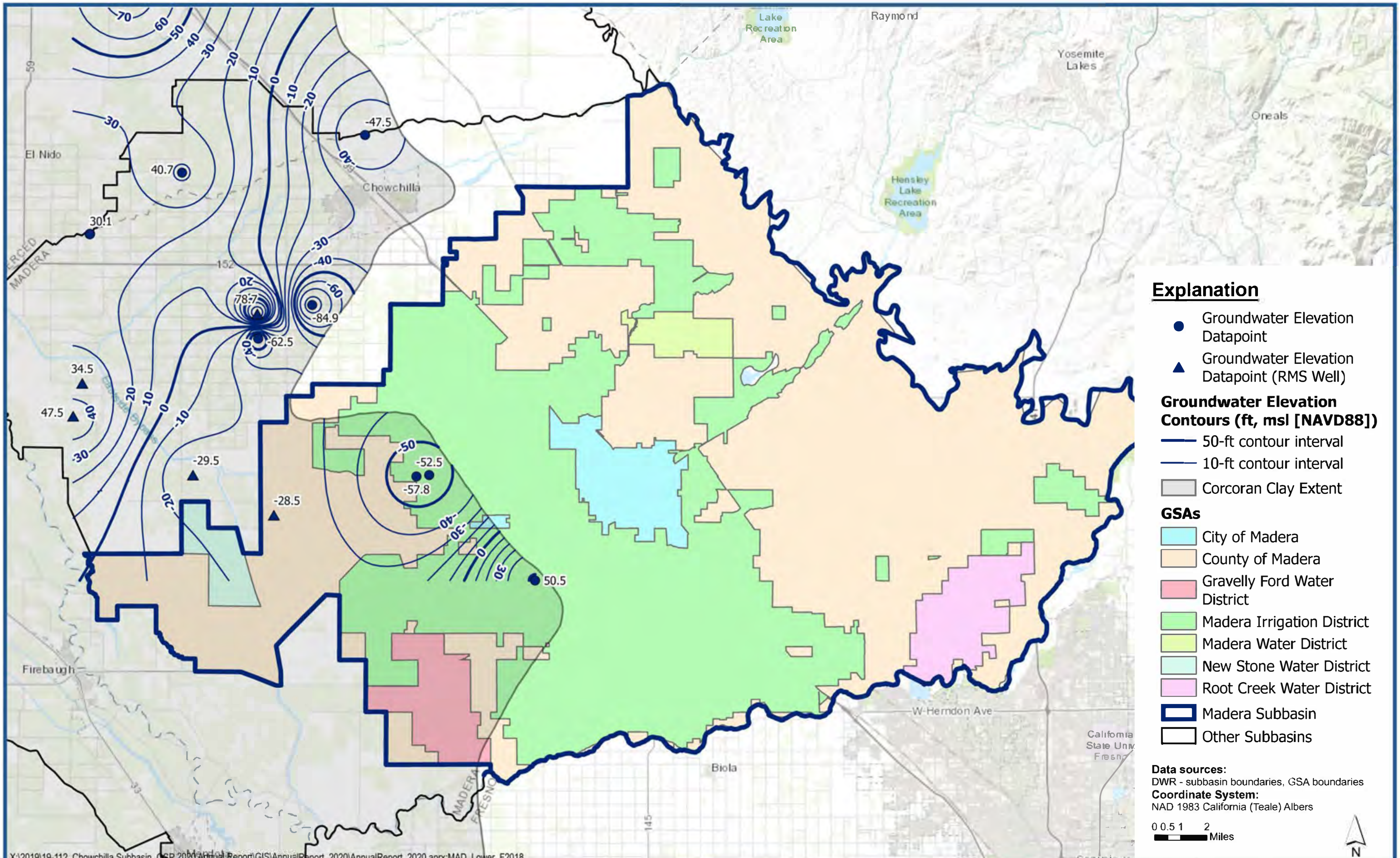
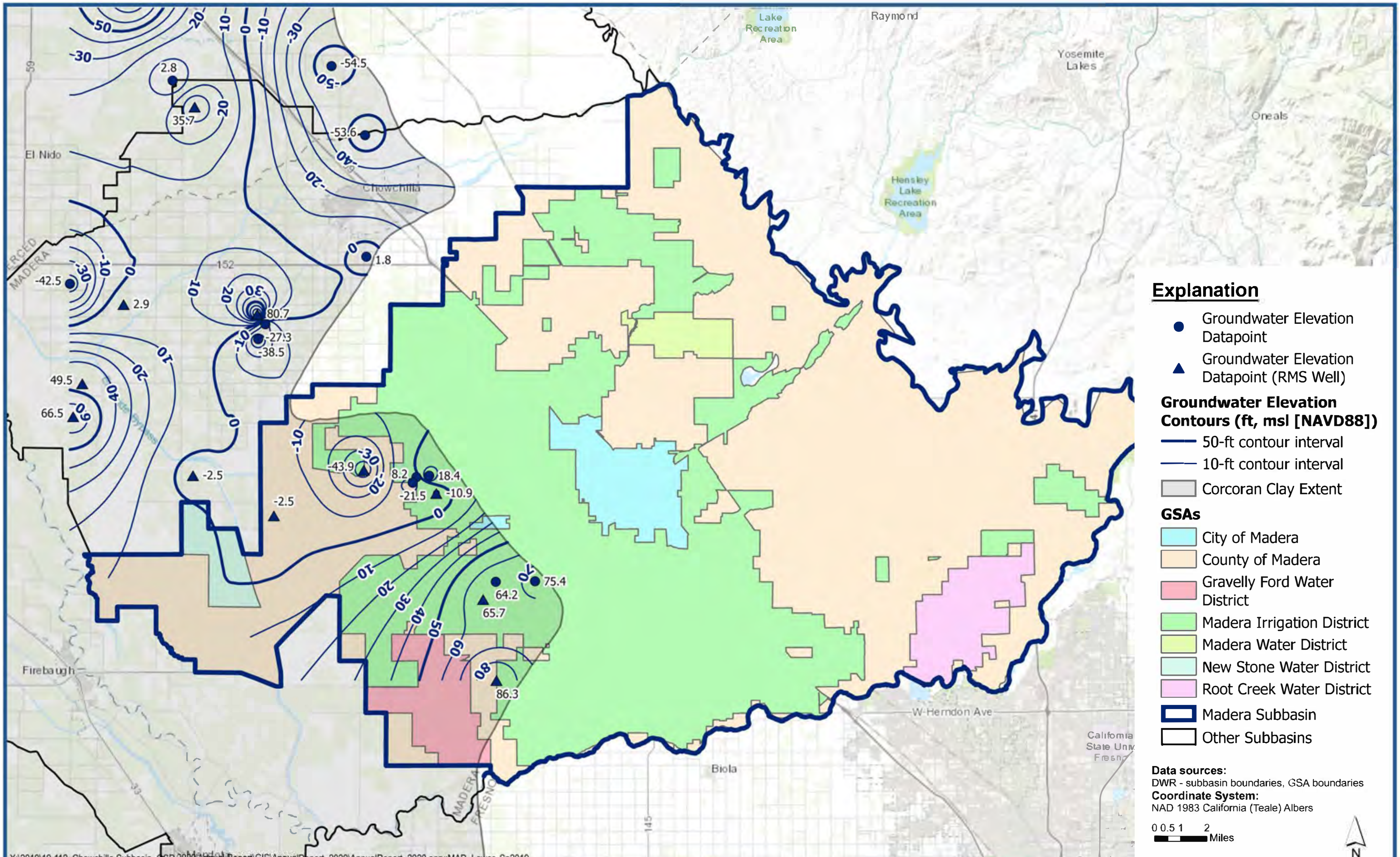
X:\2019\19-112 Chowchilla Subbasin GSP 2020\Annual Report\GIS\AnnualReport_2020\AnnualReport_2020.aprx:MAD_Lower_Sp2018



Contours of Equal Groundwater Elevation
Lower Aquifer - Fall 2018

Figure A-22

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

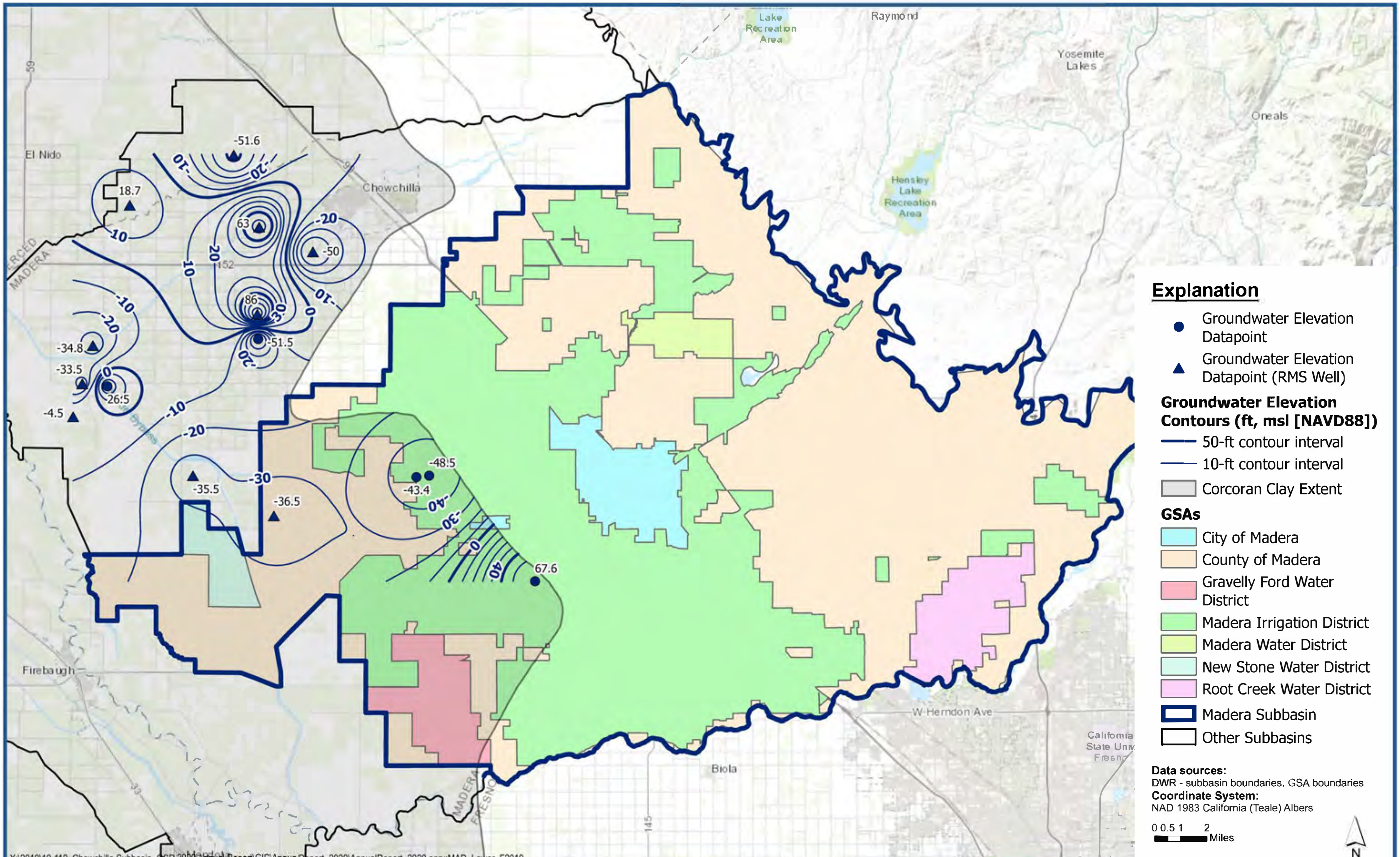


Contours of Equal Groundwater Elevation
Lower Aquifer - Spring 2019

Figure A-23

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

DAVIDS ENGINEERING, INC
Luhdorff & Scalmanini Consulting Engineers



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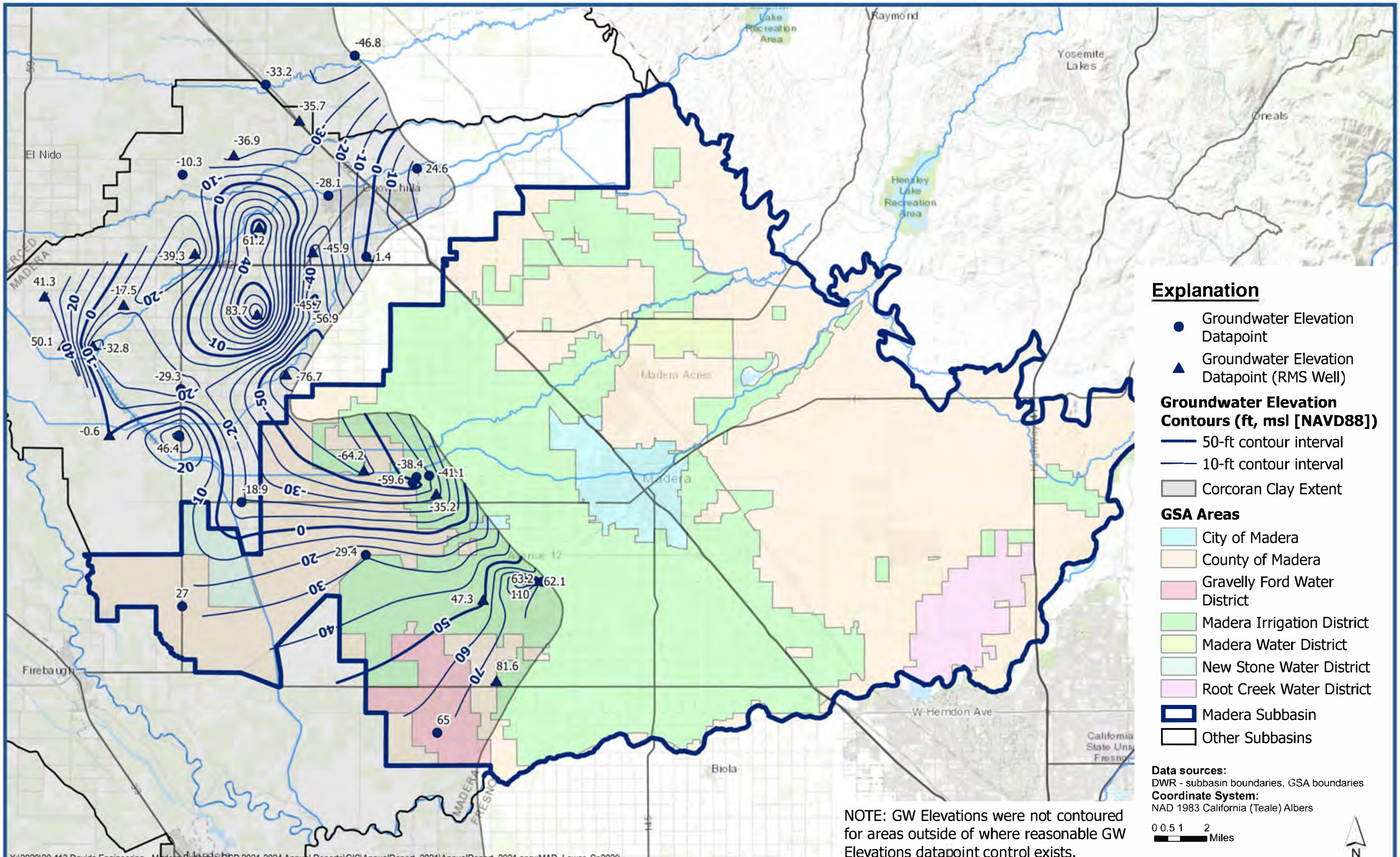
Contours of Equal Groundwater Elevation
Lower Aquifer - Fall 2019

Figure A-24

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



Contours of Equal Groundwater Elevation
Lower Aquifer - Spring 2020

Figure A-25

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

DAVIDS ENGINEERING, INC
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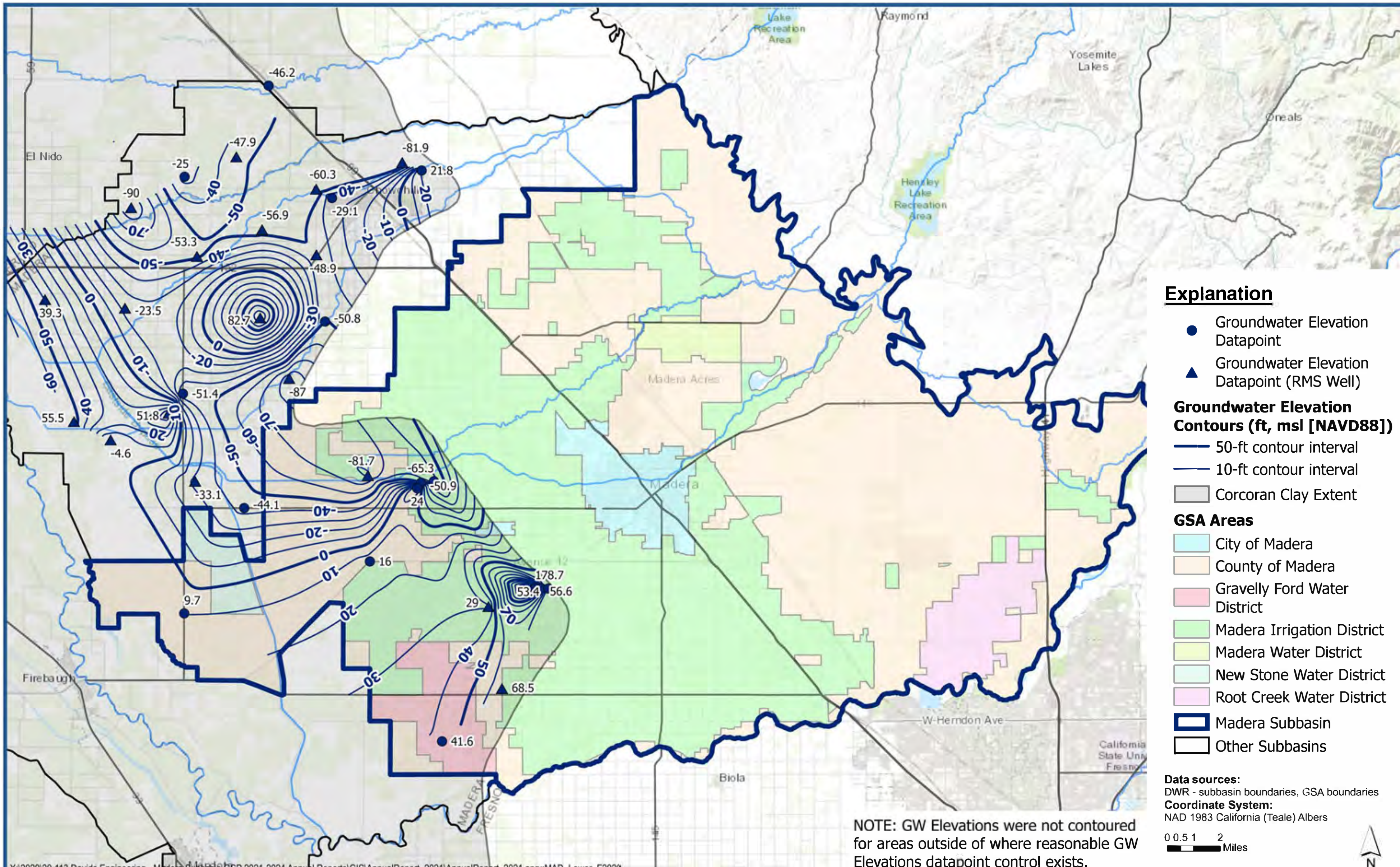

Contours of Equal Groundwater Elevation
Lower Aquifer - Fall 2020

Figure A-26

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

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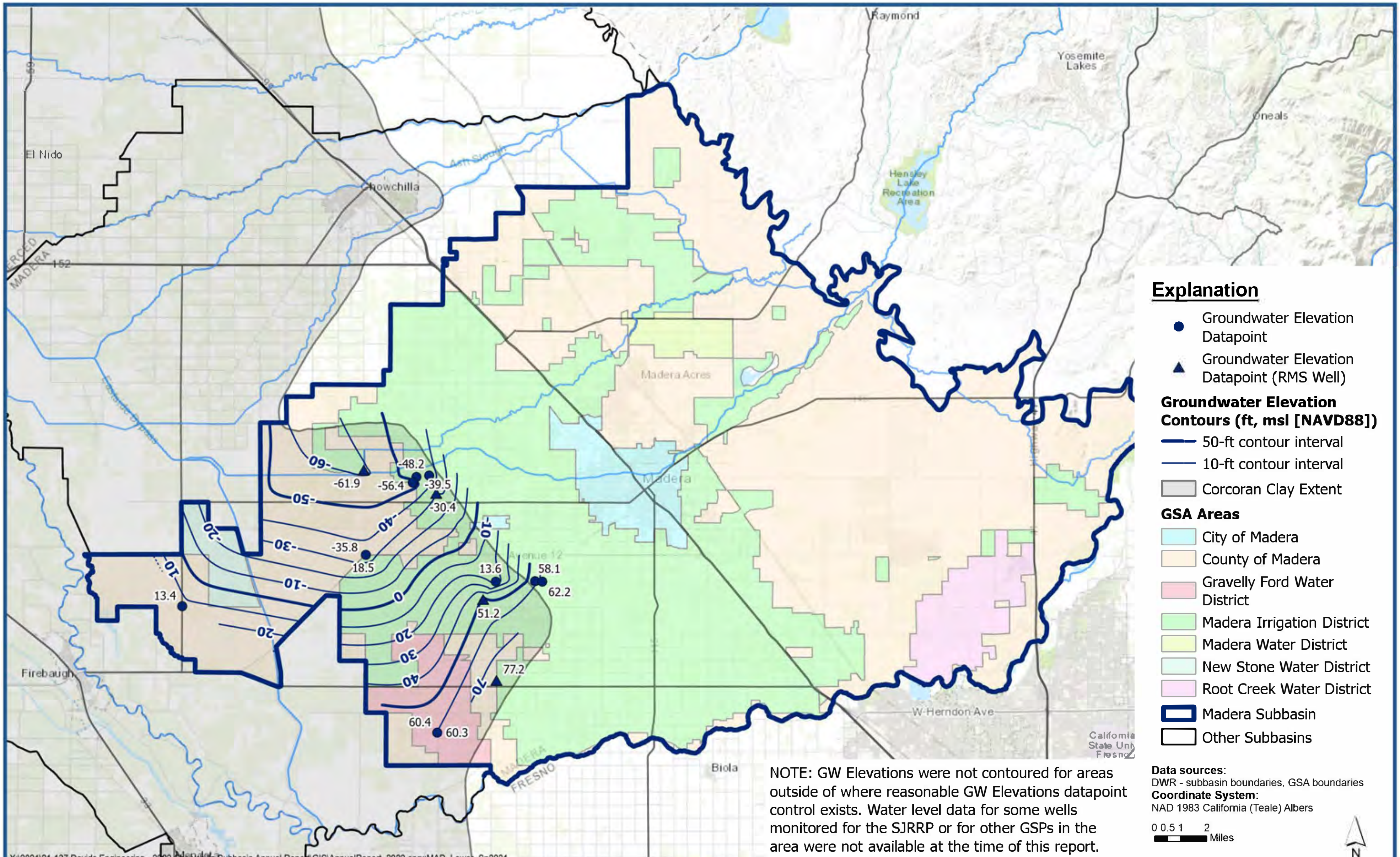
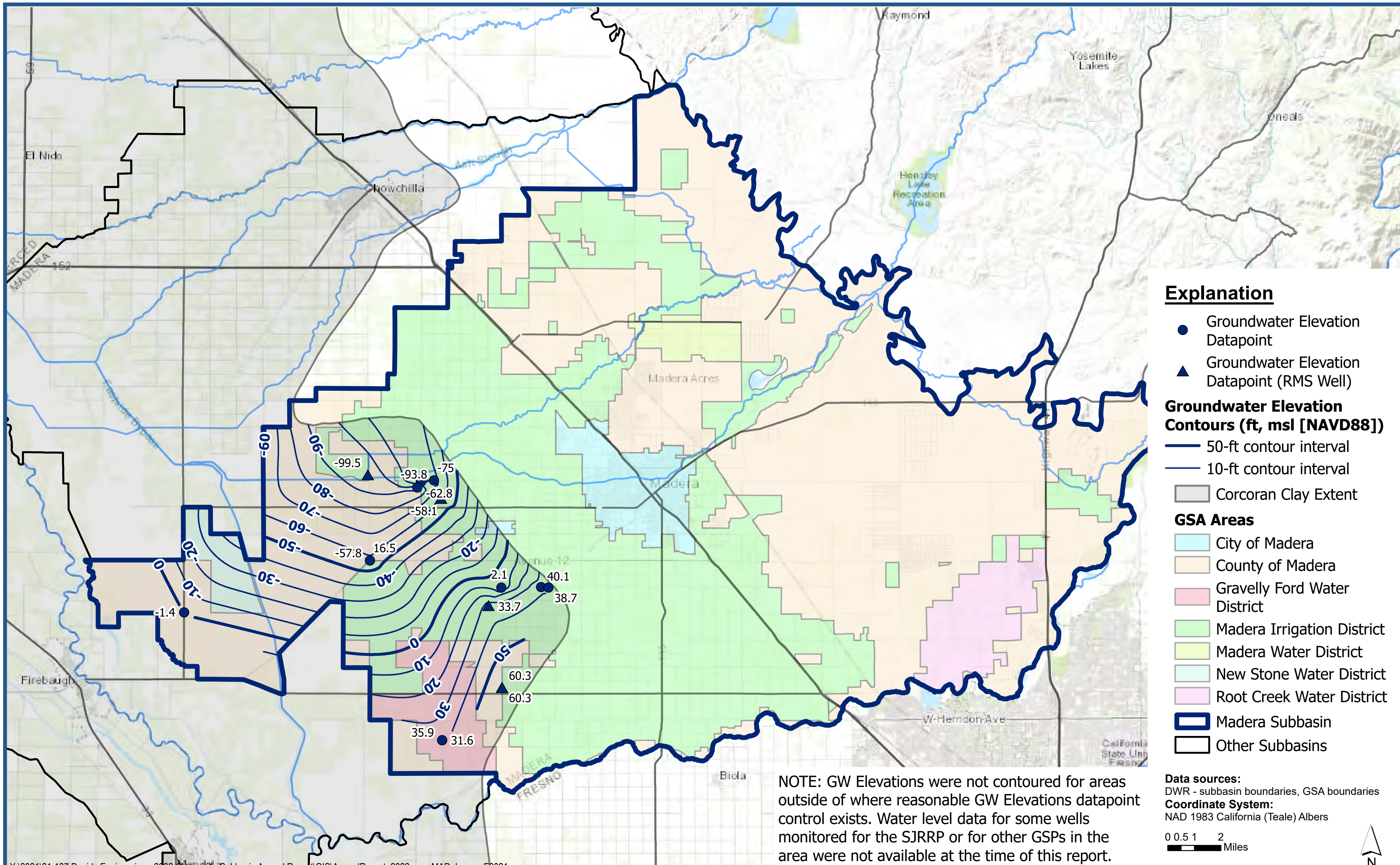


Contours of Equal Groundwater Elevation
Lower Aquifer - Spring 2021

Figure A-27

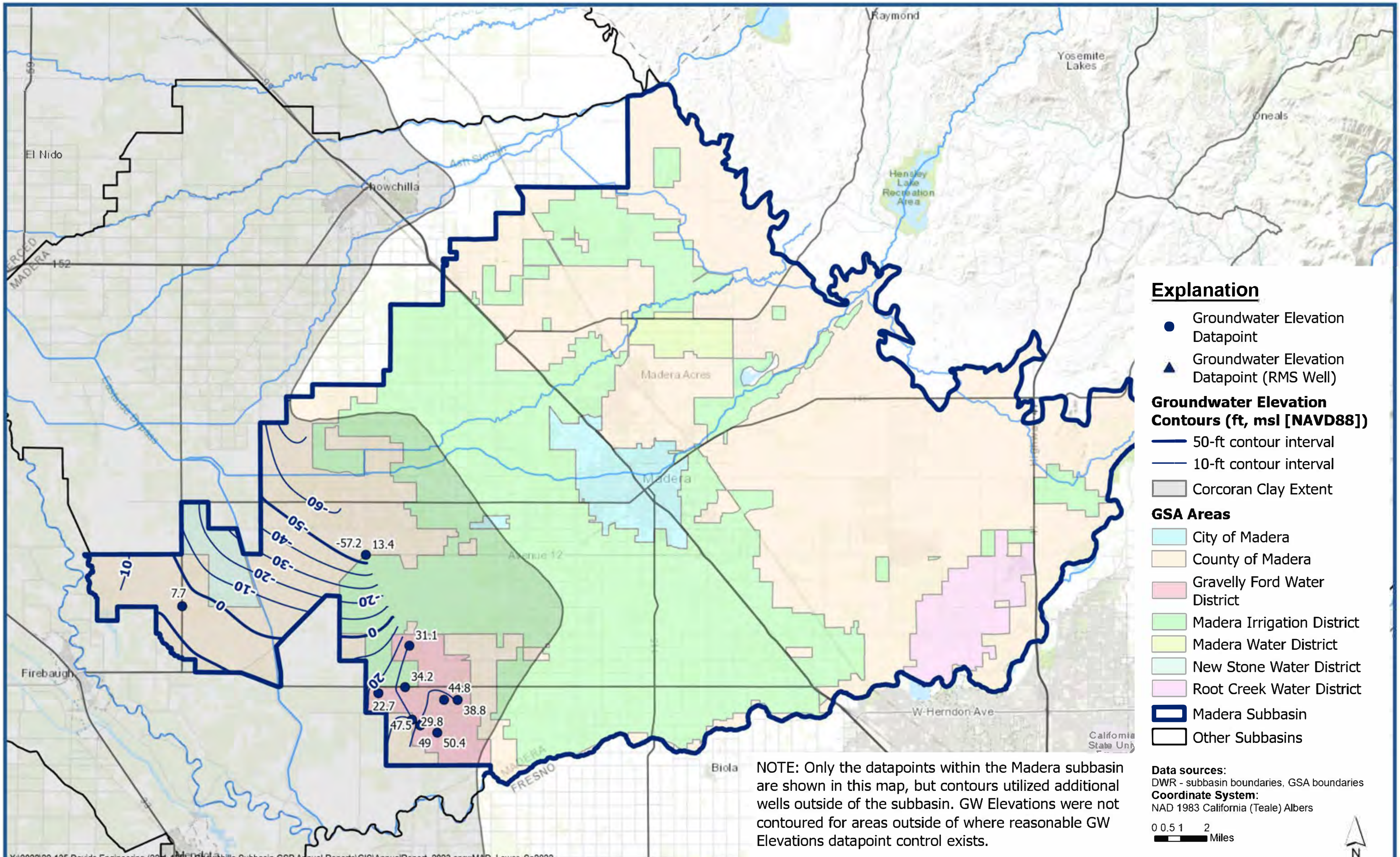
Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



Contours of Equal Groundwater Elevation
Lower Aquifer - Fall 2021

Figure A-28

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



NOTE: Only the datapoints within the Madera subbasin are shown in this map, but contours utilized additional wells outside of the subbasin. GW Elevations were not contoured for areas outside of where reasonable GW Elevations datapoint control exists.

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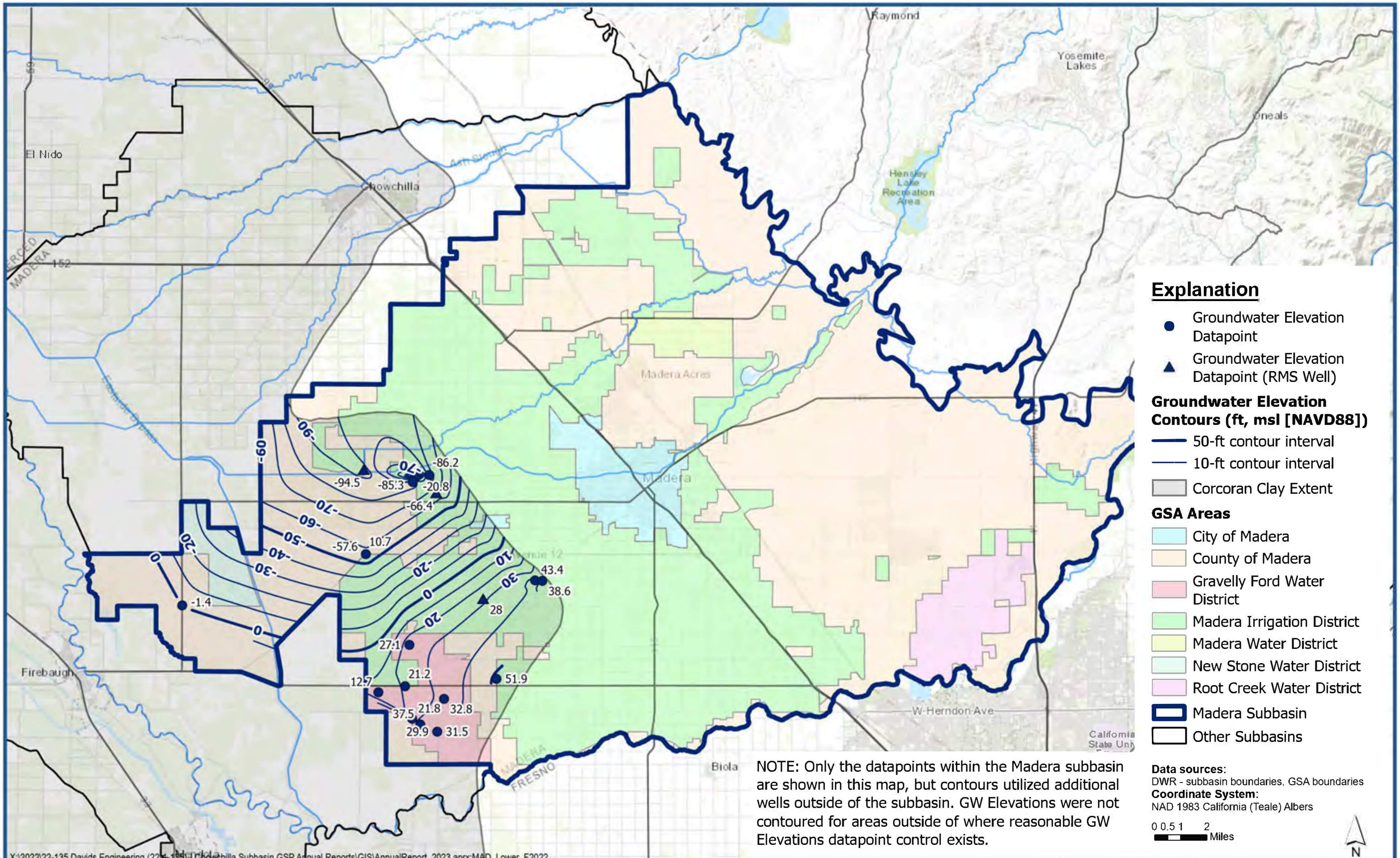
Contours of Equal Groundwater Elevation
Lower Aquifer - Spring 2022

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure A-29



Contours of Equal Groundwater Elevation
Lower Aquifer - Fall 2022

Figure A-30

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

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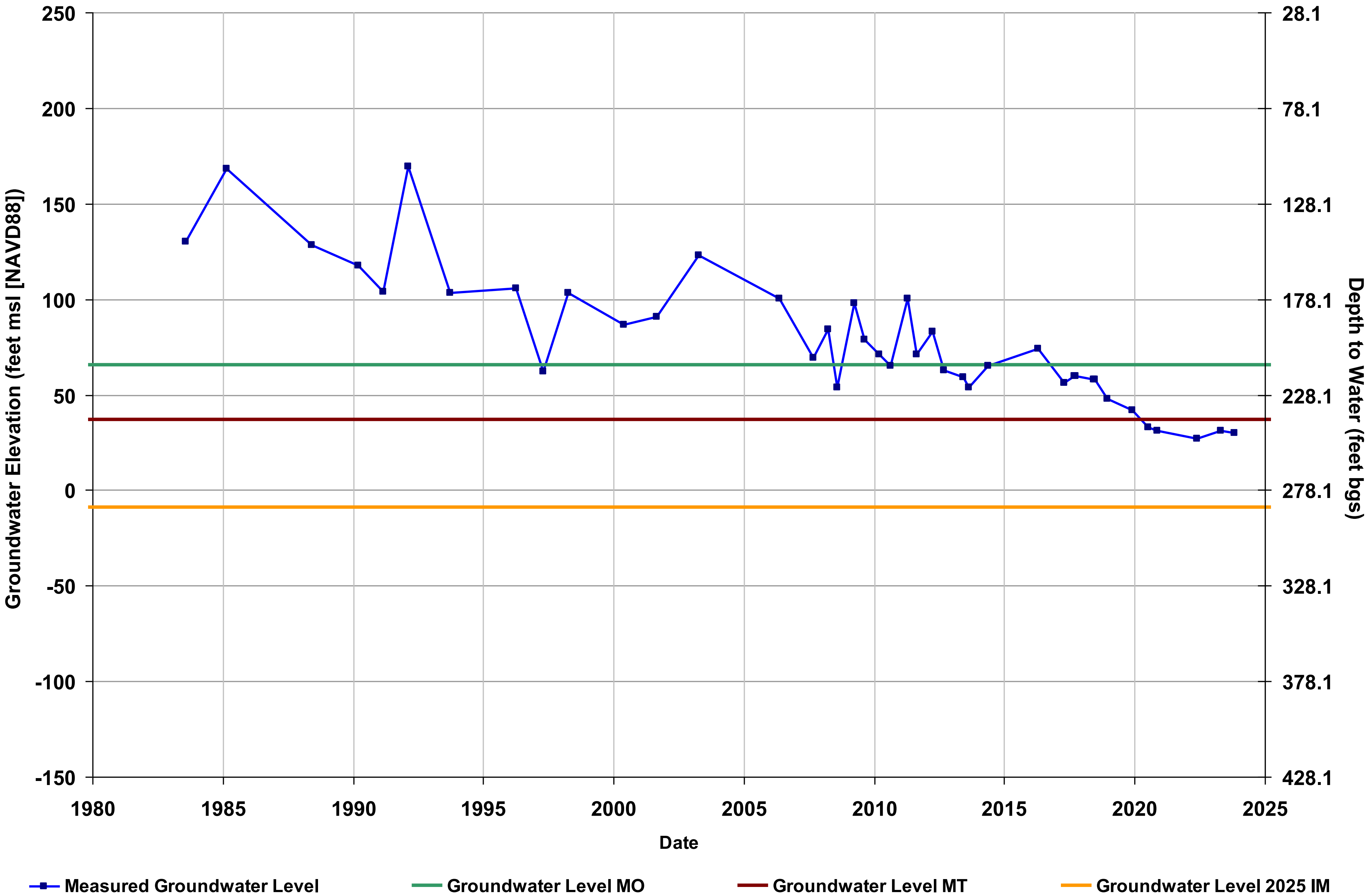
Appendix B. Hydrographs of Time-Series Groundwater Level Data for Groundwater Level RMS Wells.

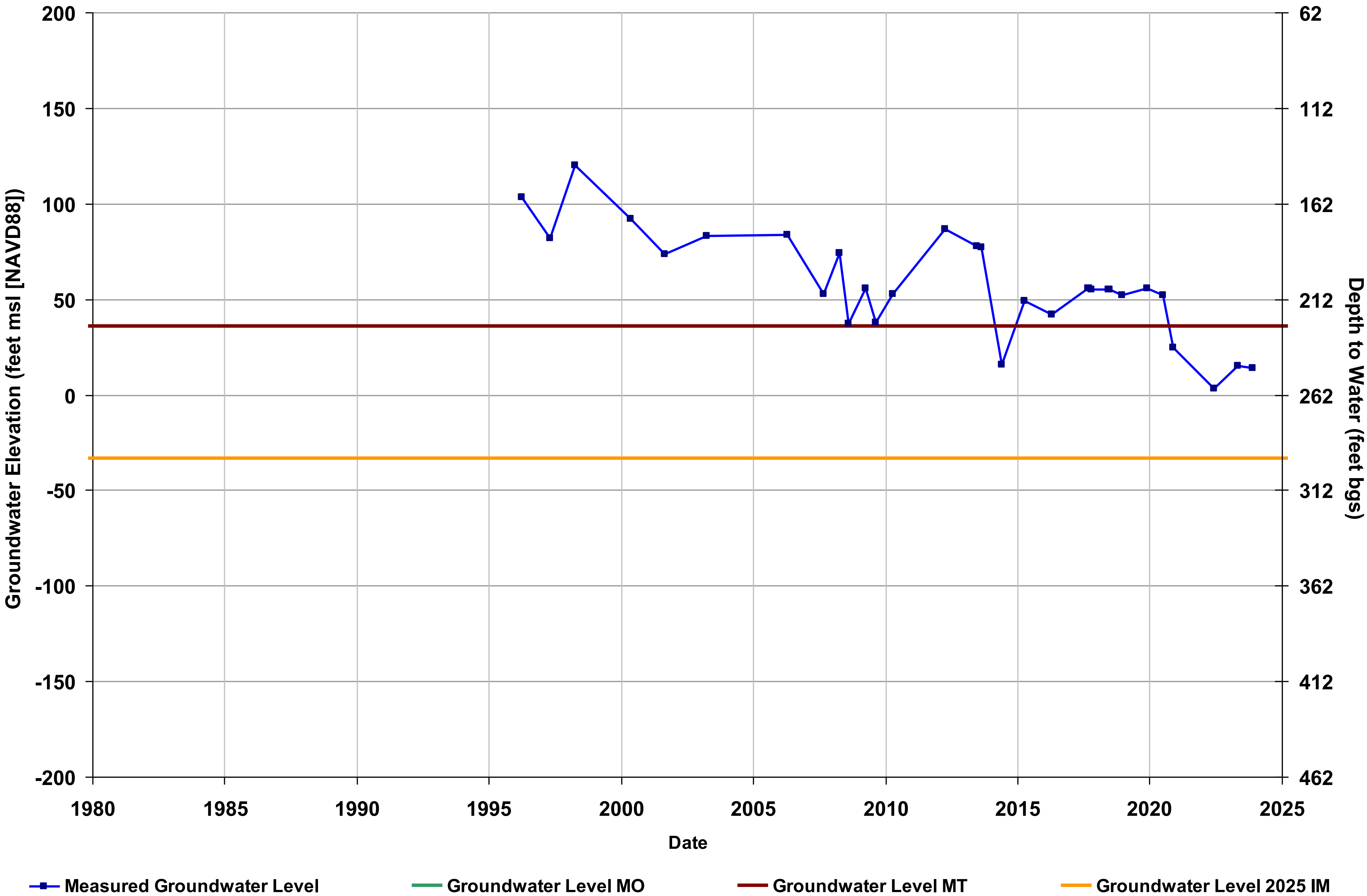
Well Name: COM RMS-1
Depth Zone: Lower
Subbasin: Madera
GSA: City of Madera

Total Depth (ft bgs): 520
Perf. Top (ft bgs): 210
Perf. Bottom (ft bgs): 510
GSE (ft, msl): 278.1



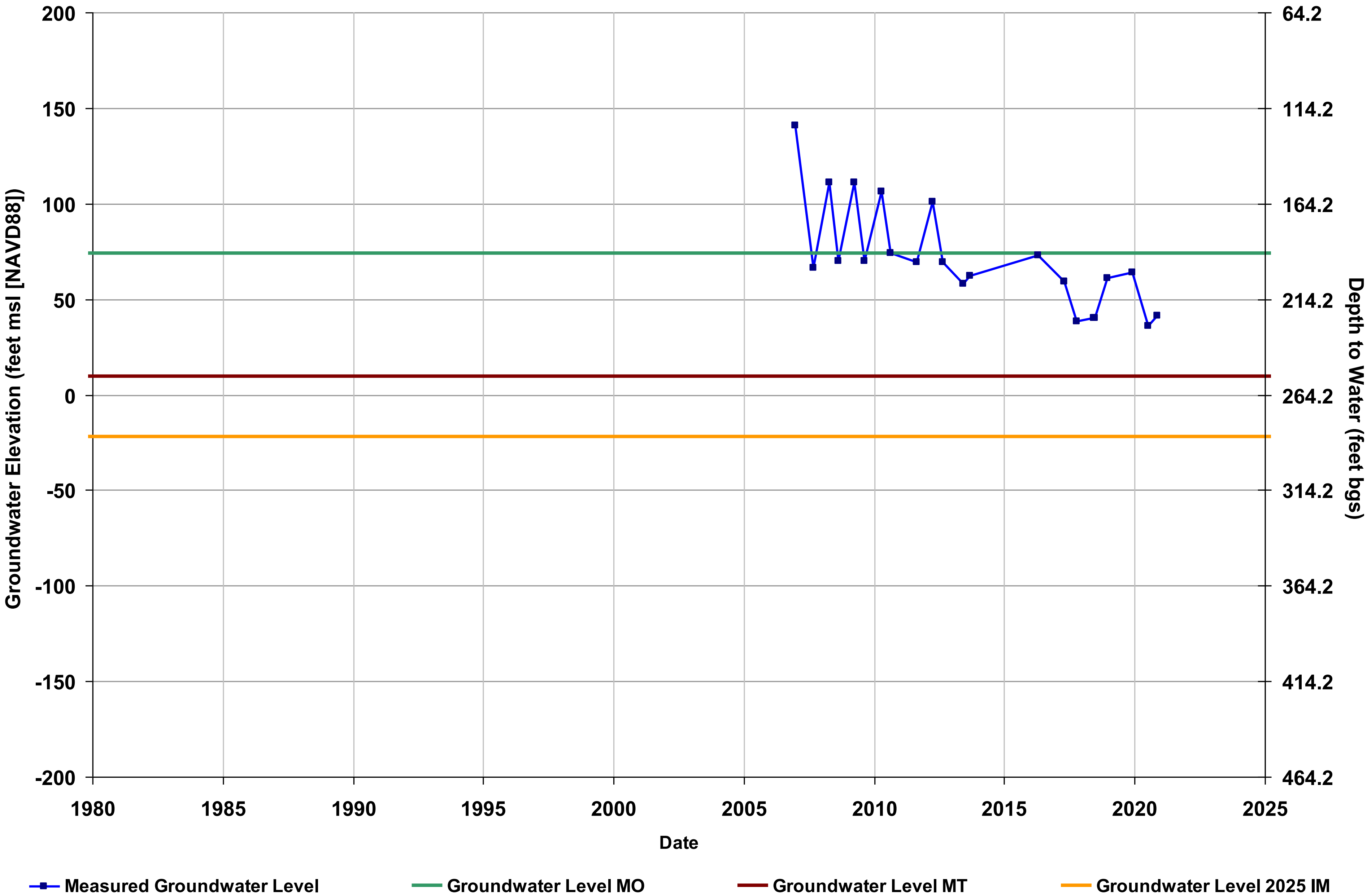
Well Name: COM RMS-2
Depth Zone: Lower
Subbasin: Madera
GSA: City of Madera

Total Depth (ft bgs): 590
Perf. Top (ft bgs): 370
Perf. Bottom (ft bgs): 590
GSE (ft, msl): 262



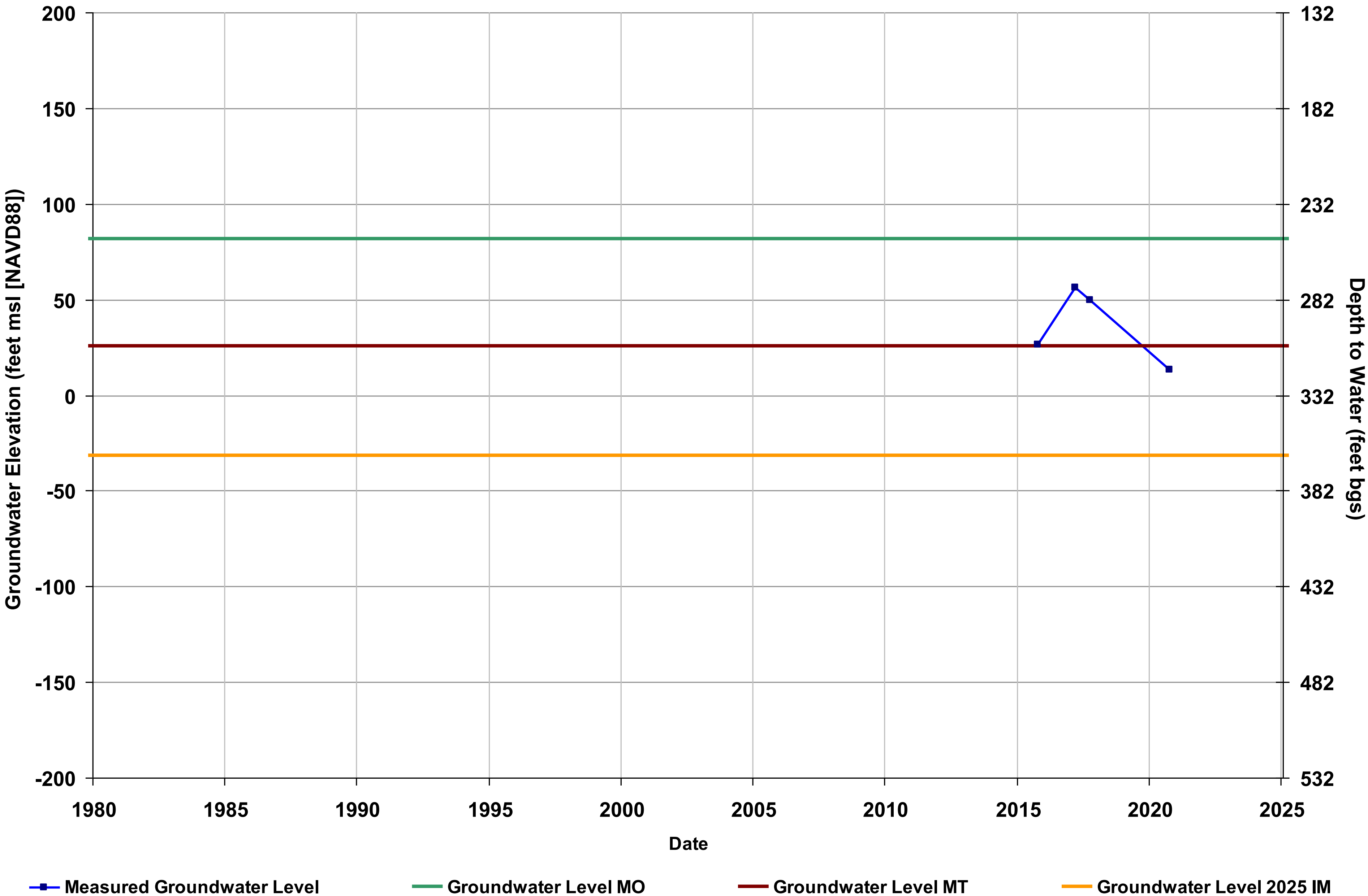
Well Name: COM RMS-3
Depth Zone: Lower
Subbasin: Madera
GSA: City of Madera

Total Depth (ft bgs): 620
Perf. Top (ft bgs): 310
Perf. Bottom (ft bgs): 600
GSE (ft, msl): 264.2



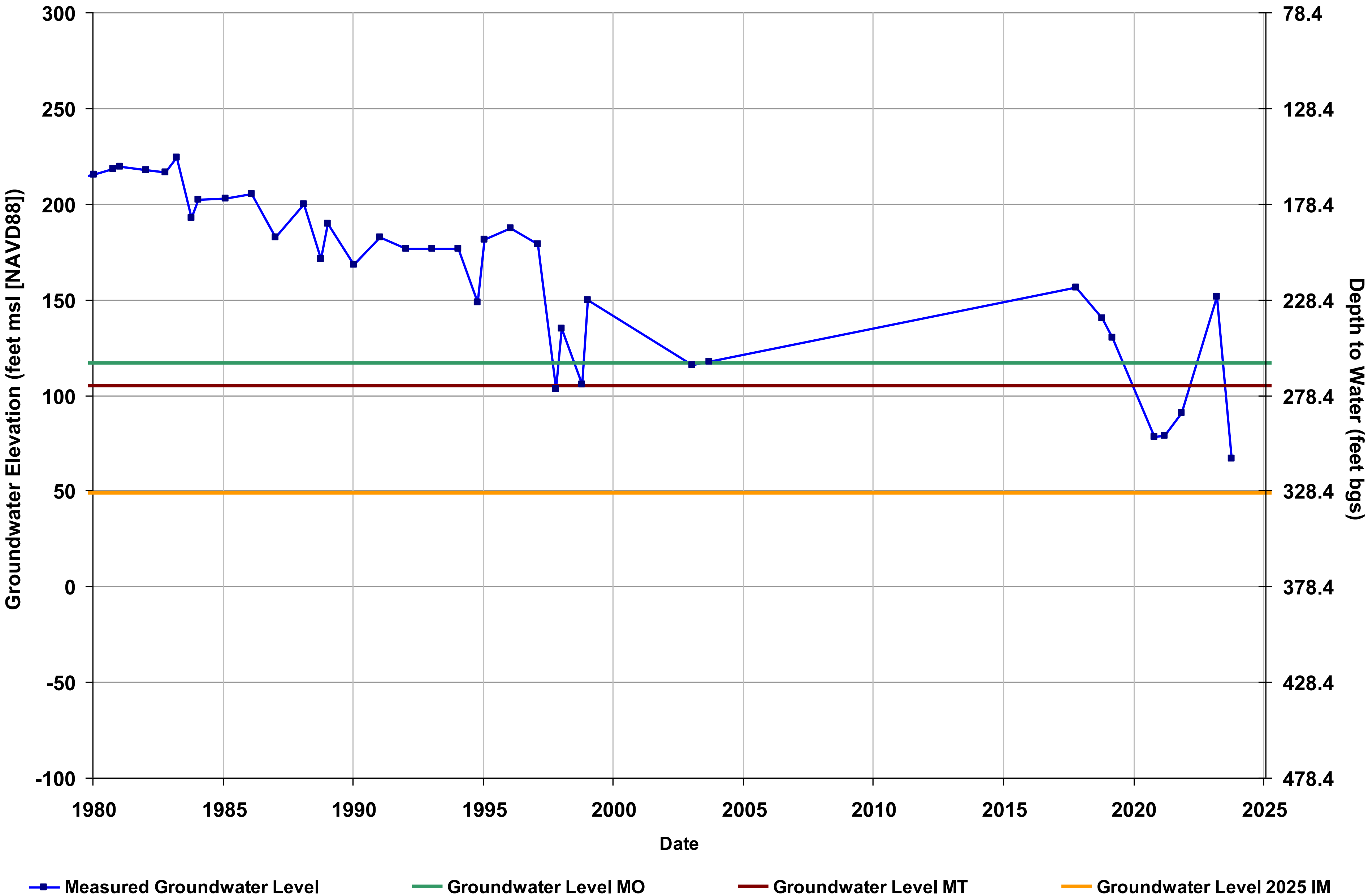
Well Name: MCE RMS-1
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

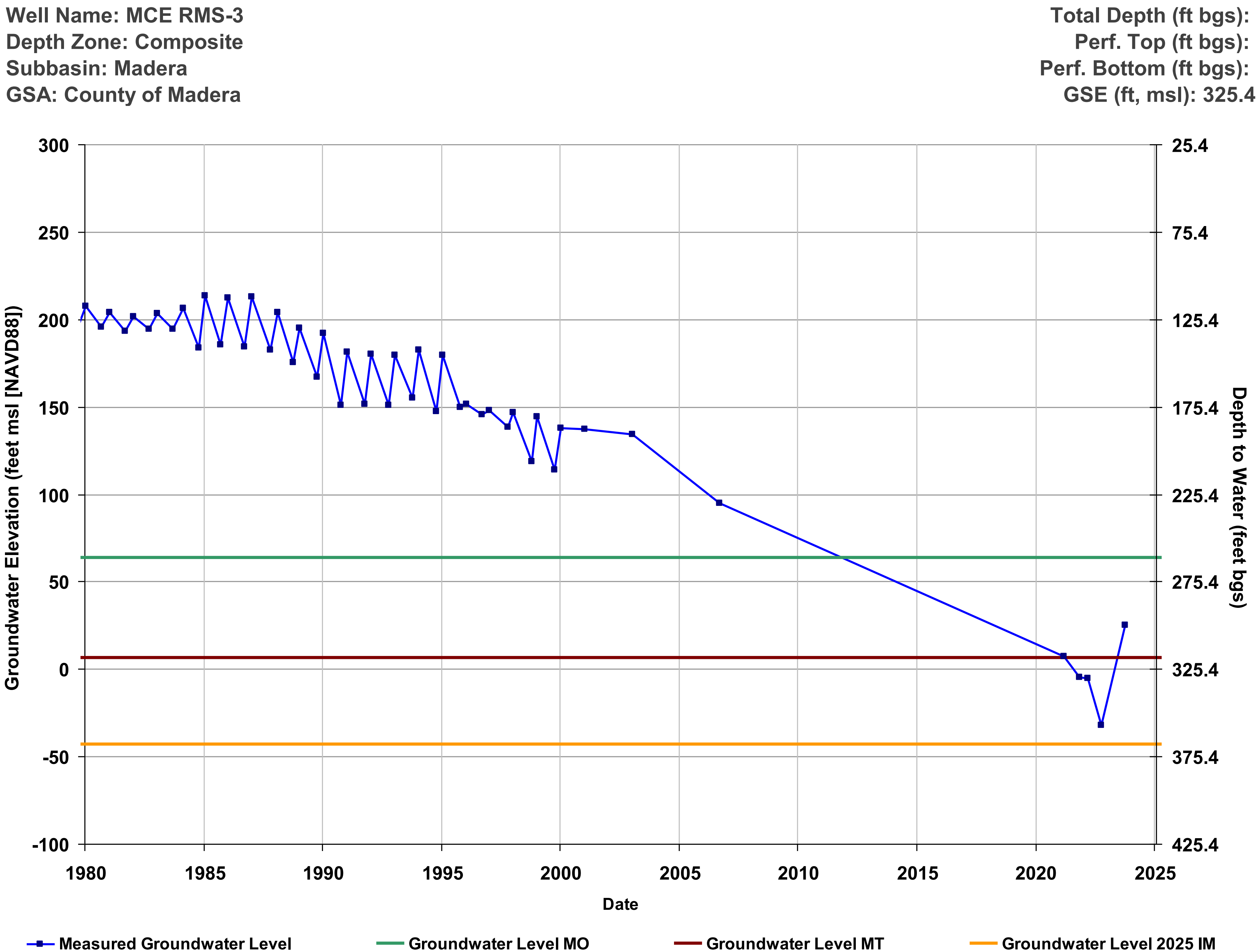
Total Depth (ft bgs): 500
Perf. Top (ft bgs): 420
Perf. Bottom (ft bgs): 500
GSE (ft, msl): 332



Well Name: MCE RMS-2
Depth Zone: Composite
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 378.4

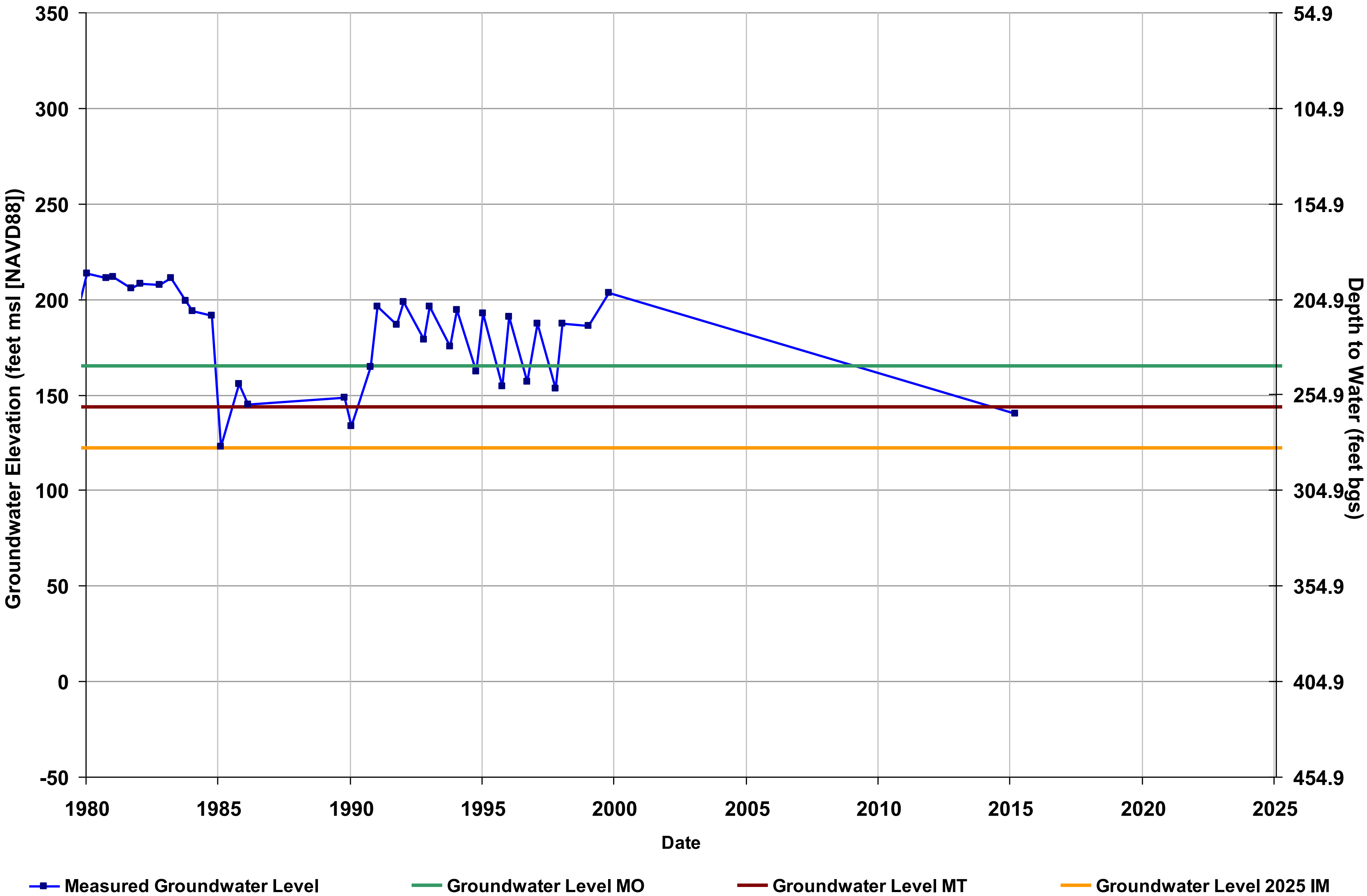




Well Name: MCE RMS-3
Depth Zone: Composite
Subbasin: Madera
GSA: County of Madera
Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 325.4
Groundwater Elevation (feet msl [NAVD88])
Depth to Water (feet bgs)
300
250
200
150
100
50
0
-50
-100
25.4
75.4
125.4
175.4
225.4
275.4
325.4
375.4
425.4
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
Date
Measured Groundwater Level
Groundwater Level MO
Groundwater Level MT
Groundwater Level 2025 IM

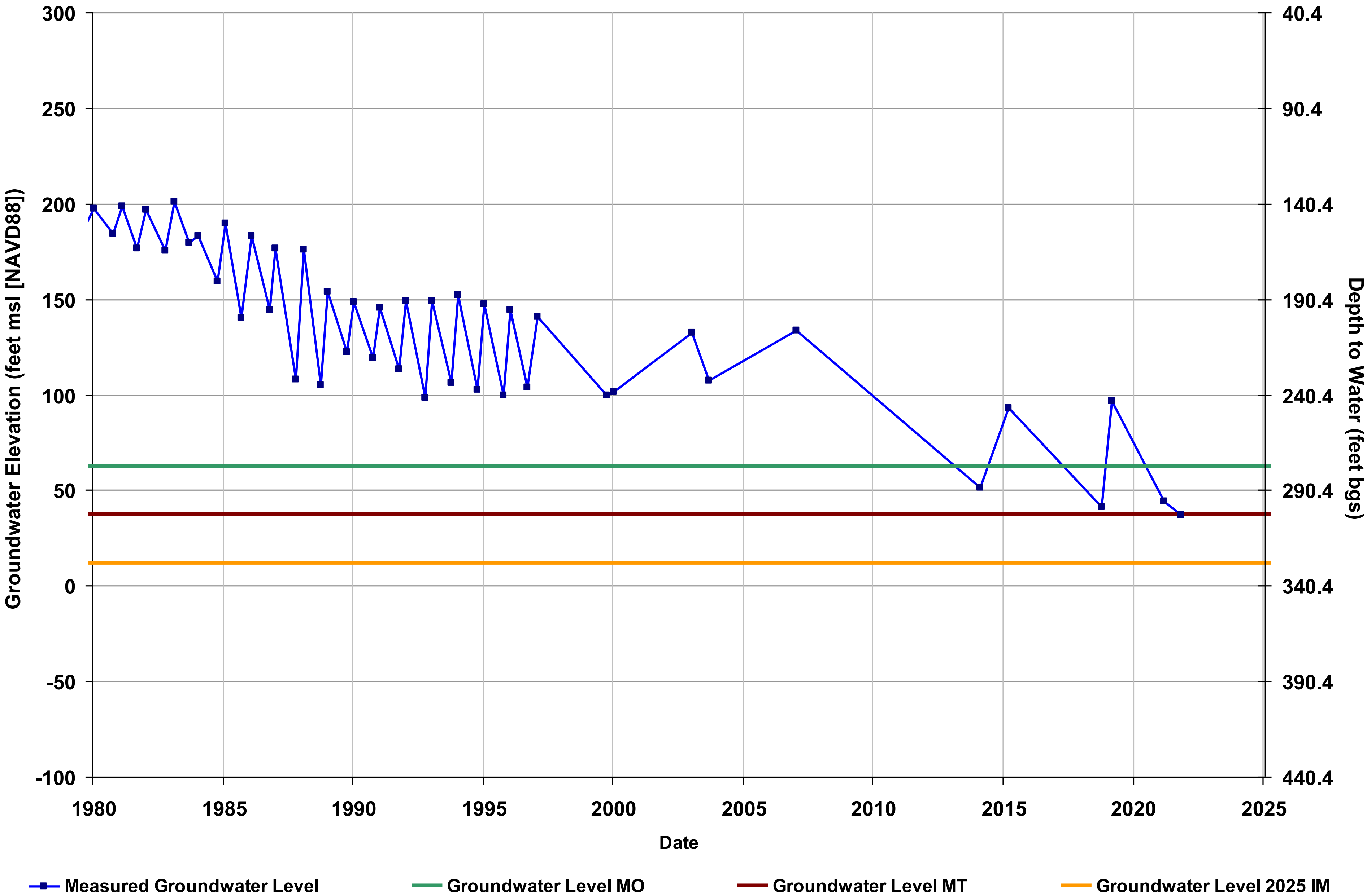
Well Name: MCE RMS-4
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 405



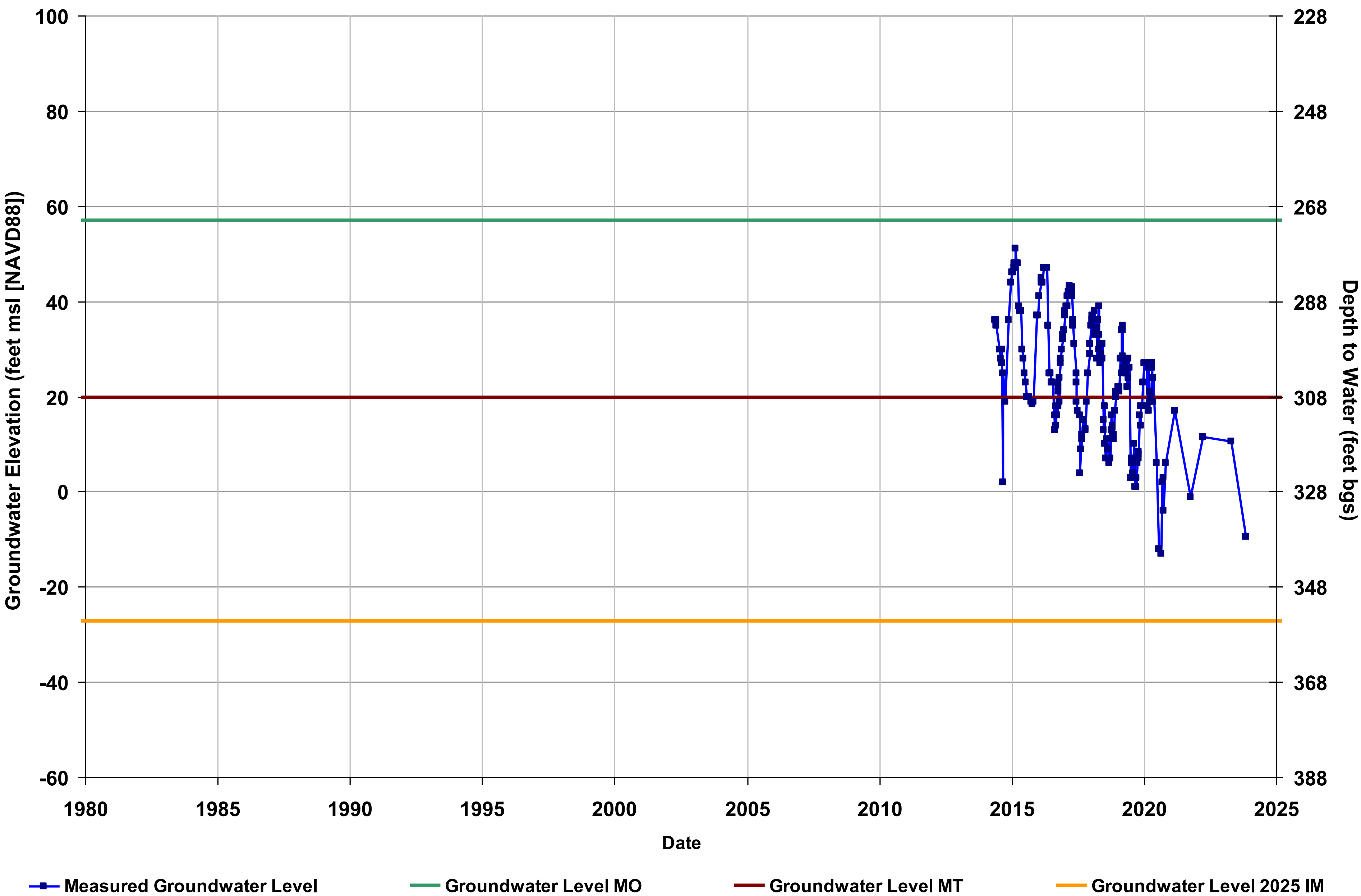
Well Name: MCE RMS-5
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 340.4



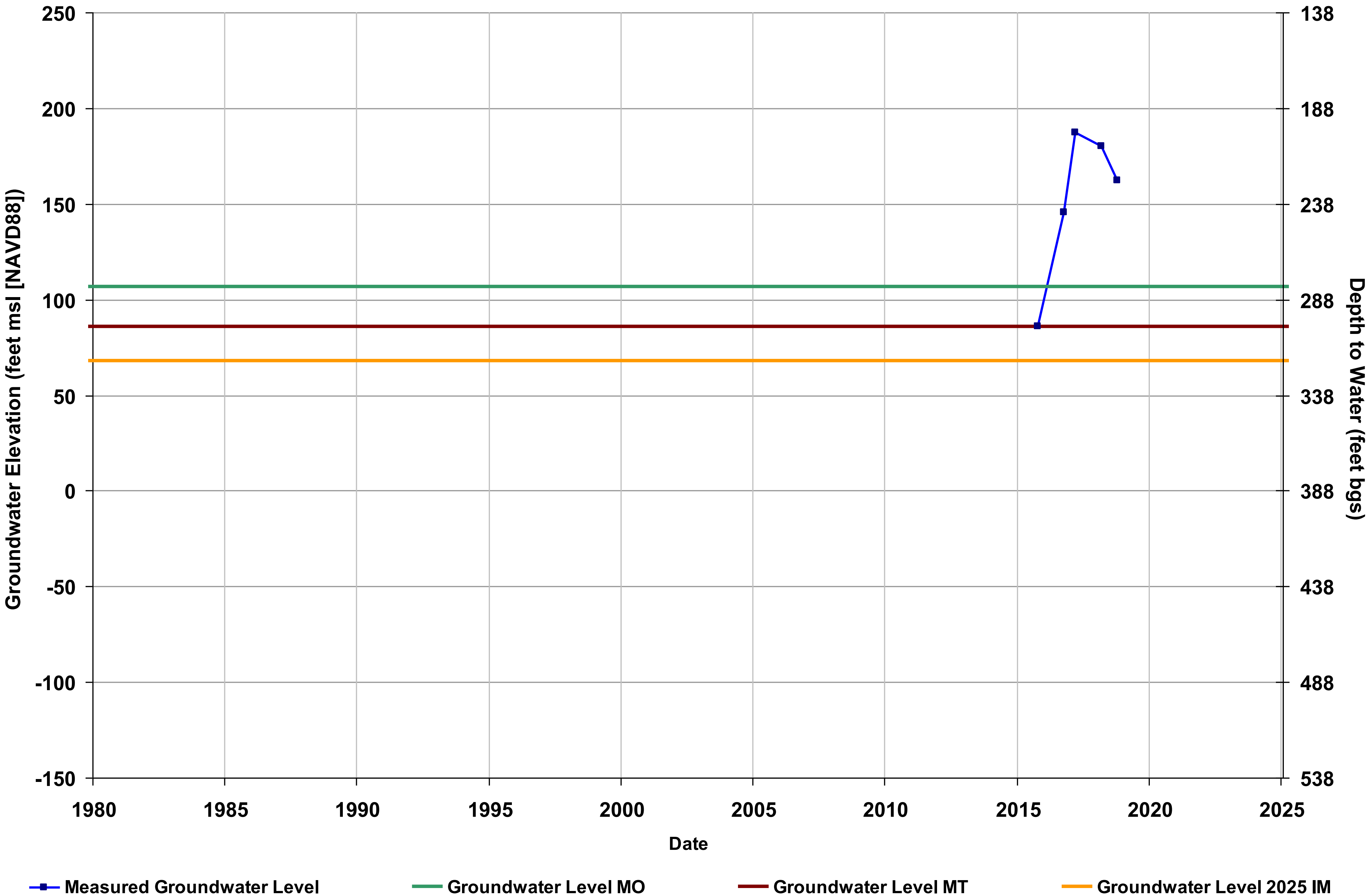
Well Name: MCE RMS-6
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 550
Perf. Top (ft bgs): 450
Perf. Bottom (ft bgs): 550
GSE (ft, msl): 328



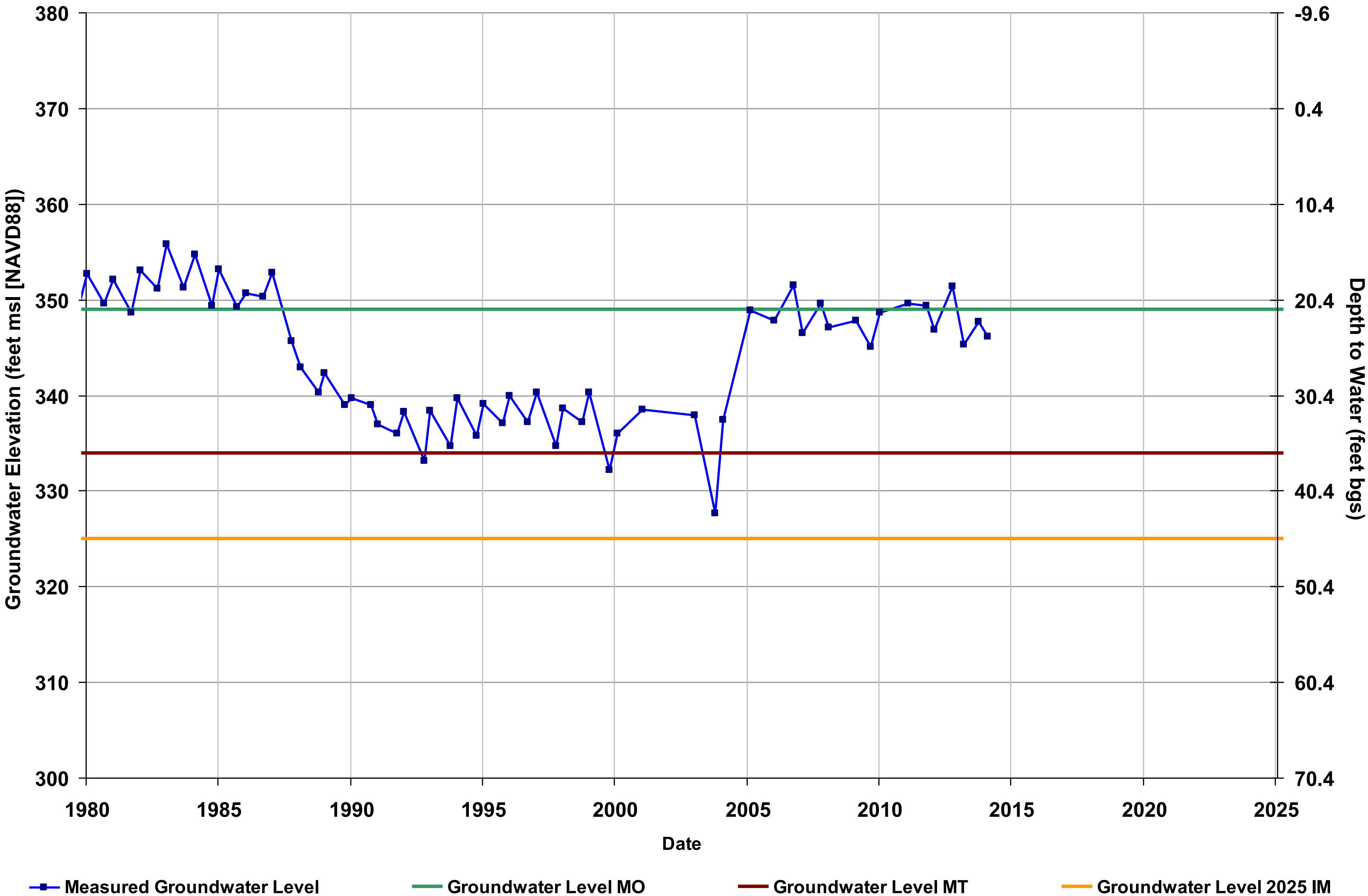
Well Name: MCE RMS-7
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 840
Perf. Top (ft bgs): 370
Perf. Bottom (ft bgs): 820
GSE (ft, msl): 388



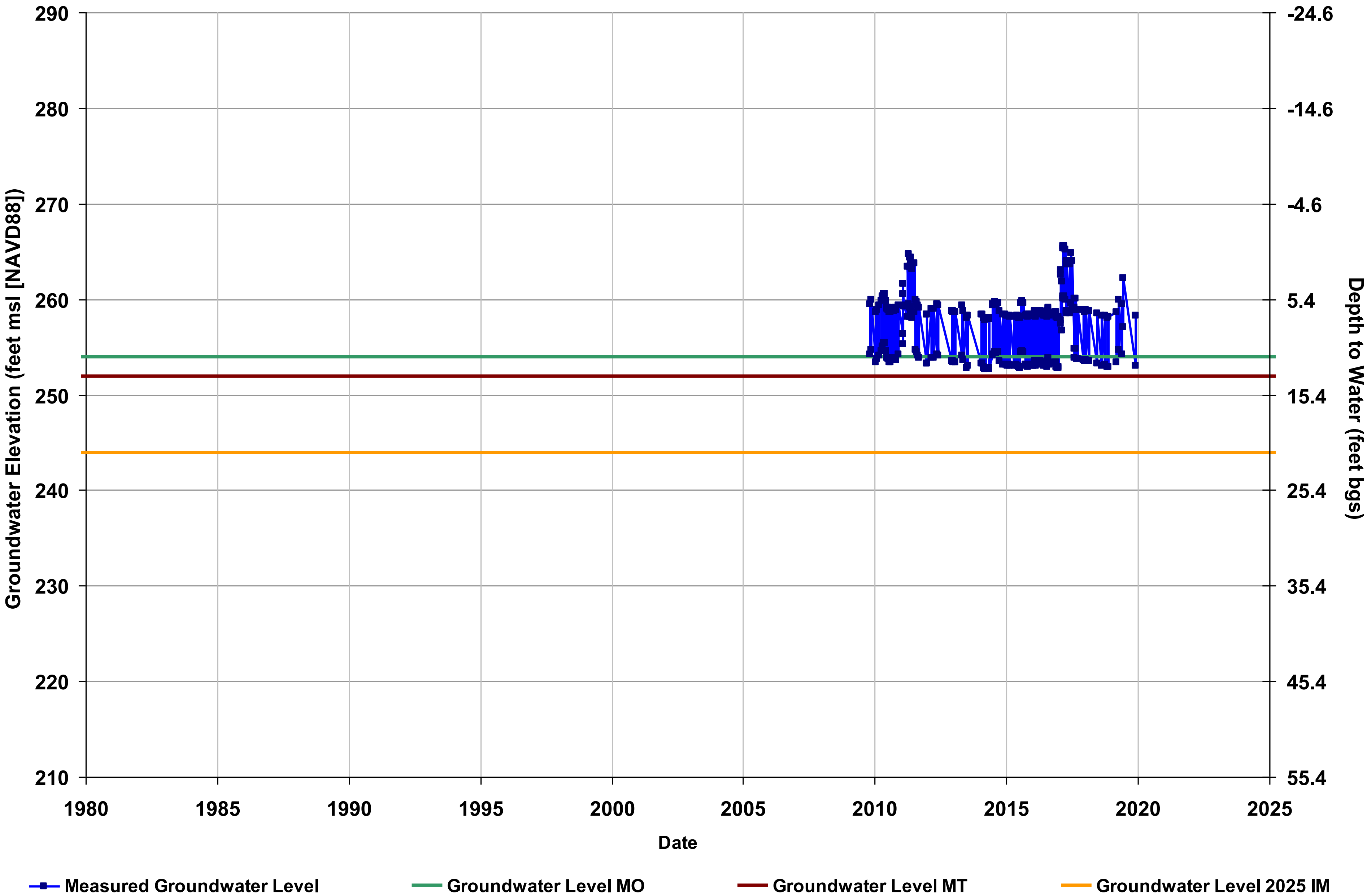
Well Name: MCE RMS-8
Depth Zone: Upper
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 92
Perf. Top (ft bgs): 32
Perf. Bottom (ft bgs): 92
GSE (ft, msl): 370.4



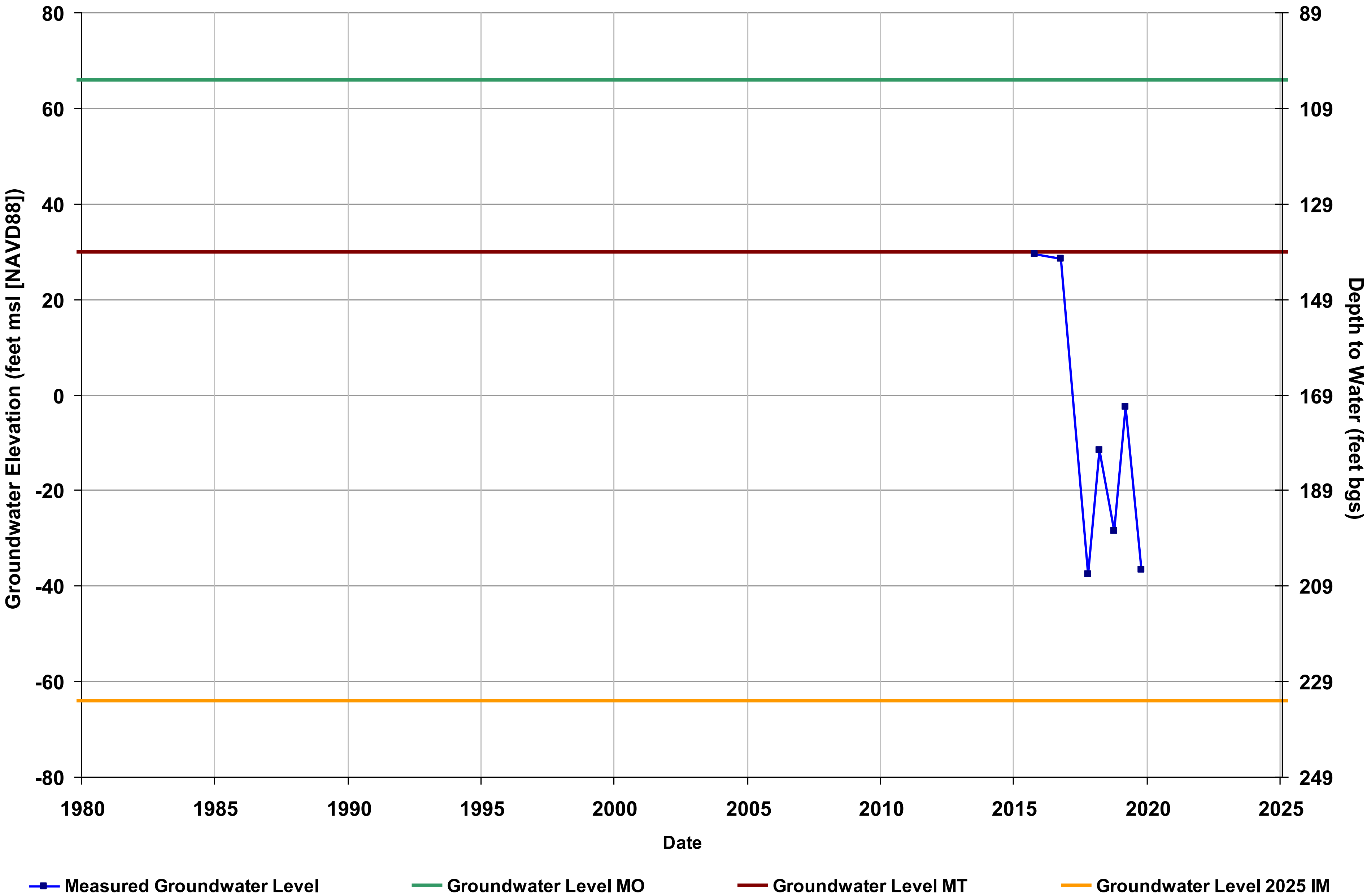
Well Name: MCE RMS-9
Depth Zone: Upper
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 37
Perf. Top (ft bgs): 17
Perf. Bottom (ft bgs): 37
GSE (ft, msl): 265.4



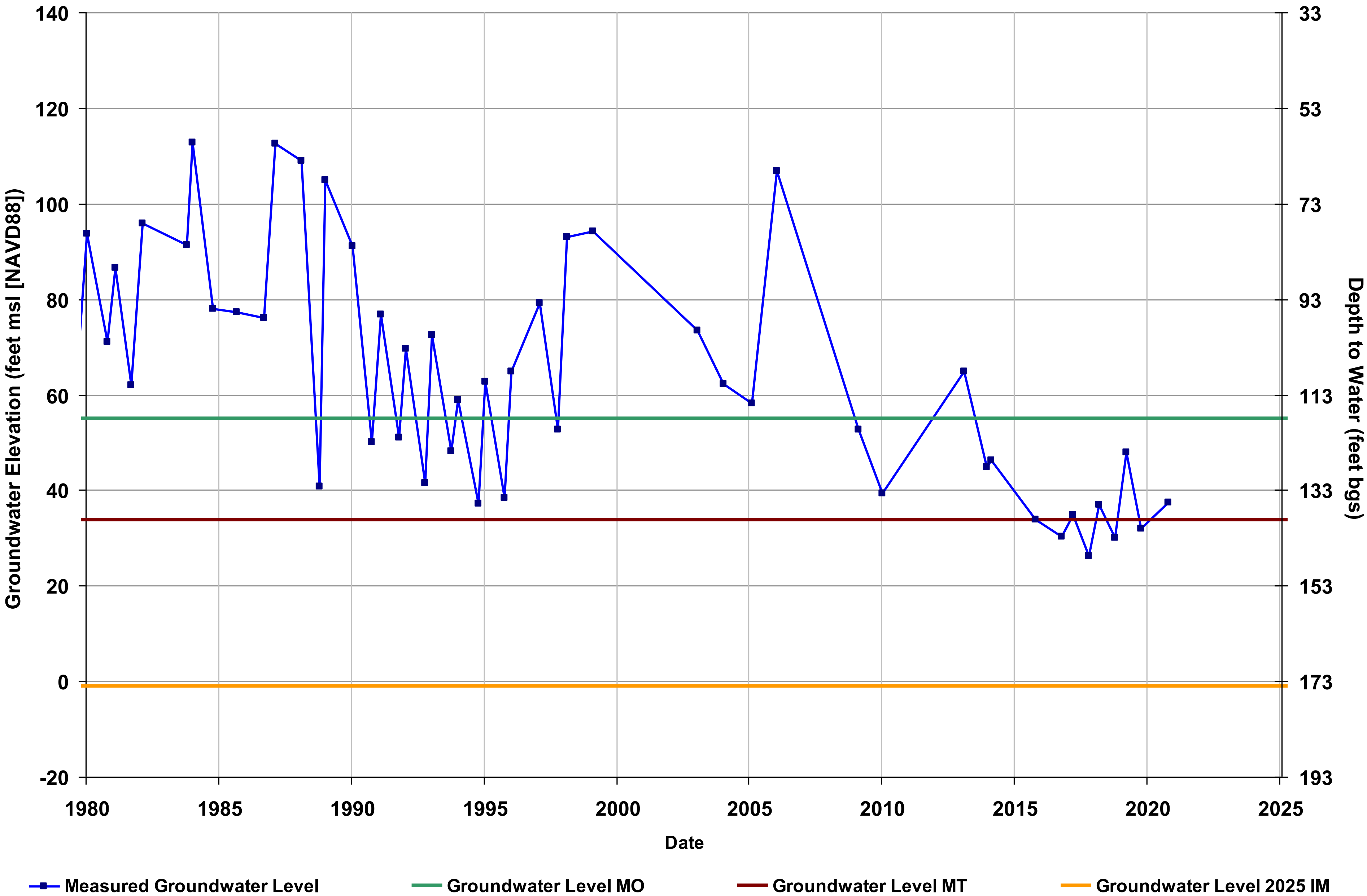
Well Name: MCW RMS-1
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 800
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 169



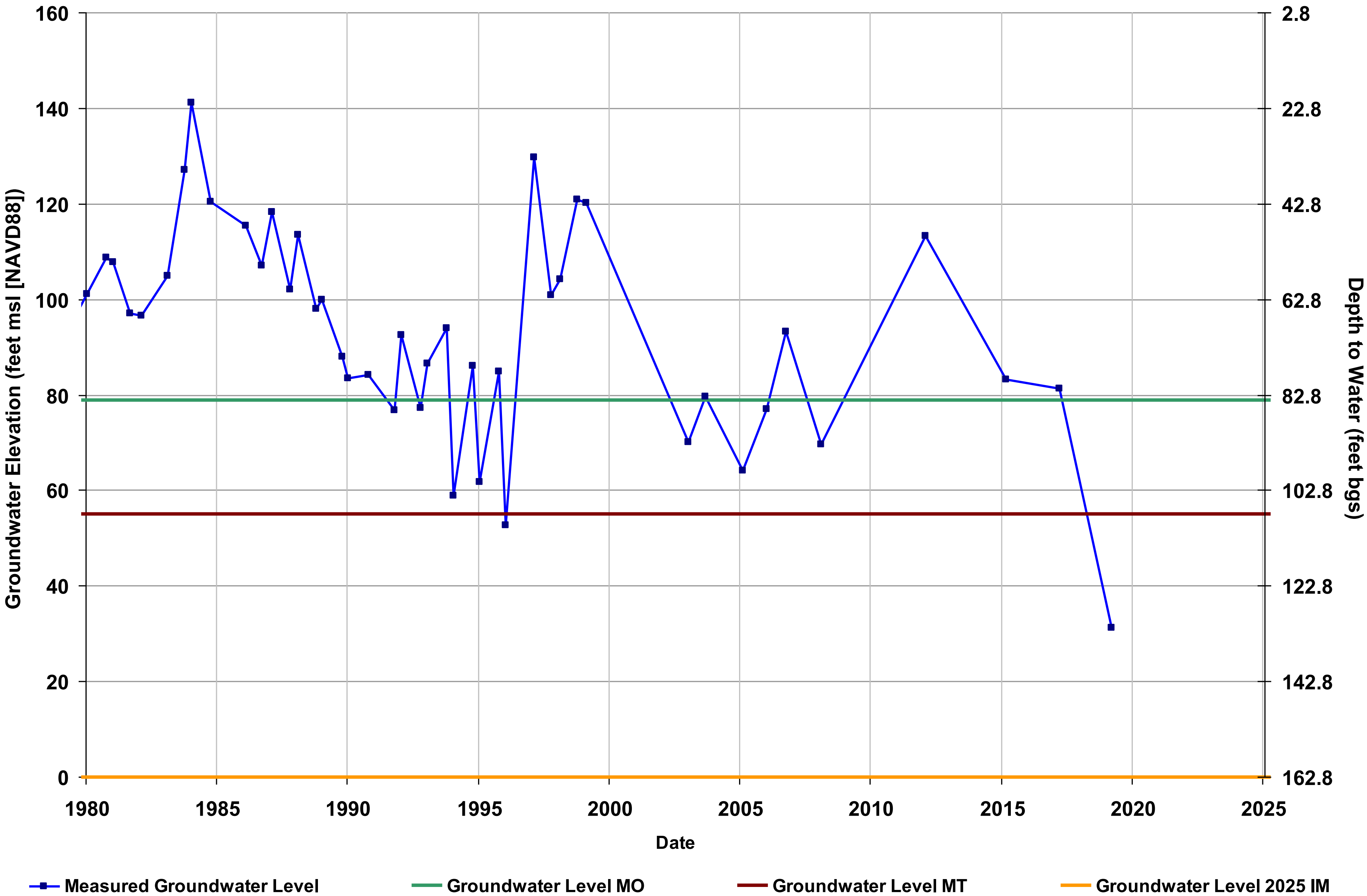
Well Name: MCW RMS-2
Depth Zone: Upper
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 216
Perf. Top (ft bgs): 205
Perf. Bottom (ft bgs): 212
GSE (ft, msl): 173



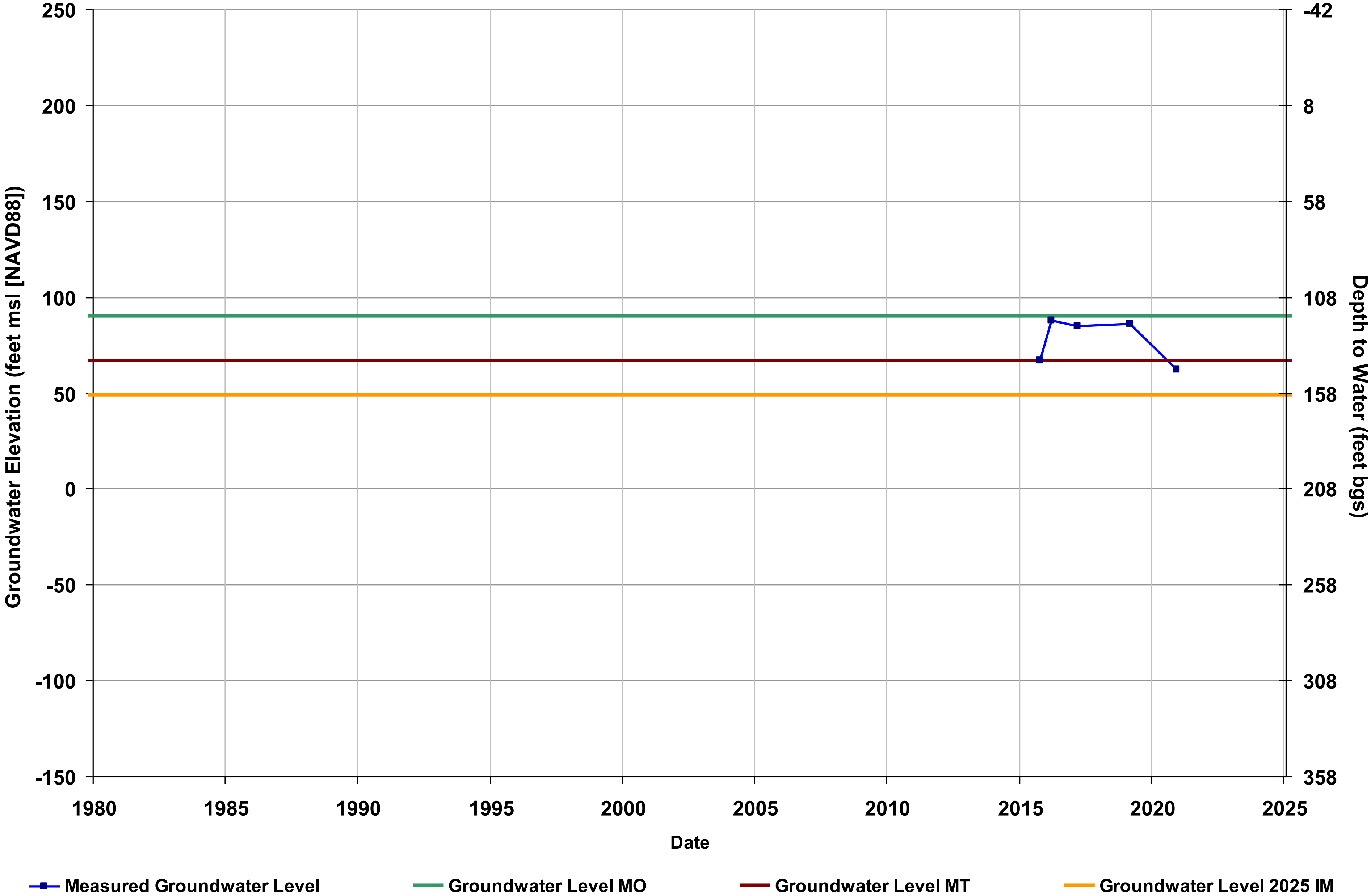
Well Name: MCW RMS-3
Depth Zone: Upper
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 162.8



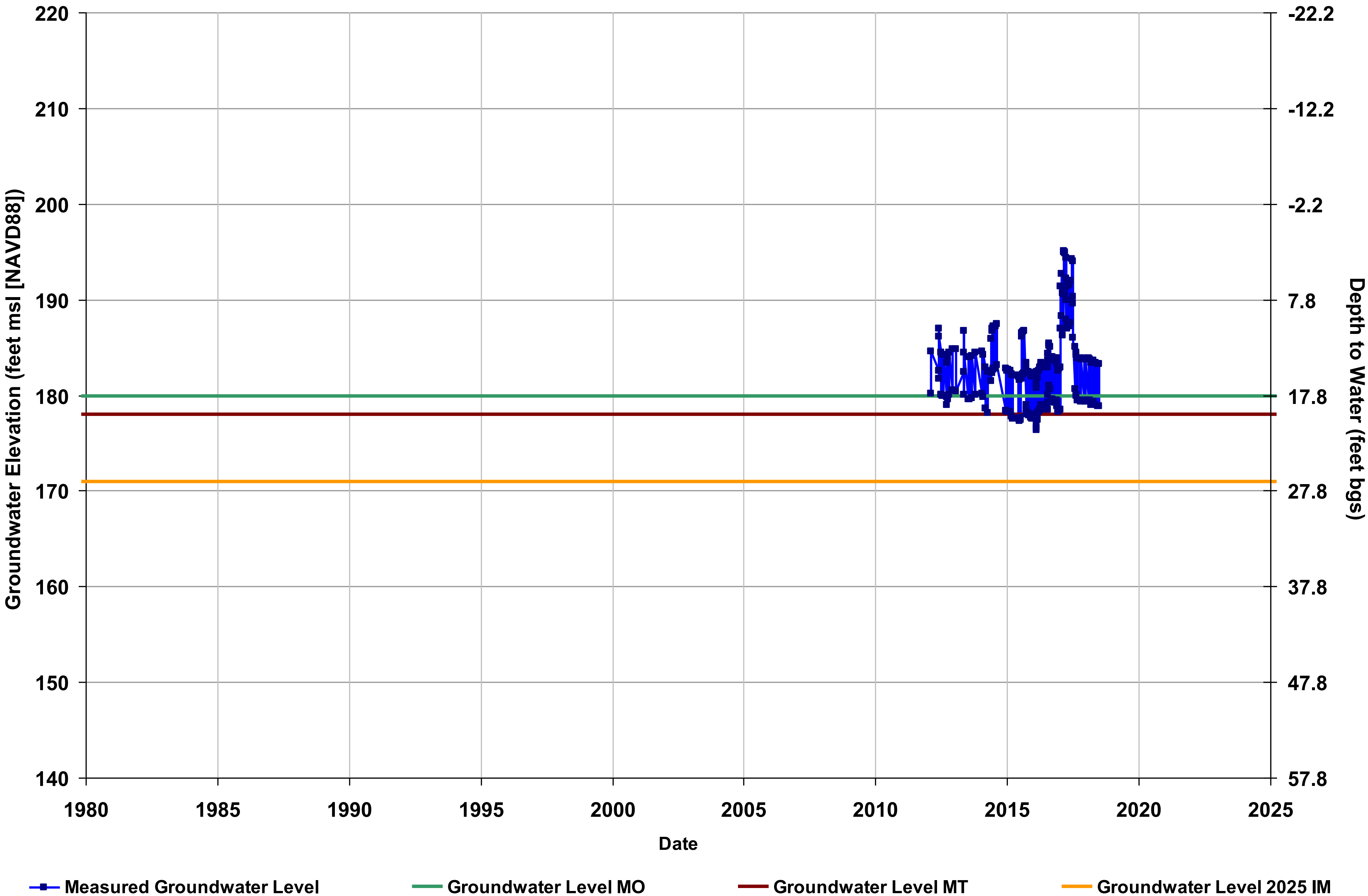
Well Name: MCW RMS-4
Depth Zone: Lower
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 580
Perf. Top (ft bgs): 220
Perf. Bottom (ft bgs): 580
GSE (ft, msl): 208



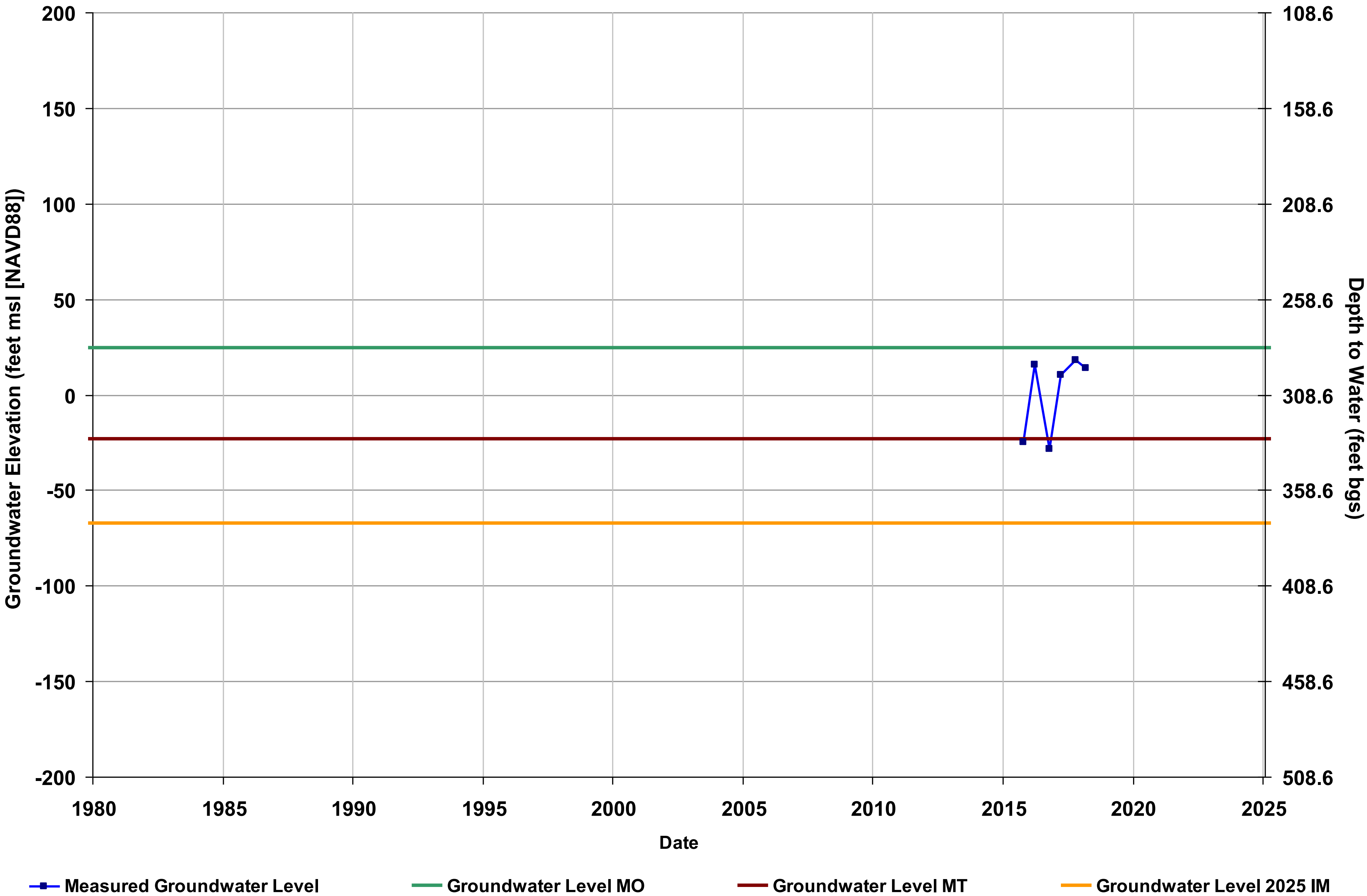
Well Name: MCW RMS-5
Depth Zone: Upper
Subbasin: Madera
GSA: County of Madera

Total Depth (ft bgs): 30
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 197.8



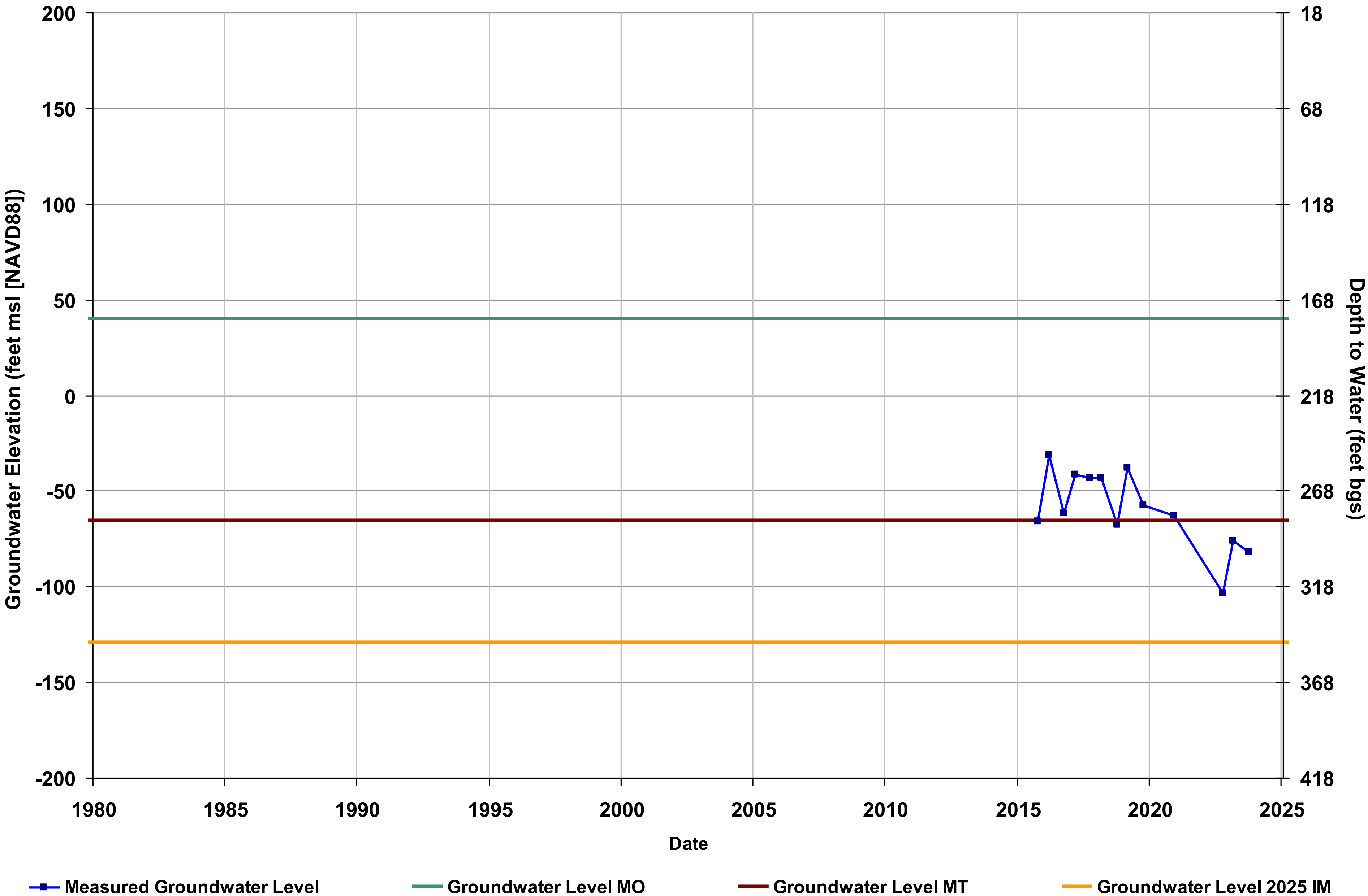
Well Name: MID RMS-1
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 950
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 942
GSE (ft, msl): 308.6



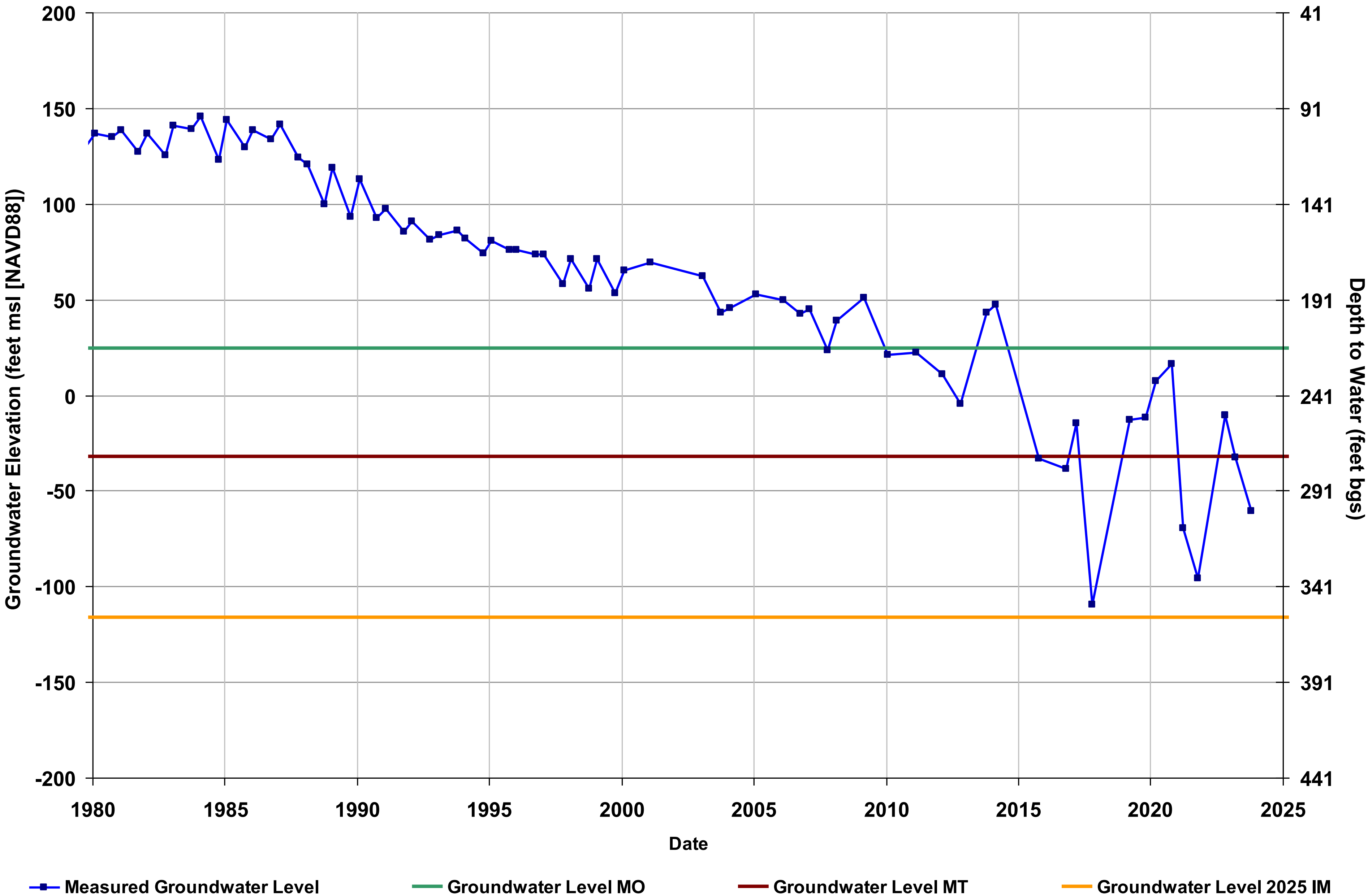
Well Name: MID RMS-2
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

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

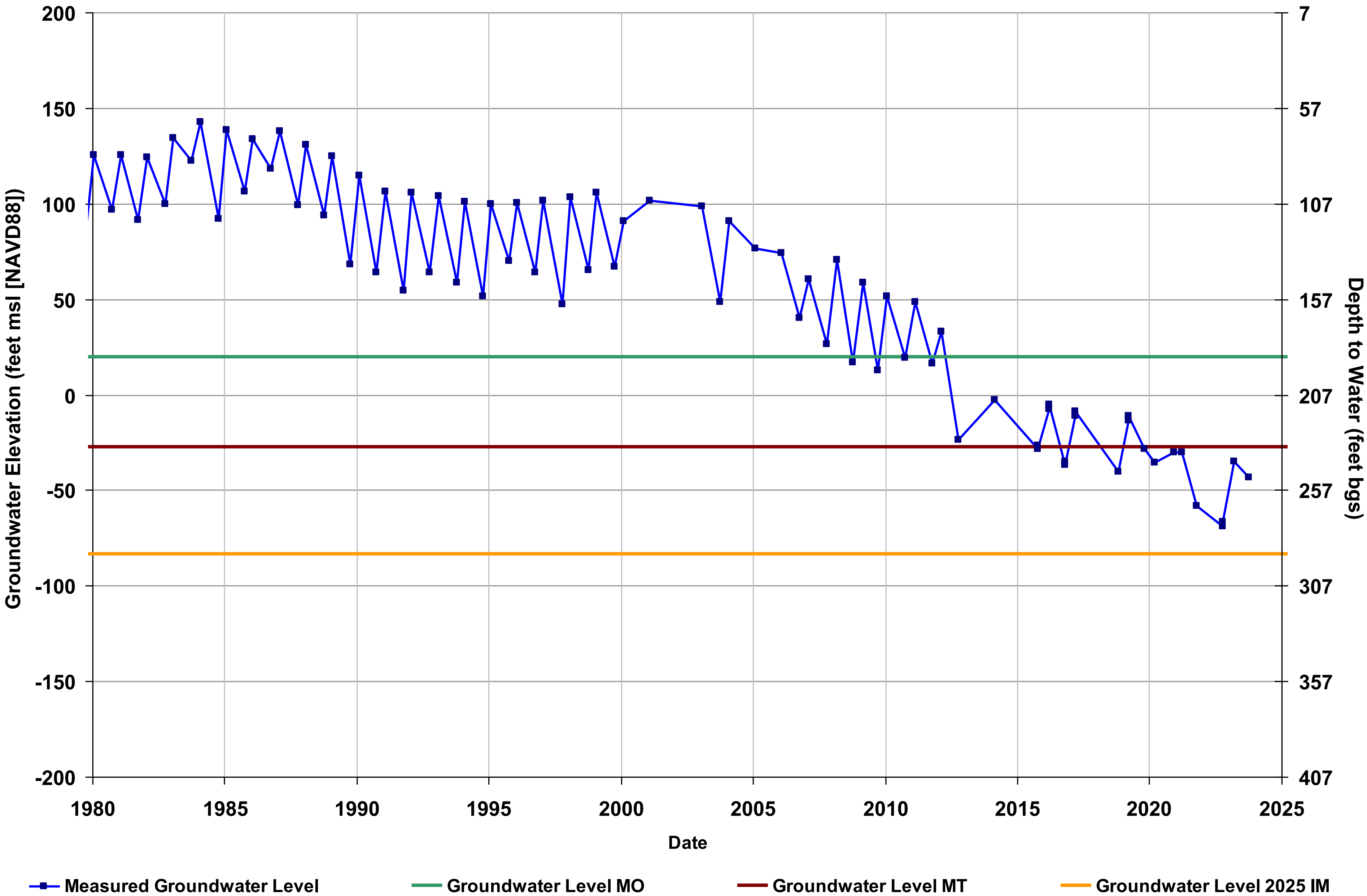


Well Name: MID RMS-4
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 698
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 667
GSE (ft, msl): 190

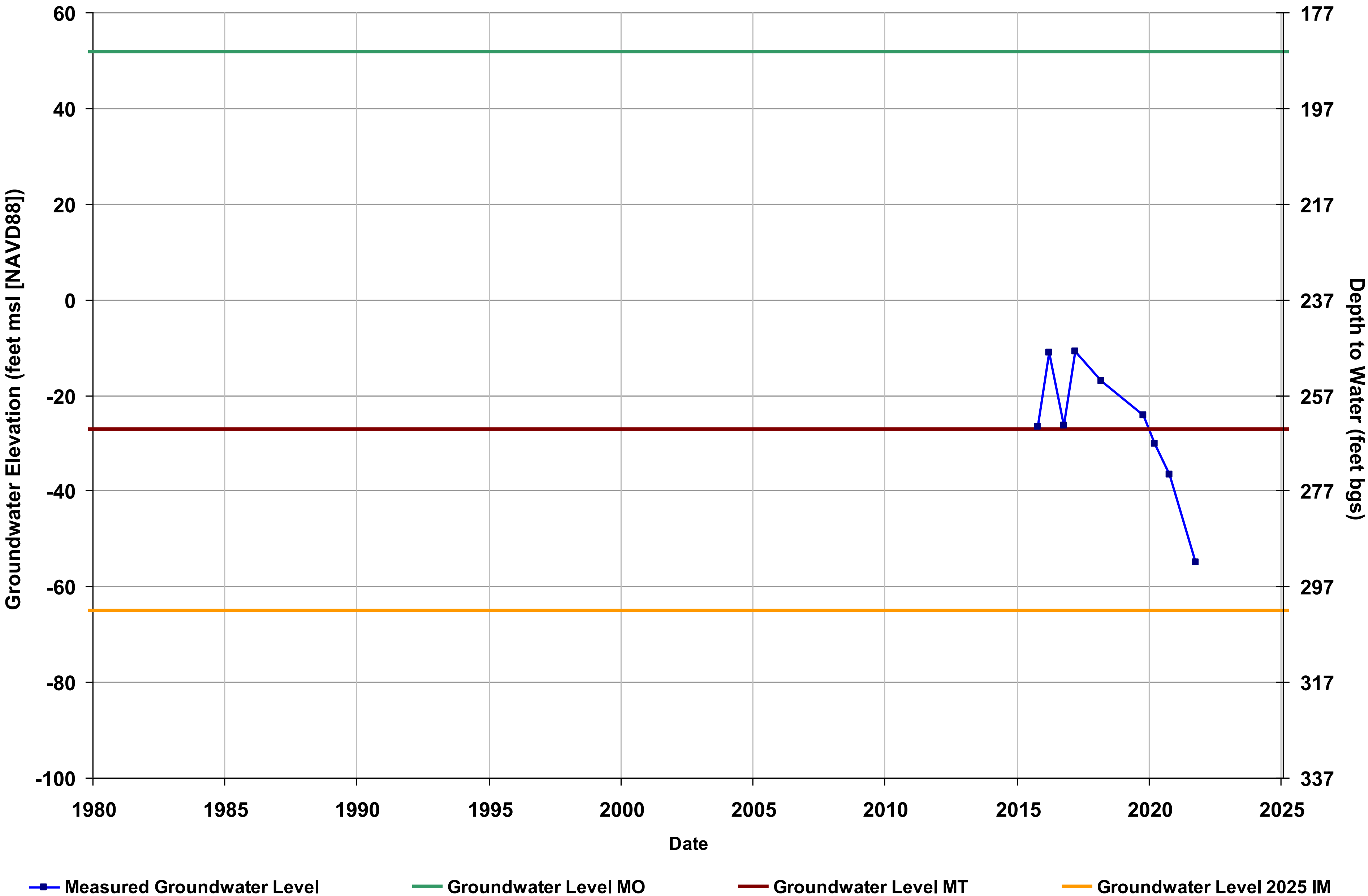
Well Name: MID RMS-5
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 570
Perf. Top (ft bgs): 270
Perf. Bottom (ft bgs): 570
GSE (ft, msl): 207



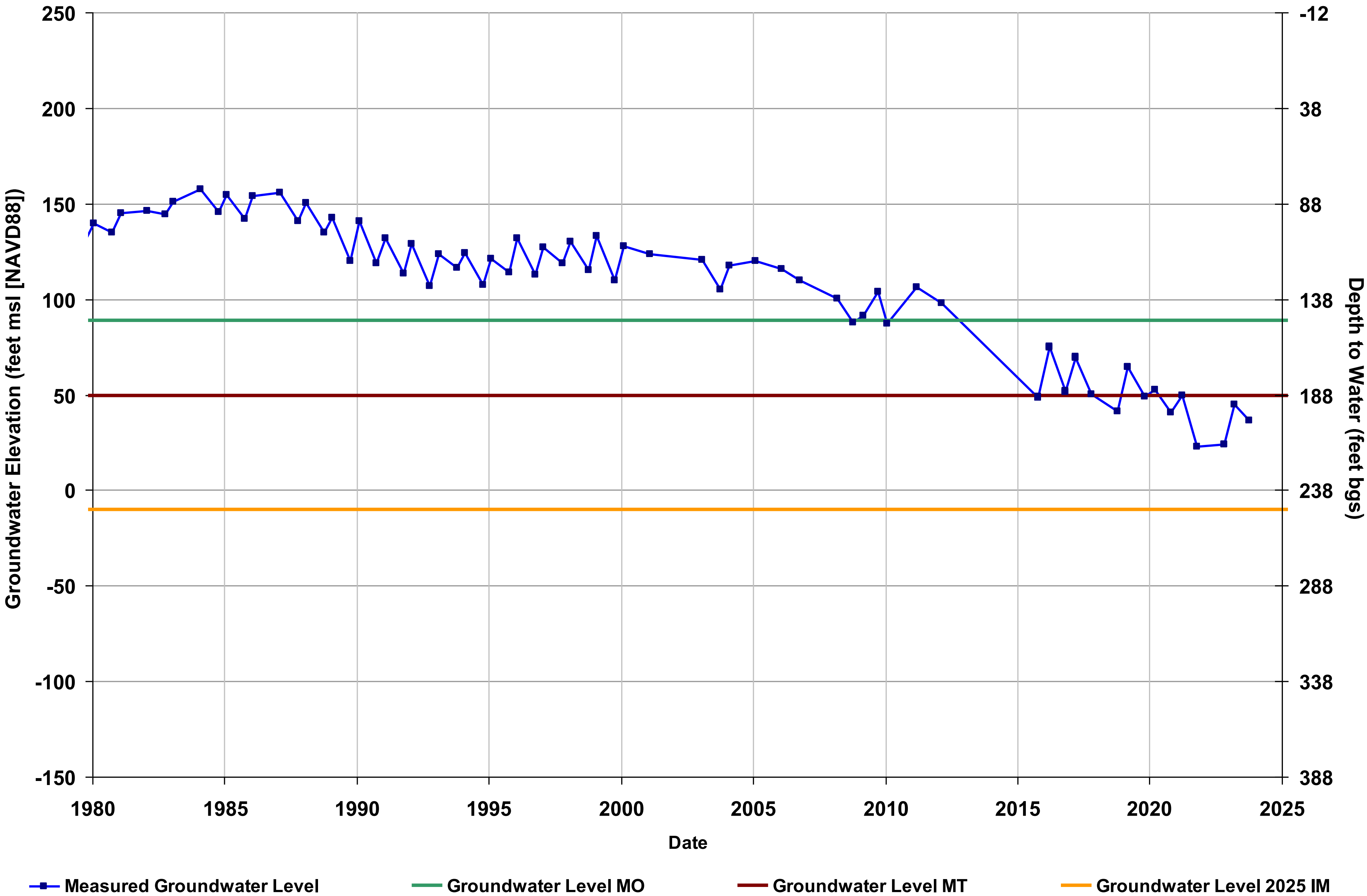
Well Name: MID RMS-6
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 680
Perf. Top (ft bgs): 320
Perf. Bottom (ft bgs): 680
GSE (ft, msl): 237



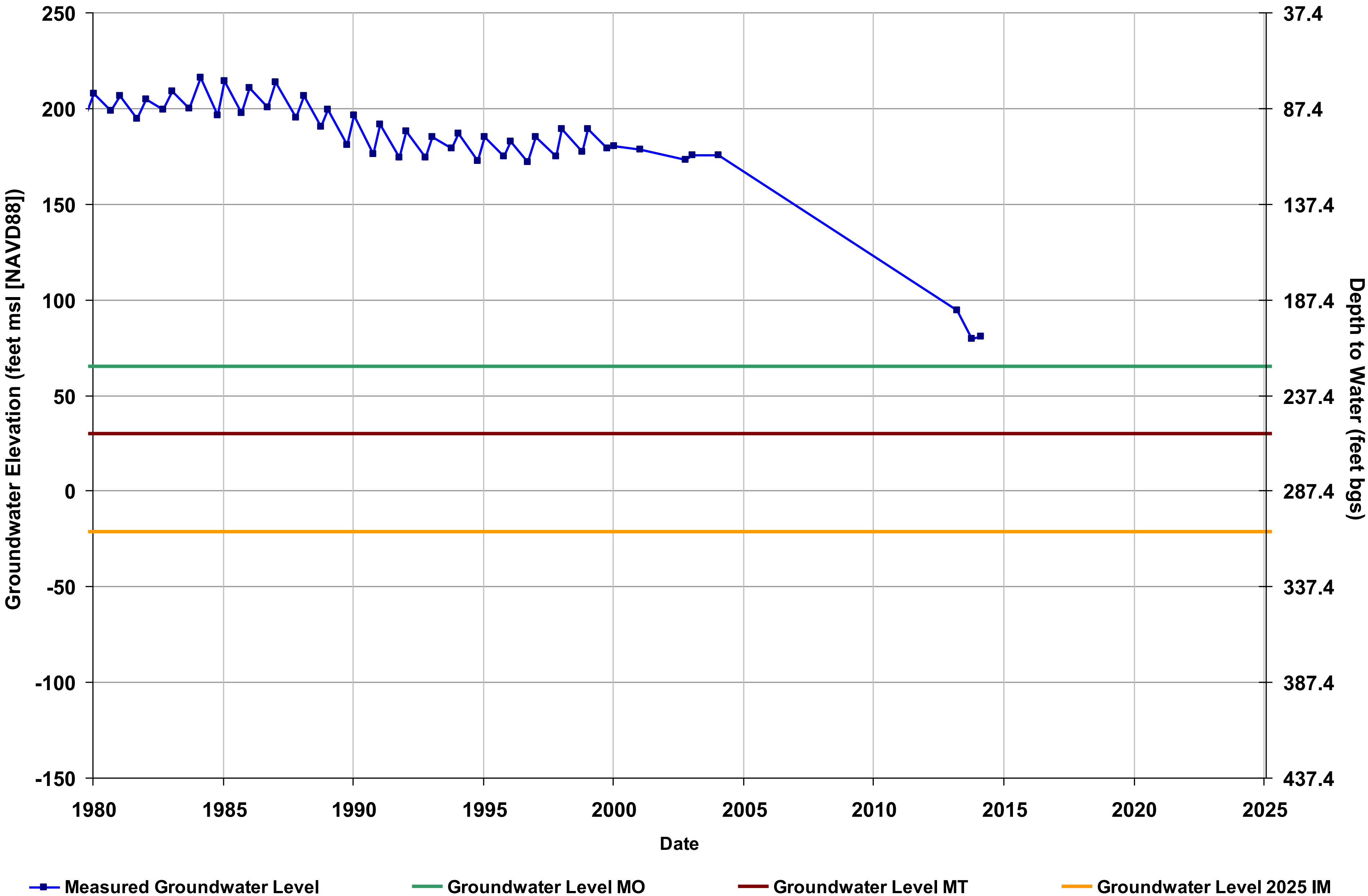
Well Name: MID RMS-7
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 656
Perf. Top (ft bgs): 290
Perf. Bottom (ft bgs): 635
GSE (ft, msl): 238



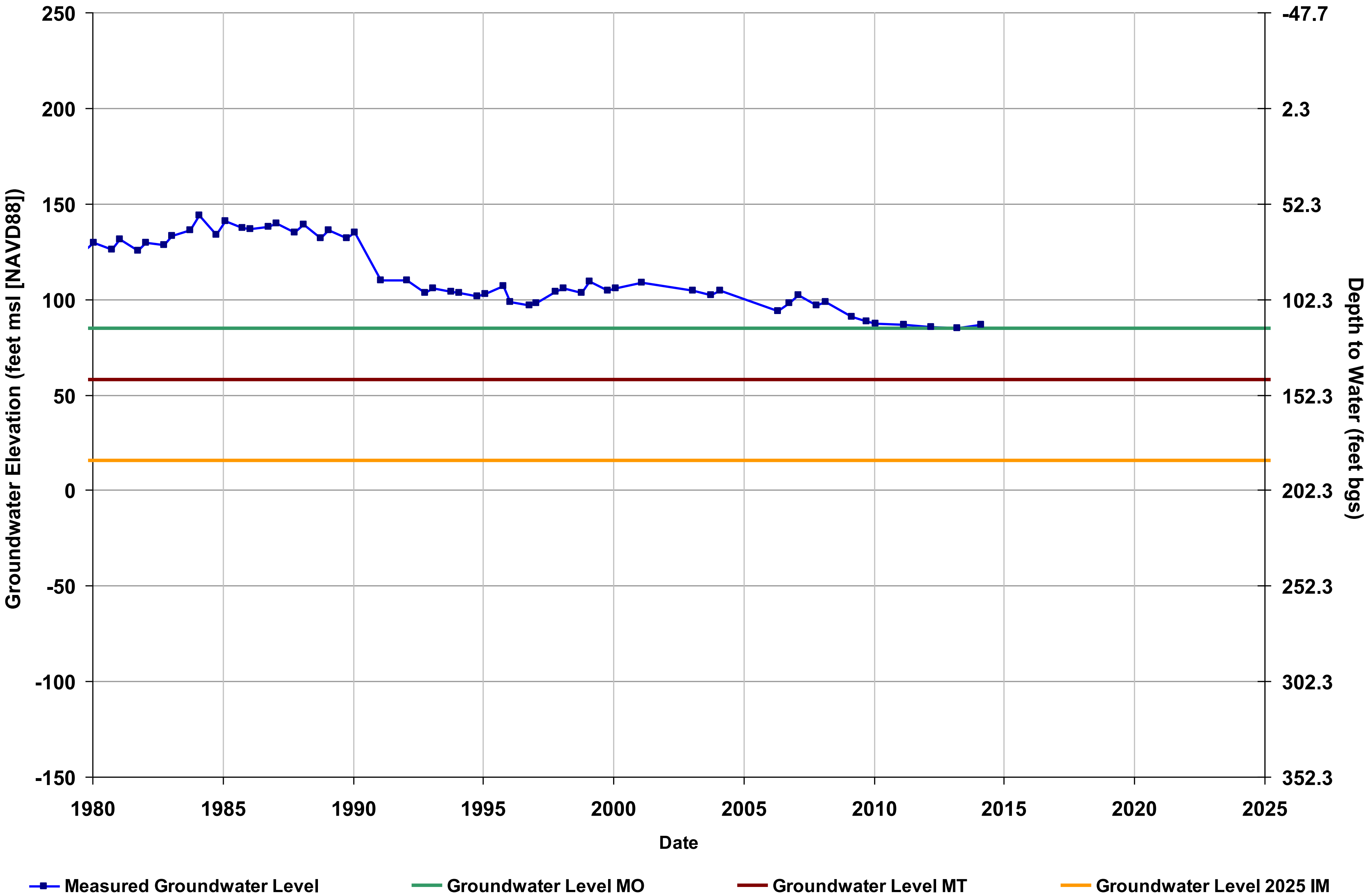
Well Name: MID RMS-8
Depth Zone: Composite
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 287.4



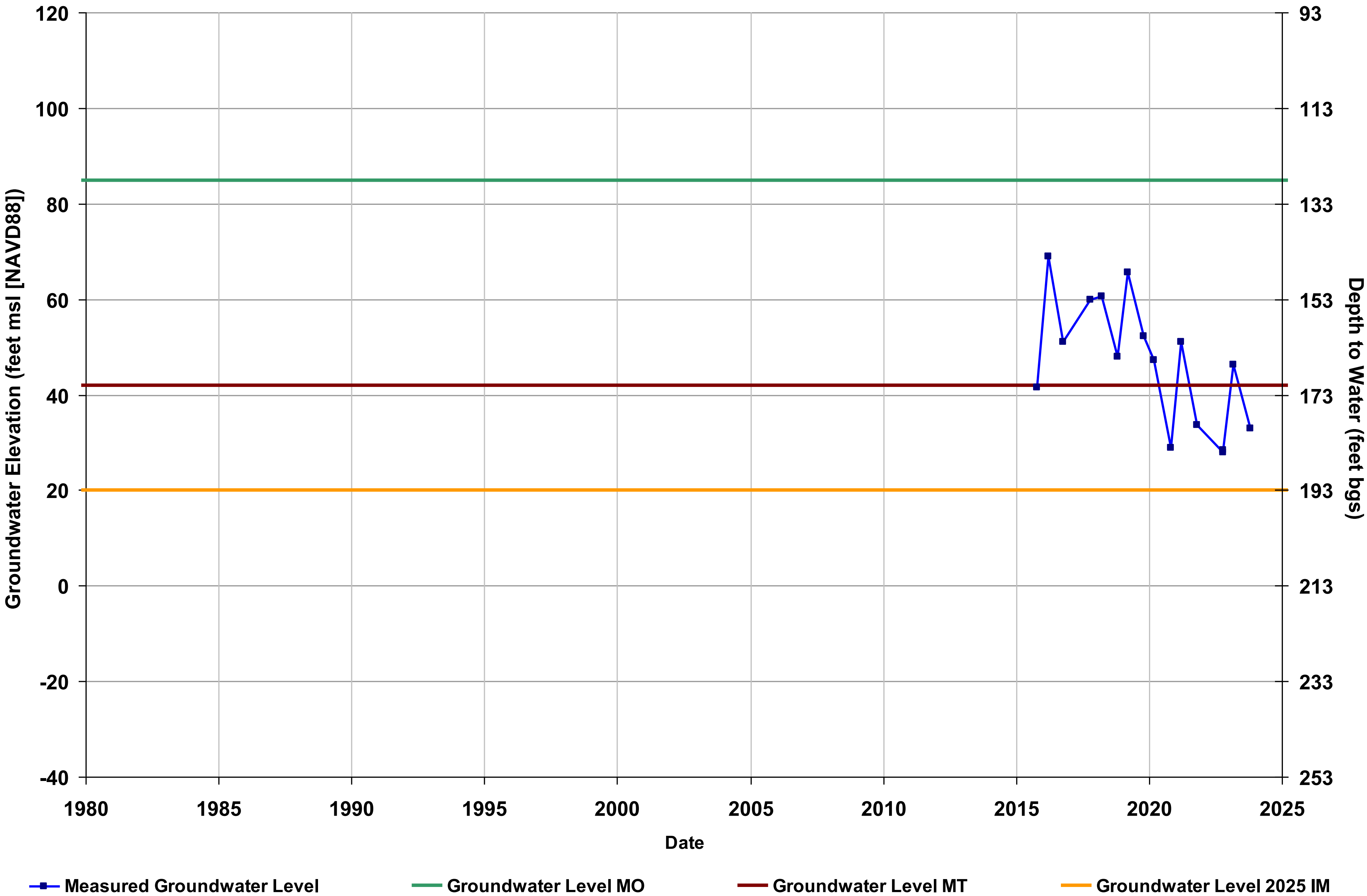
Well Name: MID RMS-9
Depth Zone: Upper
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 202.3



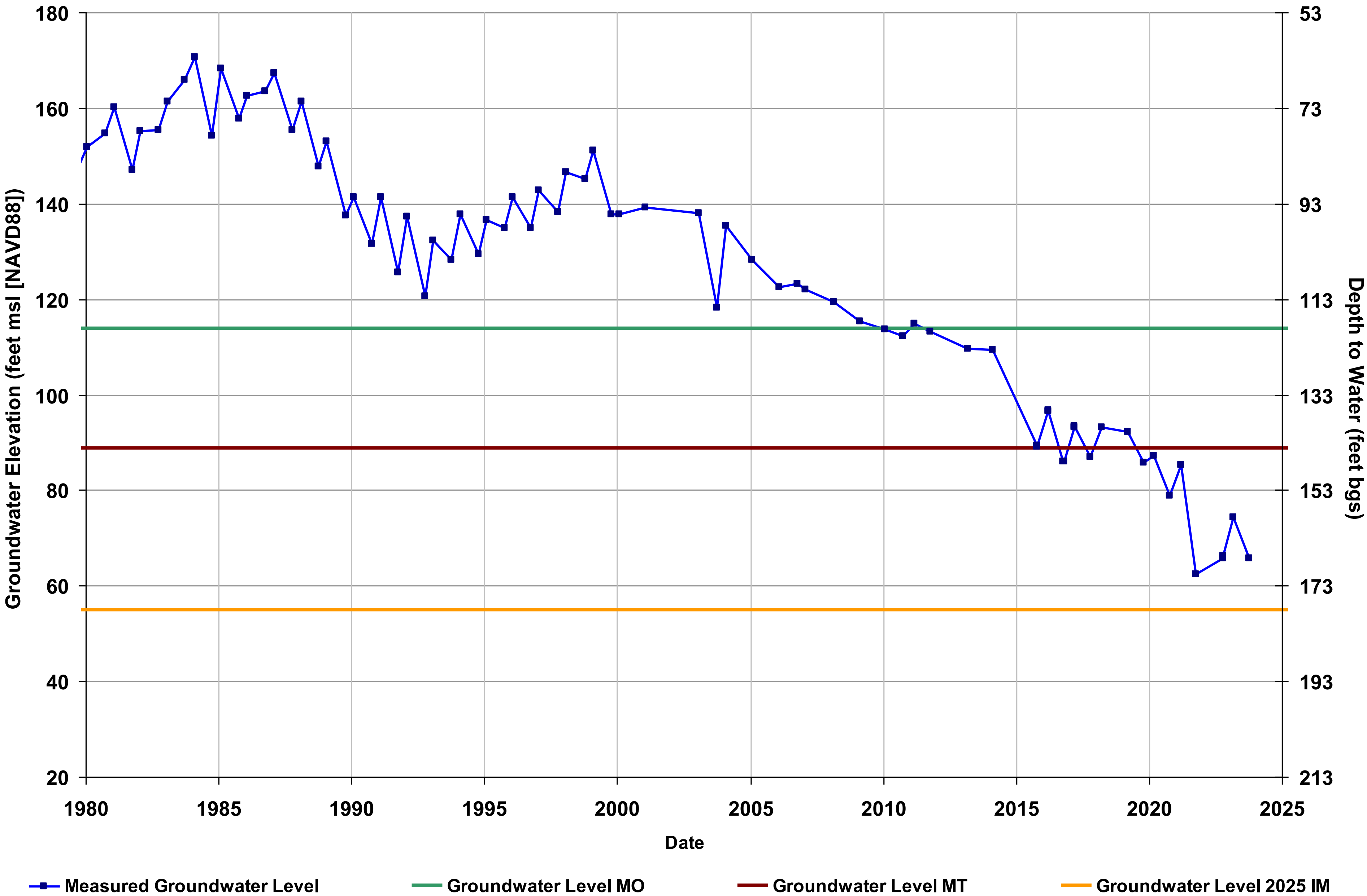
Well Name: MID RMS-10
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 615
Perf. Top (ft bgs): 315
Perf. Bottom (ft bgs): 615
GSE (ft, msl): 213



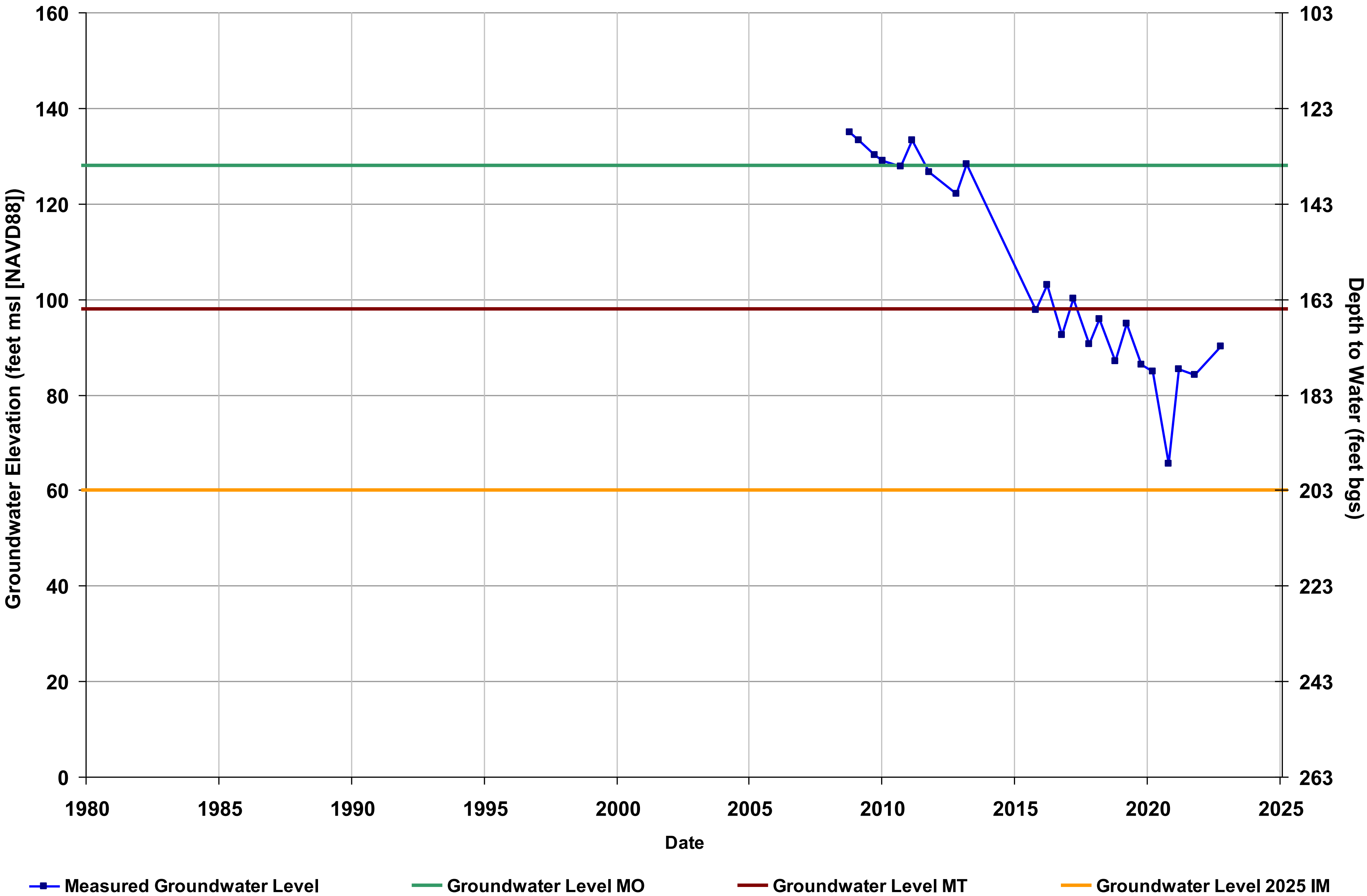
Well Name: MID RMS-11
Depth Zone: Upper
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 315
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 233



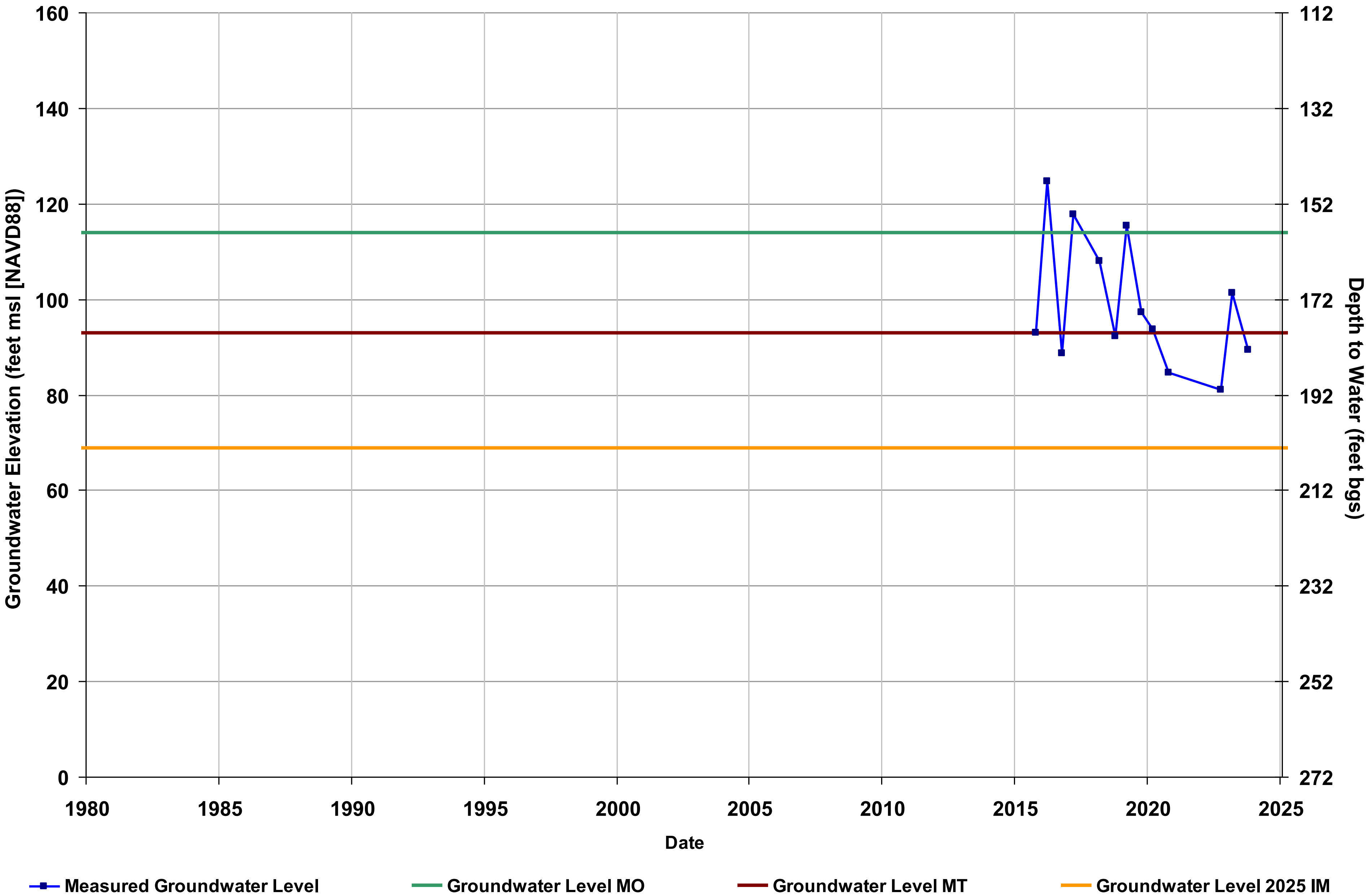
Well Name: MID RMS-12
Depth Zone: Upper
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 176
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 263



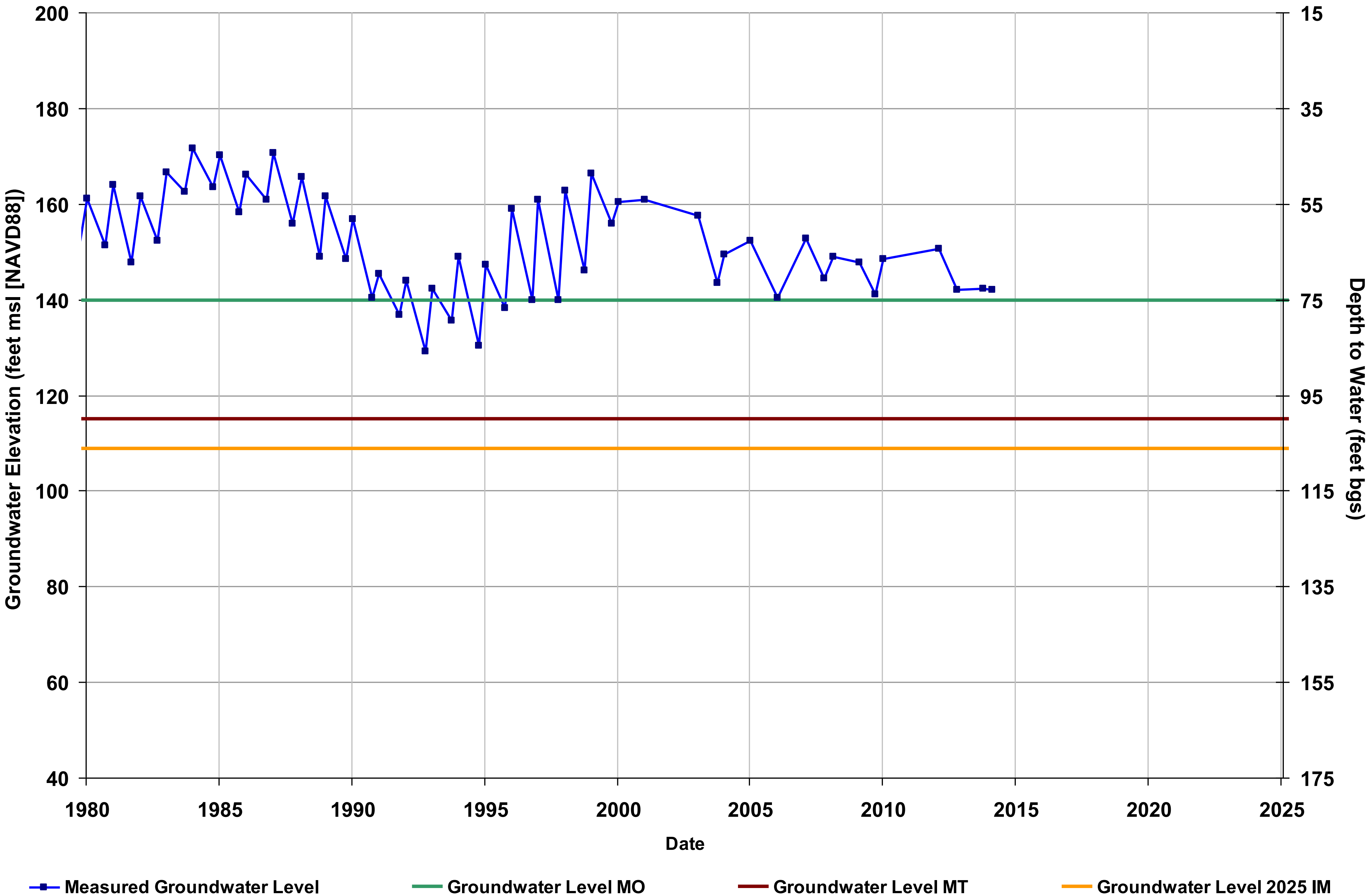
Well Name: MID RMS-13
Depth Zone: Composite
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 600
Perf. Top (ft bgs): 228
Perf. Bottom (ft bgs): 552
GSE (ft, msl): 272



Well Name: MID RMS-14
Depth Zone: Upper
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs):
Perf. Top (ft bgs):
Perf. Bottom (ft bgs):
GSE (ft, msl): 215

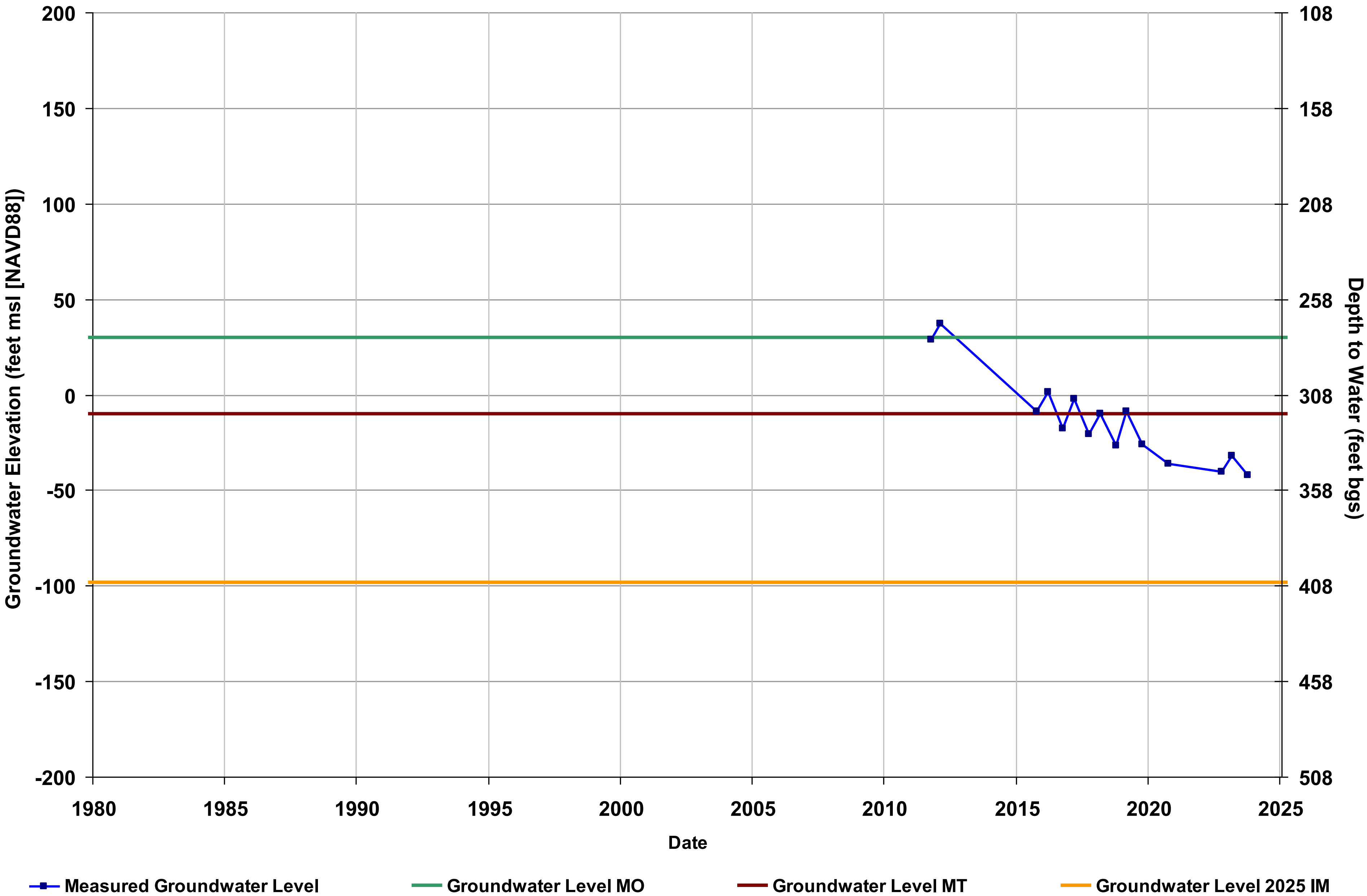


Well Name: MID RMS-15
Depth Zone: Upper
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 502
Perf. Top (ft bgs): 160
Perf. Bottom (ft bgs): 200
GSE (ft, msl): 247

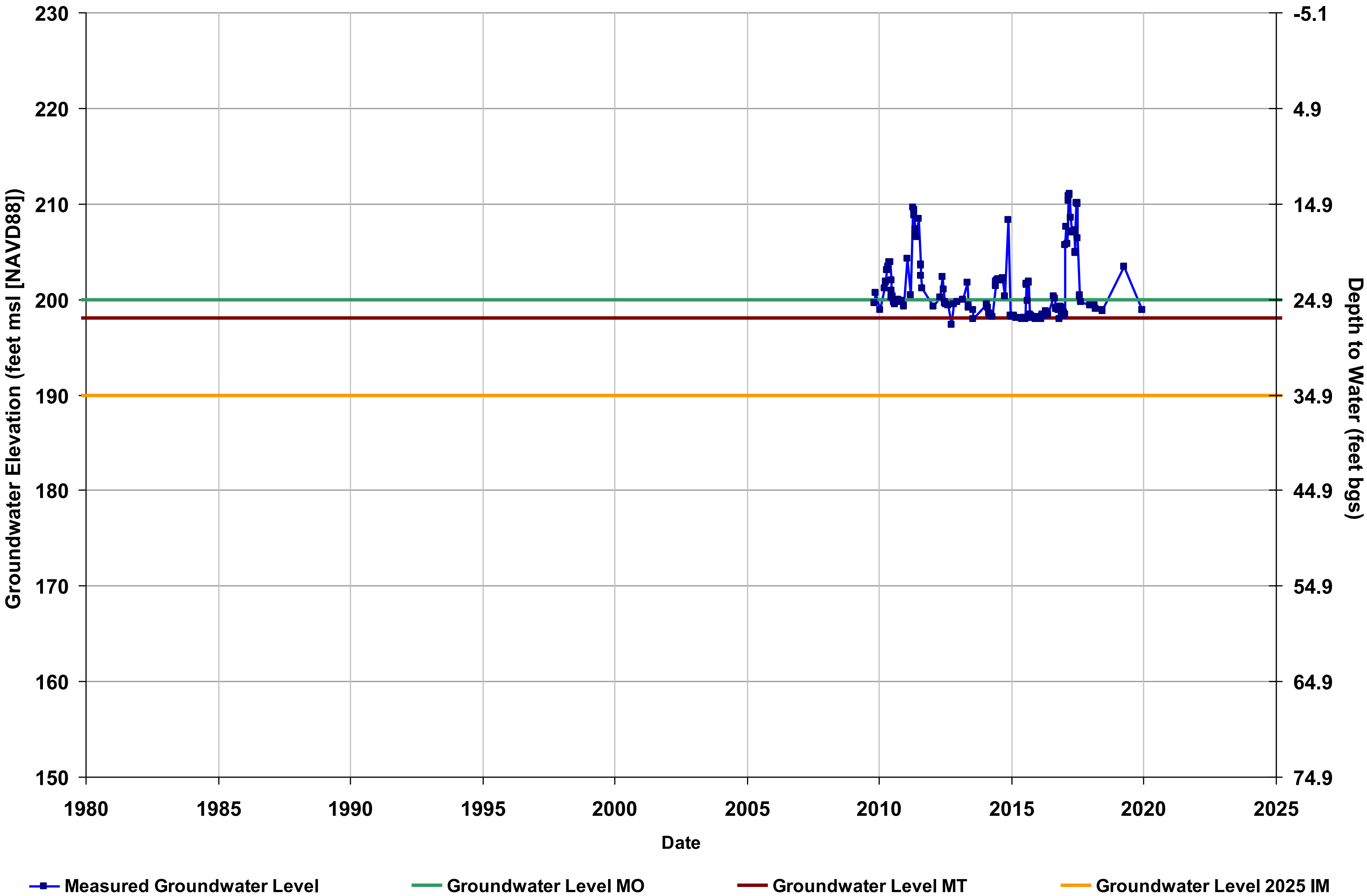
Well Name: MID RMS-16
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 452
Perf. Top (ft bgs): 348
Perf. Bottom (ft bgs): 388
GSE (ft, msl): 308



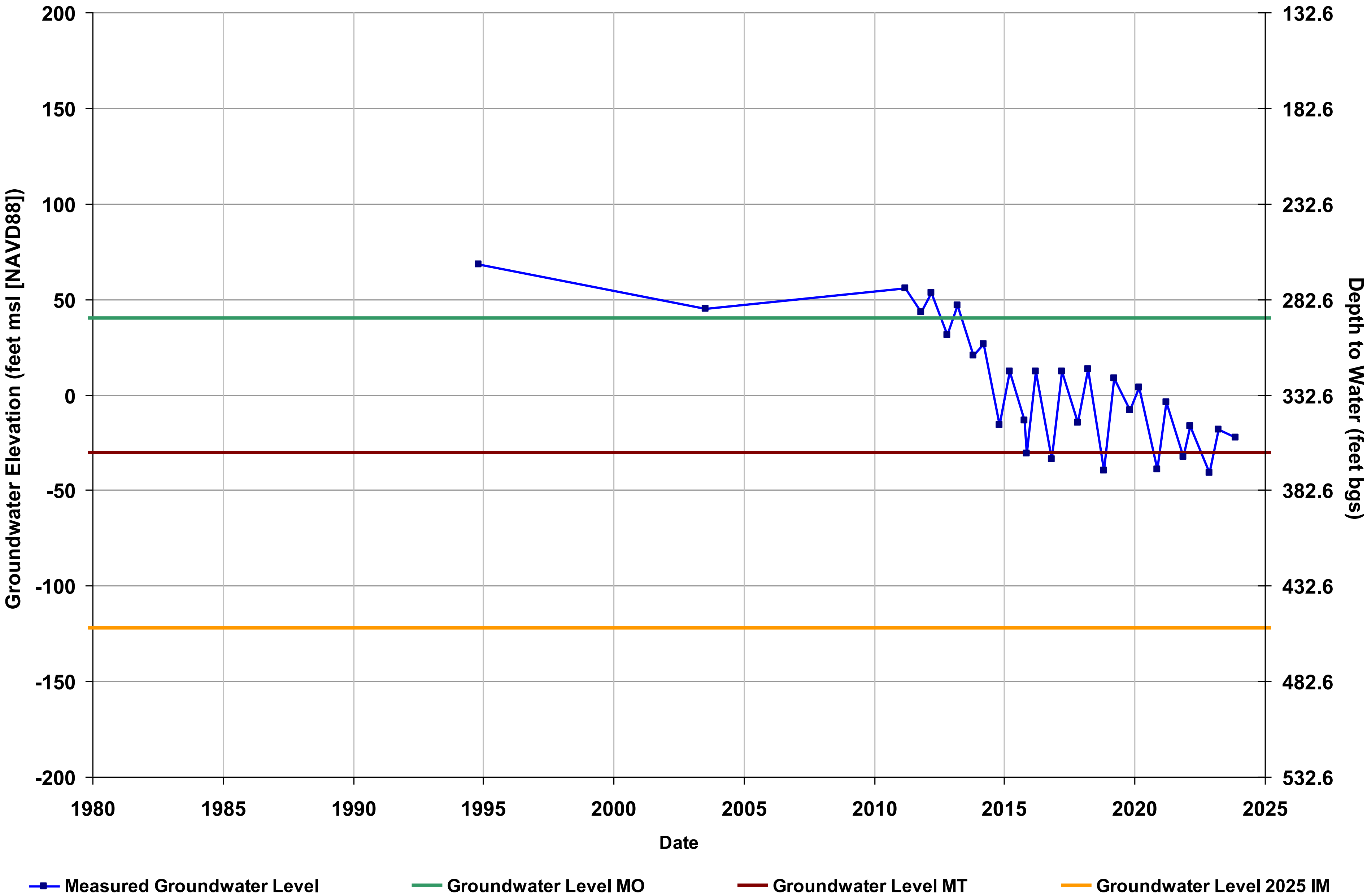
Well Name: MID RMS-17
Depth Zone: Upper
Subbasin: Madera
GSA: Madera Irrigation District

Total Depth (ft bgs): 47
Perf. Top (ft bgs): 26
Perf. Bottom (ft bgs): 46
GSE (ft, msl): 224.9



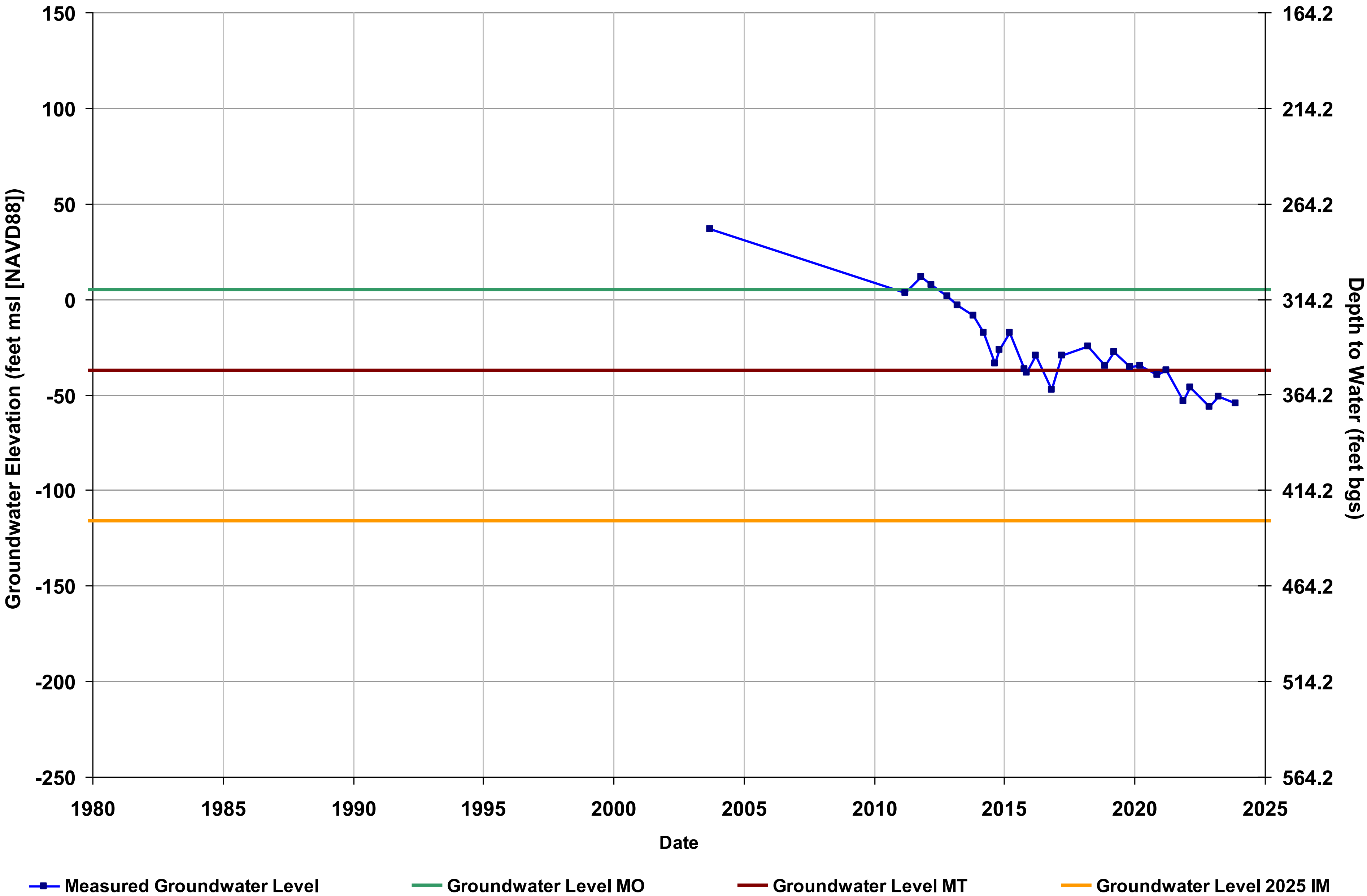
Well Name: MWD RMS-1
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Water District

Total Depth (ft bgs): 504
Perf. Top (ft bgs): 200
Perf. Bottom (ft bgs): 500
GSE (ft, msl): 332.6



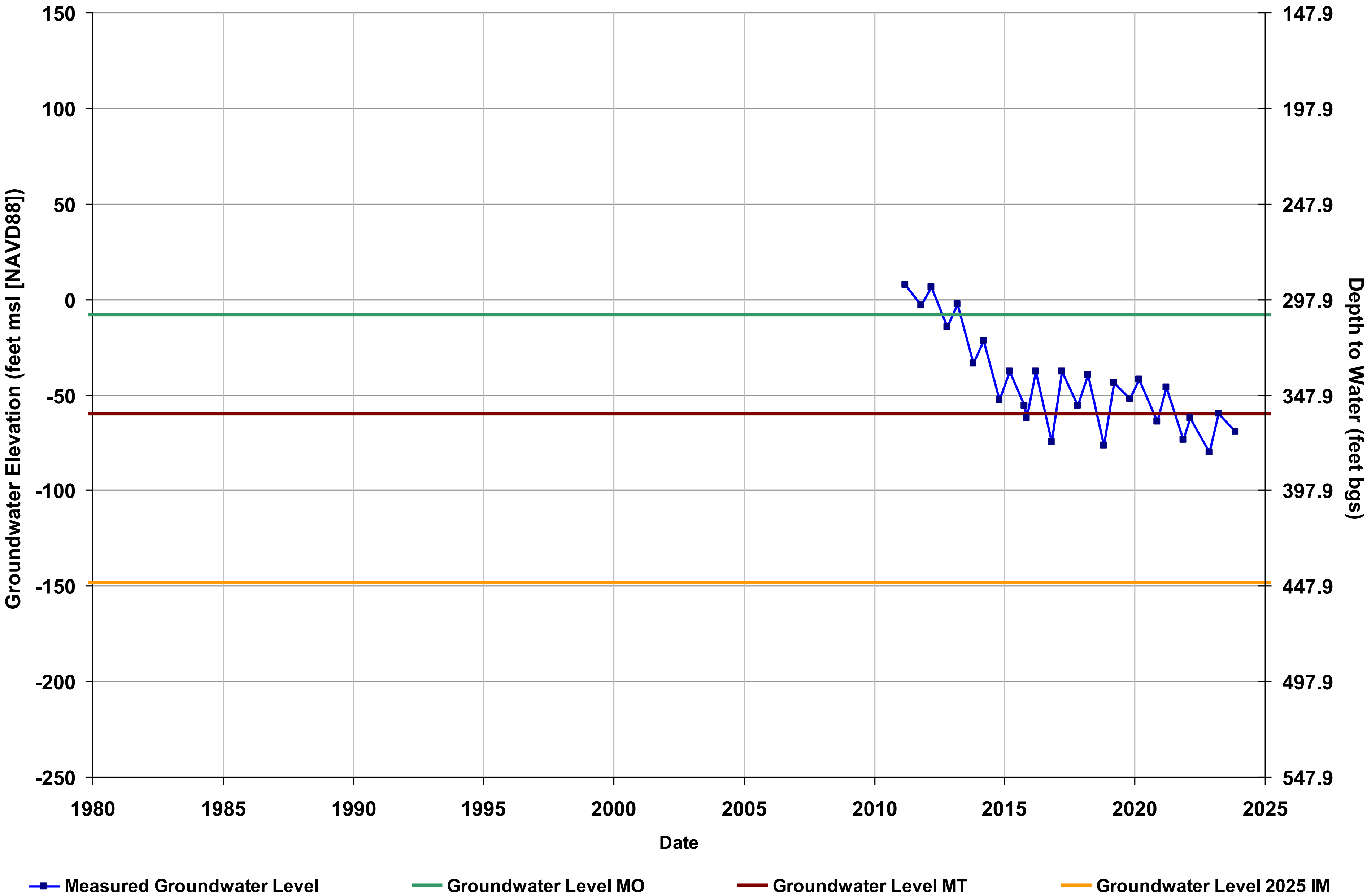
Well Name: MWD RMS-2
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Water District

Total Depth (ft bgs): 537
Perf. Top (ft bgs): 200
Perf. Bottom (ft bgs): 537
GSE (ft, msl): 314.2

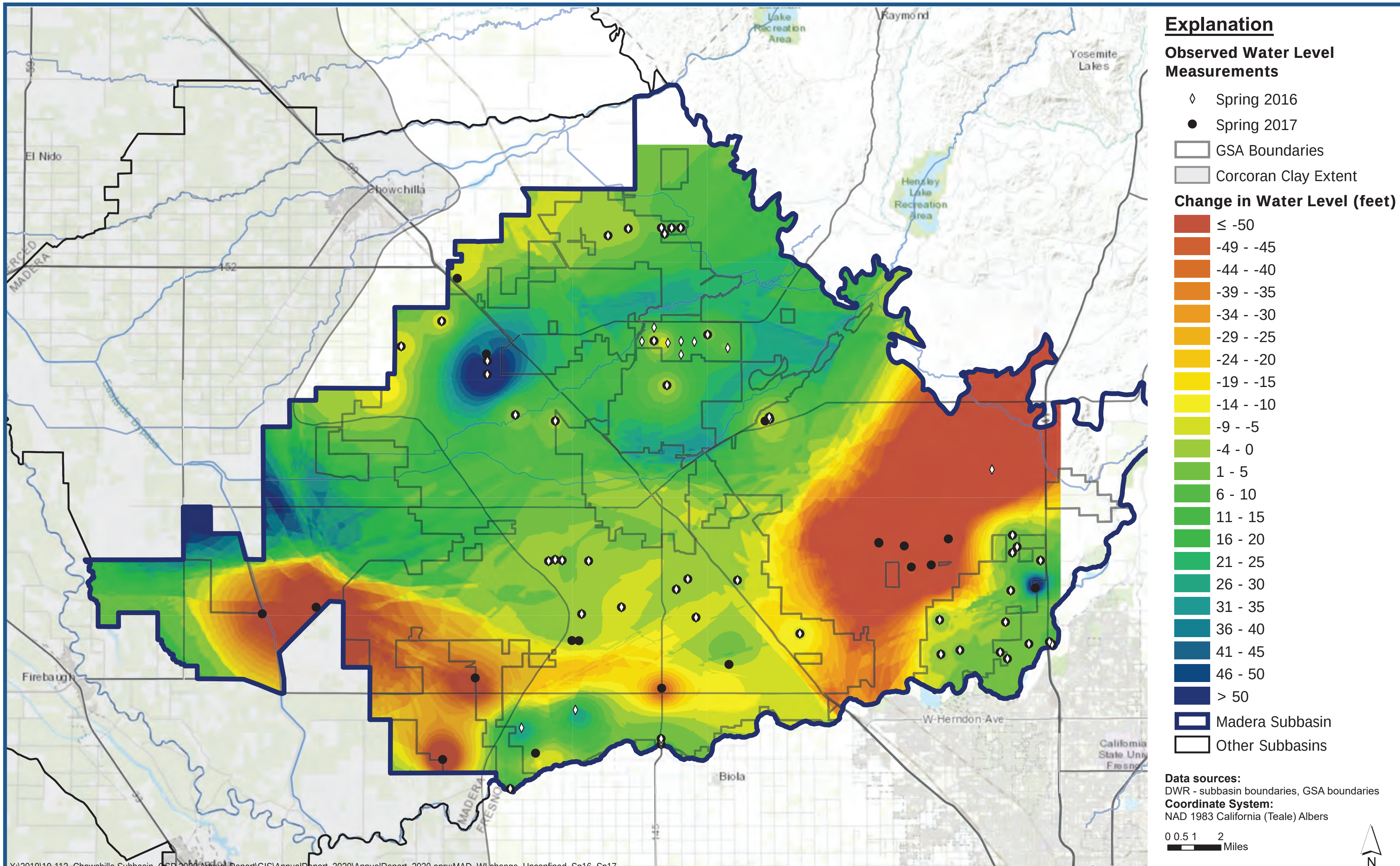


Well Name: MWD RMS-3
Depth Zone: Lower
Subbasin: Madera
GSA: Madera Water District

Total Depth (ft bgs): 800
Perf. Top (ft bgs): 380
Perf. Bottom (ft bgs): 800
GSE (ft, msl): 297.9



Appendix C. Maps of Change in Groundwater Levels and Change in Groundwater Storage in 2016 through 2022, Separated by Principal Aquifer.



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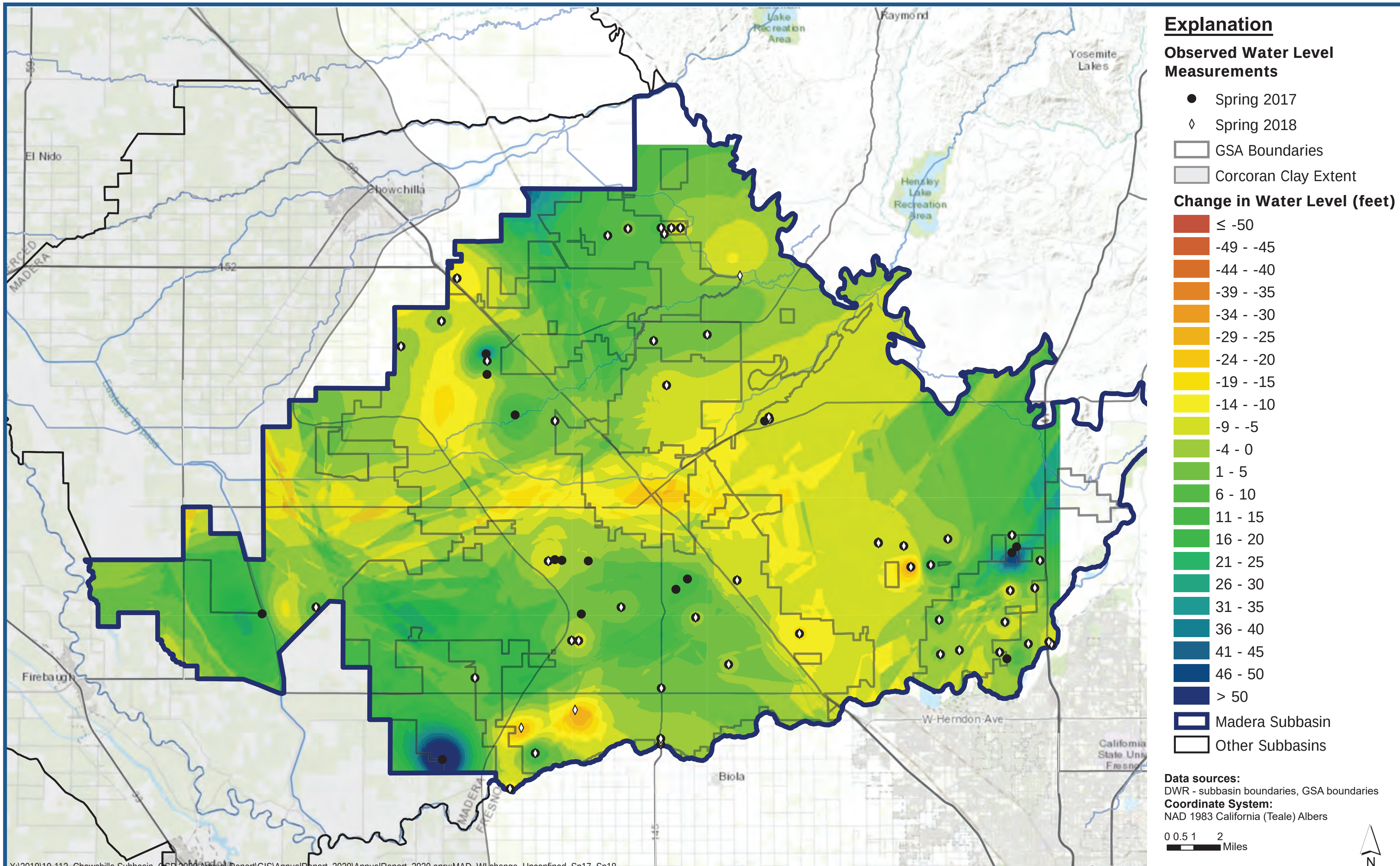
Change in Water Level in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2016 through Spring 2017

Figure C-1

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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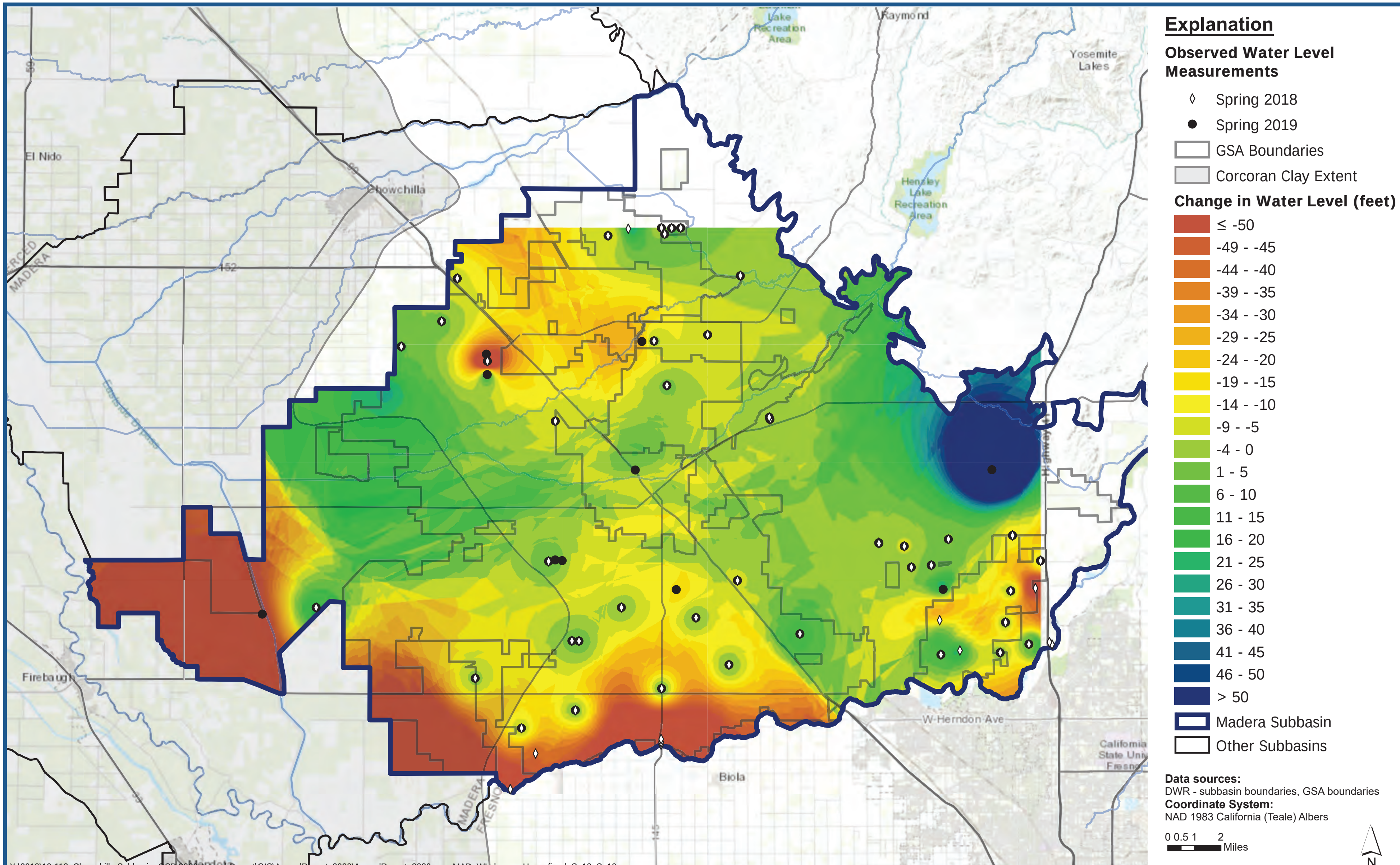
Change in Water Level in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2017 through Spring 2018

Figure C-2

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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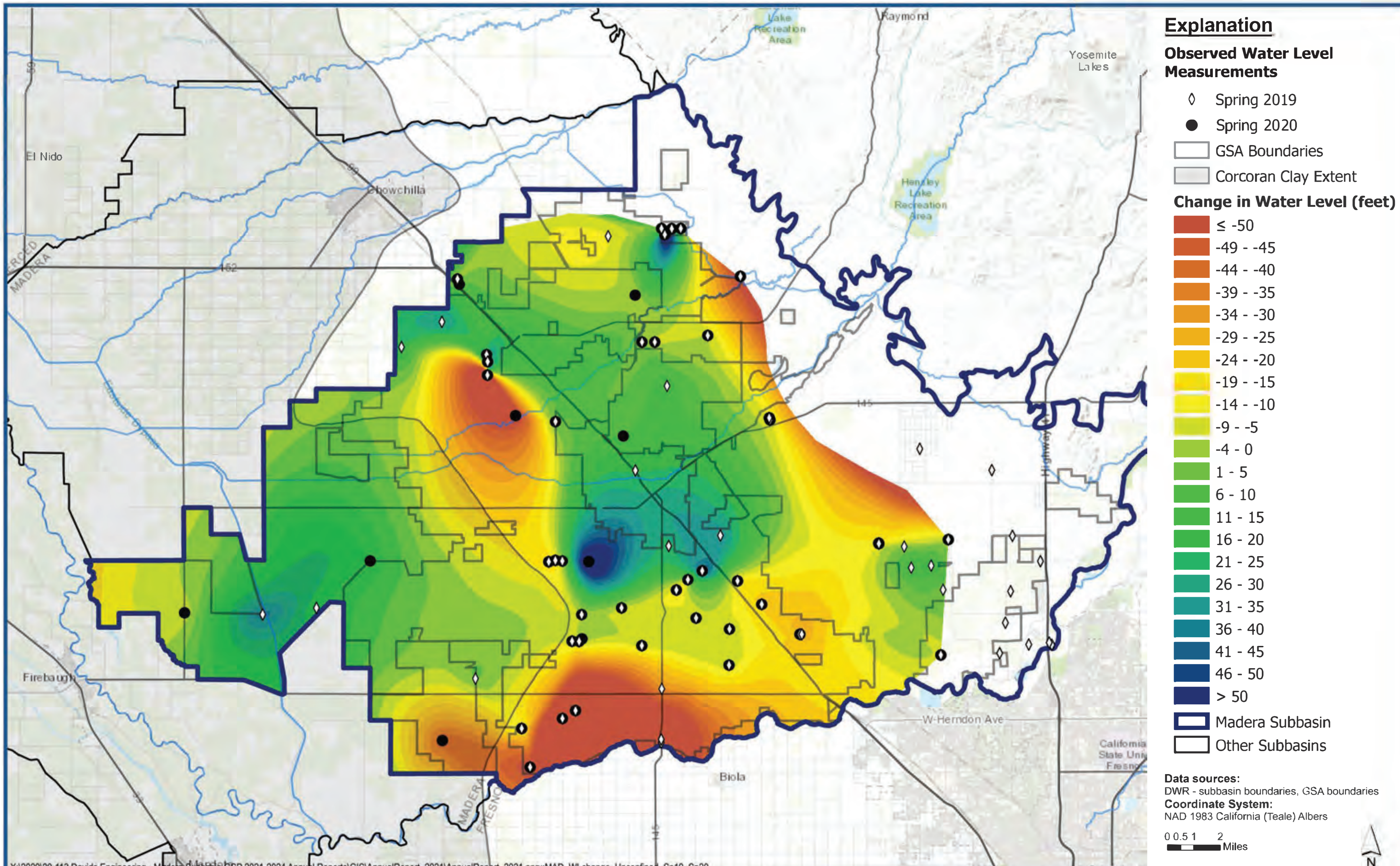
Change in Water Level in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2018 through Spring 2019

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-3



X:\2020\20-113 Davids Engineering - Madera Subbasin GSP 2021-2024 Annual Reports\GIS\AnnualReport_2021\AnnualReport_2021.aprx MAD_WLchange_Unconfined_Sp19_Sp20

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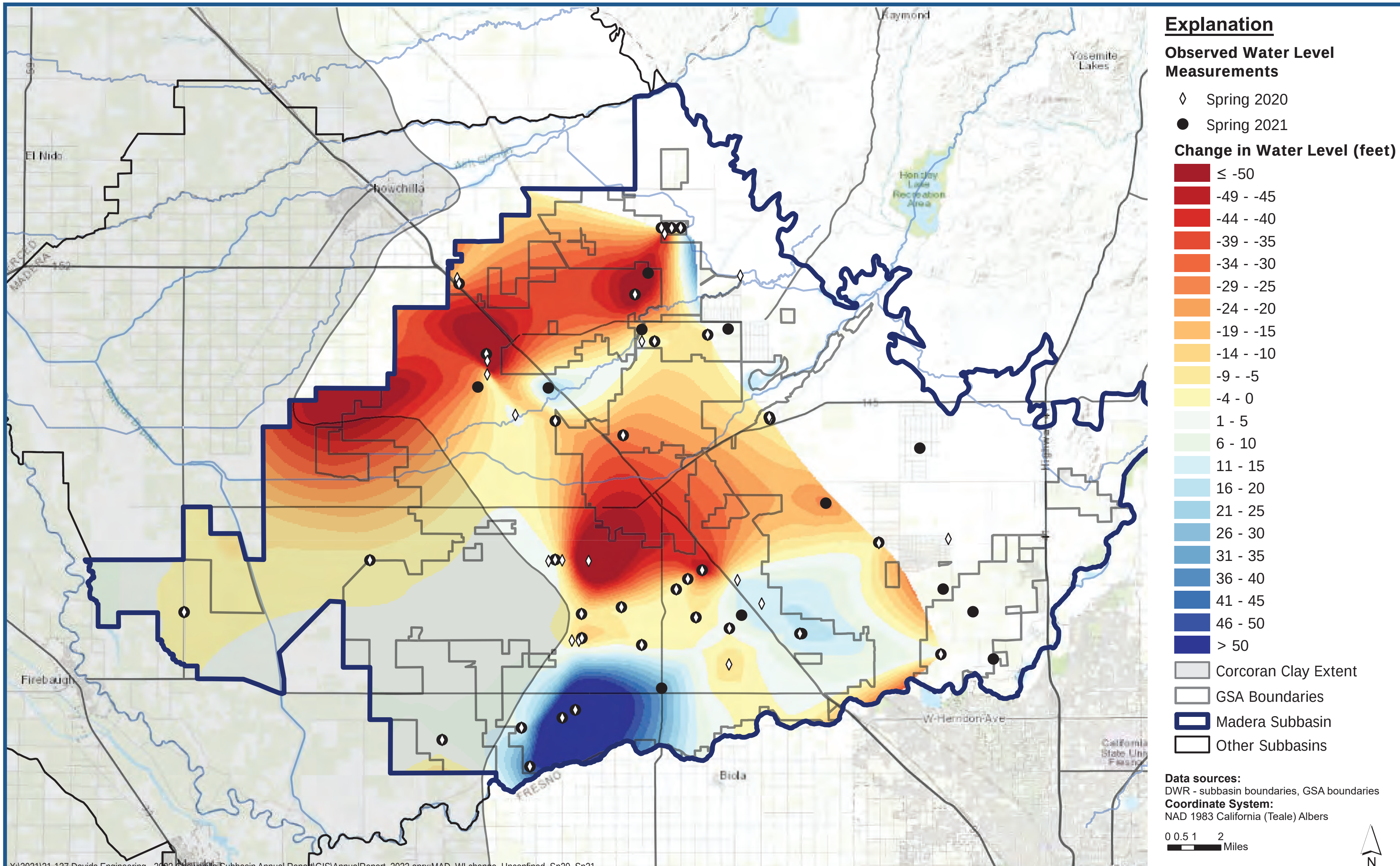
Change in Water Level in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2019 through Spring 2020

Figure C-4

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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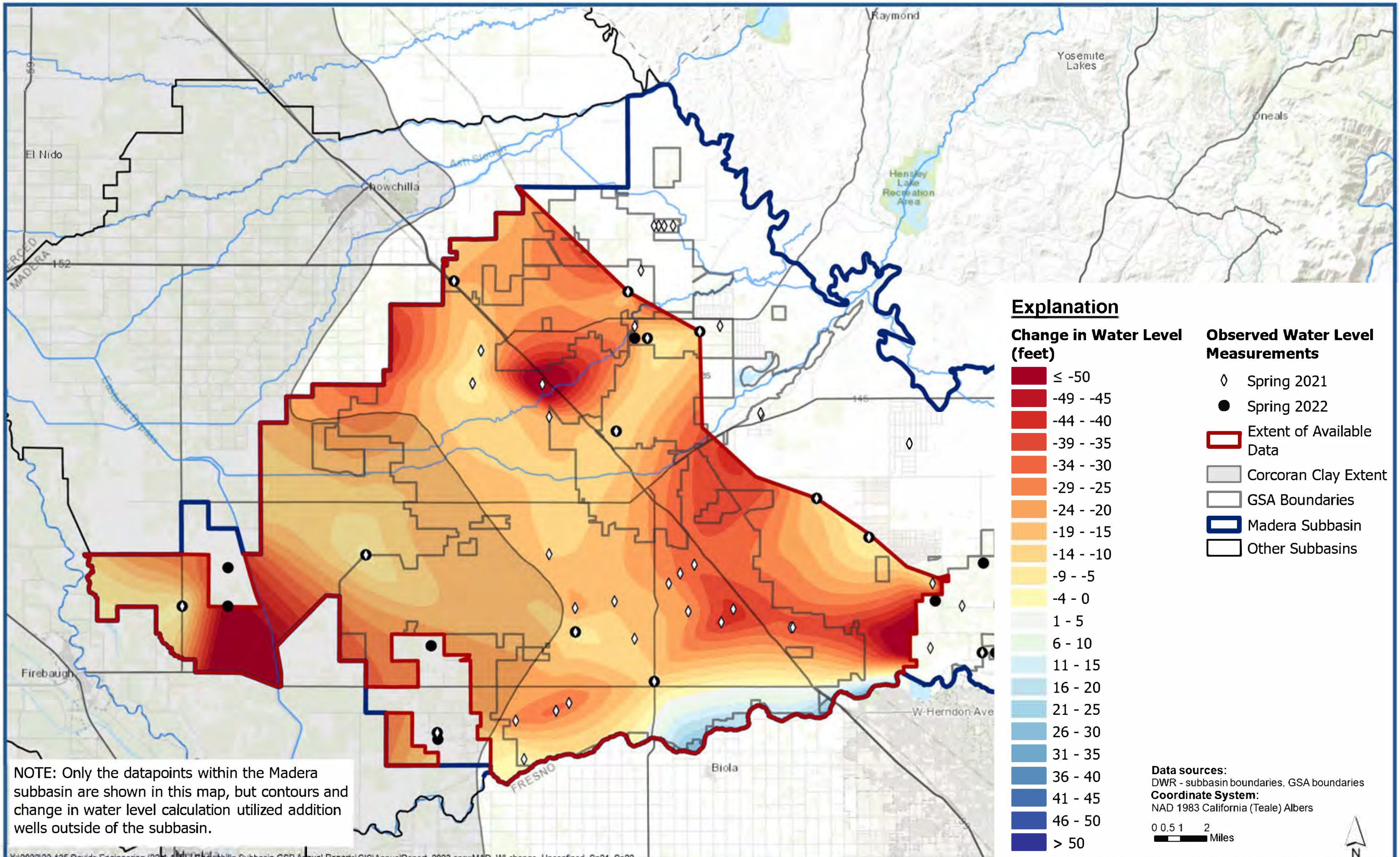
Change in Water Level in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2020 through Spring 2021

Figure C-5

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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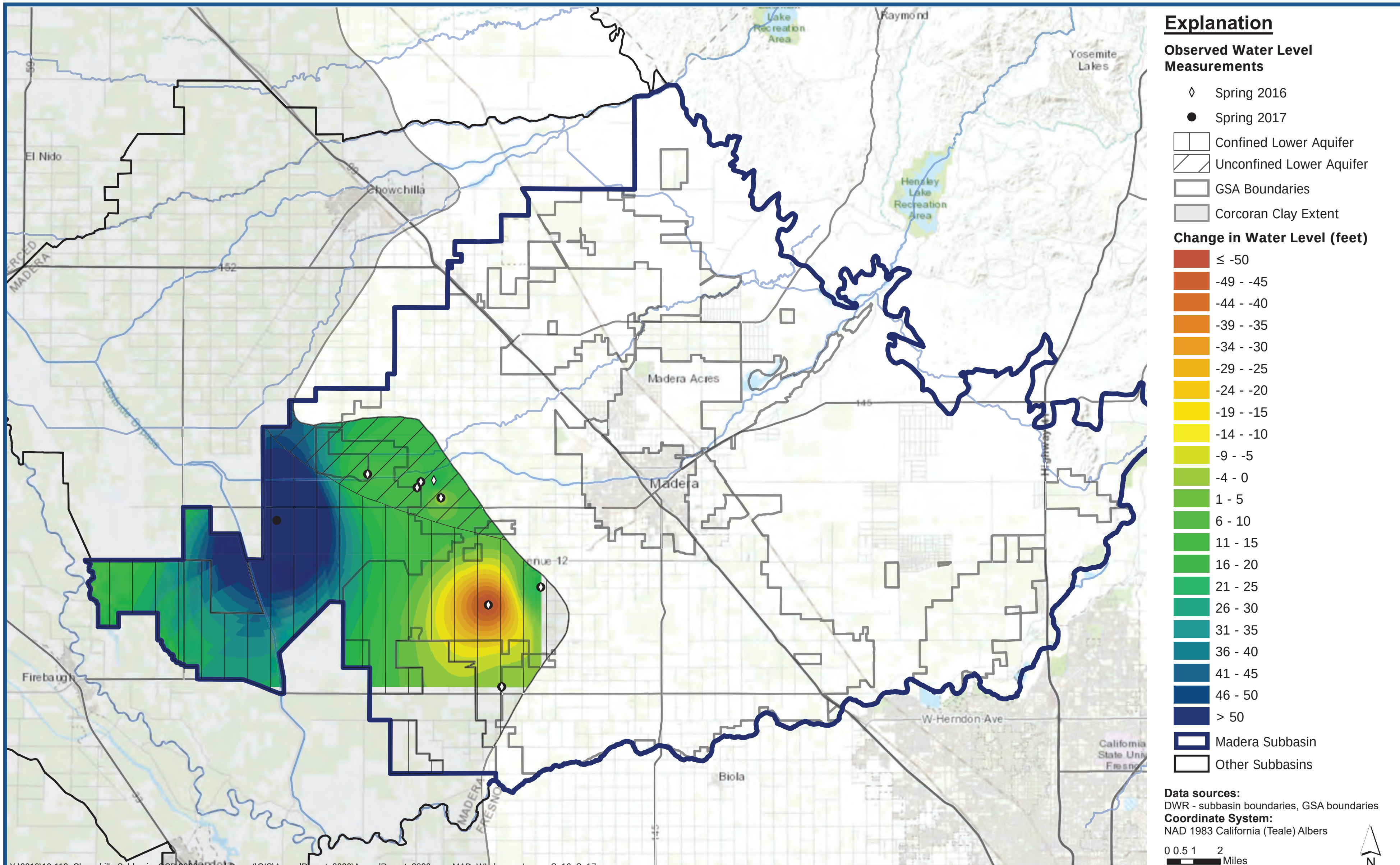
Change in Water Level in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2021 through Spring 2022

Figure C-6

Madera Subbasin

Groundwater Sustainability Plan 2024 Annual Report



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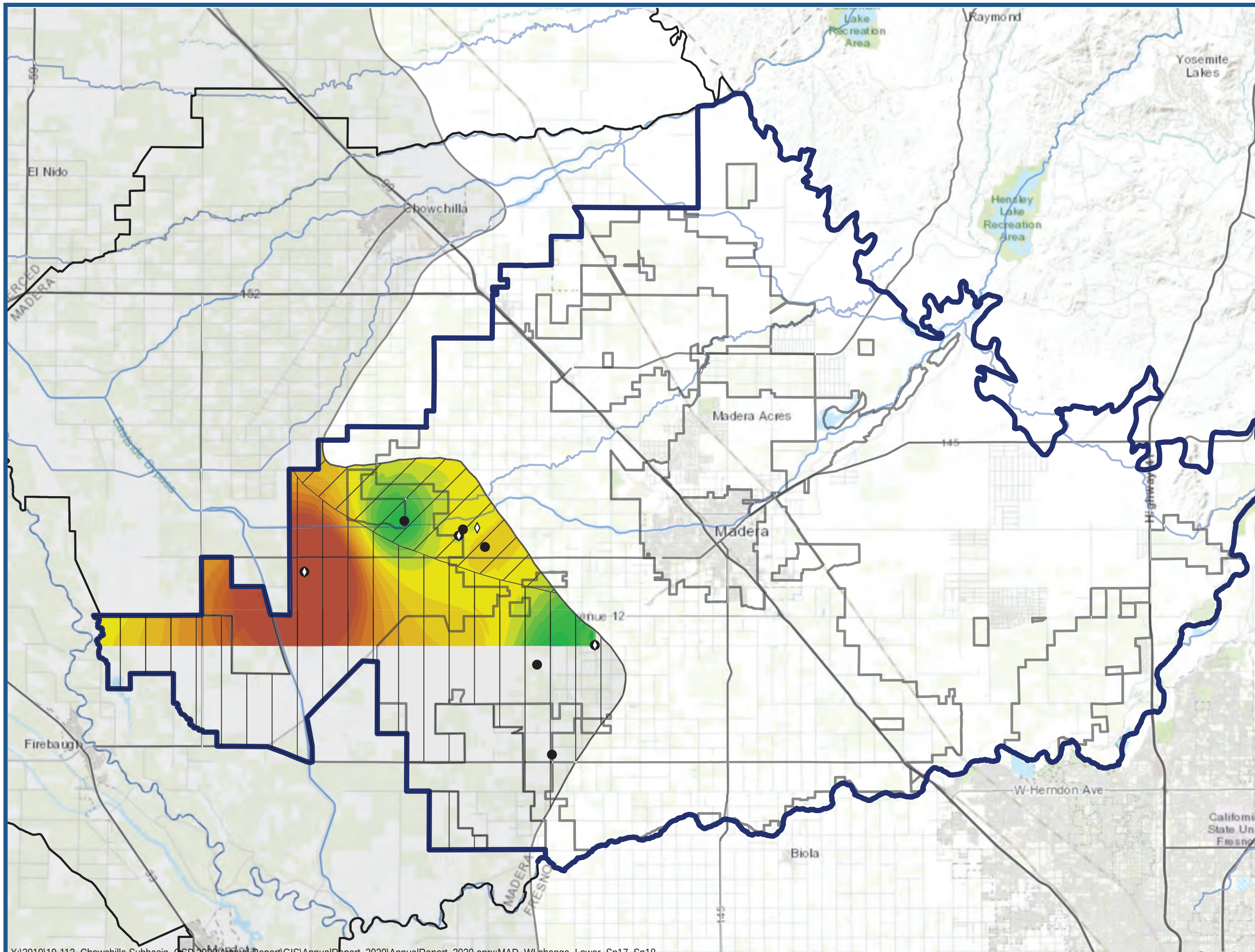
Change in Water Level in the Lower Aquifer - Spring 2016 through Spring 2017

Figure C-7

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



Change in Water Level in the Lower Aquifer - Spring 2017 through Spring 2018

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-8

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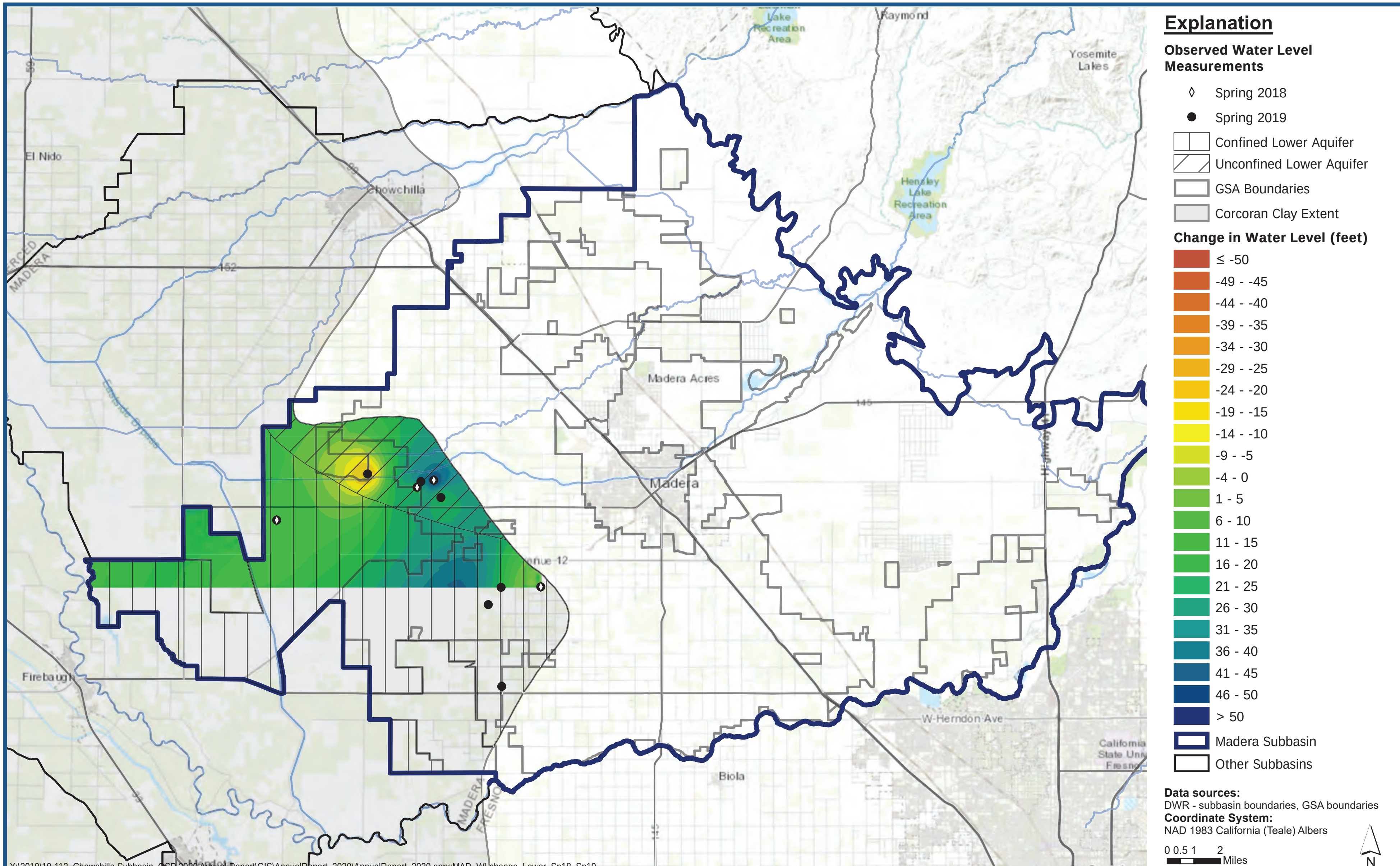

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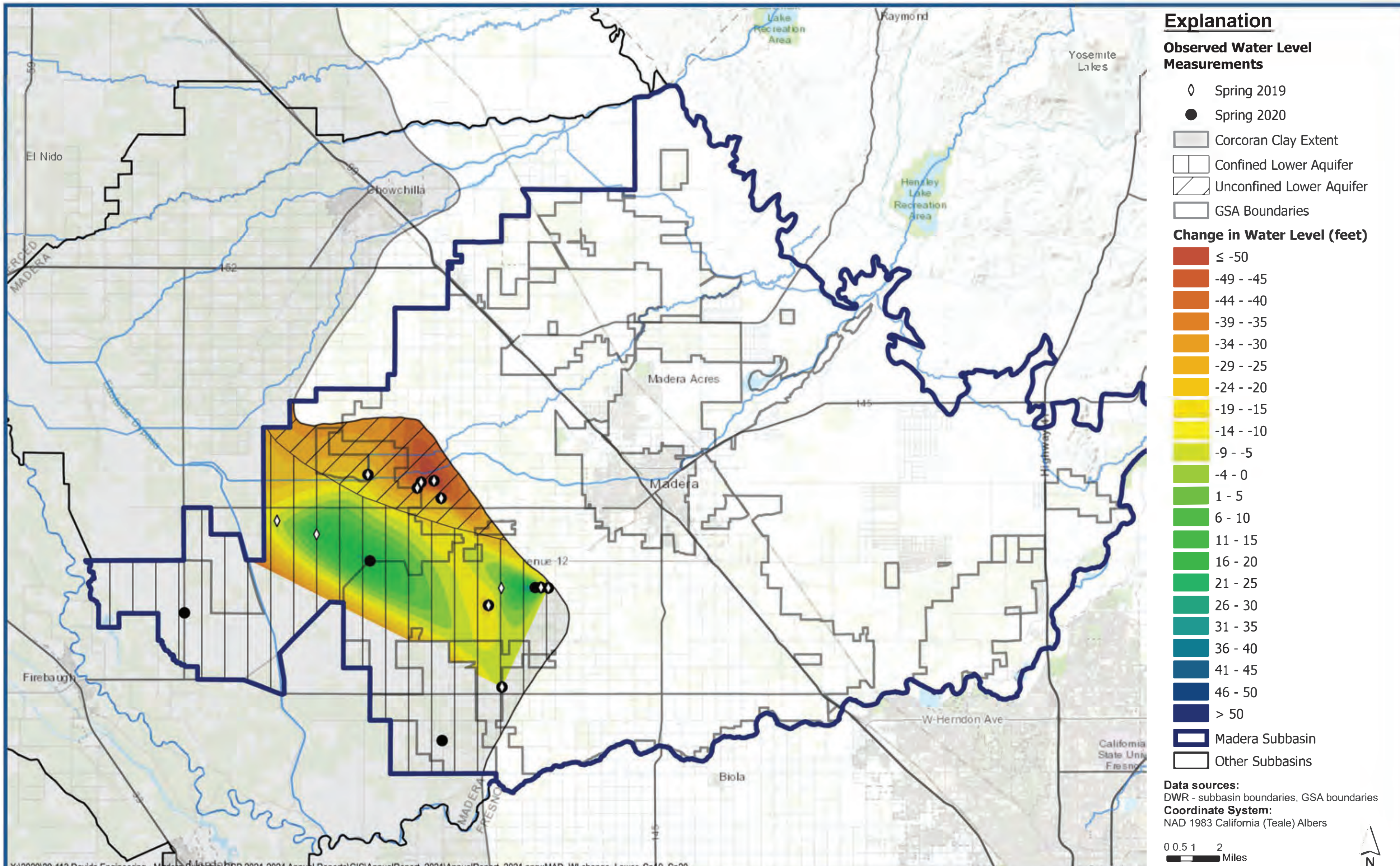
Change in Water Level in the Lower Aquifer - Spring 2018 through Spring 2019

Figure C-9

Madera Subbasin

Groundwater Sustainability Plan 2024 Annual Report



Change in Water Level in the Lower Aquifer - Spring 2019 through Spring 2020

Figure C-10

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

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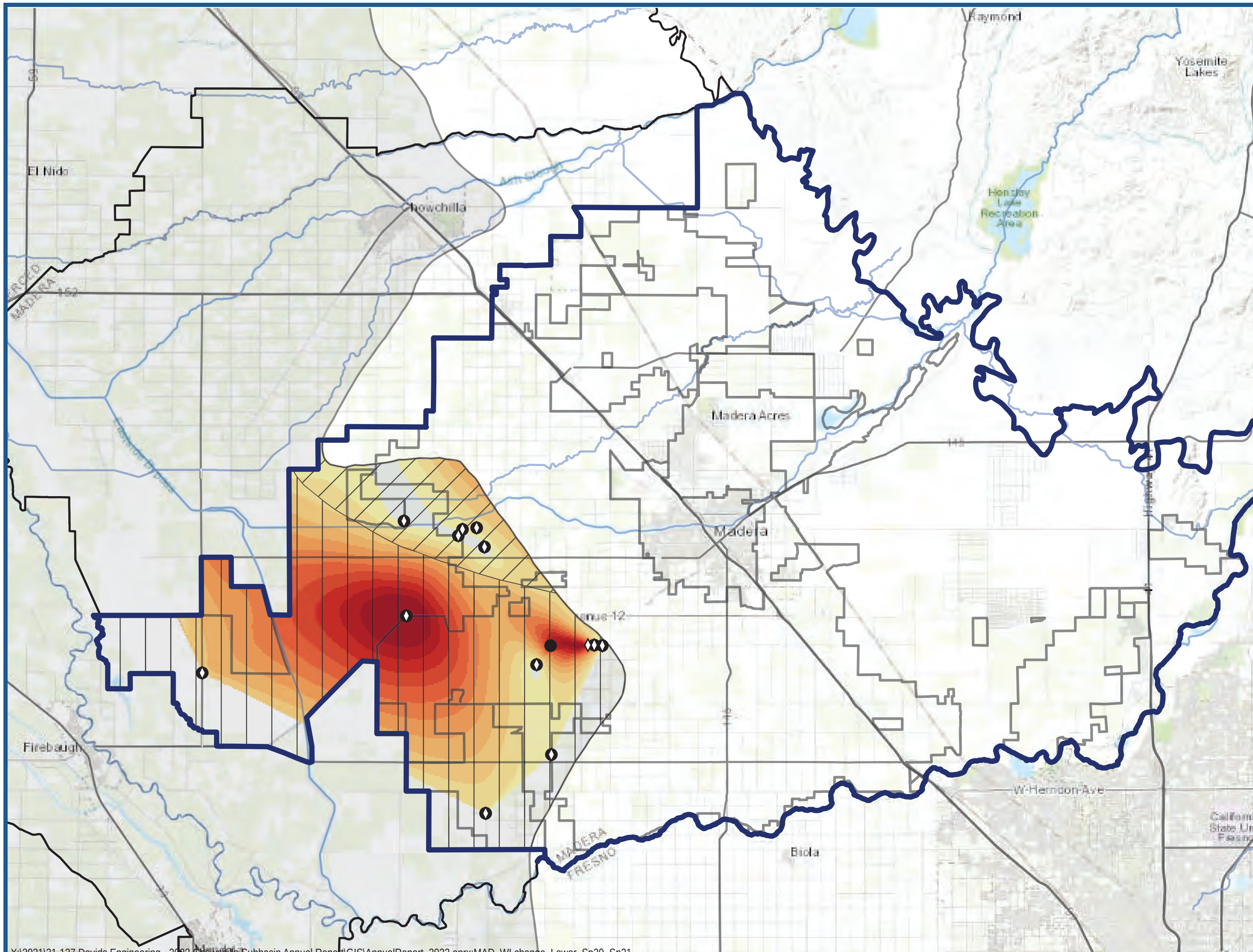

Explanation

Observed Water Level Measurements

- ◊ Spring 2020
- ● Spring 2021

Change in Water Level (feet)

- ≤ -50
- -49 - -45
- -44 - -40
- -39 - -35
- -34 - -30
- -29 - -25
- -24 - -20
- -19 - -15
- -14 - -10
- -9 - -5
- -4 - 0
- 1 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- 21 - 25
- 26 - 30
- 31 - 35
- 36 - 40
- 41 - 45
- 46 - 50
- > 50

- Corcoran Clay Extent
- Confined Lower Aquifer
- Unconfined Lower Aquifer
- GSA Boundaries
- Madera Subbasin
- Other Subbasins

Data sources:
DWR - subbasin boundaries, GSA boundaries
Coordinate System:
NAD 1983 California (Teale) Albers

0 0.5 1 2 Miles

N

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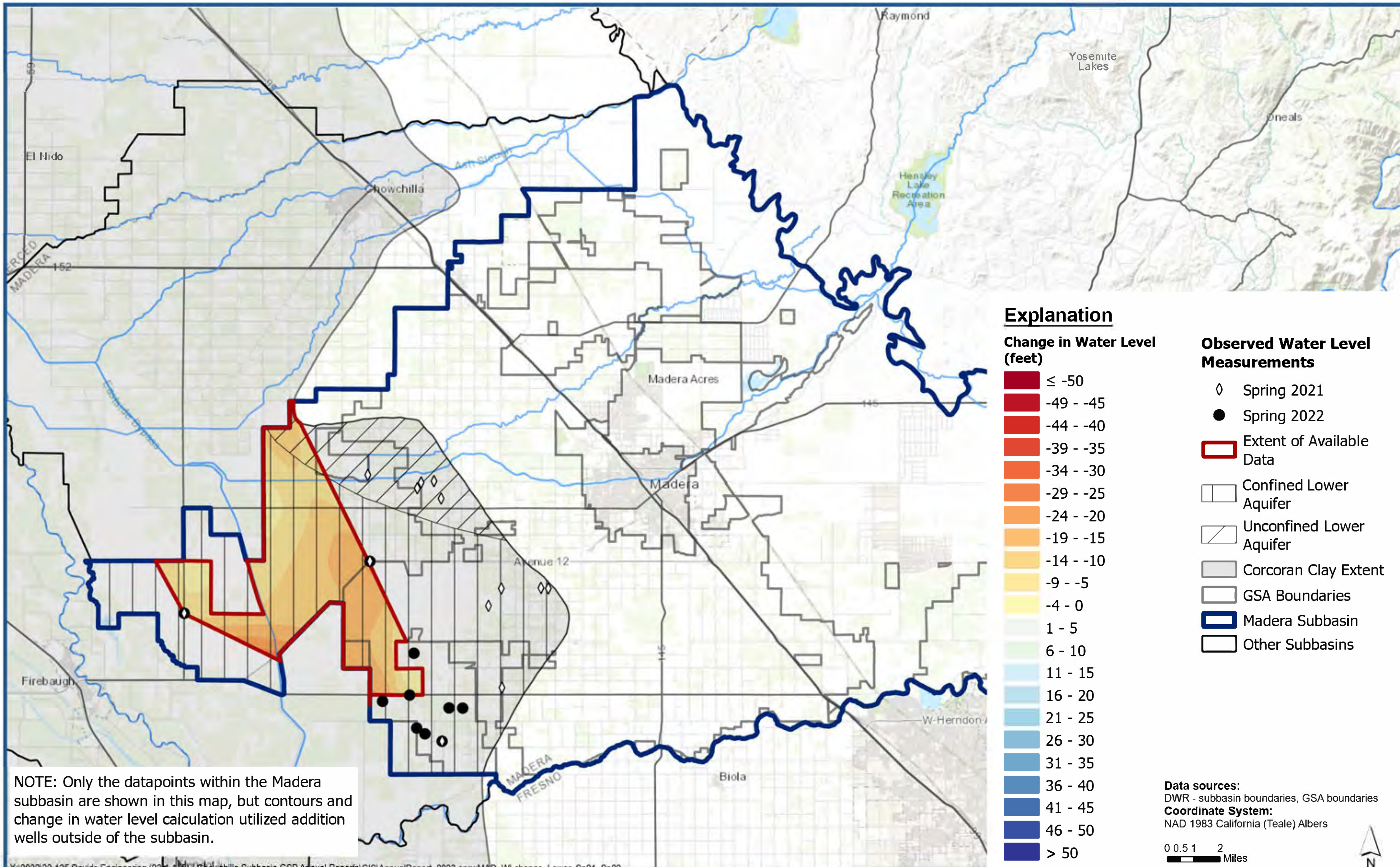
Change in Water Level in the Lower Aquifer - Spring 2020 through Spring 2021

Figure C-11

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



Change in Water Level in the Lower Aquifer - Spring 2021 through Spring 2022

Figure C-12

Madera Subbasin

Groundwater Sustainability Plan 2024 Annual Report

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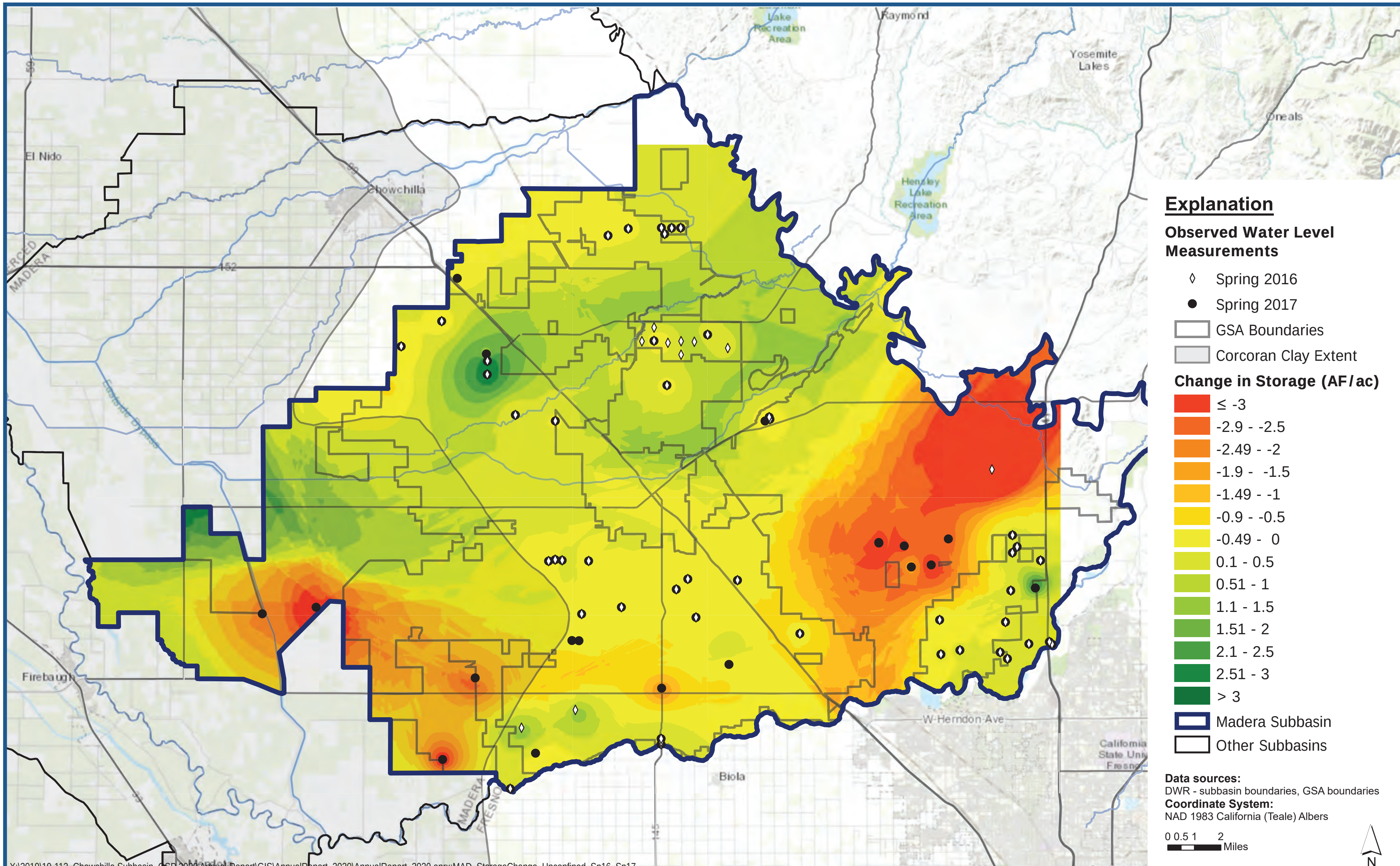

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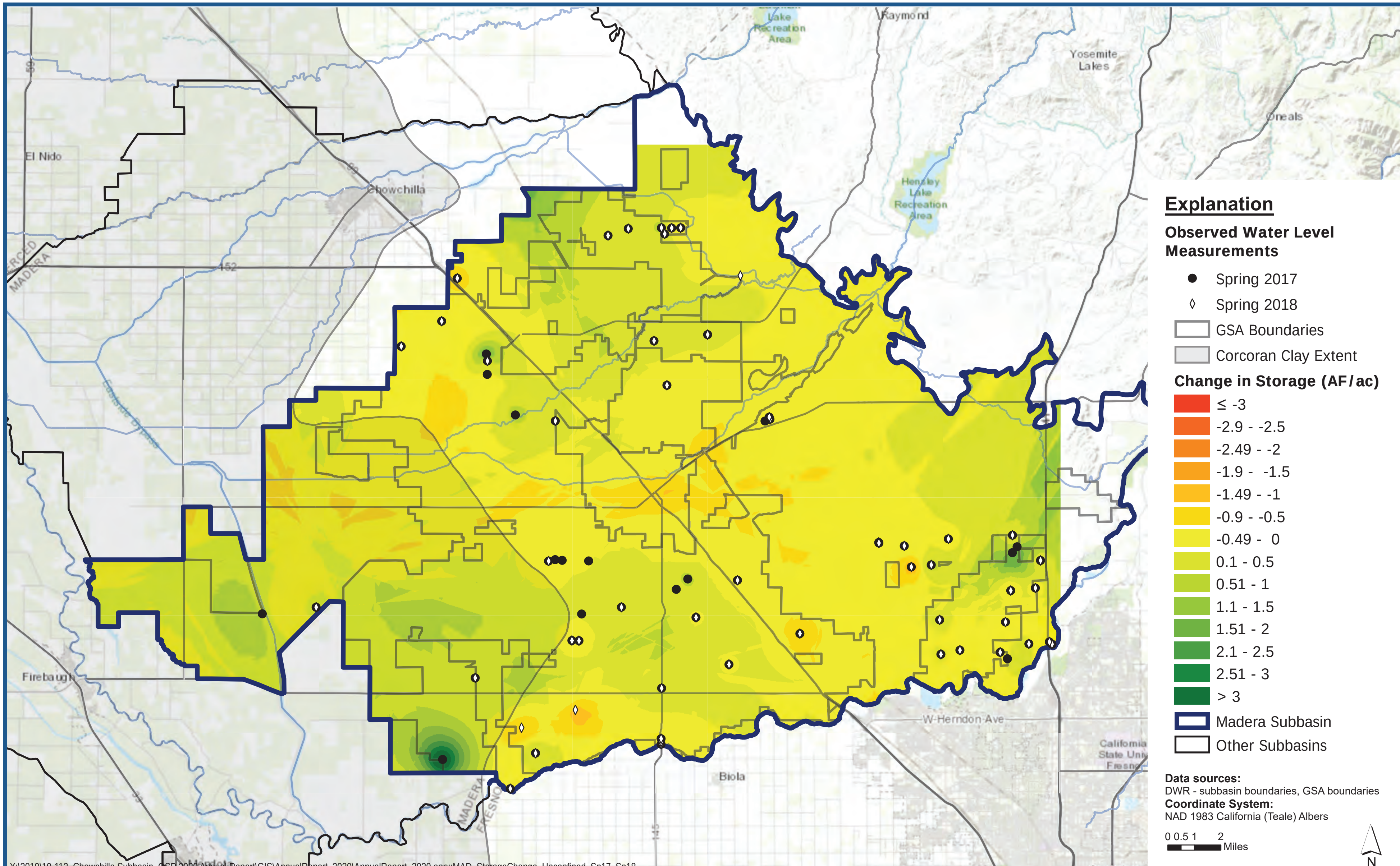
Change in Groundwater Storage in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2016 through Spring 2017

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-13



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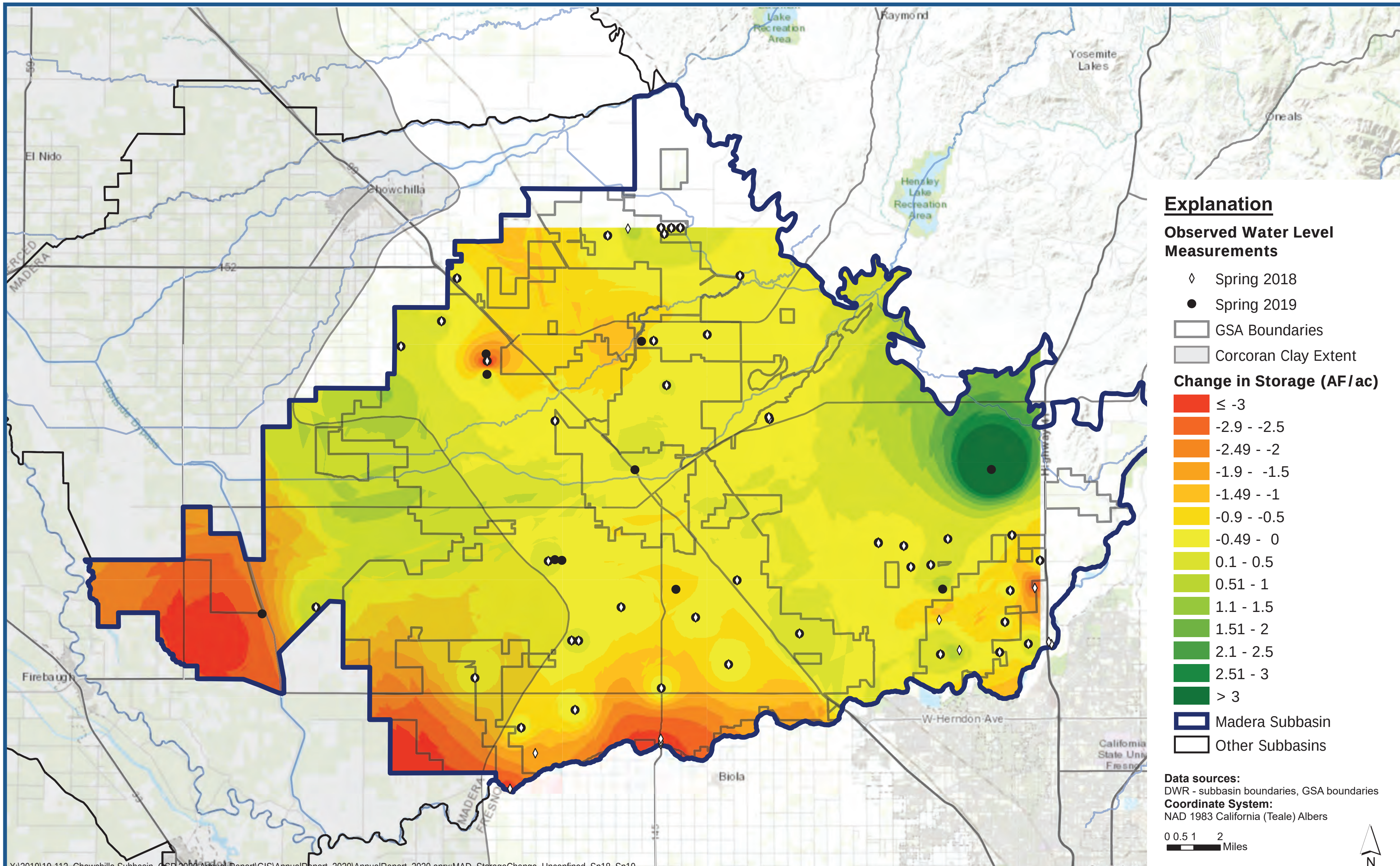
Change in Groundwater Storage in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2017 through Spring 2018

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-14



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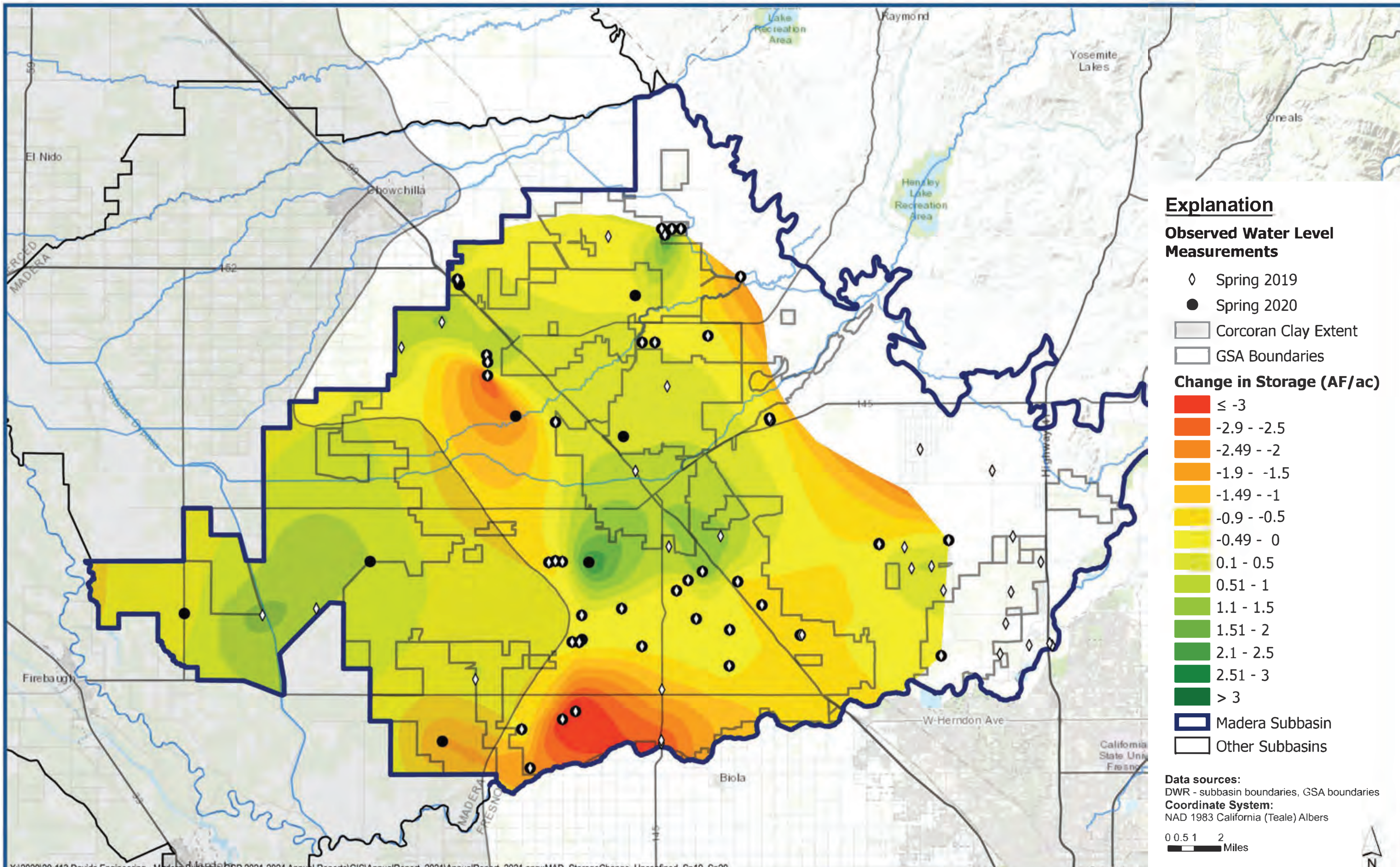
Change in Groundwater Storage in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2018 through Spring 2019

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-15



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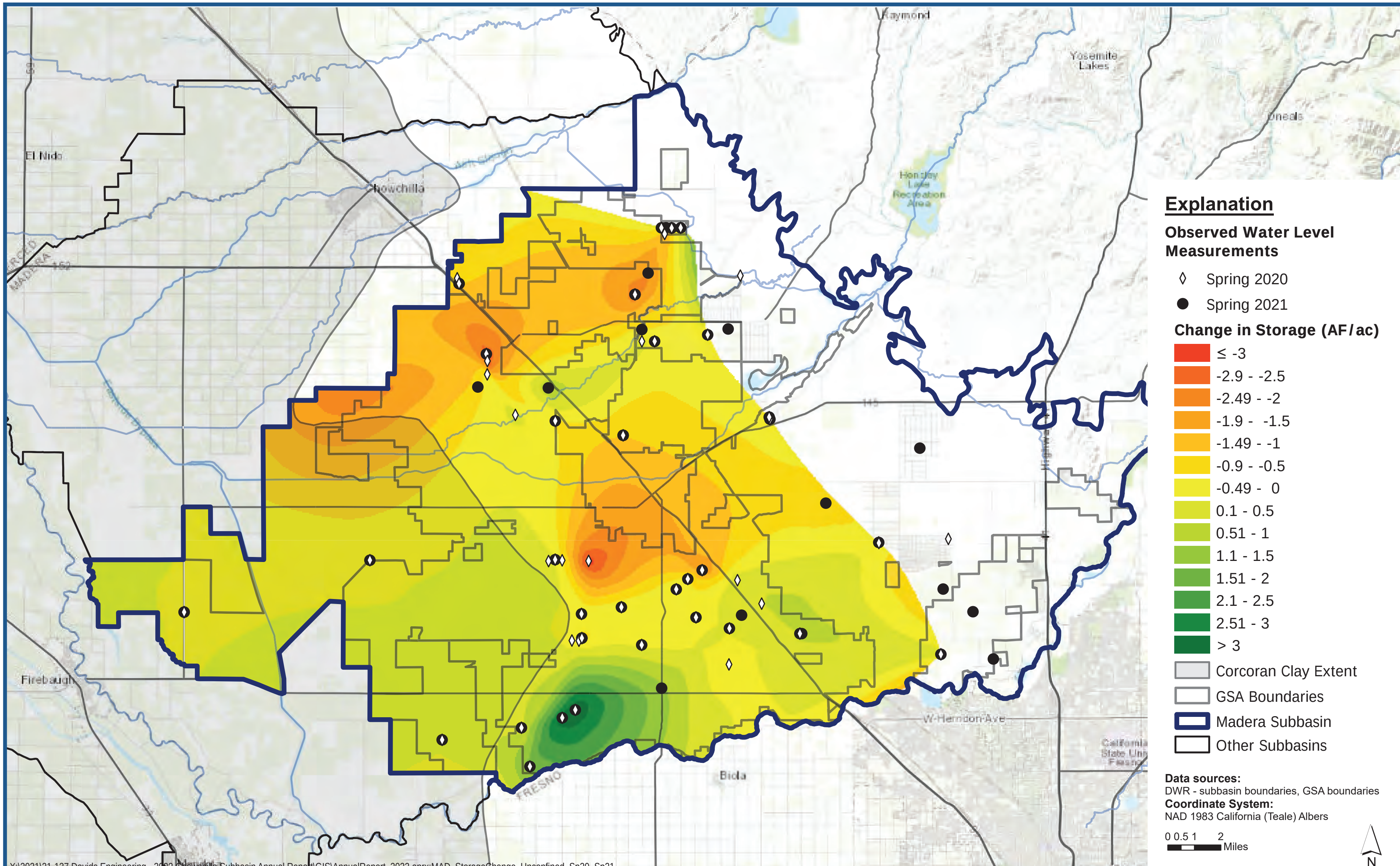
Change in Groundwater Storage in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2019 through Spring 2020

Figure C-16

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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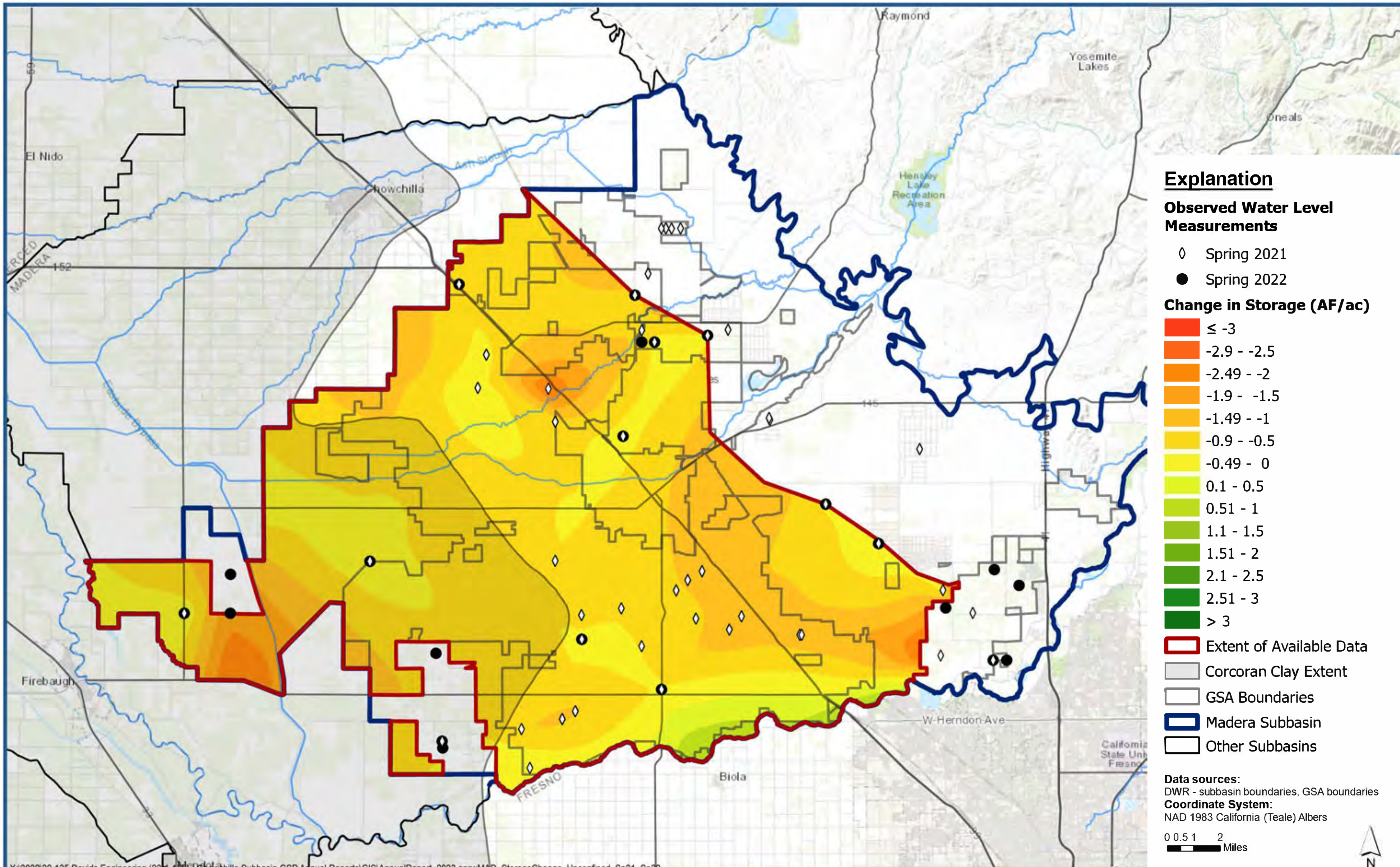
Change in Groundwater Storage in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2020 through Spring 2021

Figure C-17

Madera Subbasin

Groundwater Sustainability Plan 2024 Annual Report



Change in Groundwater Storage in the Upper Aquifer/Undifferentiated Unconfined Zone - Spring 2021 through Spring 2022

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-18

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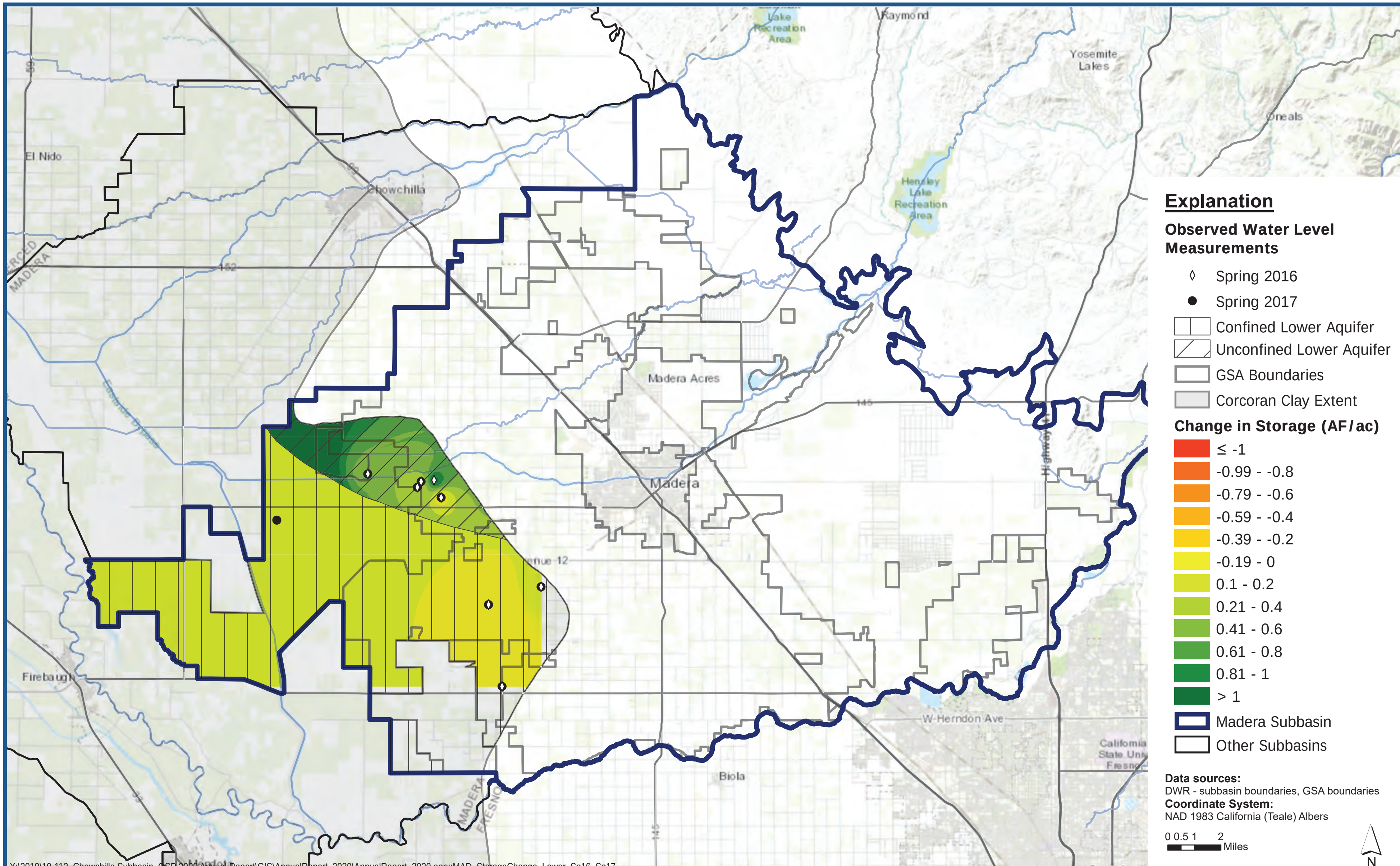

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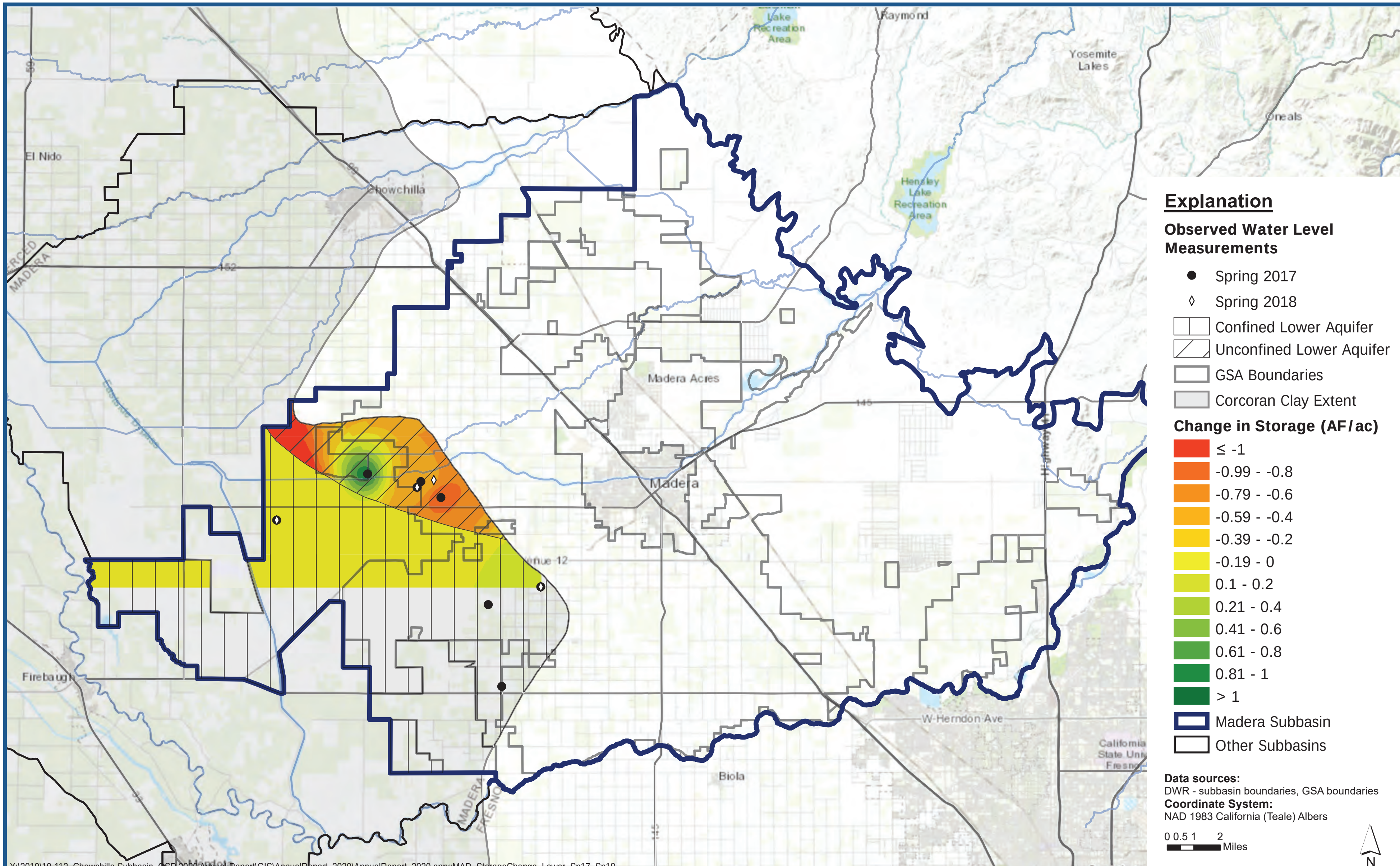
Change in Groundwater Storage in the Lower Aquifer - Spring 2016 through Spring 2017

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-19



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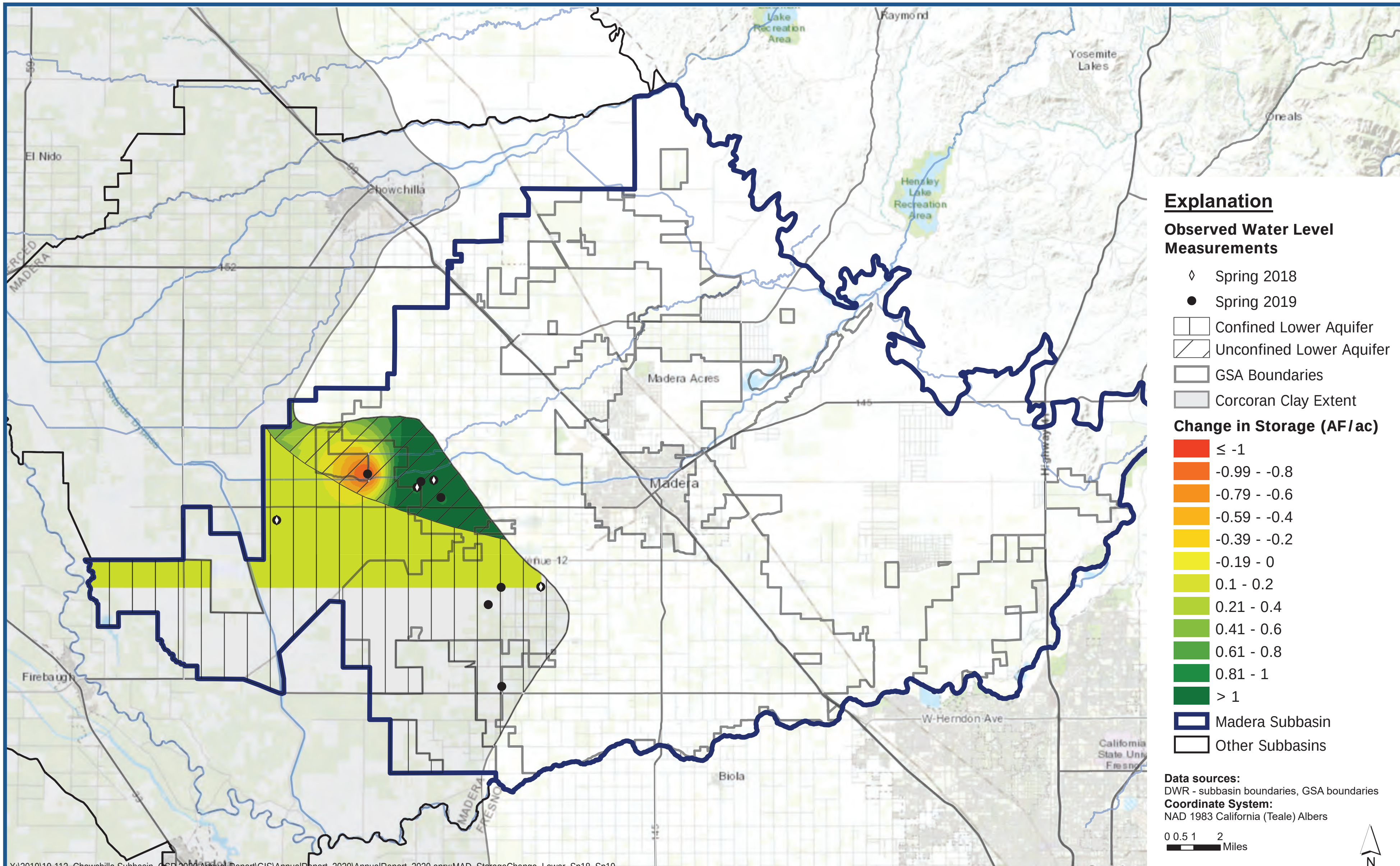
Change in Groundwater Storage in the Lower Aquifer - Spring 2017 through Spring 2018

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-20



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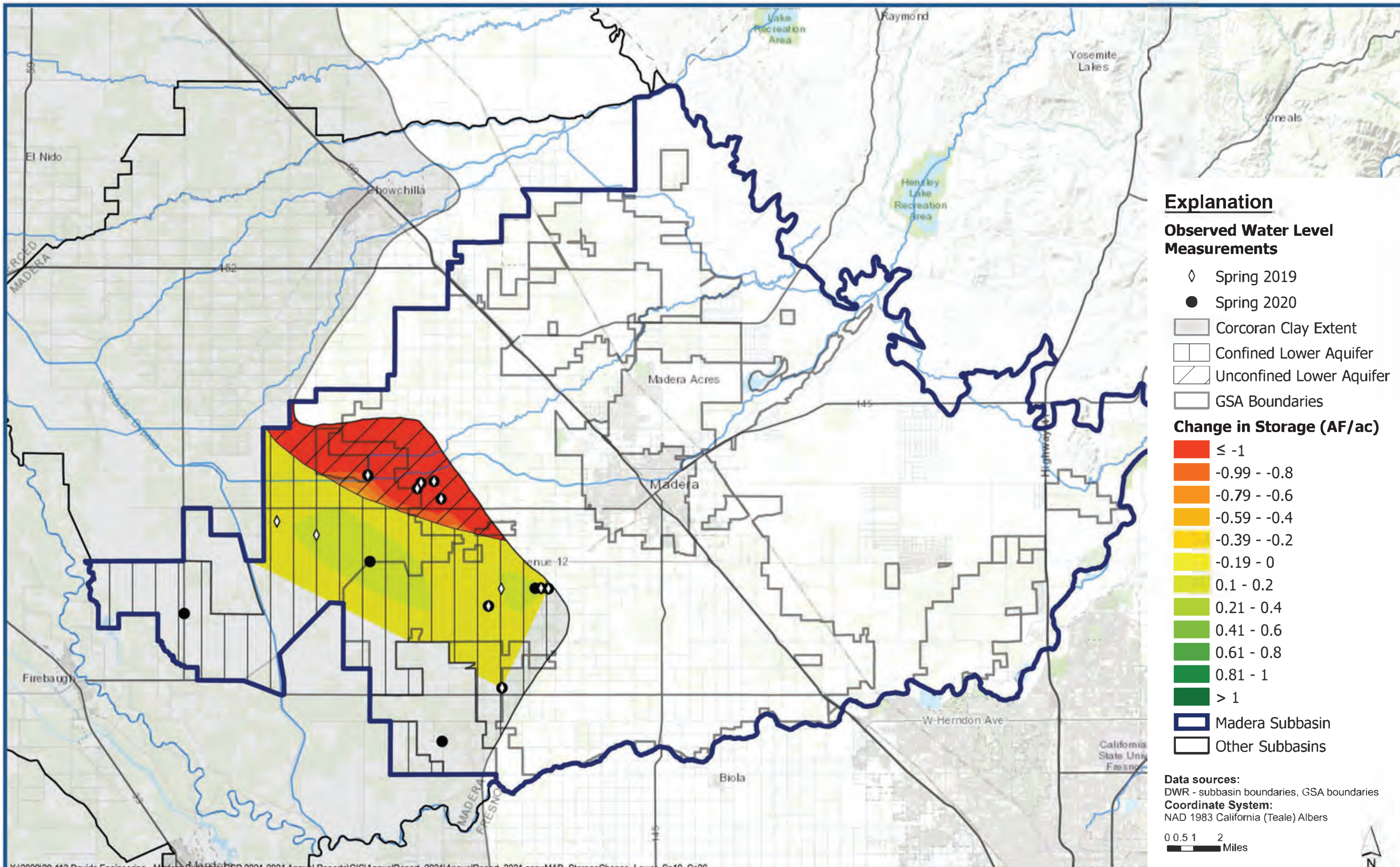
Change in Groundwater Storage in the Lower Aquifer - Spring 2018 through Spring 2019

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

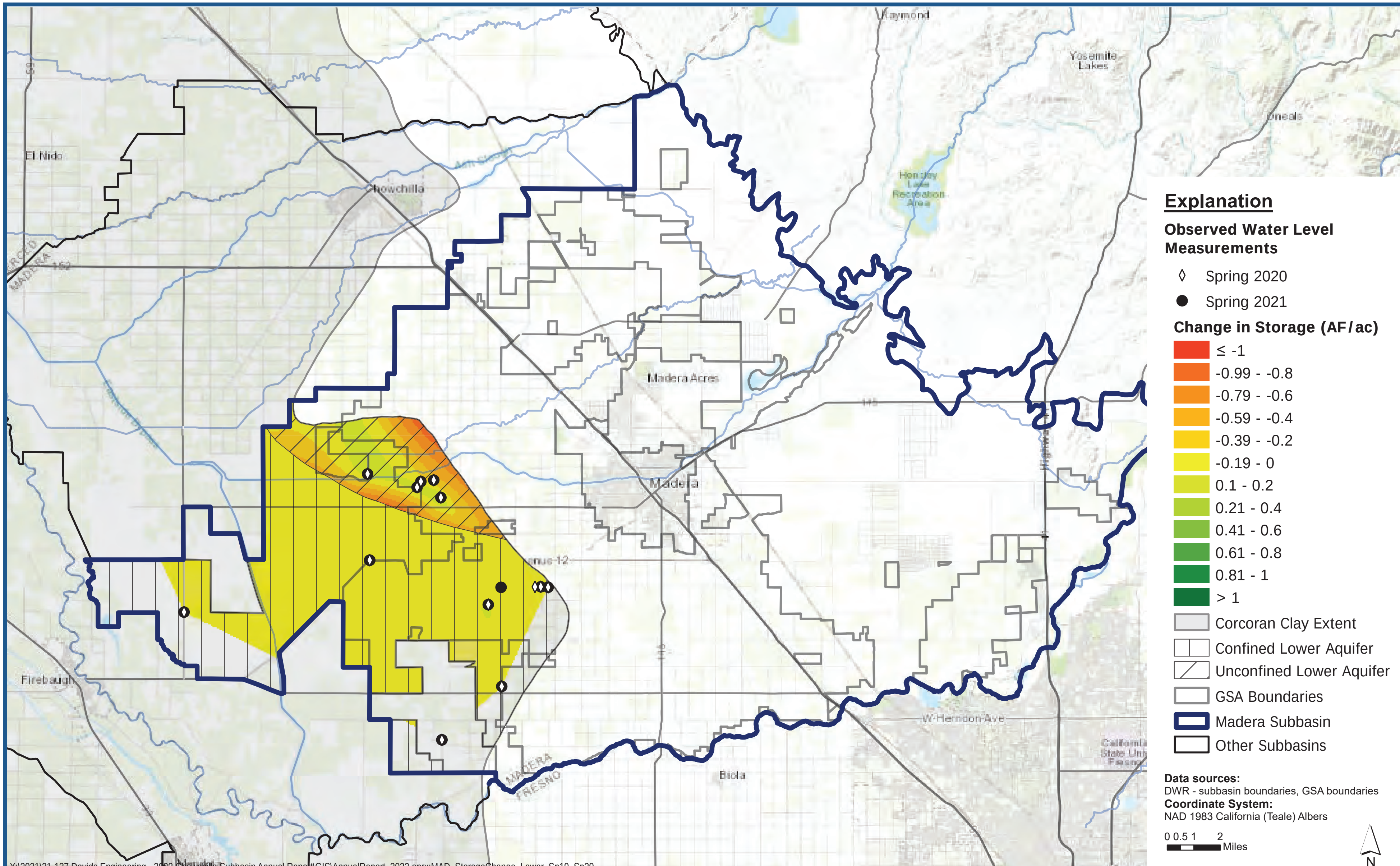
Figure C-21



Change in Groundwater Storage in the Lower Aquifer - Spring 2019 through Spring 2020

Figure C-22

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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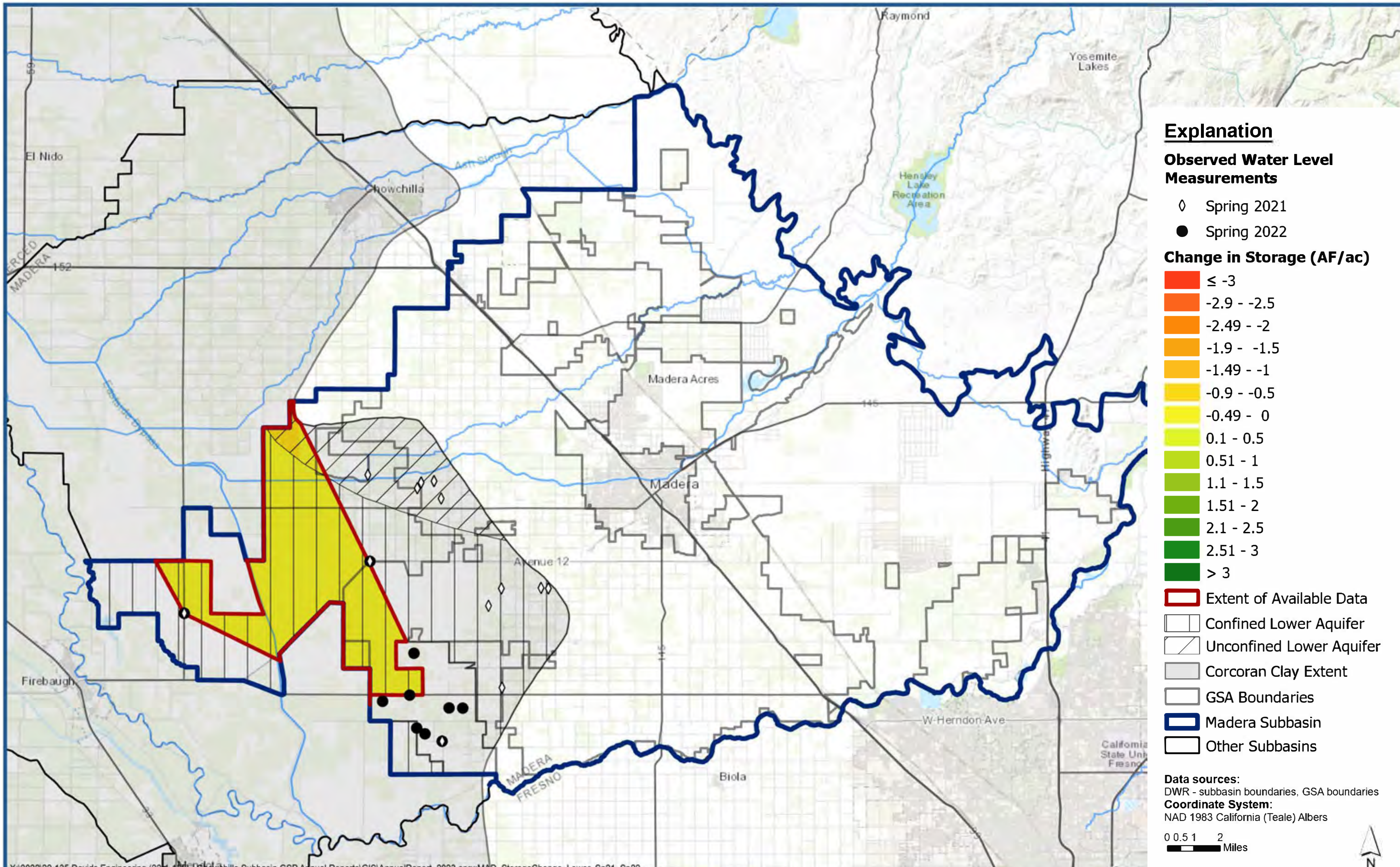
Change in Groundwater Storage in the Lower Aquifer - Spring 2020 through Spring 2021

Figure C-23

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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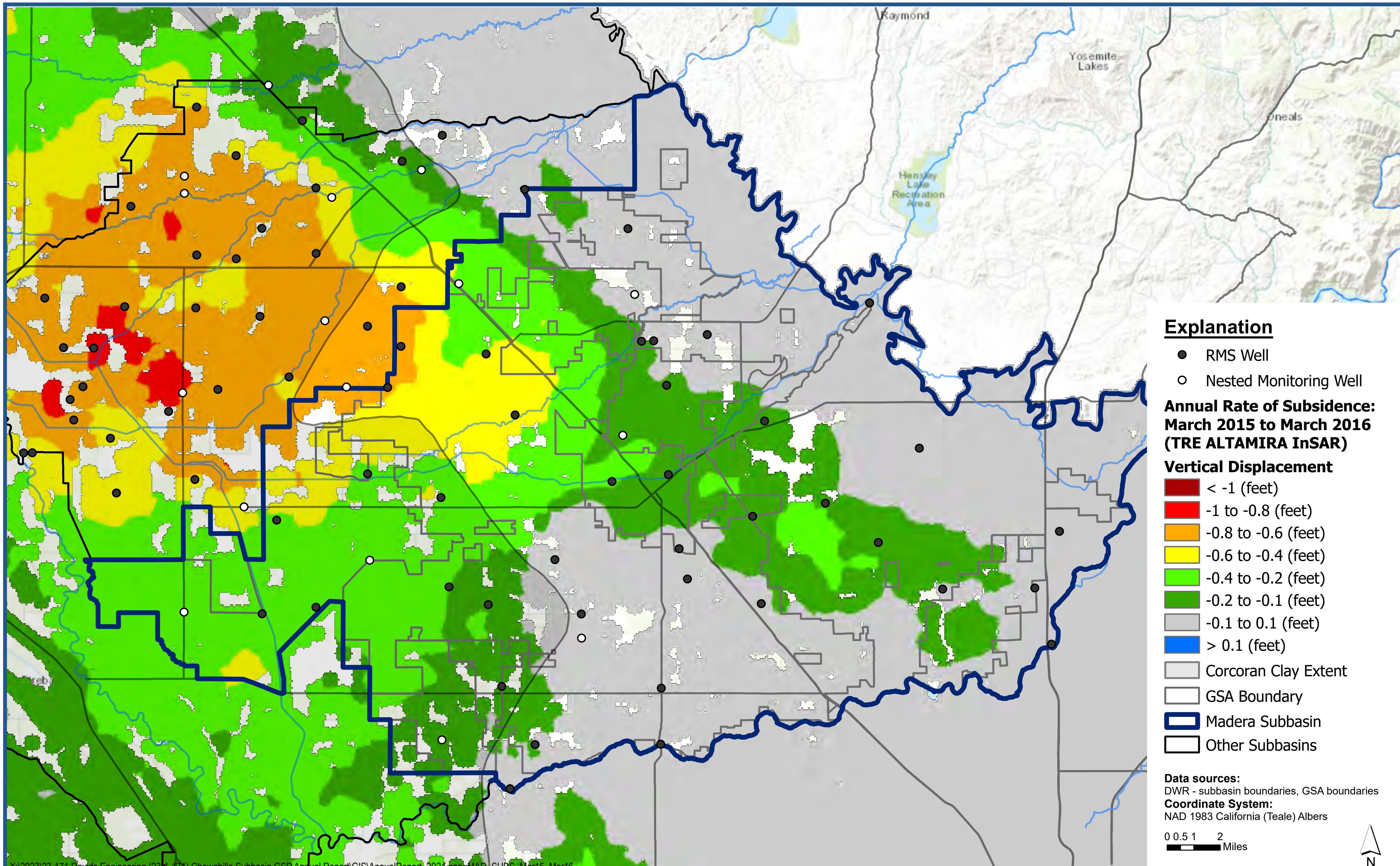
Change in Groundwater Storage in the Lower Aquifer - Spring 2021 through Spring 2022

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure C-24

Appendix D. Maps of Annual and Cumulative Subsidence in 2015 through 2022.



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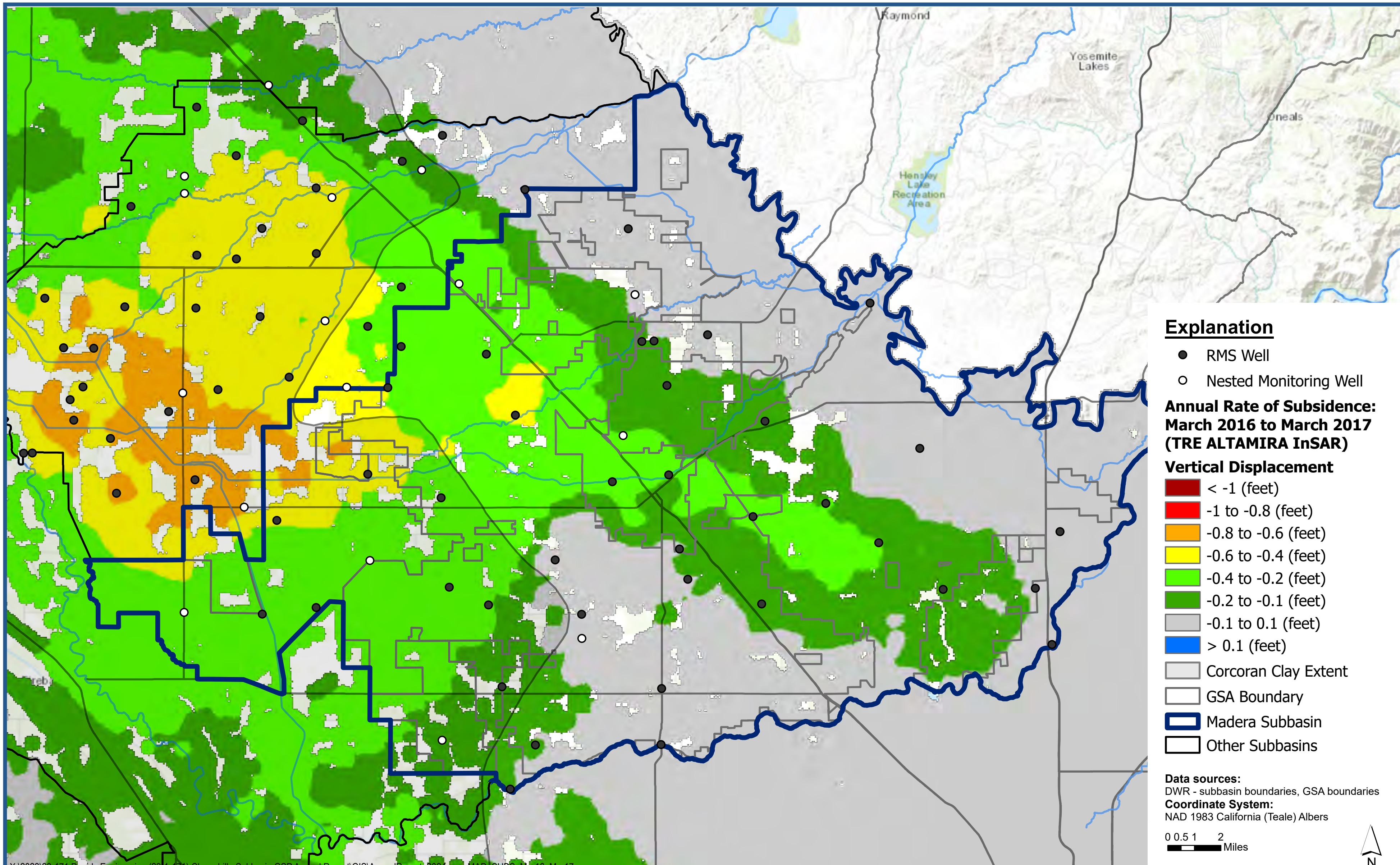
Annual Rate of Subsidence: March 2015 to March 2016 (TRE ALTAMIRA InSAR)

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-1



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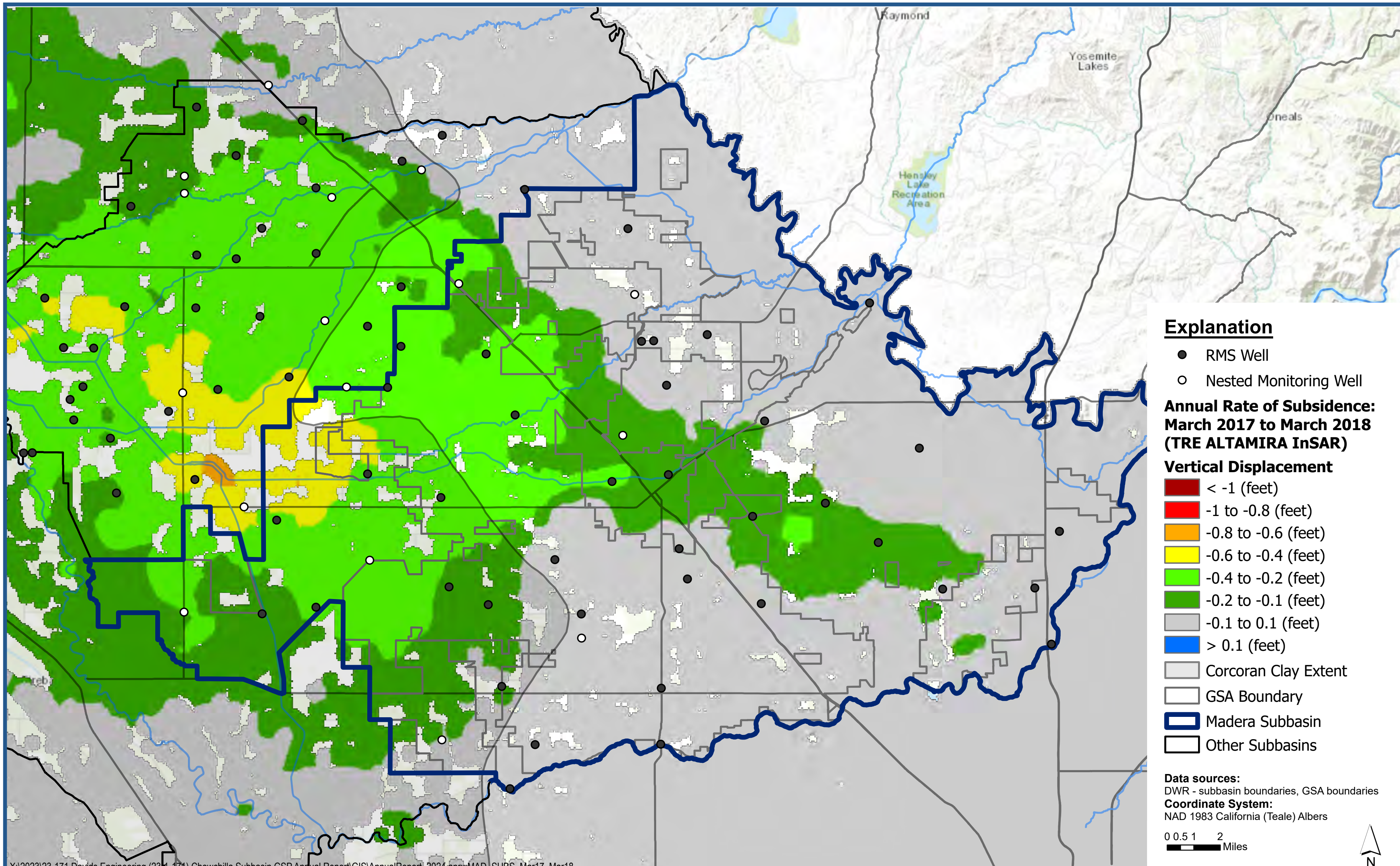
Annual Rate of Subsidence: March 2016 to March 2017 (TRE ALTAMIRA InSAR)

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-2



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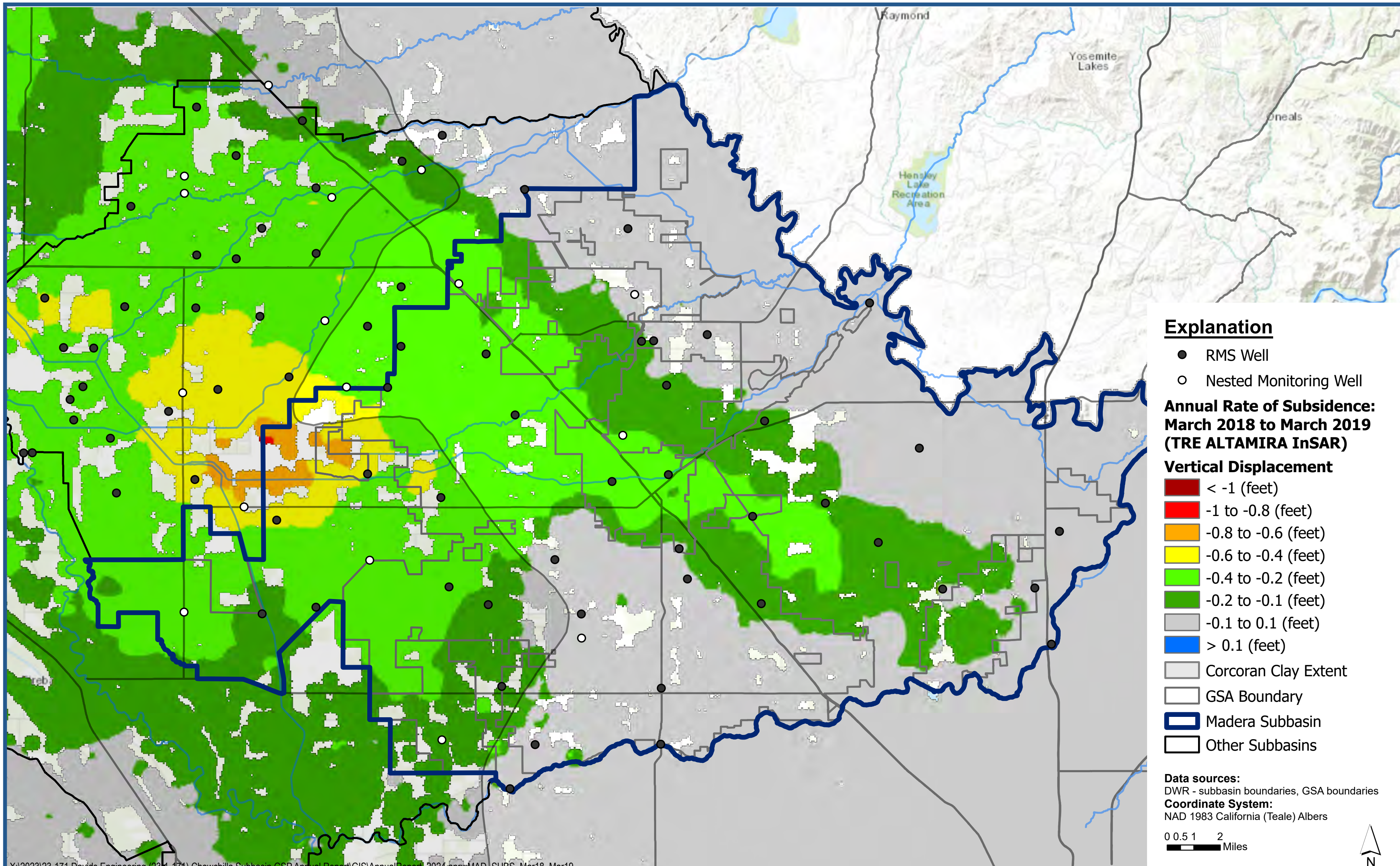
Annual Rate of Subsidence: March 2017 to March 2018 (TRE ALTAMIRA InSAR)

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-3



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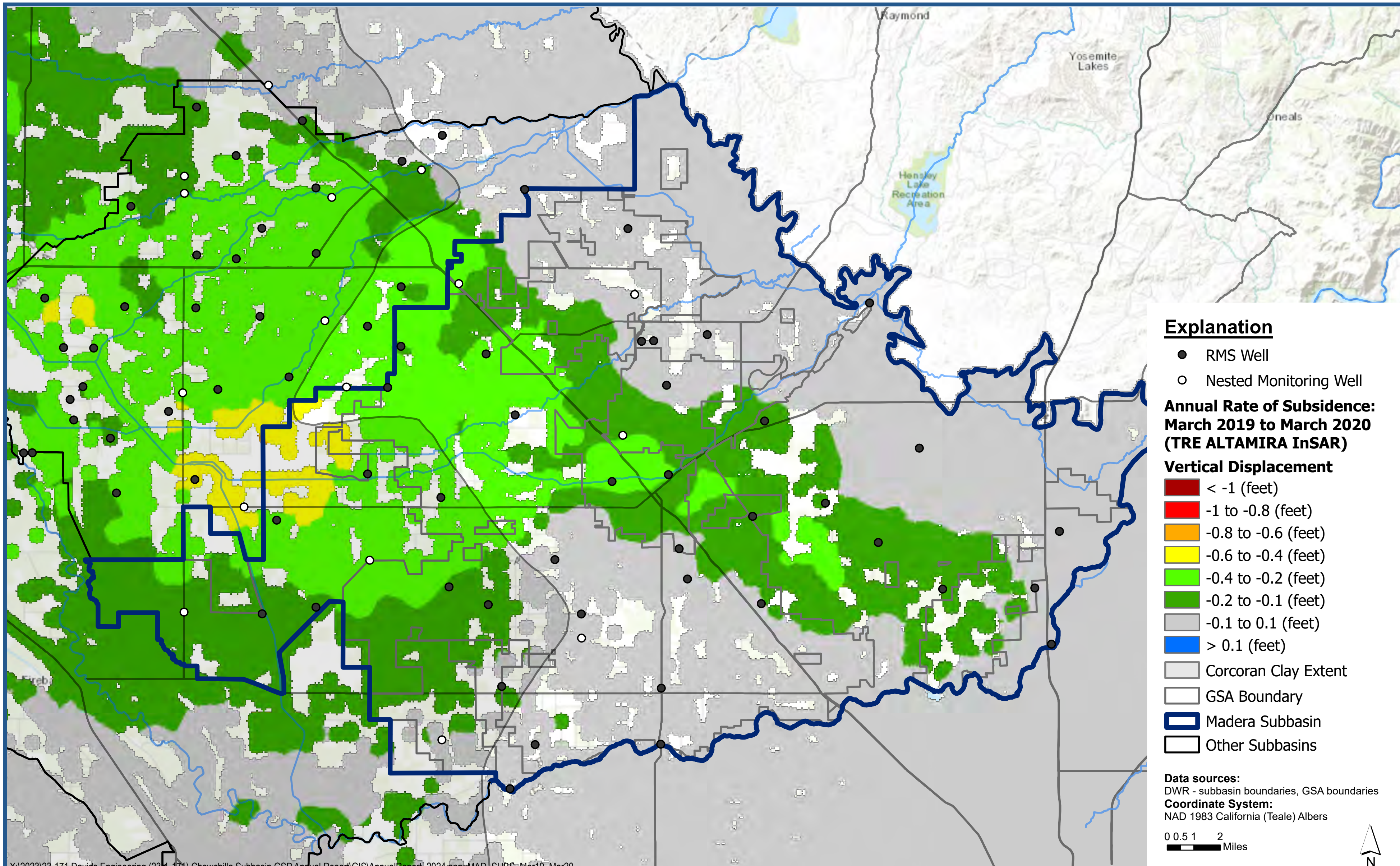
Annual Rate of Subsidence: March 2018 to March 2019 (TRE ALTAMIRA InSAR)

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-4



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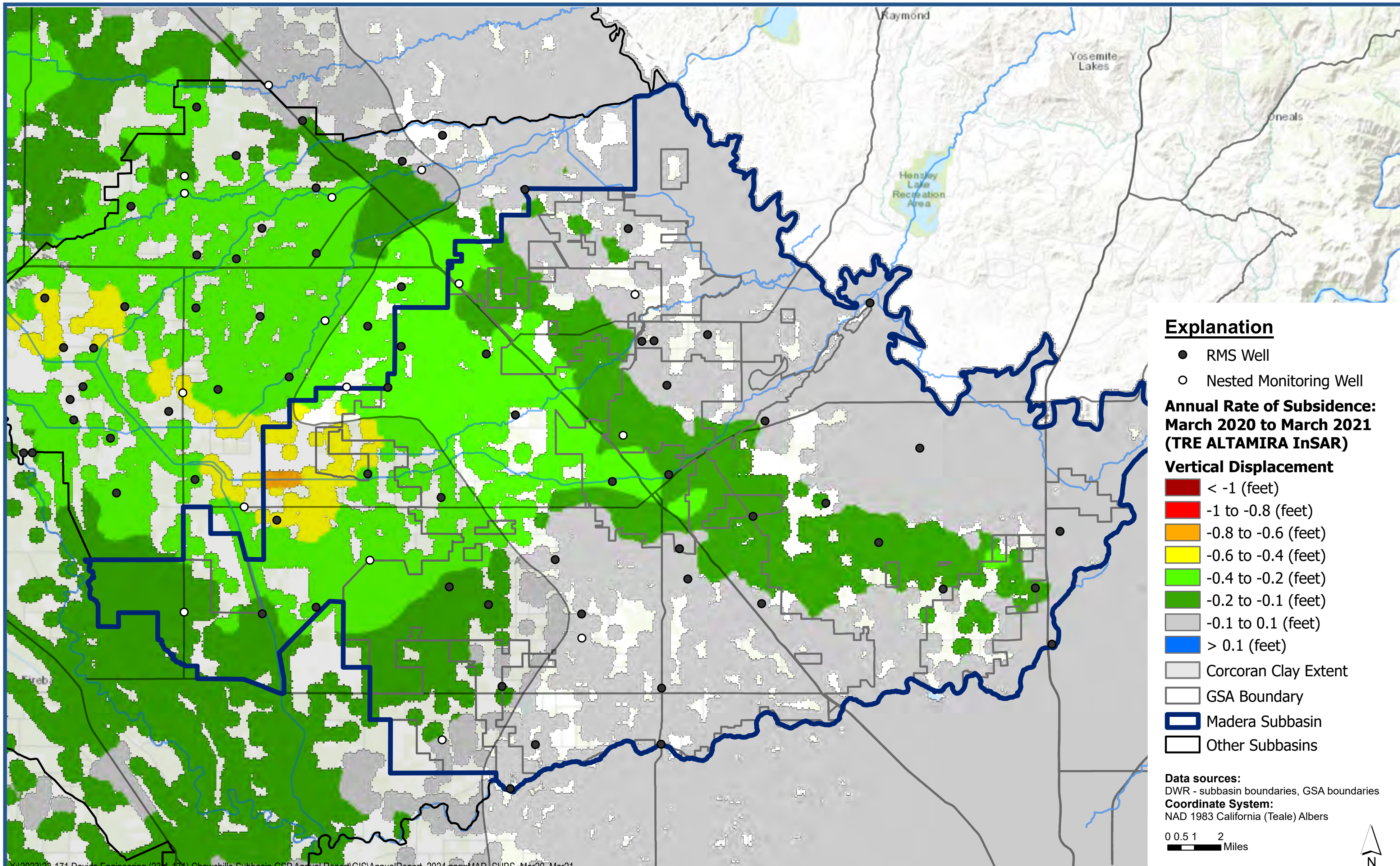
Annual Rate of Subsidence: March 2019 to March 2020 (TRE ALTAMIRA InSAR)

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-5



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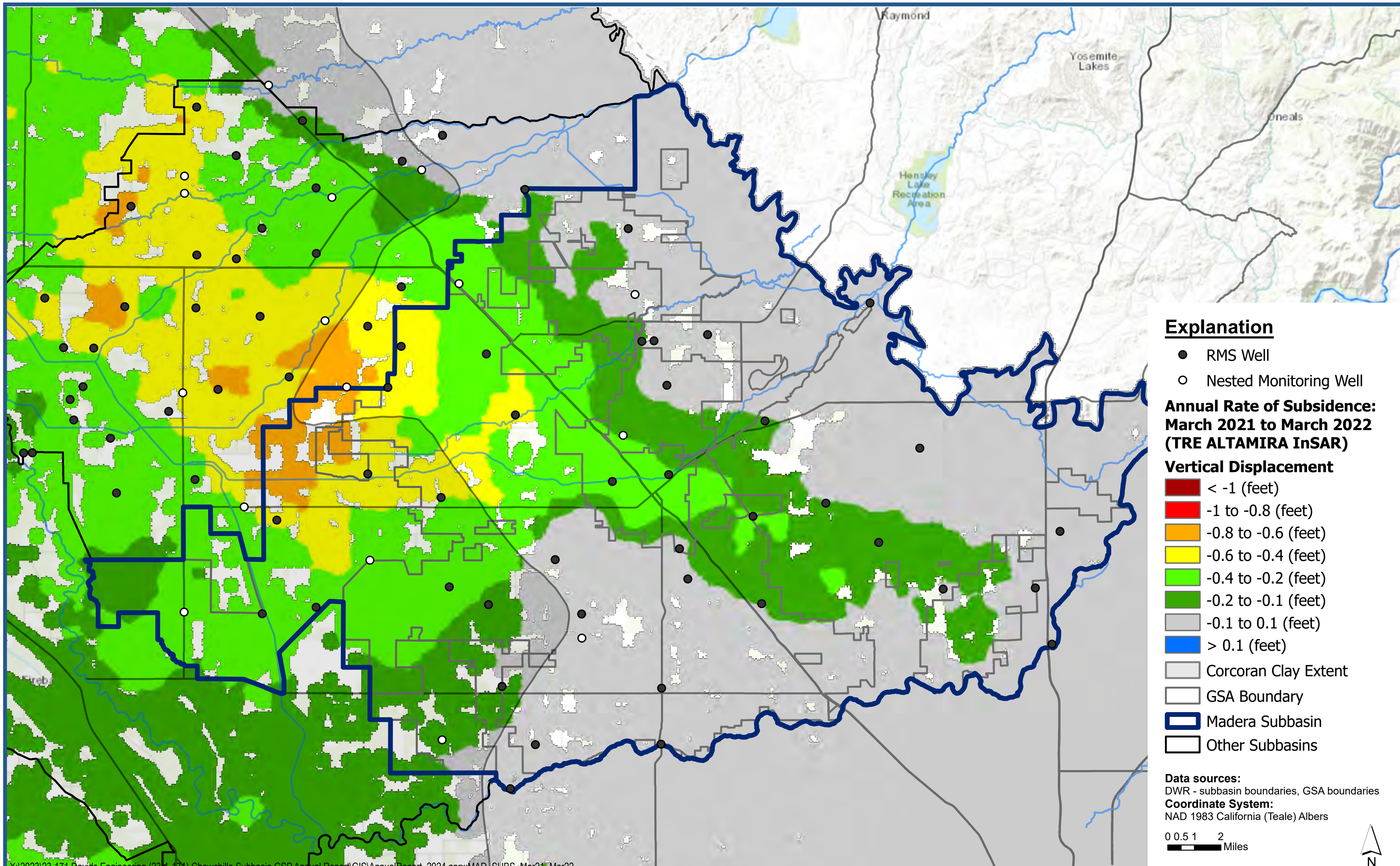
Annual Rate of Subsidence: March 2020 to March 2021 (TRE ALTAMIRA InSAR)

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-6



X:\2023\23-171 Davids Engineering (23-4-171) Chowchilla Subbasin GSP Annual Report\GIS\AnnualReport_2024.aprx MAD_SUBS_Mar21_Mar22

DAVIDS ENGINEERING, INC

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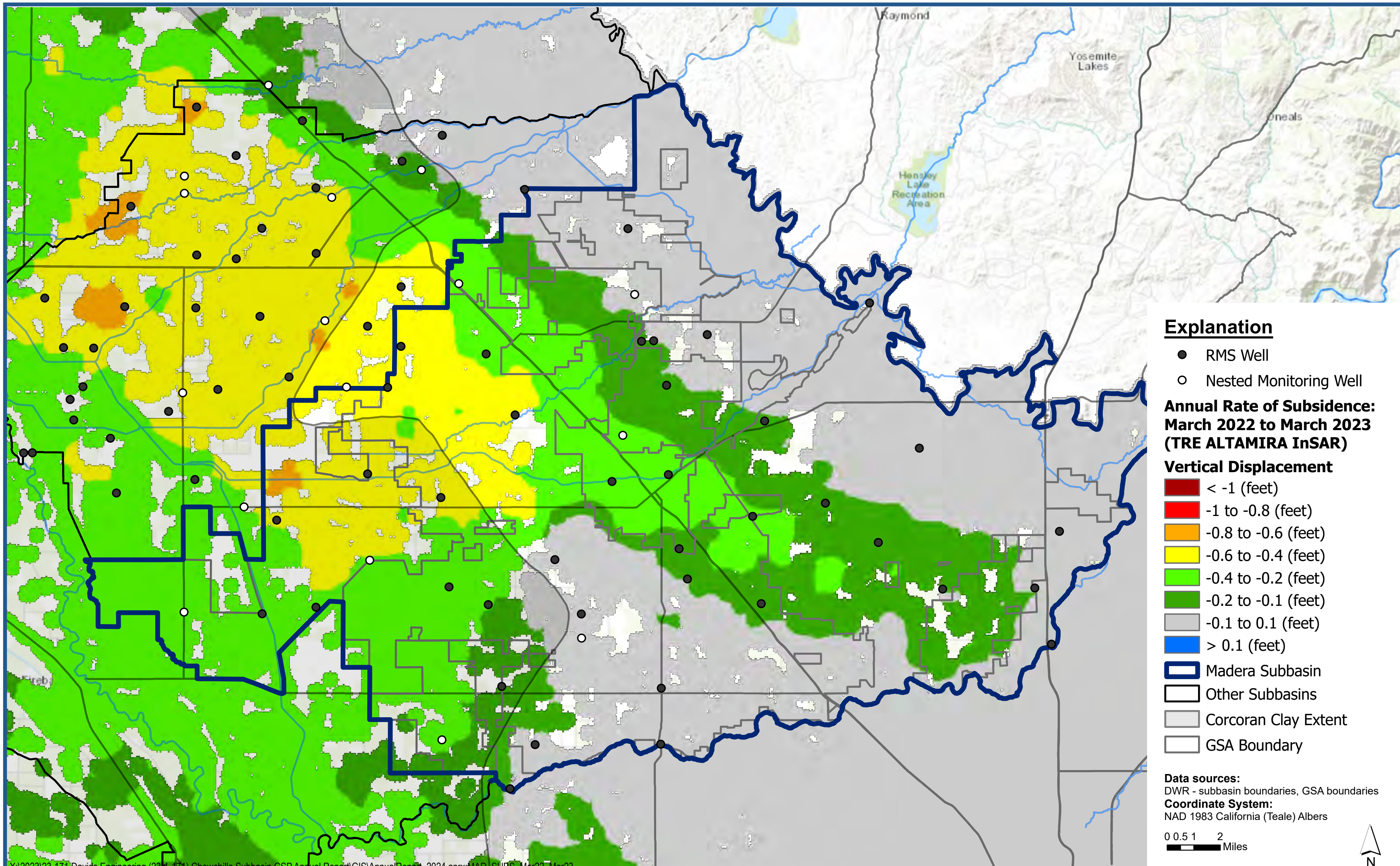
Annual Rate of Subsidence: March 2021 to March 2022 (TRE ALTAMIRA InSAR)

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-7



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Annual Rate of Subsidence: March 2022 to March 2023 (TRE ALTAMIRA InSAR)

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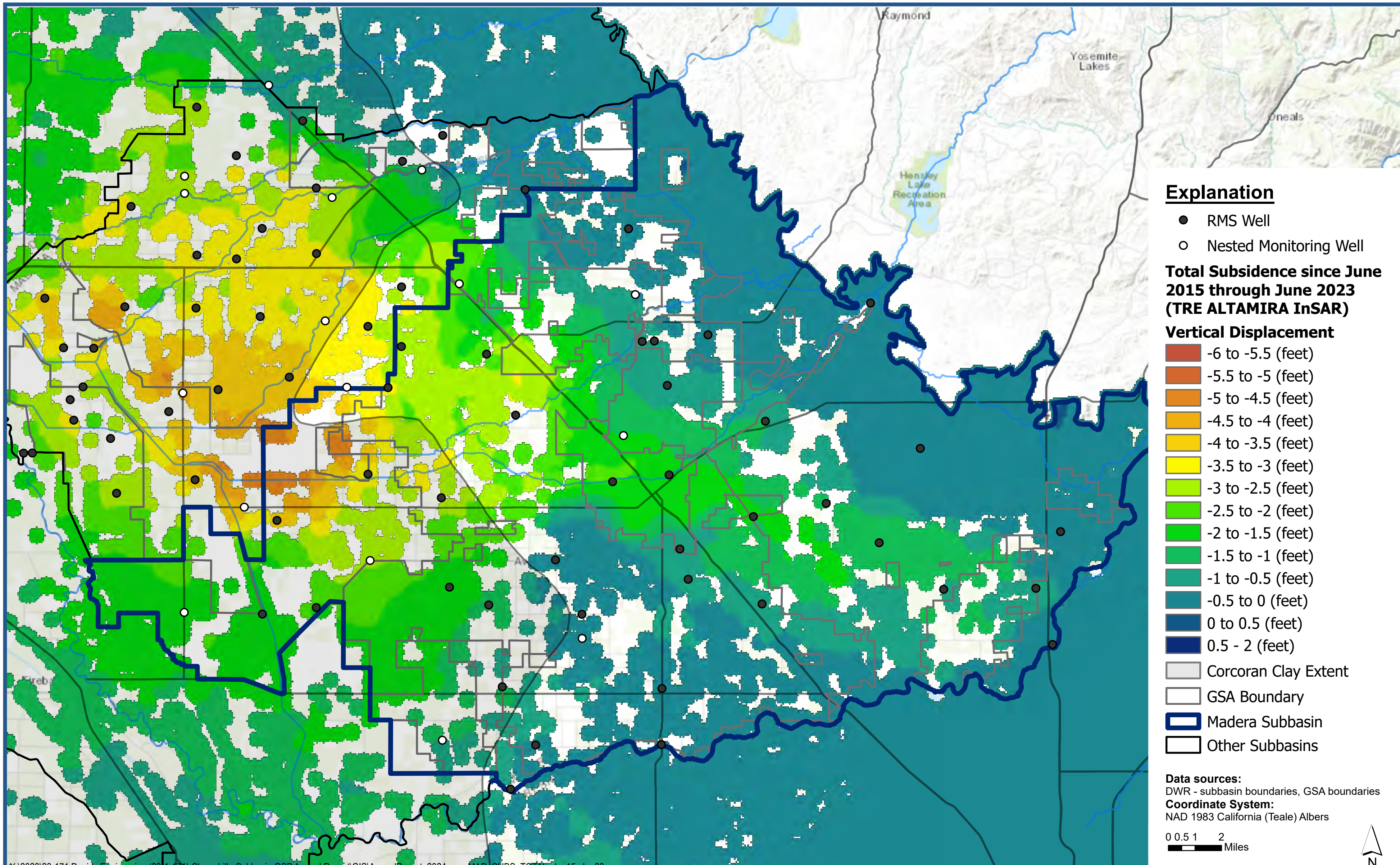
Figure D-8



Total Subsidence since June 2015 through June 2023 (TRE ALTAMIRA InSAR)

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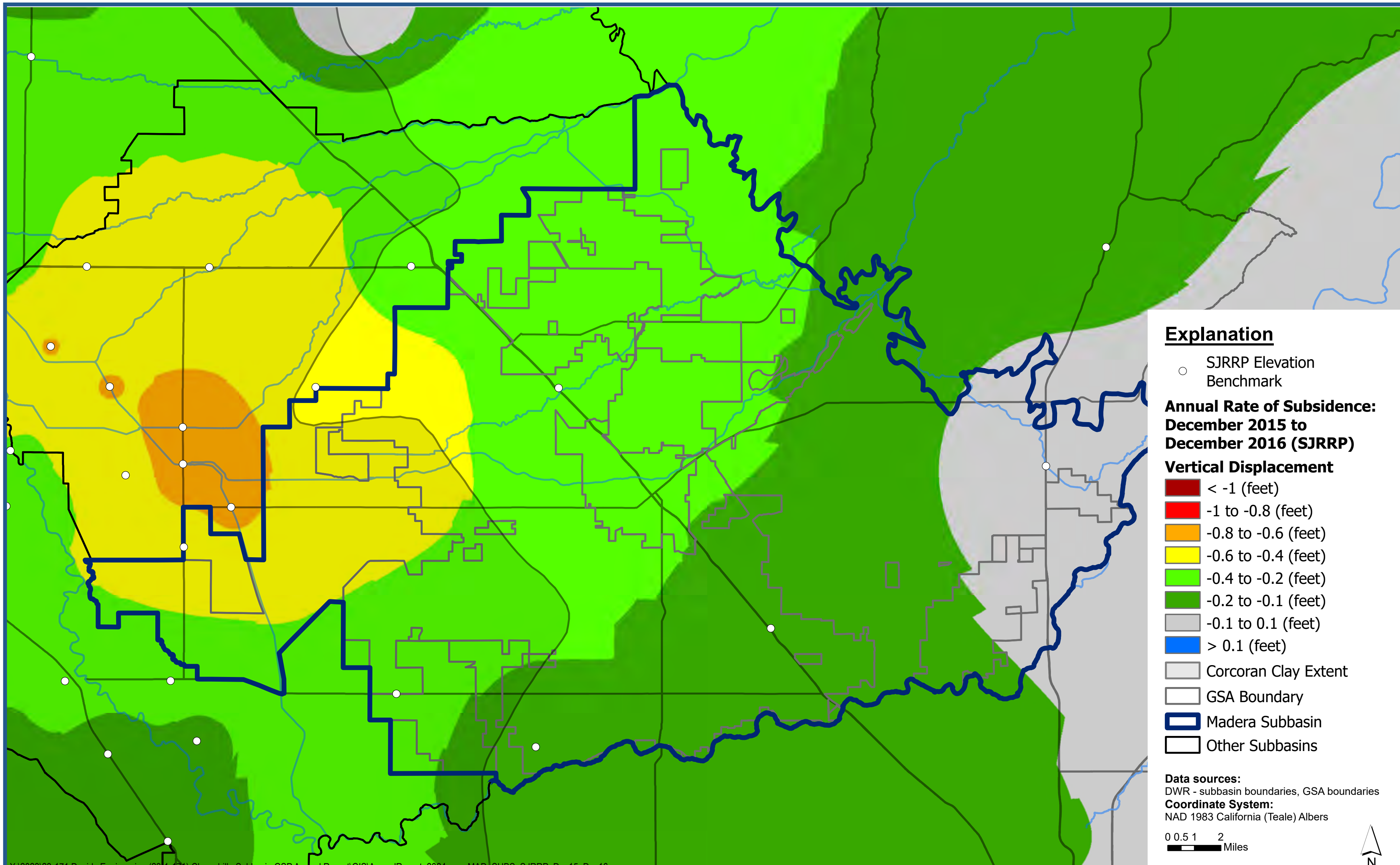
Figure D-9



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Annual Rate of Subsidence: December 2015 to December 2016 (SJRRP Elevation Benchmark)

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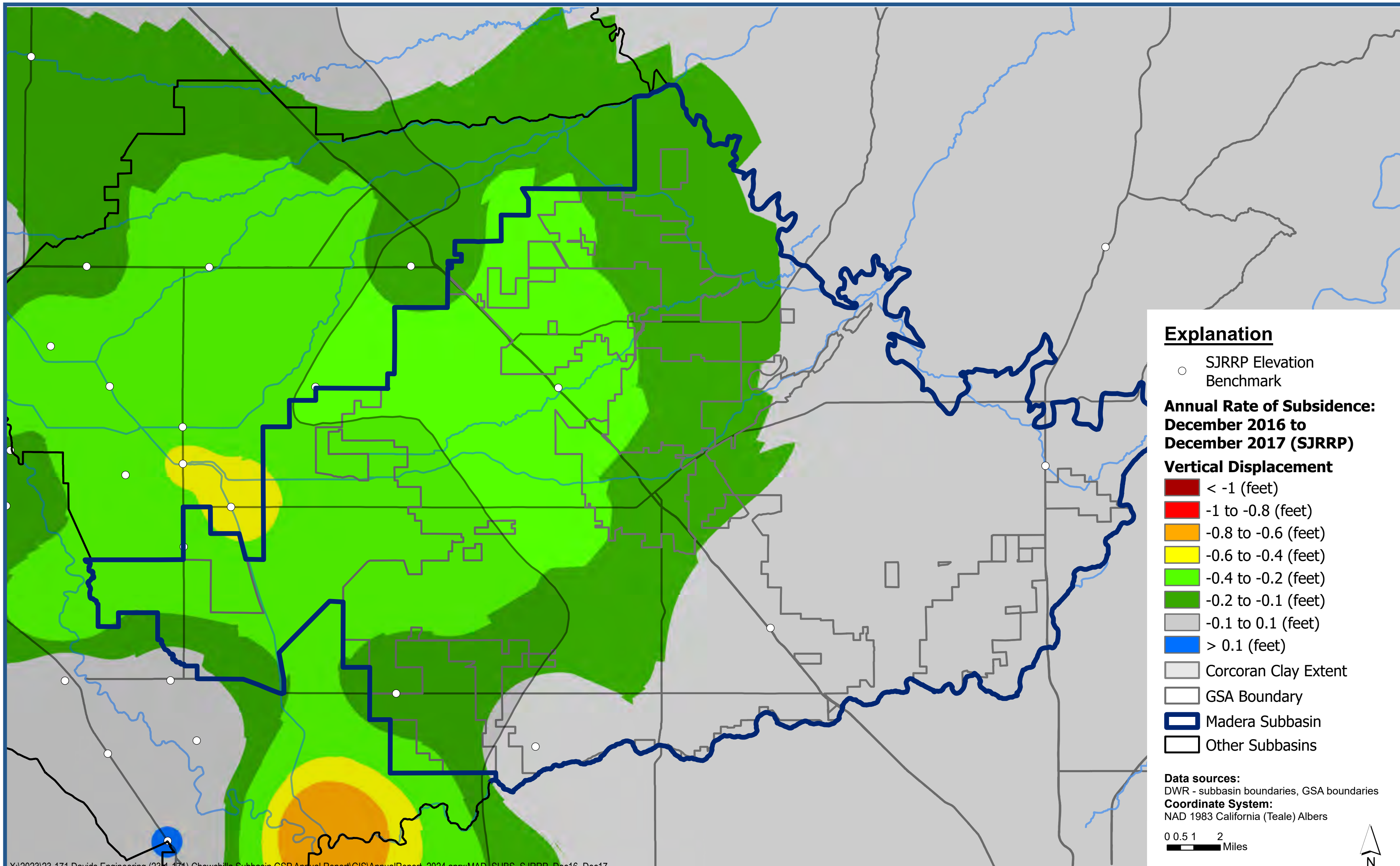
Groundwater Sustainability Plan 2024 Annual Report

Figure D-10



Annual Rate of Subsidence: December 2016 to December 2017 (SJRRP Elevation Benchmark)

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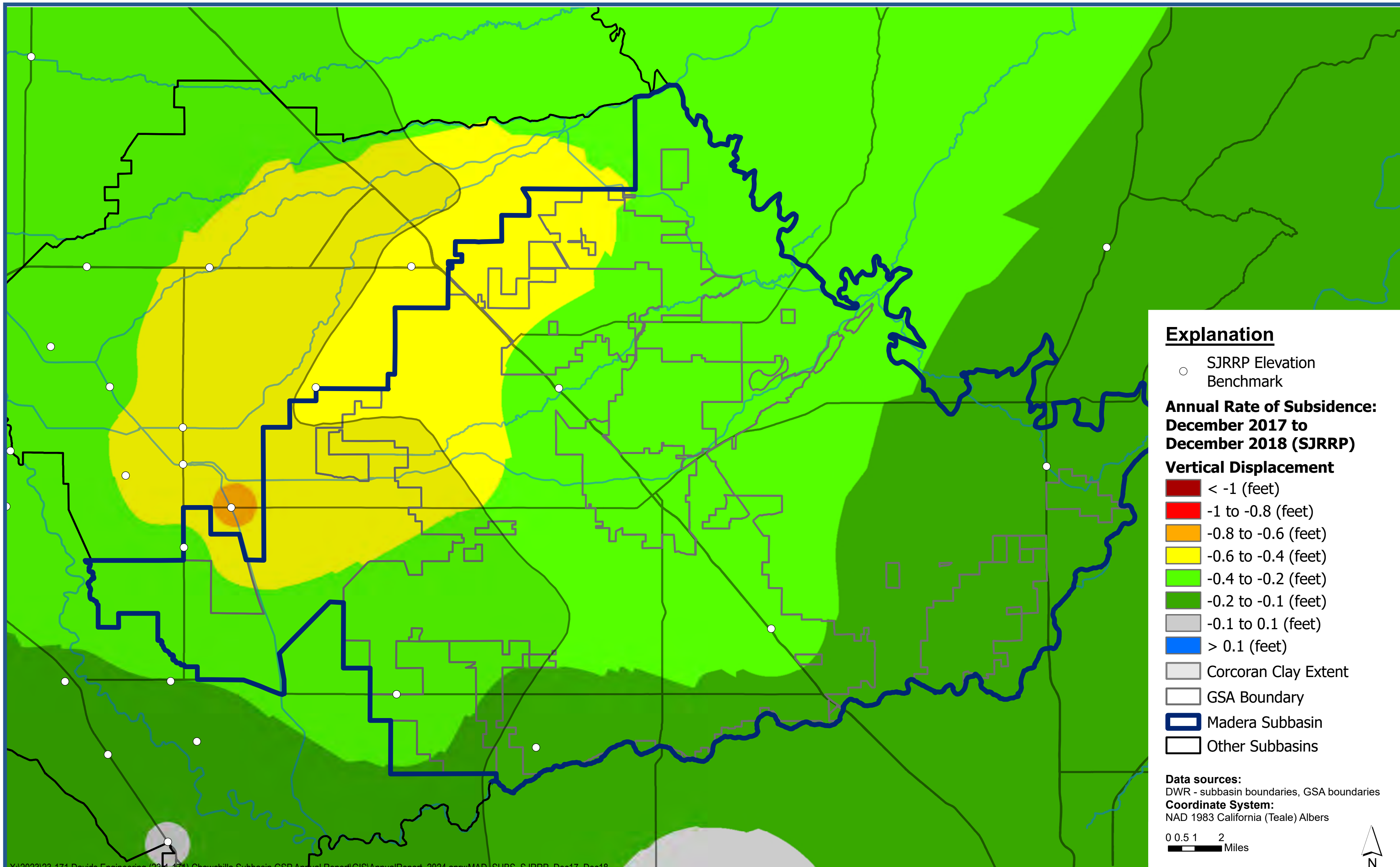
Figure D-11



Annual Rate of Subsidence: December 2017 to December 2018 (SJRRP Elevation Benchmark)

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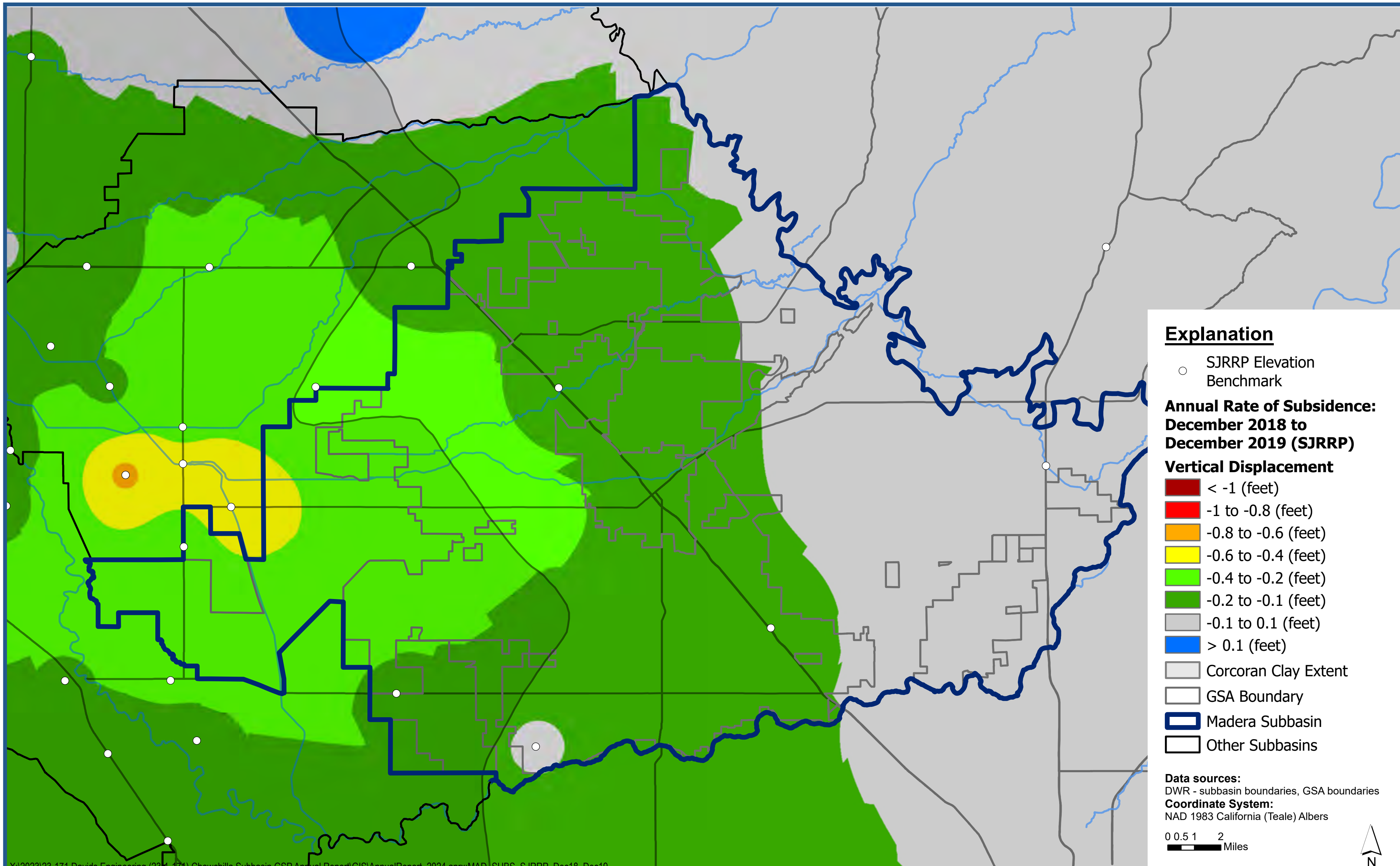
Figure D-12



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Annual Rate of Subsidence: December 2018 to December 2019 (SJRRP Elevation Benchmark)

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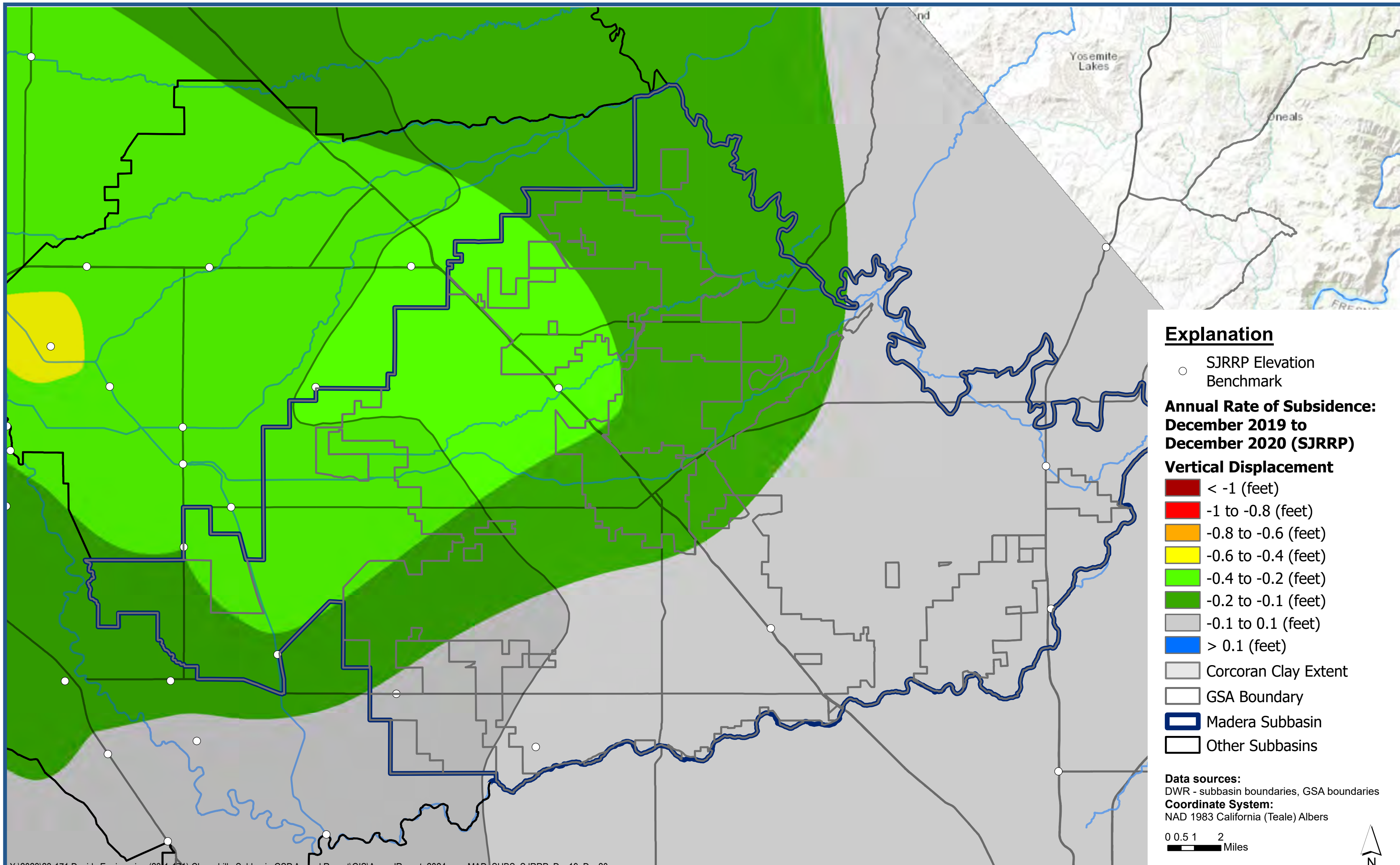
Figure D-13



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Annual Rate of Subsidence: December 2019 to December 2020 (SJRRP Elevation Benchmark)

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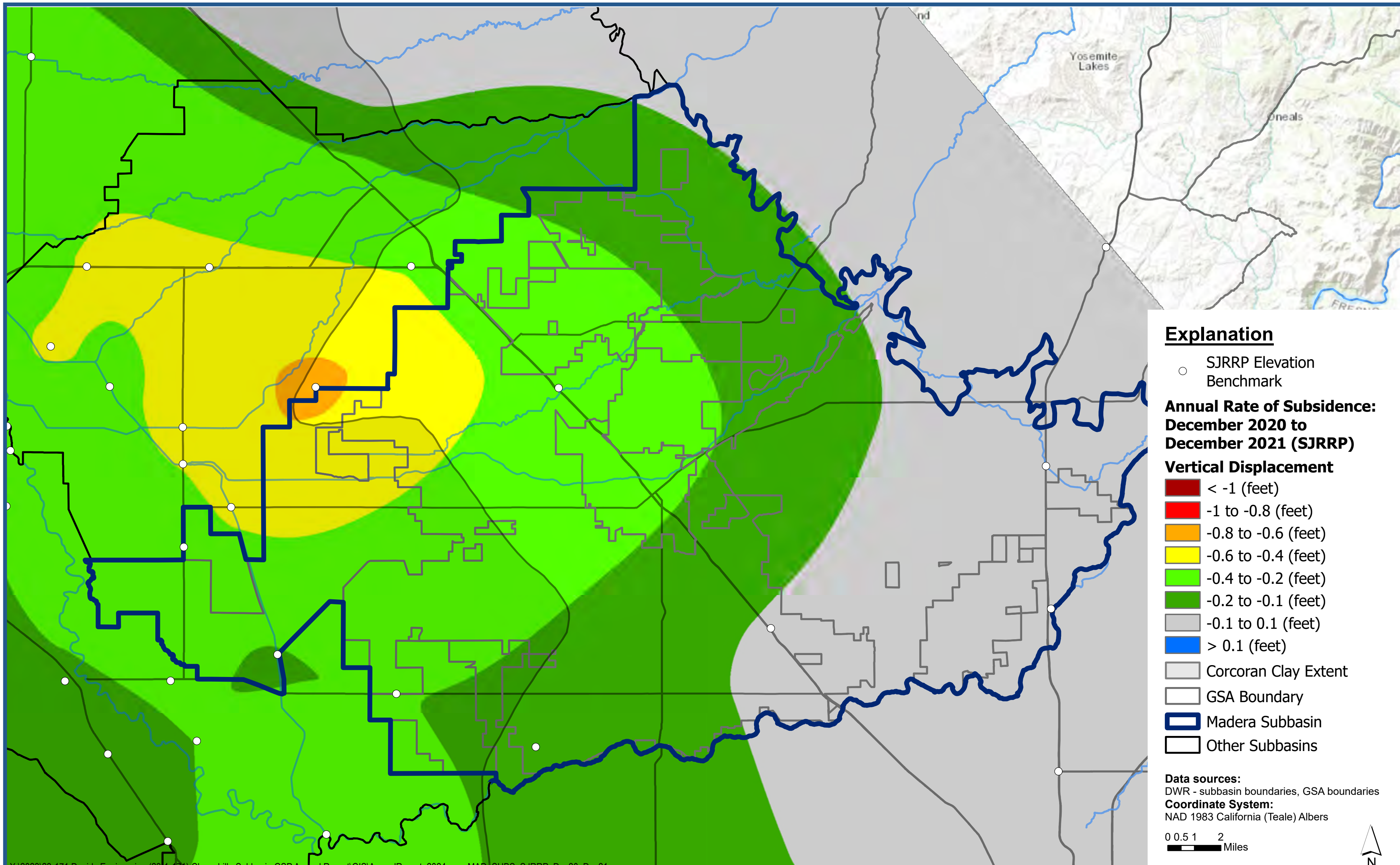
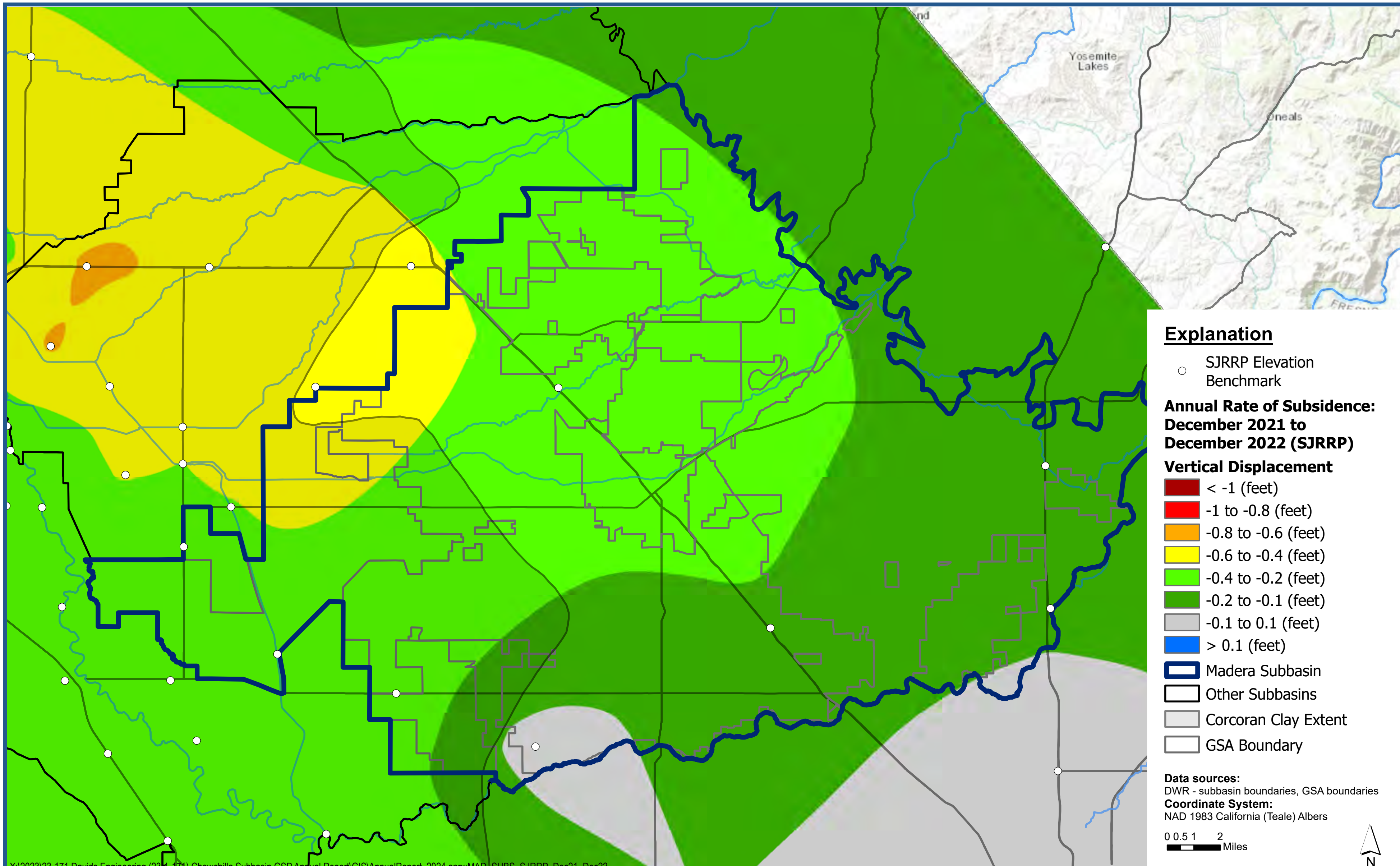
Figure D-14



Annual Rate of Subsidence: December 2020 to December 2021 (SJRRP Elevation Benchmark)

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-15



X:\2023\23-171 Davids Engineering (23-171) Chowchilla Subbasin GSP Annual Report\GIS\AnnualReport_2024.aprx:MAD_SUBS_SJRRP_Dec21_Dec22

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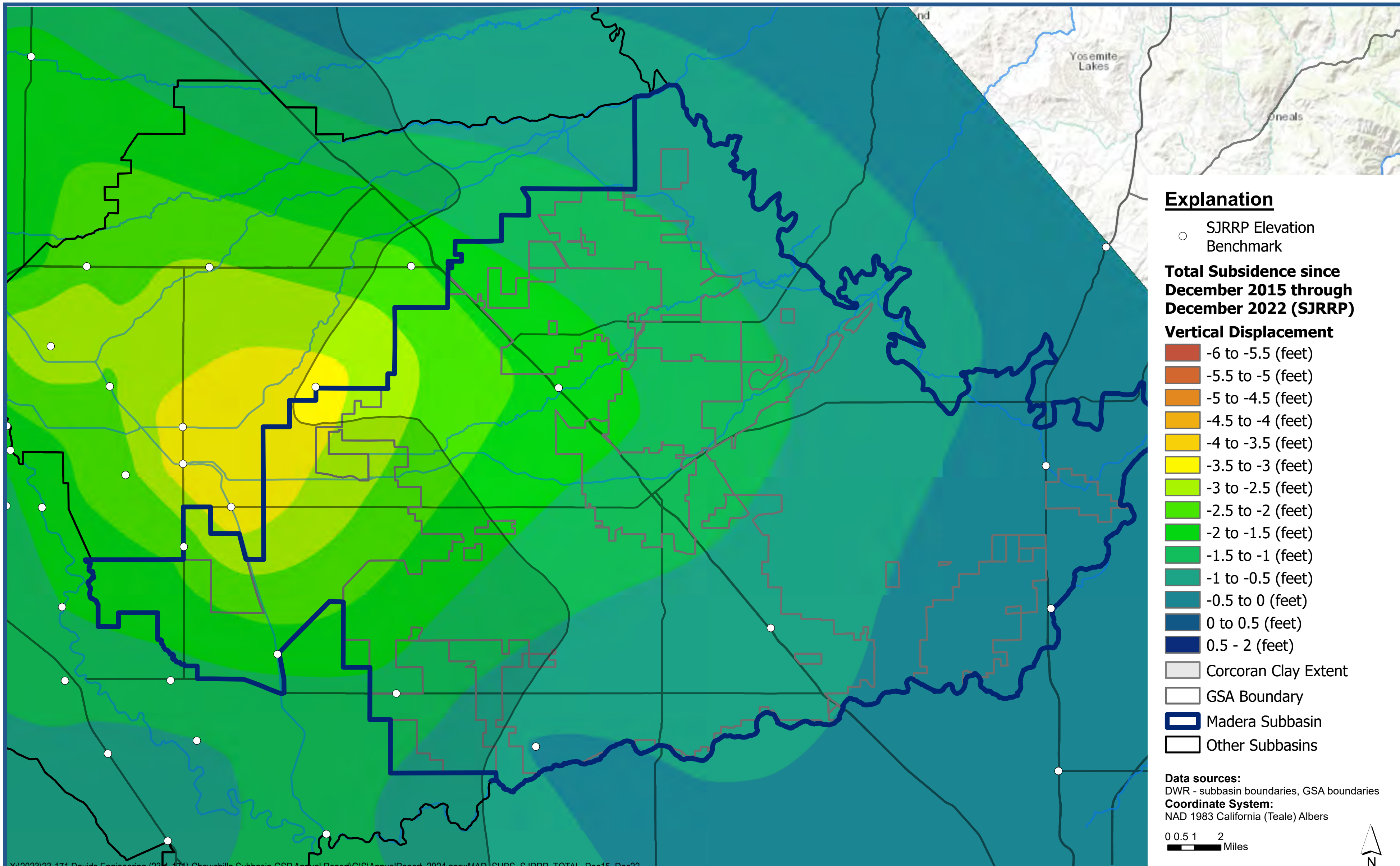
Annual Rate of Subsidence: December 2021 to December 2022 (SJRRP Elevation Benchmark)

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-16



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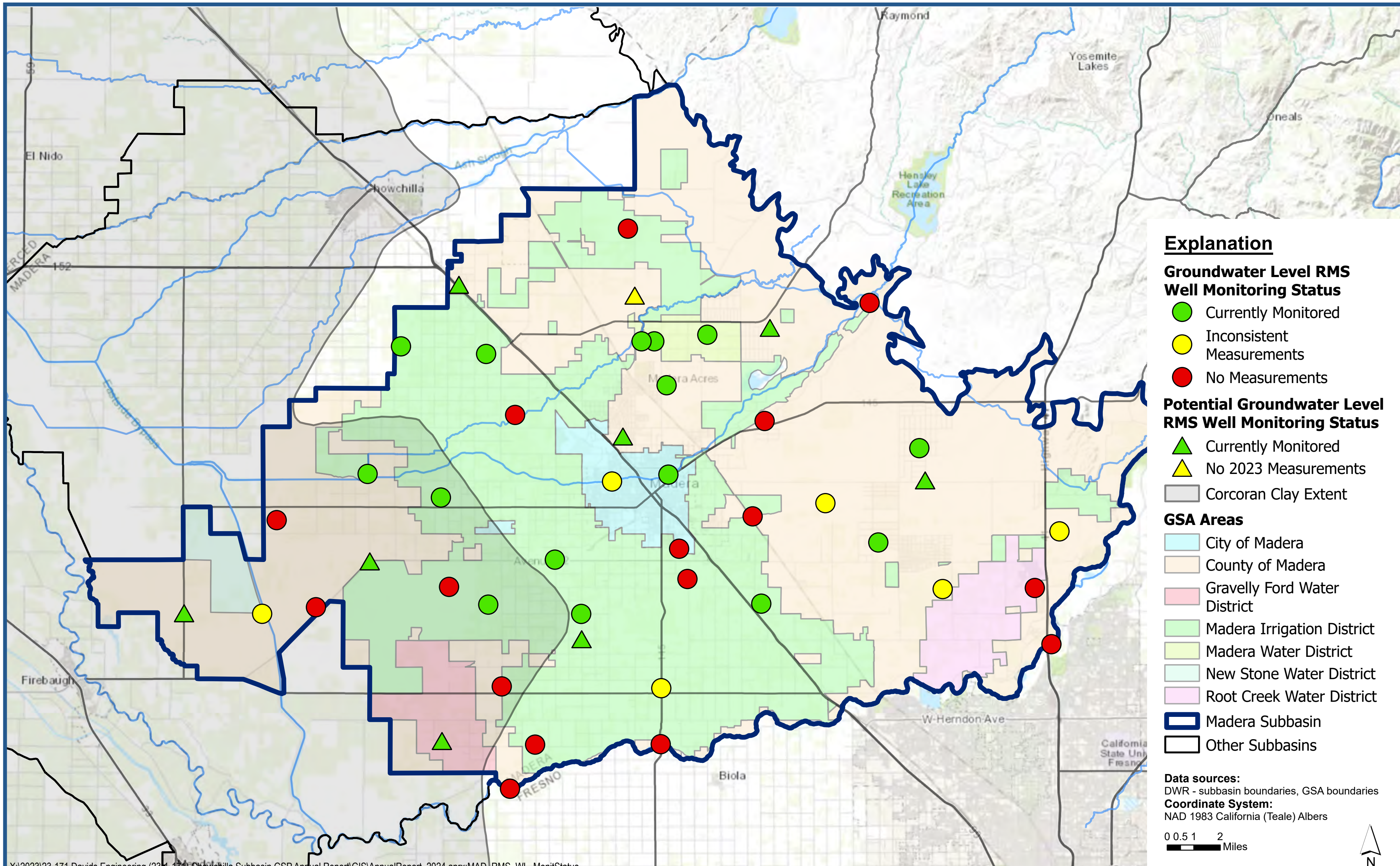
Total Subsidence since December 2015 through December 2021 (SJRRP Elevation Benchmark)

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure D-17

Appendix E. Status of Monitoring Efforts for RMS Wells in Madera Subbasin.



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Monitoring Status of Groundwater Level RMS Network

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure E-1

Table E-1. Status of Monitoring Efforts for Water Level RMS Wells in Madera Subbasin

Subbasin	GSA	RMS ID	Fall 2023 Monitoring Status	Most Recent Successful WL Msmt	Most Recent Successful WL Msmt (Season)
Madera	City of Madera	COM RMS-1	Currently Monitored	11/6/2023	Fall 2023
Madera	City of Madera	COM RMS-2	Currently Monitored	11/14/2023	Fall 2023
Madera	City of Madera	COM RMS-3	NM - Unable to Sound	11/5/2020	Fall 2020
Madera	County of Madera	MCE RMS-1	NM - Temporarily inaccessible	3/16/2021	Spring 2021
Madera	County of Madera	MCE RMS-2	Currently Monitored	10/31/2023	Fall 2023
Madera	County of Madera	MCE RMS-3	Currently Monitored	10/31/2023	Fall 2023
Madera	County of Madera	MCE RMS-4	Currently Monitored	10/31/2023	Fall 2023
Madera	County of Madera	MCE RMS-5	Currently Monitored	10/31/2023	Fall 2023
Madera	County of Madera	MCE RMS-6	Currently Monitored	11/3/2023	Fall 2023
Madera	County of Madera	MCE RMS-7	NM - Well has been destroyed	10/18/2018	Fall 2018
Madera	County of Madera	MCE RMS-8	NM - Owner will not allow access	10/16/2015	Fall 2015
Madera	County of Madera	MCE RMS-9	Need to follow up with SJRRP	12/6/2019	Fall 2019
Madera	County of Madera	MCW RMS-1	NM - Well has been destroyed	10/18/2019	Fall 2019
Madera	County of Madera	MCW RMS-2	NM - Temporarily inaccessible	3/12/2021	Spring 2021
Madera	County of Madera	MCW RMS-3	Currently Monitored	10/31/2023	Fall 2023
Madera	County of Madera	MCW RMS-4	NM - Temporarily inaccessible	3/29/2023	Spring 2023
Madera	County of Madera	MCW RMS-5	Need to follow up with SJRRP	6/20/2018	Summer 2018
Madera	Madera Irrigation District	MID RMS-1	NM - Special/Other	10/17/2019	Fall 2019
Madera	Madera Irrigation District	MID RMS-2	Currently Monitored	10/16/2023	Fall 2023
Madera	Madera Irrigation District	MID RMS-3	Currently Monitored	10/18/2023	Fall 2023
Madera	Madera Irrigation District	MID RMS-4	Currently Monitored	10/13/2023	Fall 2023
Madera	Madera Irrigation District	MID RMS-5	Currently Monitored	10/12/2023	Fall 2023
Madera	Madera Irrigation District	MID RMS-6	Currently Monitored	10/18/2023	Fall 2023
Madera	Madera Irrigation District	MID RMS-7	Currently Monitored	10/11/2023	Fall 2023
Madera	Madera Irrigation District	MID RMS-8	Need to reengage with well owner	2/14/2014	Spring 2014
Madera	Madera Irrigation District	MID RMS-9	Need to reengage with well owner	2/12/2014	Spring 2014

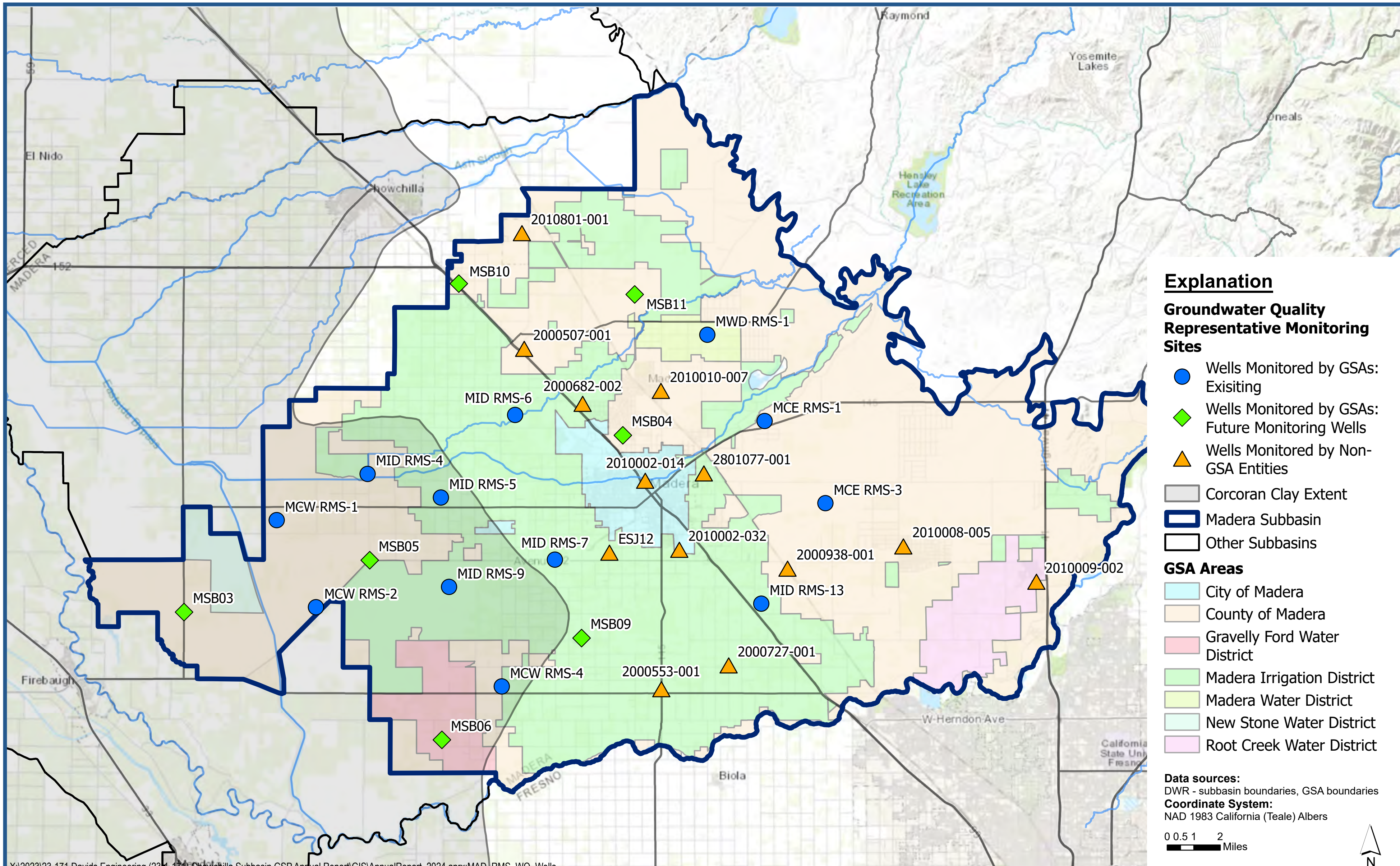
Table E-1. Status of Monitoring Efforts for Water Level RMS Wells in Madera Subbasin

Subbasin	GSA	RMS ID	Fall 2023 Monitoring Status	Most Recent Successful WL Msmt	Most Recent Successful WL Msmt (Season)
Madera	Madera Irrigation District	MID RMS-10	Currently Monitored	10/23/2023	Fall 2023
Madera	Madera Irrigation District	MID RMS-11	Currently Monitored	10/10/2023	Fall 2023
Madera	Madera Irrigation District	MID RMS-12	NM - No measurement reported	10/12/2022	Fall 2022
Madera	Madera Irrigation District	MID RMS-13	Currently Monitored	10/9/2023	Fall 2023
Madera	Madera Irrigation District	MID RMS-14	Need to reengage with well owner	2/11/2014	Spring 2014
Madera	Madera Irrigation District	MID RMS-15	Currently Monitored	10/25/2023	Fall 2023
Madera	Madera Irrigation District	MID RMS-16	Currently Monitored	10/23/2023	Fall 2023
Madera	Madera Irrigation District	MID RMS-17	Need to follow up with SJRRP	6/14/2023	Summer 2023
Madera	Madera Water District	MWD RMS-1	Currently Monitored	11/13/2023	Fall 2023
Madera	Madera Water District	MWD RMS-2	Currently Monitored	11/13/2023	Fall 2023
Madera	Madera Water District	MWD RMS-3	Currently Monitored	11/13/2023	Fall 2023

NM = no measurement. Measurement attempted but was unsuccessful.

Table E-2. Status of Monitoring Efforts for Potential Water Level RMS Wells in Madera Subbasin

Subbasin	GSA	RMS ID	Fall 2023 Monitoring Status	Most Recent Successful WL Msmt	Most Recent Successful WL Msmt (Season)
Madera	County of Madera	MSB03A	Currently Monitored	10/26/2023	Fall 2023
Madera	County of Madera	MSB03B	Currently Monitored	10/26/2023	Fall 2023
Madera	County of Madera	MSB03C	Currently Monitored	10/26/2023	Fall 2023
Madera	County of Madera	MSB04A	Currently Monitored	10/27/2023	Fall 2023
Madera	County of Madera	MSB04B	Currently Monitored	10/27/2023	Fall 2023
Madera	County of Madera	MSB04C	Currently Monitored	10/27/2023	Fall 2023
Madera	County of Madera	MSB05A	Currently Monitored	10/27/2023	Fall 2023
Madera	County of Madera	MSB05B	Currently Monitored	10/27/2023	Fall 2023
Madera	County of Madera	MSB05C	Currently Monitored	10/27/2023	Fall 2023
Madera	Gravelly Ford Water District	MSB06A	Currently Monitored	10/27/2023	Fall 2023
Madera	Gravelly Ford Water District	MSB06B	Currently Monitored	10/27/2023	Fall 2023
Madera	Gravelly Ford Water District	MSB06C	Currently Monitored	10/27/2023	Fall 2023
Madera	Madera Irrigation District	MSB09A	Currently Monitored	10/27/2023	Fall 2023
Madera	Madera Irrigation District	MSB09B	Currently Monitored	10/27/2023	Fall 2023
Madera	Madera Irrigation District	MSB09C	Currently Monitored	10/27/2023	Fall 2023
Madera	County of Madera	MSB10A	NM - Well is Dry	3/30/2023	Spring 2023
Madera	County of Madera	MSB10B	Currently Monitored	10/27/2023	Fall 2023
Madera	County of Madera	MSB10C	Currently Monitored	10/27/2023	Fall 2023
Madera	County of Madera	MSB11A	NM - Temporarily Inaccessible	10/27/2022	Fall 2022
Madera	County of Madera	MSB11B	NM - Temporarily Inaccessible	3/8/2022	Spring 2022
Madera	County of Madera	MSB11C	NM - Temporarily Inaccessible	10/27/2022	Fall 2022
Madera	County of Madera	MSB12	Currently Monitored	10/27/2023	Fall 2023
Madera	County of Madera	MSB13A	NM - Well is Dry	-	-
Madera	County of Madera	MSB13B	Currently Monitored	10/27/2023	Fall 2023
Madera	County of Madera	MSB13C	Currently Monitored	10/27/2023	Fall 2023



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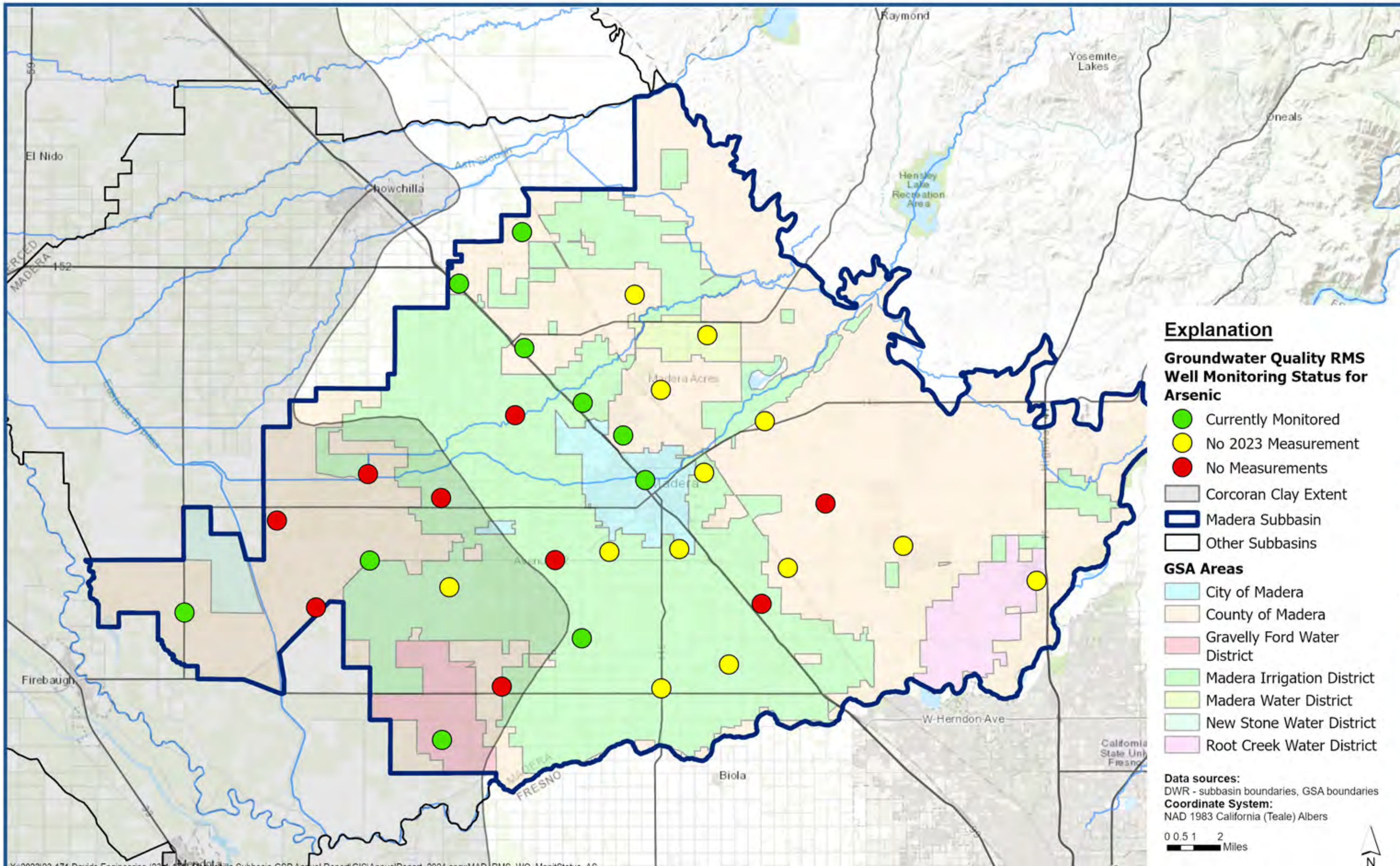
Groundwater Quality Sustainable Indicator Wells

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Figure E-2



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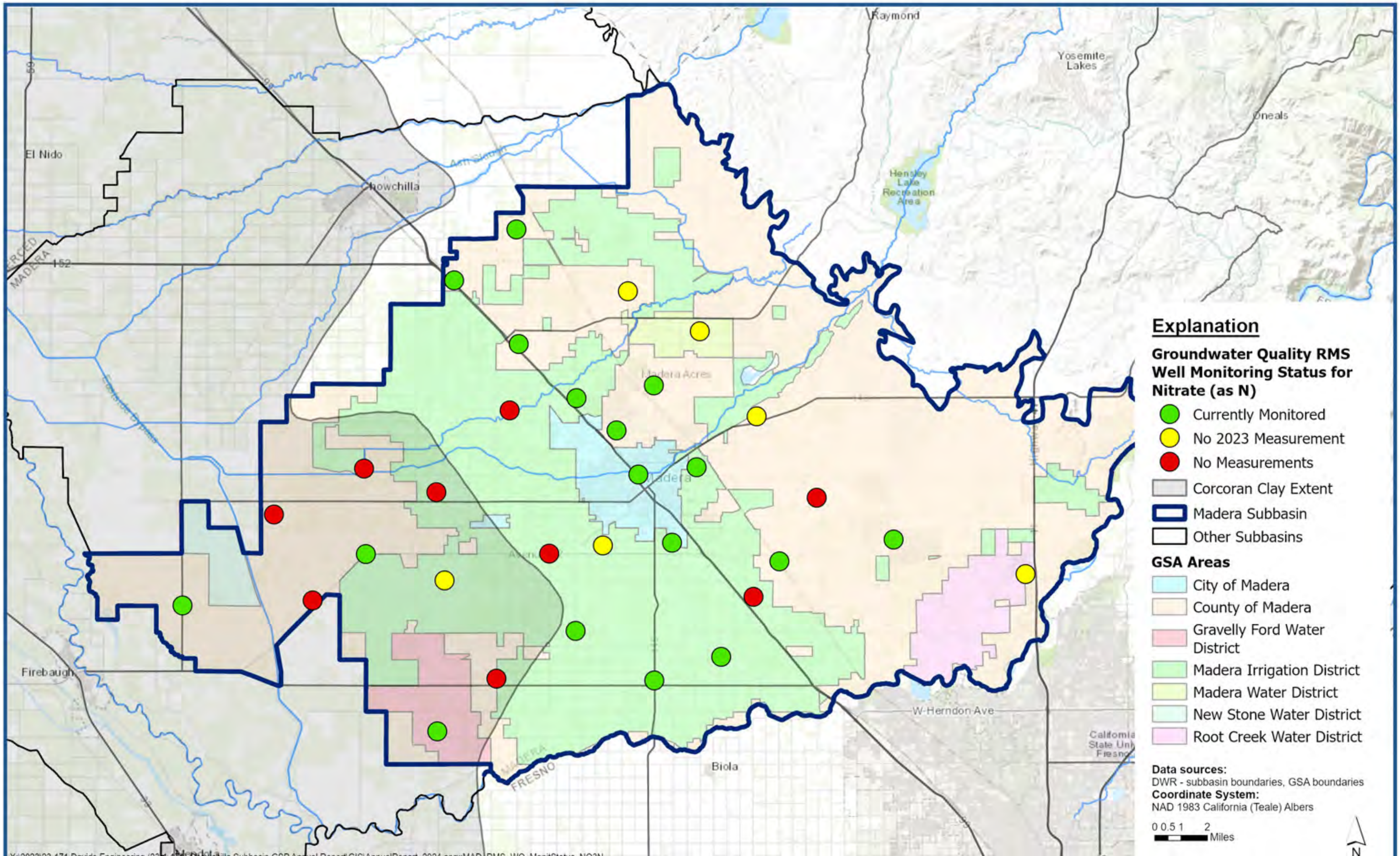
Monitoring Status of Groundwater Quality RMS Network - Arsenic

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

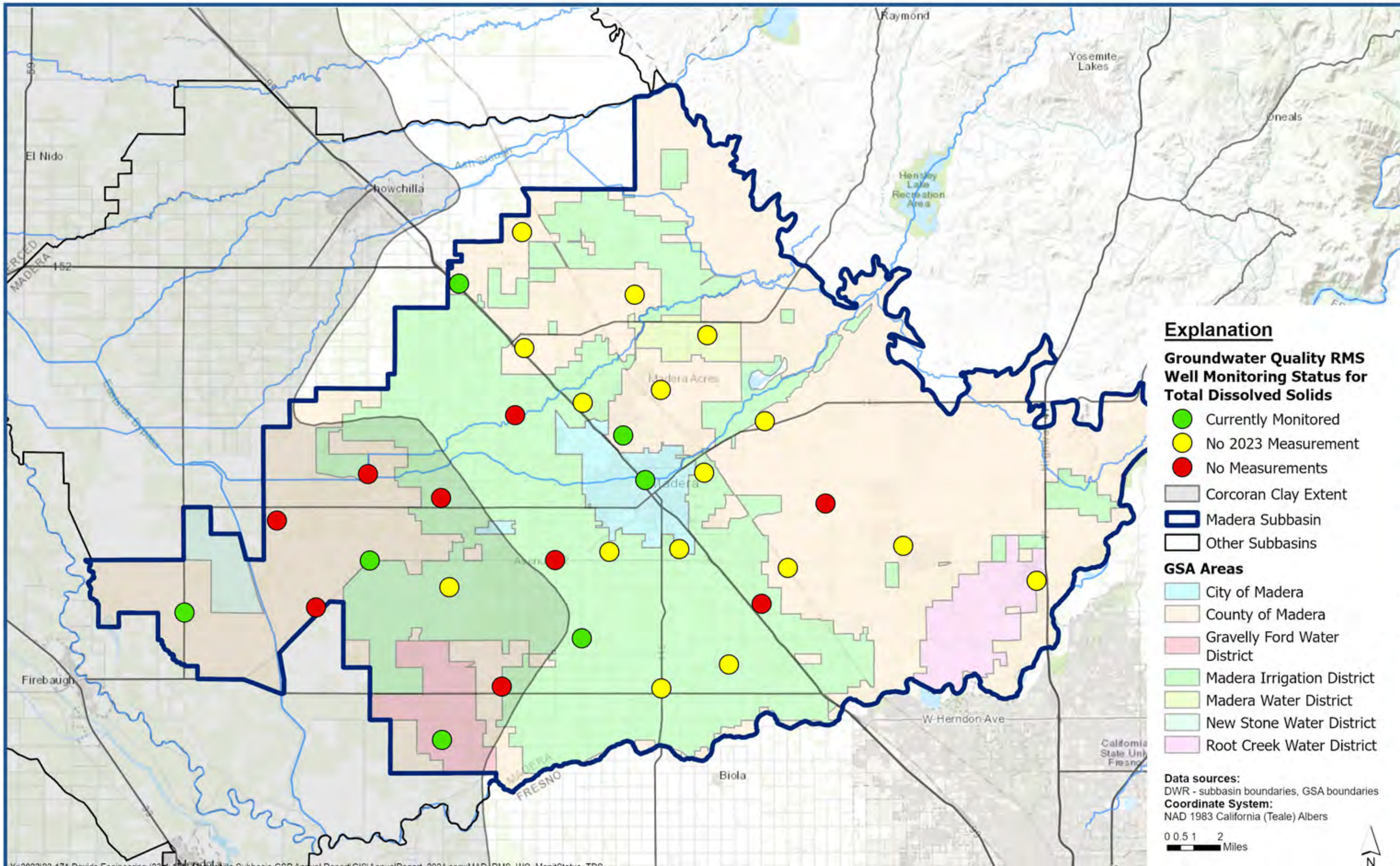
Figure E-3



Monitoring Status of Groundwater Quality RMS Network - Nitrate (as N)

Figure E-4

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report



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Monitoring Status of Groundwater Quality RMS Network - Total Dissolved Solids

Figure E-5

Madera Subbasin
Groundwater Sustainability Plan 2024 Annual Report

Appendix E. Table 3 - Status of Monitoring Efforts for Water Quality RMS Wells in Madera Subbasin

		Arsenic		Nitrate as N		Total Dissolved Solids	
	RMS ID	Most Recent Sampling Date	Sample Count	Most Recent Sampling Date	Sample Count	Most Recent Sampling Date	Sample Count
GSA-Current	MCE RMS-1						
GSA-Current	MCE RMS-3	6/20/2023	3	6/20/2023	3	6/20/2023	3
GSA-Current	MCW RMS-1						
GSA-Current	MCW RMS-2						
GSA-Current	MCW RMS-4						
GSA-Current	MID RMS-13						
GSA-Current	MID RMS-4						
GSA-Current	MID RMS-5						
GSA-Current	MID RMS-6	7/12/2022	1	7/12/2022	1	7/12/2022	1
GSA-Current	MID RMS-7	7/12/2022	1	7/12/2022	1	7/12/2022	1
GSA-Current	MID RMS-9			4/6/1966	1		
GSA-Current	MWD RMS-1	8/19/2022	4	8/19/2022	4	8/19/2022	4
GSA-Future	MSB03A	6/13/2023	5	6/13/2023	2	6/13/2023	5
GSA-Future	MSB03B	6/28/2023	4	6/28/2023	3	6/28/2023	4
GSA-Future	MSB03C	6/13/2023	4	6/13/2023	3	6/13/2023	4
GSA-Future	MSB04A	6/15/2023	4	6/15/2023	3	6/15/2023	4
GSA-Future	MSB04B	6/15/2023	4	6/15/2023	3	6/15/2023	4
GSA-Future	MSB04C	6/15/2023	4	6/15/2023	3	6/15/2023	4
GSA-Future	MSB05A	6/13/2023	5	6/13/2023	2	6/13/2023	5
GSA-Future	MSB05B	6/13/2023	3	6/13/2023	2	6/13/2023	3
GSA-Future	MSB05C	6/13/2023	3	6/13/2023	2	6/13/2023	3
GSA-Future	MSB06A	6/14/2023	6	6/14/2023	3	6/14/2023	6
GSA-Future	MSB06B	6/14/2023	5	6/14/2023	4	6/14/2023	5
GSA-Future	MSB06C	6/28/2023	5	6/28/2023	4	6/28/2023	5
GSA-Future	MSB09A	6/13/2023	6	6/13/2023	3	6/13/2023	6
GSA-Future	MSB09B	6/13/2023	4	6/13/2023	3	6/13/2023	4
GSA-Future	MSB09C	6/13/2023	4	6/13/2023	3	6/13/2023	4
GSA-Future	MSB10A						
GSA-Future	MSB10B	6/15/2023	6	6/15/2023	3	6/15/2023	6
GSA-Future	MSB10C	6/15/2023	4	6/15/2023	3	6/15/2023	4
GSA-Future	MSB11A	2/11/2020	1			2/11/2020	1
GSA-Future	MSB11B	2/11/2020	1			2/11/2020	1
GSA-Future	MSB11C	6/21/2022	2	6/21/2022	1	6/21/2022	2
Non-GSA	2000507-001	5/11/2023	4	5/11/2023	9		
Non-GSA	2000553-001	1/13/2021	5	10/9/2023	32	1/13/2021	7
Non-GSA	2000682-002	8/23/2023	4	8/23/2023	17	5/20/2008	1
Non-GSA	2000727-001	1/6/2021	7	3/6/2023	22	1/6/2021	7
Non-GSA	2000846-002						
Non-GSA	2000938-001	8/23/2022	6	1/17/2023	21		
Non-GSA	2010002-014	5/22/2023	13	5/22/2023	34	5/22/2023	15
Non-GSA	2010002-032	11/10/2021	11	2/27/2023	22	11/10/2021	11
Non-GSA	2010008-005	1/6/2021	7	3/1/2023	35	1/6/2021	9
Non-GSA	2010009-002	7/15/2013	7	1/26/2017	20	7/15/2013	7
Non-GSA	2010010-007	9/9/2022	7	2/23/2023	20	9/9/2022	7
Non-GSA	2010801-001	12/5/2023	139	8/15/2023	30	8/5/2021	11
Non-GSA	2801077-001	4/3/2002	1	4/20/2023	21		
Non-GSA	ESJ12	7/27/2021	1			8/4/2020[1]	1[1]
Non-GSA	ESJ17	7/27/2021	1			8/4/2020[1]	1[1]

[1] Monitoring for the Irrigated Lands Regulatory Program annual monitoring includes specific conductance (SC), TDS is tested every five years; SC will be used as proxy for TDS in years in which TDS is not tested.

Attachment 1

DRAFT TECHNICAL MEMORANDUM

DATE: January 4, 2024 Project No. XX-X-XXX

TO: Madera Subbasin Joint GSP GSAs

FROM: LSCE and DE

SUBJECT: Madera Subbasin Joint GSP First Periodic Update – Groundwater Level Representative Monitoring Site (RMS) Network Evaluation Workplan

Introduction and Background

The Joint Groundwater Sustainability Agencies (GSAs) (City of Madera GSA, County of Madera GSA – Madera, Madera Irrigation District GSA, and Madera Water District GSA) developed a Groundwater Level Representative Monitoring Sites (RMS) network as part of the development of a Groundwater Sustainability Plan (GSP) for the Madera Subbasin that was originally submitted in January 2020. During the implementation of the GSP, various issues have arisen that have affected the consistency of groundwater level measurements at a number of these RMS. As part of the first periodic update to the GSP, the groundwater level RMS network will be evaluated and updated to ensure consistent measurements that will satisfy Sustainable Groundwater Management Act (SGMA) monitoring requirements and support GSP activities in the Subbasin.

Groundwater Level RMS Network

The Joint GSP Groundwater Level RMS network in Madera Subbasin (**Figure 1**) currently consists of 37 wells: 11 screened in the Upper Aquifer, 22 screened in the Lower Aquifer, and four screened across both aquifers (composite). The monitoring network was initially developed using existing wells in the GSP Area. The database for existing wells was reviewed with the following criteria in mind:

- CASGEM wells preferred;
- Known construction (screen intervals, depth) preferred;
- Long histories of water level data (including recent data) preferred;
- Relatively good match between observed and modeled water levels preferred;
- Good spatial distribution preferred;
- Representation of both Upper (where present in western portion of Plan Area) and Lower Aquifers preferred.

As required by SGMA, groundwater level RMS are to be measured on a semi-annual basis at a minimum during periods which will capture seasonal highs and lows (i.e., spring and fall). A summary of annual monitoring activities is provided in each year's Annual Report for the Joint GSP. A more comprehensive review of the monitoring network will be conducted as part of this workplan, and a revised monitoring network will be implemented.

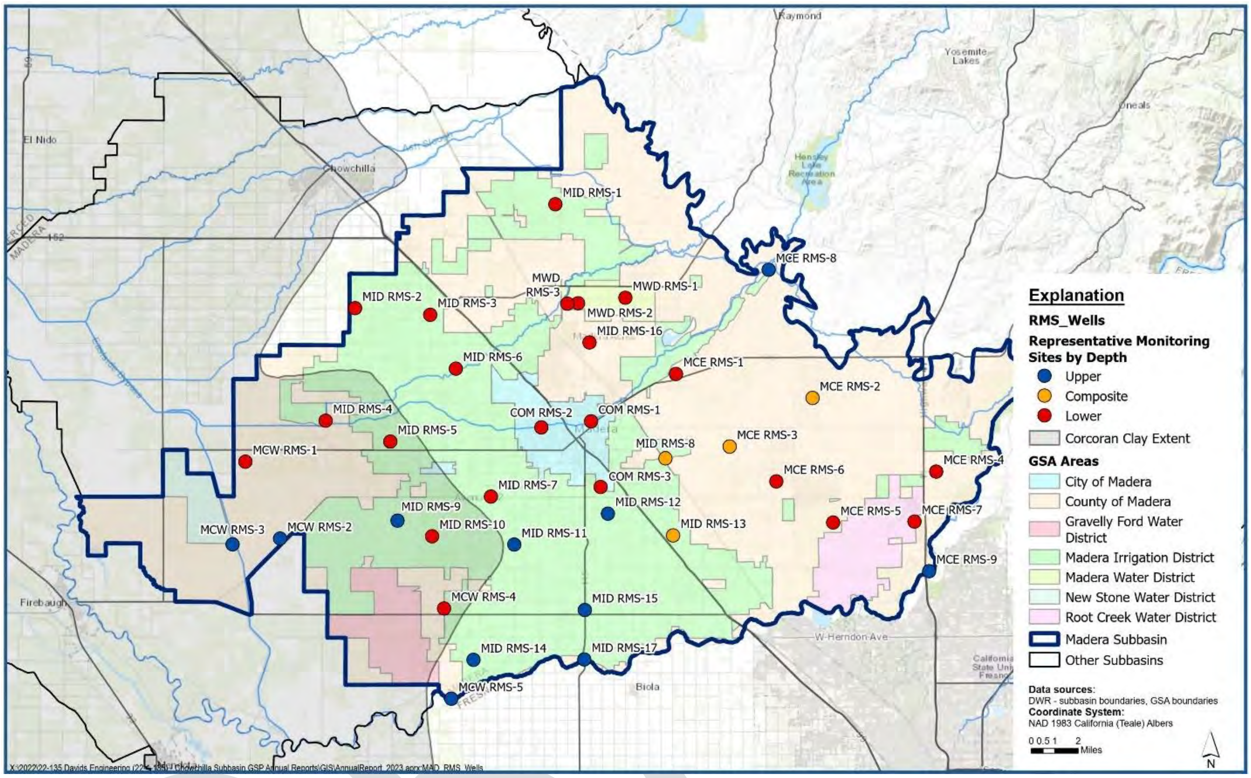


Figure 1. Current Groundwater Level Representative Monitoring Sites (RMS) Network

Proposed Scope of Work

The proposed scope of work details the planned updates to groundwater level RMS network as part of the first periodic update to the Madera Subbasin Joint GSP. Refinements to the RMS network are necessary to ensure that the GSP is in compliance with the monitoring requirements set forth under SGMA. This scope of work involves three main tasks including evaluation of the current monitoring network, evaluation of wells for inclusion in the updated monitoring network, and finalization of the update monitoring network. The proposed scope of work is described in more detail below.

Task 1. Evaluate Current Monitoring Network

The first task will involve reviewing the monitoring history of each groundwater level RMS well. Wells that do not have consistent, reliable groundwater level measurements will require further evaluation, these include wells with both non-measurements and questionable measurements. Further evaluation will involve a detailed review of the issues encountered during monitoring. If these issues are persistent and preclude the well from satisfying the SGMA monitoring requirements on a regular basis, they will be identified for removal from the RMS network and possible replacement.

Task 2. Evaluate New Wells for Inclusion in Monitoring Network

Wells that have been identified for removal from the RMS network and possible replacement will either be replaced with dedicated nested monitoring wells or other existing wells.

Dedicated Nested Monitoring Wells

A total of 25 dedicated monitoring wells at nine locations were drilled as part of GSP implementation. These dedicated monitoring wells have been consistently measured upon completion, with the intention of including these wells into the groundwater level RMS network. Where possible, these nested monitoring wells will replace current network RMS that have been identified for removal from the RMS network. In other locations, these wells will provide additional spatial coverage to the monitoring network.

Additional Existing Wells

In areas where existing RMS have been identified for removal from the RMS network but no dedicated nested monitoring wells exist, other existing wells will be used to fill in gaps in the RMS network. Potential wells for inclusion in the updated monitoring network will be identified through conversations with the GSAs, as well as review of currently monitored wells. At least five years of measurement history and known well construction will be required. After potential wells have been identified, field verification and permission from landowners will be acquired. If these conditions have been satisfied, a well will be included in the updated RMS network.

Task 3. Finalize Updates to Monitoring Network

Prepare a Technical Memorandum (TM) Summarizing Monitoring Network Updates

A TM will be prepared for the Madera Subbasin summarizing the updates to the groundwater level RMS network. This TM will cover the wells identified for removal from the RMS network and possible replacement, the reason for removal/replacement, the new wells selected for inclusion in the RMS network, and a summary of the final updated RMS network. This TM will be included as a detailed appendix to the periodic update of the GSP.

Update the RMS Network Description in the GSP

As part of the first periodic update, the GSP will be updated to include a description of the new groundwater level RMS network. Wells added to the network will have sustainable management criteria developed consistent with the method described in the approved GSP.

Update the RMS Network in the SGMA Portal

The groundwater level RMS network will be updated in the SGMA Portal to reflect all changes made to the network as part of this workplan.

Schedule

The overall implementation of this Workplan is envisioned as a part of a larger effort for the first periodic update to the Madera Subbasin Joint GSP. Implementation of the Workplan is planned to start in early 2024 with a target completion of mid-2024. A general planned schedule for implementation of the Workplan is outlined in **Table 1**.

Table 1. Summary of Proposed Schedule for Implementation of the Madera Subbasin Joint GSP Groundwater Level Representative Monitoring Site (RMS) Network Evaluation Workplan

Task No.	Task Description	Task Completion Timeframe
1	Evaluate Current Monitoring Network	Early 2024
2	Evaluate New Wells for Inclusion in Monitoring Network	Early 2024 – Mid 2024
3	Finalize Updates to Monitoring Network	Mid 2024

Luhdorff & Scalmanini
Consulting Engineers

DRAFT TECHNICAL MEMORANDUM

DATE: January 5, 2024 Project No. XX-X-XXX

TO: Madera Subbasin Joint GSP GSAs

FROM: LSCE and DE

SUBJECT: Madera Subbasin Joint GSP First Periodic Update – Groundwater Quality Representative Monitoring Site (RMS) Network Evaluation Workplan

Introduction and Background

The Joint Groundwater Sustainability Agencies (GSAs) (City of Madera GSA, County of Madera GSA – Madera, Madera Irrigation District GSA, and Madera Water District GSA) developed a Groundwater Quality Representative Monitoring Sites (RMS) network as part of the development of a Groundwater Sustainability Plan (GSP) for the Madera Subbasin that was originally submitted in January 2020. During the implementation of the GSP, various issues have arisen that have affected the consistency of groundwater quality measurements at a number of these RMS. As part of the first periodic update to the GSP, the groundwater quality RMS network will be evaluated and updated to ensure consistent measurements that will satisfy Sustainable Groundwater Management Act (SGMA) monitoring requirements and support GSP activities in the Subbasin.

Groundwater Quality RMS Network

The Joint GSP Groundwater Quality RMS network in Madera Subbasin (**Figure 1**) currently consists of 12 existing wells that are also part of the groundwater level RMS network and will also be sampled for groundwater quality by the Joint GSP GSAs, and 15 wells that are currently being monitored by other entities for the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW) program and Irrigated Lands Regulatory Program (ILRP). An additional 21 wells at seven nested monitoring well locations were identified in the GSP for future inclusion in the RMS network. These wells have been constructed and are currently being monitored.

As required by SGMA, groundwater quality samples are to be collected annually for key constituents and every five years for all other constituents. Wells that are a part of both the groundwater level and groundwater quality RMS networks, as well as the nested monitoring wells, will be monitored by the GSAs. Additional groundwater quality results reported by monitoring entities to DDW (in accordance with DDW testing requirements) for indicator public supply wells will be obtained for evaluation as part of the groundwater quality monitoring program, although the sampling of these wells will not necessarily be performed by the GSAs. A comprehensive review of the monitoring network will be conducted as part of this workplan, and a revised monitoring network will be implemented.

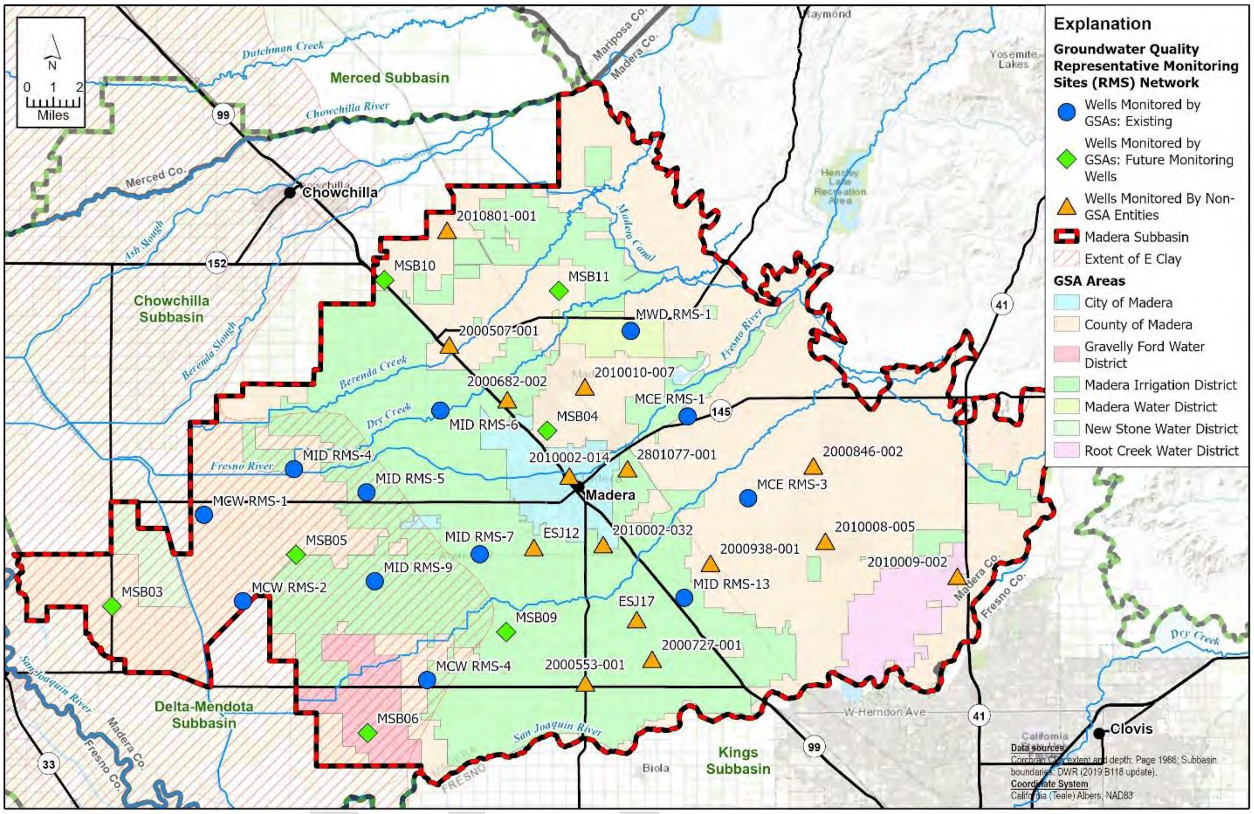


Figure 1. Current Groundwater Quality Representative Monitoring Sites (RMS) Network

Proposed Scope of Work

The proposed scope of work details the planned updates to groundwater quality RMS network as part of the first periodic update to the Madera Subbasin Joint GSP. Refinements to the RMS network are necessary to ensure that the GSP is in compliance with the monitoring requirements set forth under SGMA. This scope of work involves three main tasks including evaluation of the current monitoring network, evaluation of wells for inclusion in the updated monitoring network, and finalization of the update monitoring network. The proposed scope of work is described in more detail below.

Task 1. Evaluate Current Monitoring Network

The first task will involve reviewing the monitoring history of each groundwater quality RMS well. Wells that do not have consistent, reliable groundwater quality measurements will require further evaluation, involving a detailed review of the issues encountered during monitoring. If these issues are persistent and preclude the well from satisfying the SGMA monitoring requirements on a regular basis, they will be identified for removal from the RMS network and possible replacement.

Task 2. Evaluate New Wells for Inclusion in Monitoring Network

Wells that have been identified for removal from the RMS network and possible replacement will either be replaced with dedicated nested monitoring wells or other existing wells.

Dedicated Nested Monitoring Wells

An additional 13 dedicated monitoring wells at five locations have been drilled as part of GSP implementation. Where possible, these nested monitoring wells will replace current network RMS that have been identified for removal from the RMS network. In other locations, these wells will provide additional spatial coverage to the monitoring network.

Additional Existing Wells

In areas where existing RMS have been identified for removal from the RMS network but no dedicated nested monitoring wells exist, other existing wells will be used to fill in gaps in the RMS network. Potential wells for inclusion in the updated monitoring network will be identified through conversations with the GSAs, as well as review of currently monitored wells. At least five years of measurement history and known well construction will be required. After potential wells have been identified, field verification and permission from landowners will be acquired. If these conditions have been satisfied, a well will be included in the updated RMS network.

Task 3. Finalize Updates to Monitoring Network

Prepare a Technical Memorandum (TM) Summarizing Monitoring Network Updates

A TM will be prepared for the Madera Subbasin summarizing the updates to the groundwater quality RMS network. This TM will cover the wells identified for removal from the RMS network and possible replacement, the reason for removal/replacement, the new wells selected for inclusion in the RMS network, and a summary of the final updated RMS network. This TM will be included as a detailed appendix to the periodic update of the GSP.

Update the RMS Network Description in the GSP

As part of the first periodic update, the GSP will be updated to include a description of the new groundwater quality RMS network. Wells added to the network will have sustainable management criteria developed consistent with the method described in the approved GSP.

Update the RMS Network in the SGMA Portal

The groundwater quality RMS network will be updated in the SGMA Portal to reflect all changes made to the network as part of this workplan.

Schedule

The overall implementation of this Workplan is envisioned as a part of a larger effort for the first periodic update to the Madera Subbasin Joint GSP. Implementation of the Workplan is planned to start in early 2024 with a target completion of mid-2024. A general planned schedule for implementation of the Workplan is outlined in **Table 1**.

Table 1. Summary of Proposed Schedule for Implementation of the Madera Subbasin Joint GSP Groundwater Quality Representative Monitoring Site (RMS) Network Evaluation Workplan

Task No.	Task Description	Task Completion Timeframe
1	Evaluate Current Monitoring Network	Early 2024
2	Evaluate New Wells for Inclusion in Monitoring Network	Early 2024 – Mid 2024
3	Finalize Updates to Monitoring Network	Mid 2024

Appendix F. Interconnected Surface Water Data Gaps Workplan.

Luhdorff & Scalmanini
Consulting Engineers

TECHNICAL MEMORANDUM

DATE: March 20, 2023 Project No. 22-1-020

TO: Madera Subbasin GSAs

FROM: LSCE and DE

SUBJECT: Madera Subbasin Revised GSP – Interconnected Surface Water Draft Workplan

Introduction and Background

The relationship between the San Joaquin River (SJ River) and shallow groundwater along the southern boundary of the Madera Subbasin (Subbasin) is complex and data to characterize the groundwater-surface water relationship in this area of the Subbasin are limited. Implementation of the Interconnected Surface Water Workplan (Workplan) is expected to better characterize the following conditions:

- Shallow subsurface conditions,
- The relationship between streamflow and fluctuations of shallow groundwater levels, and
- The relationship between groundwater pumping and streamflow.

Shallow monitoring wells (typically less than 30 feet deep, although some extend to greater depths) installed in areas along the SJ River as part of the San Joaquin River Restoration Program (SJRRP) provide much of the existing monitoring information related to shallow groundwater adjacent to the SJ River. These wells were initially installed to monitor for potential increases in shallow groundwater levels west of the river due to increased reservoir releases to and flows in the SJ River as part of implementing the San Joaquin River Restoration Program (SJRRP). Monitoring of these wells has been inconsistent since 2018, and part of implementation of this work plan will involve reengagement with well owners to restart monitoring of these wells. Additional field data collection and technical analyses will be completed at depths greater than 30 feet to better characterize the shallow subsurface along the SJ River along the southern boundary of the Subbasin, which is likely to improve overall understanding of the relationship between groundwater in the upper 30 feet, the zone between 30 and 100 feet below ground surface (bgs), and the remaining portion of the Upper Aquifer below a depth of 100 feet where most groundwater pumping currently occurs.

This Workplan outlines potential plans and a related scope of work to compile and review existing data and reports pertaining to the study area, construct/install new monitoring facilities, collect additional field data, and conduct additional technical analyses. The purpose of this scope of work is to provide sufficient data and analyses to:

- Make a more informed determination of whether or not ISW is present along the SJ River at the southern boundary of the Subbasin;
- Improve understanding of the relationship between streamflow and fluctuations in shallow groundwater levels;
- Improve understanding of the relationship between shallow groundwater and regional groundwater pumping from deeper zones within the Upper Aquifer that may be separated from shallowest groundwater by intervening clay layers;
- Improve understanding of the relationship between streamflow and regional groundwater pumping; and
- Provide an improved basis for setting sustainable management criteria (SMC) if it is determined that interconnected surface water conditions exist.

Previous Work Summarized in GSP

As summarized in the Revised Groundwater Sustainability Plan (GSP) for the Subbasin, comparison of historical maps of unconfined groundwater elevations prepared by the Department of Water Resources (DWR) and the SJ River thalweg elevation indicated a connection between groundwater and surface water likely existed from 1958 (and likely before) through 1984. Subsequent data appeared to indicate groundwater elevations below (and disconnected from) the SJ River thalweg from 1989 to 2016. This analysis was based on contour maps of unconfined groundwater elevation prepared by DWR for the following years: Spring 1958, Spring 1962, Spring 1969, Spring 1970, Spring 1976, Spring 1984, Spring 1989 through Spring 2011 (see Revised GSP Appendix 2.E), Spring 2014 (Revised GSP Figure 2-48), and Spring 2016 (Revised GSP Figure 2-49).

Maps of depths to shallowest groundwater (including perched groundwater) for 2014 and 2016 are displayed on Revised GSP Figures 2-71 and 2-72. These maps incorporate very shallow monitoring wells (i.e., less than 50 feet deep), including SJRRP wells (many of which have well screens in the upper 30 feet). Depth to shallow groundwater maps were generated by contouring groundwater surface elevation and subtracting the contoured groundwater surface from the ground surface elevation as represented by the United States Geological Survey (USGS) National Elevation Dataset Digital Elevation Model. Some of the areas on the southern and southwestern boundaries of Madera Subbasin and along/adjacent to the San Joaquin River may be underlain by shallow clay layers that are above principal aquifers in the area. These clay layers impede the vertical movement of water within the shallowest part of the groundwater system and shallow groundwater in these areas can be considered perched/mounded as a result of the shallow clay layers, although there may be no unsaturated zone beneath them as exists in what is conventionally considered a perched groundwater condition. It is likely that seepage from the SJ River is the source of water combined with presence of shallow clay layers, which serves to maintain shallow groundwater levels at these locations. While groundwater levels in this perched zone appear to be approximately 10 to 30 feet below ground surface, water levels in the underlying regional groundwater system are typically much deeper, in excess of 50 feet below ground surface.

The SJRRP involves augmenting flow releases from Friant Dam with restoration flows. SJRRP restoration flows were initiated in October 2009 and referred to as “Interim” flows, while SJRRP “Restoration” flows were initiated in January 2014. The commencement of the SJRRP flows complicates the historical review and understanding of surface water – groundwater interaction and the potential effects (or lack thereof) on surface water flow from groundwater pumping. A more detailed assessment of the timing and magnitude of SJRRP flow releases and relationships to shallow groundwater levels is something that should be taken into consideration.

Review of Revised GSP Figures 2-71 and 2-72 indicates that the SJ River was disconnected from the shallow perched/mounded groundwater during these time periods (Spring 2014 and Spring 2016). The 2014 and 2016 water years were considered Critical and Dry water years, respectively, according to the San Joaquin Valley Hydrologic Index (although water year 2016 was on the border of being classified as a Below Normal year). The relationship between stream seepage in the SJ River along the southern boundary of Subbasin and groundwater pumping along this portion of the SJ River within the Subbasin (i.e., within approximately 0.75 miles of the SJ River) is shown in Revised GSP Figure 2-73. The relationship between groundwater pumping from the Upper Aquifer withing five miles of the SJ River and stream seepage is shown in Revised GSP Figure 2-74. These figures suggest that at the highest end of the range of groundwater pumping (over 16,000 af/year in Revised GSP Figure 2-73 and over 200,000 AF/year in Revised GSP Figure 2-74), stream seepage increases with increased groundwater pumping. However, at the low to mid-range of groundwater pumping, the relationship is inconsistent. The highest amounts of groundwater pumping generally occur during drought periods when groundwater recharge is less, groundwater levels are lower, and groundwater would not be expected to be connected to the steam bed. In non-drought periods, when groundwater levels are higher and possibly connected to the streambed, there appears to be no strong relationship between groundwater pumping and stream seepage. This is supported by the relationship between streamflow entering the Subbasin at the upstream boundary of this river reach and stream seepage is shown in Revised GSP Figure 2-75. This figure indicates that stream seepage (i.e., infiltration) occurs during Critical, Dry, and Below Normal Years, and that the SJ River is a losing reach and likely not connected to groundwater at these times. During Above Normal and Wet Years, both stream seepage and groundwater discharge to streams occurs, indicating that the SJ River is connected to groundwater for some duration during these times. Additional evaluation of these relationships in the field and in the groundwater model will be conducted for the 2025 GSP Update.

Based on guidance received from DWR and because of limitations in available information to evaluate the interconnected nature of groundwater and surface water on the SJ River, for the Revised GSP it is assumed that conditions along the SJ River in the Subbasin constitute an ISW condition as defined by SGMA and under the GSP regulations. As a result, the Revised GSP established interim SMC for ISW until the shallow hydrogeologic conditions along the SJ River are more fully characterizing and a final determination regarding the presence/absence of ISW can be made.

In the Subbasin, an area identified as having a Groundwater Dependent Ecosystem (GDE) is located adjacent to the SJ River (see Revised GSP Figure 2-77). As noted above, the SJ River is in a net-losing condition and infiltrating surface water flows (stream seepage) likely contributes directly to the shallow groundwater system that supports the vegetation in the GDE unit (San Joaquin River GDE Unit). While it appears the source of shallow groundwater adjacent to the SJ River is stream seepage from the SJ River (when water is present) and shallow groundwater does not support surface water flows, there nevertheless is some potential for surface water flows and the shallow groundwater system supporting GDEs to be affected by regional pumping during certain times when shallow groundwater is present below the stream thalweg but within the root zone of GDEs. These GDEs/beneficial users include environmental users such as riparian vegetation along the SJ River and the wildlife habitat and ecosystem functions it provides. The potential effects on the San Joaquin River Riparian GDE Unit are presented in Revised GSP Appendix 2.B.

As summarized above, the revised Madera Subbasin GSP established interim SMC for ISW based on DWR review/input received in the initial consultation letter. However, additional characterization of the relationship between groundwater and surface water along the SJ River is needed to provide an improved basis for making a final determination of the nature of the interconnection and appropriate SMC. Implementation of this Workplan is intended to provide additional field data and technical analyses as input to better characterizing ISW for the 2025 GSP Update (and beyond).

Proposed Scope of Work

The proposed scope of work involves seven main tasks including collection and analysis of existing data (beyond data compiled for the Revised GSP), installation of new monitoring facilities and collection of additional field data, completion of additional technical analyses, and completion of an updated assessment of presence/absence of ISW with recommendations for updated SMC (if necessary). The proposed scope of work is described in more detail below. It should be noted that implementation of the potential work set-forth herein is predicated on Groundwater Sustainability Agency (GSA) approval and allocation of the necessary funds as may be required (local funding and/or grants).

Task 1. Compile Additional Existing Data/Analyses (Supplemental to GSP)

This task includes several aspects involving compiling and reviewing of supplemental existing data for incorporation in analyses and characterization of conditions relating to ISW in the Subbasin. This task can be performed in coordination with similar efforts planned as part of implementation of the Subsidence Workplan proposed for the Subbasin.

Compile and Review Supplemental Existing Data

In this task, data collected during preparation of the Revised GSP will be supplemented with other newly available data related to ISW along the SJ River including:

- information presented in GSPs for other subbasins adjacent to the SJ River in the area, such as the GSP prepared by the North Kings GSA;
- new data available from specific local landowners or entities previously not available for incorporation into the Revised GSP;
- DWR Well Completion Reports (WCRs) for the area immediately adjacent to the SJ River (i.e., a zone extending approximately one mile on either side of the River along the southern boundary of Madera Subbasin);
- additional data compiled by USBR for the SJRRP for areas in the Subbasin;
- additional data from USGS and modeling information for their study of the SJ River;
- and other reports and data that may now be available.

The available data will be compiled and reviewed to inform subsequent field work (Task 2) and as input for technical analyses (Task 3).

AEM Data

Data from airborne electromagnetic (AEM) surveys conducted in Spring 2022 to support additional characterization of subsurface conditions in the Subbasin and surrounding areas are expected to be available in 2023. AEM data can provide helpful information on hydrogeologic conditions through measurements of the resistivity of subsurface materials. These surveys have the potential to improve the understanding of the configuration and composition of different subsurface materials. To the extent that AEM data was collected in the vicinity of the southern boundary of Subbasin along the SJ River, these data will be evaluated for their potential usefulness in helping to supplement the delineation of shallow stratigraphy along the portion of SJ River that forms a portion of the southern boundary of Subbasin. One potential application of AEM that is of particular interest related to potential interconnectedness of surface water is delineation of any shallow clay layers under and adjacent to the SJ River. A quality assurance/quality control (QA/QC) analysis of the data will be conducted by comparing AEM hydrostratigraphic interpretations to existing and new field data collected as described in this Workplan. Lithologic data from borehole logs along AEM section lines will be compared to evaluate if AEM interpretations are consistent with field data. If AEM data interpretations are found to be consistent and the resolution of shallow aquifer stratigraphy from AEM data interpretations is sufficient, the AEM data will be combined with field borehole lithologic data to develop refined hydrogeologic cross-sections along the SJ River (as described below in Task 3).

Task 2. Complete Additional Field Work

Enhancements to groundwater level and surface water monitoring facilities and activities, specifically along the SJ River, are important for improving the understanding of the relationships between groundwater levels and surface water in the Subbasin. Additional field work tasks fall into two categories: instrumentation of existing wells, and new monitoring facilities and field data collection.

Instrumentation of Existing Wells

The monitoring frequency in some of the Representative Monitoring Site (RMS) wells designated for the ISW minimum thresholds (MTs) and measurable objectives (MOs) in the Revised GSP presents some limitations for characterizing groundwater level fluctuations and development of appropriate SMC. The RMS wells related to ISW include MCE RMS-9, MCW RMS-5, MID RMS-14, and MID RMS-17 (**Figure 1**). These wells do not currently have continuous and automated groundwater level monitoring with pressure transducers. This task involves working with the owners of key RMS wells to prioritize and implement instrumentation of wells with transducers for collecting continuous groundwater data. As part of this task, if the assessment and monitoring of ISW would benefit from more continuous monitoring at other RMS well locations, other RMS wells could be considered and prioritized for automated monitoring. If further characterization and evaluation of ISW during implementation of this Workplan determines there are important benefits to continuous monitoring of other (non-ISW SMC) RMS wells, and arrangements can be made with the well owner(s), additional well instrumentation could be prioritized for implementation. It is assumed for purposes of estimating the cost of implementing the Workplan that two additional RMS wells will be selected for instrumentation.

New Monitoring Facilities and Field Data Collection.

Several key data gaps related to ISW in the Subbasin include coupled monitoring of groundwater levels at different depths within the Upper Aquifer (including very shallow groundwater and more regional groundwater zone) and stream conditions of stage, flow, and channel configuration at locations adjacent to the SJ River. Construction of new monitoring facilities and additional field data collection efforts are anticipated to focus on, but are not limited to: supplemental monitoring wells; stream stage and flow; stream elevation profile/thalweg profiles; and possible aquifer or well pump testing if cooperation can be obtained from landowners with wells at suitable locations near the SJ River. Potential field efforts are described in more detail below.

Install New Monitoring Wells

Monitoring wells are recommended for installation at four locations near the SJ River to augment existing groundwater level monitoring to understand dynamics between surface water conditions in the SJ River, groundwater conditions at very shallow depths where there is greater potential for interconnection between groundwater and surface water, and groundwater conditions in the regional groundwater system where groundwater is extracted by wells for irrigation and other uses. Three locations will target sites near existing SJRRP monitoring wells MCE RMS-9, MCW RMS-5, and MID RMS-17, which are approximately 30 feet deep; the new monitoring wells at these three locations will be screened slightly deeper in a coarse-grained zone between depths of 50 to 90 feet below ground surface (bgs). In addition, one new location will be selected for installation of a nested monitoring well: one screened in the upper 30 feet and one screened at depths between 50 and 90 feet. Preliminarily identified locations for potential new nested wells are shown in **Figure 1**, pending the outcome from review of additional data and evaluation of site suitability relating to access for construction and ongoing monitoring. Target well locations may also include consideration of proximity to existing production wells that might be used in evaluating shallow groundwater level responses to pumping from deeper zones.

The monitoring wells are planned to be drilled using the hollow-stem auger drilling method with split spoon core sediment samples collected every five feet. A lithologic log of the borehole will be prepared based on samples collected and under the supervision and guidance of a Professional Geologist, who will also provide recommendations regarding well construction details such as depth intervals for placement of well screen, filter pack, blank casing, and surface sanitary seal. Preliminarily, the new monitoring wells are planned to be constructed using 2-inch diameter Schedule 40 PVC materials, which will enable installation of automated groundwater level monitoring instrumentation and also provide access for groundwater quality sampling equipment. The new monitoring wells and existing RMS wells listed above will be surveyed to a consistent elevation datum to ensure there are no recent changes in groundwater surface or reference point elevations related to any recent subsidence that may have occurred in the area. Water quality samples will be collected from the new monitoring wells, and they will be outfitted with pressure transducers for ongoing automated collection of groundwater level data.

Install Stream Stage Recording Device(s)

Accurate assessment of dynamics related to surface water-groundwater interaction requires detailed information on river stage for relating to groundwater levels. There is currently a number of active stream stage monitoring locations along the SJ River within the Madera Subbasin (**Figure 1**), including a number that are in close proximity to the sites preliminarily recommended for installation of additional monitoring wells. Installation of stream stage recorders are recommended at several additional locations corresponding to the locations of nested monitoring wells described in this Workplan (assuming permission/access can be obtained) and where existing stream gages are not sufficient for characterizing surface water conditions. Various options for instrumentation should be considered for these stage monitoring sites, but options include constructing the stream stage recorders from small-diameter (1- or 2-inch) PVC slotted pipe, which could be secured to the riverbank and extended into the low flow channel to enable the pipe to remain submerged during low-flow conditions and also provide access to monitoring instrumentation during higher flow conditions. A transducer would be installed in the PVC pipe for automated collection of river stage at all flow conditions. The river stage recorders will be coupled with a staff gage for periodic manual readings of stage to ensure accuracy of all data collected through automated instrumentation. The staff gage and stream stage recorder will be surveyed to the same elevation datum as the new monitoring wells.

Complete Stream Profile Surveys

Stream channel elevation profiles will improve characterization of the SJ River channel elevation and shape, which relates to potential for interconnectivity between surface water and groundwater when compared with groundwater levels. To better characterize the potential surface water-groundwater interconnectivity along the SJ River, stream channel elevation profiles perpendicular to the river channel orientation will be obtained at key locations through surveying, using the same elevation datum used for the monitoring wells and river stage recorders. The stream channel profiles will be conducted near each of the four new nested monitoring well locations and will extend perpendicularly from the new/existing monitoring well locations on the east side of the river and across the SJ River to the opposite riverbank (and possibly to any existing nearby monitoring wells on the west side of the river). The stream channel surveys should be conducted at a time of low flow (or no flow) in the river in an effort to accurately survey as much of the streambed as possible.

Complete Aquifer Testing

One of the key aspects related to ISW that is not well characterized in the areas along the SJ River includes understanding of how groundwater pumping from the regional aquifer may influence groundwater levels in the very shallow part of the groundwater system (and in turn surface water), especially in areas where the movement of water between the shallow part of the groundwater and the deeper regional groundwater system may be impeded to a great degree by the presence of clay layers. Aquifer testing conducted through pumping of existing production wells while monitoring conditions in the shallow part of the groundwater system and in the nearby SJ River would help understand the cross-communication between different depth zones of the groundwater system and potential communication between shallow groundwater and streamflow. One of the goals of the proposed aquifer testing is to evaluate how clay layers located between the top of the pumping well screen and bottom of the streambed do or do not impede a connection between groundwater pumping and streamflow. If cooperation can be obtained with one or more landowners having a suitable production well near the SJ River in Madera Subbasin, one or more pumping tests will be performed to evaluate pumping effects on shallow groundwater levels and streamflow. A suitable production well for this testing would be screened in the Upper Aquifer at a location sufficiently close to the SJ River and to adjacent shallow monitoring wells to potentially have an effect on streamflow and shallow groundwater levels in close proximity to the River within the planned pumping duration (if there is a connection between groundwater and surface water). The timing of the test will also be important with considerations being given to performing the test at a time with higher shallow groundwater elevations (to maximize chances of having a connection between streamflow and shallow groundwater levels) while having a lower range of stream discharge (to maximize opportunity to see effects on streamflow).

If cooperation with existing production well owners cannot be obtained, consideration will be given to implementing "passive" aquifer testing. This type of testing would involve conducting continuous groundwater level monitoring in proximity to a production well to observe whether influences from normal pumping cycles can be discerned in nearby shallow groundwater and surface water. In this type of testing there will be no controlled/coordinated start and stop of pumping or attempts to maintain a consistent pumping rate, but rather the well would be operated in accordance with normal use without any coordinated pumping period.

Task 3. Technical Analyses

In coordination with and utilizing new information from compilation of additional available data and field work related to additional monitoring and characterization of surface and subsurface conditions related to the potential for interconnectivity between groundwater and surface water, technical analyses involving construction of detailed hydrogeologic cross sections along the SJ River, evaluation of fluctuations in shallow groundwater levels and river stage/flow, and evaluating relationships between groundwater pumping and streamflow are also planned to synthesize the available information and groundwater-surface water dynamics along the River.

Hydrogeologic cross-sections will be constructed using geologic/lithologic logs, geophysical logs, and AEM data relating to the stratigraphy within the Upper Aquifer, with particular focus on the upper 100 feet where there is potential for interconnectivity between groundwater and surface water. These cross-sections will include the most recent available data on groundwater levels, stream thalweg elevation (stream profiles conducted for this Workplan and available LiDAR data), and stream stage in conjunction with subsurface stratigraphy. The specific locations and orientation of the cross-sections will depend on where available data exist, including new data collected through Tasks 1 and 2, but are expected to include cross-sections oriented both parallel to and perpendicular to the SJ River. The perpendicular cross-sections will focus on locations aligned with new monitoring well locations.

Field data will be evaluated relative to the dynamic relationship between surface water and groundwater levels within the Upper Aquifer (in both the shallow and deeper zones of the Upper Aquifer). Available information indicates these dynamics vary over time and space depending on climatic/hydrologic conditions within a year (seasonal fluctuations) and from year to year (variations from wet years to dry years). Analyses presented in the Revised GSP based on the limited available historical data suggest that stream seepage (i.e., infiltration) occurs during Critical, Dry, and Below Normal Years, and that the SJ River is a losing reach and likely not connected to groundwater at these times. During Above Normal and Wet

Years, both stream seepage and groundwater discharge to streams occurs, indicating that the SJ River is connected to groundwater for some duration during these times.

These additional technical analyses will focus on providing further assessment of the surface water-groundwater dynamics along four key profiles perpendicular to the river (at new monitoring well locations) where the SJ River forms the boundary of Madera Subbasin to improve understanding of groundwater conditions in relation to surface water.

Task 4. Outreach

Implementation of the Workplan will involve outreach and coordination with key stakeholders and interested parties. A key outreach effort is needed to restart consistent monitoring of SJRRP wells along the SJ River selected as RMS wells in the GSP. Additional outreach efforts will focus on efforts related to the need and benefit from additional groundwater level or surface water monitoring and prioritization of efforts to expand monitoring. In particular, there will be outreach and coordination with the adjacent Kings Subbasin, which is expected to be performing similar efforts related to ISW. In addition, it is anticipated there will be outreach to various entities that are likely to have interest in Madera Subbasin efforts related to ISW, including National Marina Fisheries Service (NMFS), United States Bureau of Reclamation (USBR), and The Nature Conservancy (TNC). The various outreach efforts may also benefit considerations related to the feasibility of potential PMAs to achieve sustainability.

Task 5. Groundwater Modeling (in Conjunction with 5-Year GSP Update)

The groundwater model developed for the GSP (MCSim) will be updated and recalibrated as necessary as part of the 5-Year Update Report. This updated modeling will be used to further evaluate ISW conditions, both historically as well as current and expected future conditions, with the objective of characterizing groundwater-surface water interaction at a broader spatial scale within the southern part of the Subbasin. The groundwater model will be used to assist in evaluation of the potential for ISW to be present along the SJ River, and to further evaluate the potential for connection between regional groundwater pumping and surface water flows.

Pending the results from analyses conducted as part of Task 3 and the model update planned as part of the five-year update of the Revised GSP, it is anticipated that additional model scenarios may need to be developed to enable more detailed assessment of stream-aquifer interaction via model simulations of conditions and mechanisms across the entire Subbasin, especially the southern Subbasin. Potential additional model runs could include simulation of 50 years of future hydrology while varying the amount and distribution of groundwater pumping. Comparisons between such hypothetical model runs could be used to improve understanding of the influence of groundwater pumping in the Subbasin on shallow groundwater levels, stream flow/stage, and dynamics of connectivity between groundwater and surface water, including frequency, duration, and percent of time any interconnectivity occurs. A key aspect of additional groundwater model simulations will be to further evaluate the percentage of time connectivity between groundwater and surface water existed along the SJ River prior to 2015 compared to current and expected future conditions with implementation of projects and management actions (PMA) and the ongoing SJRRP. These analyses will directly support the evaluation and determination of appropriate SMC related to ISW (as described in the Revised GSP) under Task 5.

Task 6. Assessment of Presence of Interconnected Surface Water and Possible Revisions to SMC

The ultimate outcome from efforts conducted as part of this Workplan will be an assessment and establishment of appropriate SMC related to ISW as part of the five-year update of the Revised GSP. This will include potential refinements or modifications to interim SMC established in the Revised GSP, if determined appropriate. In conducting this assessment, the data and analyses developed through implementation of Tasks 1 through 4 of the Workplan will be used to evaluate whether ISW exists along the southern boundary of Madera Subbasin and if there is need to include SMC for ISW in the Revised GSP for the Madera Subbasin. An important consideration related to ISW and how and whether SMC are established for ISW is that once shallow aquifer groundwater levels fall to a point where they are disconnected from the river, additional declines in groundwater levels will no longer affect the rate and amount of stream infiltration/depletion. This fact, combined with the difference between historical and current/future SJ River flow releases from Friant Dam as part of the SJRRP, likely means that rate or amount of stream depletion are not appropriate metrics for defining ISW SMC, including undesirable results. Additionally, groundwater levels as a proxy for stream depletion is also not an appropriate SMC metric for two key reasons: 1) elevations of shallow groundwater levels below the threshold when groundwater and surface water become disconnected will not affect the rate/amount of stream depletion, and 2) historical shallow groundwater level data suggest that shallow groundwater levels have commonly been below the threshold when they become disconnected from surface water and such conditions are likely to continue to occur under future conditions. As described in the Revised GSP and used as an interim ISW SMC metric in the GSP, a potential SMC metric relating to the percent of time ISW occurs based on the occurrence during historical conditions (prior to 2015), likely provides the most appropriate ISW SMC metric for future management of groundwater in the Subbasin. However, because interconnectivity of surface water may only occur under limited hydrologic circumstances (i.e., brief periods wet water years) implementing this metric necessitates that ISW conditions be evaluated over an extended period of time (e.g., 5 years as currently used as part of the interim SMC or more) to ensure the SMC assessment period spans a representative range of climatic/hydrologic conditions.

Establishing final SMC for ISW for inclusion in the five-year update of the Revised GSP will draw upon the most recent data and technical analyses developed through implementation of this Workplan with consideration for the complexities of the dynamic relationship between groundwater and surface water along the SJ River in the Subbasin under conditions prior to and after initiation of the SJRRP.

Task 7. Prepare a Technical Memorandum or Report

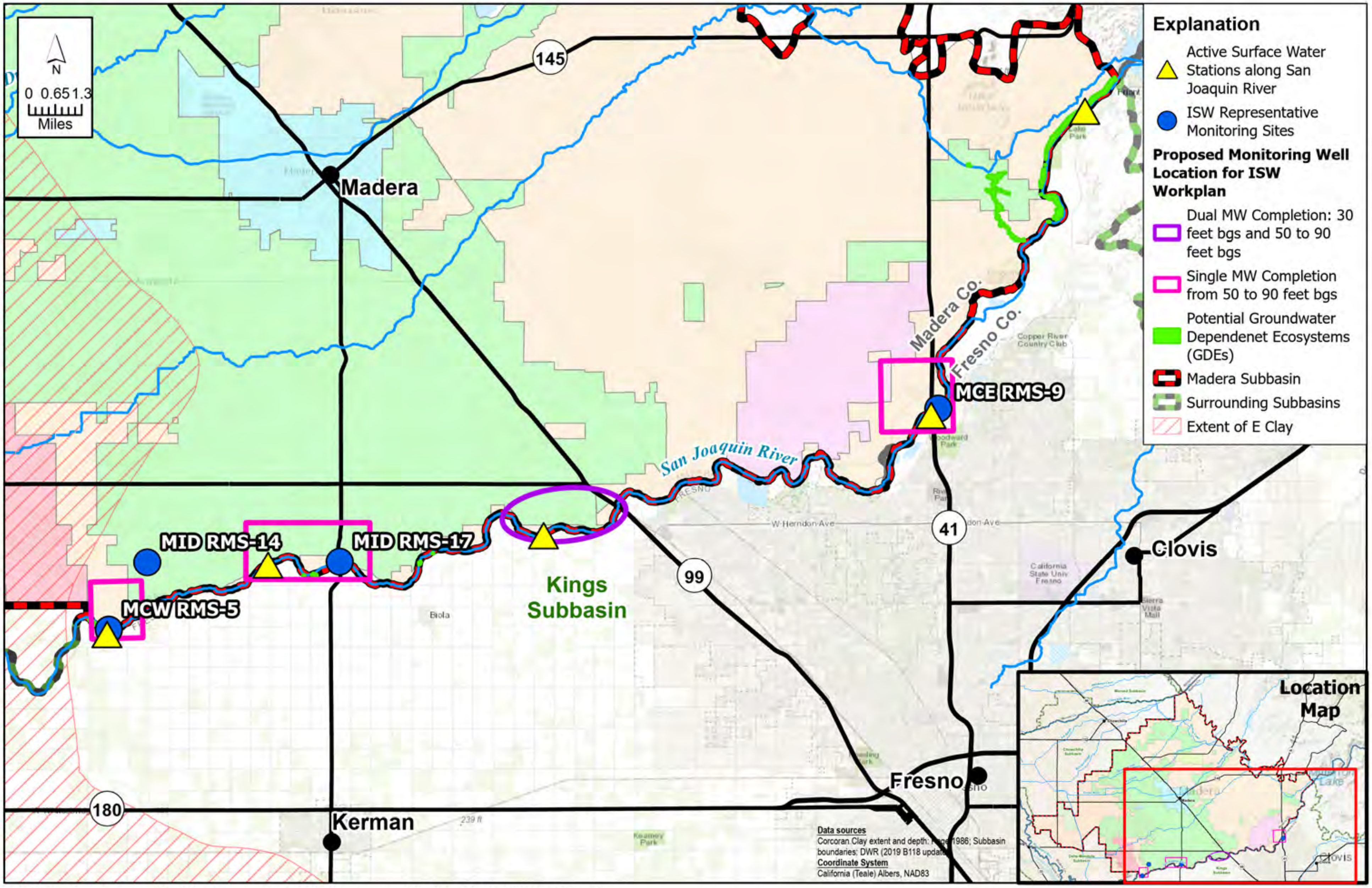
A technical memorandum (TM) or report will be prepared to document all the tasks completed as part of implementation of the ISW Workplan. A Draft TM/Report will be submitted for review by the GSAs (and their technical representatives). Comments and suggested edits received from GSAs will be reviewed and incorporated as appropriate into a Final TM/Report. The Report will include documentation of all data compiled, field work completed, technical analyses performed, modeling results, and evaluation of the nature of groundwater – surface water interactions and recommended updates to SMC. In addition, the TM/Report will include a review and summary of any remaining data gaps and recommendations for future monitoring and assessment, as needed.

Schedule

The overall implementation of this Workplan is envisioned as a longer-term effort to develop important monitoring data and facilities for tracking and understanding groundwater conditions related to ISW in the Subbasin. Additional tasks are geared towards completion in time for incorporation into the first five-year update of the Revised GSP. However, some tasks described in the Workplan will likely extend beyond January 2025, including ongoing data collection. These longer-term tasks include field work involving installation of monitoring facilities, which should be phased with consideration of funding and cooperation from other entities needed to support these efforts. Implementation of the Workplan is planned to start in 2023 with commencement of the additional data review and compilation task. Similarly, field work is also planned to begin in 2023, primarily with well inventory survey efforts and review of opportunities to instrument existing wells. As a result, not all of the field work described in this Workplan is anticipated to be completed prior to January 2025 when the first five-year update of the Revised GSP is to be submitted. A general planned schedule for implementation of the Workplan is outlined below in **Table 1**.

Table 1. Summary of Proposed Schedule for Implementation of the Interconnected Surface Water Workplan

Task No.	Task Description	Task Completion Timeframe
1	Compile Additional Existing Data/Analyses (Supplemental to GSP)	Mid 2023 - Late 2023
2	Complete Additional Field Work	Late 2023 - 2026+ (field work may be phased depending on available funding)
3	Technical Analyses	Mid 2023 - Late 2024
4	Outreach	Early 2024 - Late 2024
5	Groundwater Modeling (in Conjunction with 5-Year GSP Update)	Early 2024 - Late 2024+
6	Assessment of Presence of Interconnected Surface Water and Possible Revisions to SMC	Late 2023 - Late 2024
7	Prepare a Technical Memorandum or Report	Mid 2024 - Late 2024 for interim deliverable; 2026+ for final deliverable



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DAVIDS ENGINEERING, INC

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FIGURE 1

Proposed Monitoring Well Locations for Interconnected Surface Water Workplan